Klamath Secretarial Determination Process

Dennis Lynch
Pacific Northwest Area
U.S. Geological Survey
2130 SW Fifth Ave
Portland, OR 97201
503-803-6392

July 12, 2012

Mr. Stephen Koshy
4122 Glenalbyn Drive Apt 108
Los Angeles, CA 90065

Dear Mr. Koshy:

This letter is in response to two letters you sent to Mr. Thomas Hepler, P.E., Bureau of Reclamation, on November 18, 2011, and December 21, 2011, as well as a letter you sent to the County of Siskiyou Board of Supervisors in Yreka, California on March 23, 2012. These letters all expressed your concern that two earth dams on the Klamath River (Iron Gate and J.C. Boyle dams) could not be safely removed if there was an affirmative Secretarial Determination on the Klamath Hydroelectric Settlement Agreement. The concerns raised in the two letters you sent to the Bureau of Reclamation are included as public comment on our Draft Klamath Hydroelectric Settlement Agreement and the Klamath Basin Restoration Agreement Environmental Impact Statement (Klamath EIS). Your comments will be included in a Final Klamath EIS along with our detailed responses to each comment.

Outside the Klamath EIS preparation process, however, several people have inquired about our response to your concerns. I believe it is in the spirit of good government to publicly release a technical memorandum that was prepared to address your concerns at this point in time; this memorandum was prepared by Bureau of Reclamation's Technical Service Center, extending their analysis of Klamath dam removal design and analysis prepared and published earlier, which can be found on our website KlamathRestoration.gov.

The enclosed Bureau of Reclamation Technical Memorandum No. KM-8311-1, entitled "Removal of Iron Gate and J.C. Boyle Earth Dams on the Klamath River, Klamath River Project, California Mid-Pacific Region," dated April 2012, addresses each of the concerns you raised in your letters. In these letters you conclude that J.C. Boyle and Iron Gate dams would fail catastrophically if dam removal was initiated. The Bureau of Reclamation is not in agreement with this conclusion; the analysis leading to this conclusion is laid out in the enclosed Technical

Memorandum prepared by geotechnical engineer Randy Kuzniakowski, P.E., and reviewed by three additional geotechnical engineers.

Please give me a call at 503-803-6392 or send me an email (ddlynch@usgs.gov) if you have any additional questions on this matter. Thank you for your inquiry; it is important that all important science and engineering questions are answered in order to fully inform a decision on Klamath dam removal.

Sincerely,

Dennis Lynch
Program Manager
Klamath Secretarial Determination

Cc: Mr. Thomas Guarino, Counsel, County of Siskiyou, California
Mr. James Burney, Klamath Ranch Resort, 6930 Copco Road, Hornbrook, CA 96044

Enclosure: Reclamation's Technical Memorandum No. KM-8311-1

RECLAMATION

Managing Water in the West

Technical Memorandum No. KM-8311-1

Removal of Iron Gate and J.C. Boyle Earth Dams on the Klamath River

Klamath River Project, California
Mid-Pacific Region

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Denver, Colorado

April 2012

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

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

Technical Memorandum No. KL-8311-1

Removal of Iron Gate and J.C. Boyle Earth Dams on the Klamath River

Klamath River Project, California
Mid-Pacific Region

Prepared: Randy Kuzniakowski, P.E. | Date: 4/13/12
Geotechnical Engineer
Geotechnical Engineering Group 3, 86-68313

Technical Approval: Michael Gobla, P.E. | Date: 4/13/2012
Manager, Geotechnical Engineering Group 3, 86-68313

Peer Review: Dennis Hanneman, P.E. | Date: 4/13/2012
Manager, Geotechnical Engineering Group 1, 86-68311

Concurrence: William Engemoen, P.E. | Date: 4/13/2012
Technical Service Center, Risk Advisory Team, 86-68300

Concurrence: Tom Hepler, P.E. | Date: 4/13/12
Civil Engineer
Waterways and Concrete Dams Group, 86-68130

I. Introduction

The letter written by Mr. Stephen Koshy is the third in a series of letters with the subject of the removal of Iron Gate and J.C. Boyle dams. It is dated March 23, 2012. The first two letters were sent directly to the Bureau of Reclamation and responses were prepared for both, however public review comment responses were never released. This third letter, similar in content to the first two letters, was sent to the members of the County of Siskiyou Board of Supervisors in Yreka, California (the county where Iron Gate Dam exists).

This technical memorandum addresses each of Mr. Koshy's concerns, all of which lead him to the conclusion that the Iron Gate and J.C. Boyle earth dams will fail catastrophically if removal work is initiated. Reclamation is not in agreement with this conclusion. The responses were prepared by geotechnical engineer Randy Kuzniakowski, P.E., and reviewed by geotechnical engineers Michael Gobla, P.E., Dennis Hanneman, P.E., and William Engemoen, P.E.

II. Responses

Mr. Koshy's Review Comment: *Paragraph 1.1. "During dam construction, the clay is compacted "stone hard" with low moisture content, to resist the Gravel shell's pressure. Clay attains high strength on compaction with low moisture content by expelling the voids and interlocking its particles. Clay's strength decreases with more water."*

Reclamation's Response: The impervious materials for the core at both Iron Gate and J.C. Boyle dams were obtained from local borrow materials, and it is Reclamation's understanding that they are primarily composed of silt and sandy silt. The behavior of these core materials would not be identical to clay, particularly at J.C. Boyle Dam with the higher sand content. A generic "clay" is referenced above and numerous times in the review comments, and should more correctly be described by the term "impervious core" to avoid confusion.

The core at Iron Gate was compacted to 98 percent of standard proctor density, and would have been within a few percent of the optimum moisture content to achieve this degree of compaction. "Stone hard" is probably not a good descriptor because the compacted soils would be stiff, but not nearly as hard as stone. It would be more correct to say the core is well compacted.

Furthermore, the claim that clay (core) strength decreases with "more water" (implying reservoir saturation) is not accurate. As the water (pore) pressures within a soil increase for a given confining stress, it is true that the effective stress (or strength) of a soil will decrease. However, pore pressures within a core are typically greatest during the dam construction phase when the moist soils are compacted to high density and the void spaces in the soil that hold the water are compressed. These high pressures dissipate with time and the pore pressures within the core that develop due to steady state reservoir operations will typically be lower.

Mr. Koshy's Review Comment: *Paragraph 1.2. "During dams' operation, water under pressure enters the microscopic space in between clay particles, saturating the clay and causing pore pressure (pressure of water between its microscopic clay particles). This pore pressure is* *eventually in hydrostatic equilibrium with the outside water pressure. This is a high 174 ft of water pressure for the Iron Gate Dam."*

Reclamation Response: As stated in the previous response, the core materials probably do not classify as "clay," although the process of saturating the embankment materials described above is correct. It should be noted that the pore water pressure varies with depth. The maximum 174 feet of water pressure would only be expected at the upstream portion of the bottom of the dam, not throughout the core. Well constructed embankment cores, such as at Iron Gate and J.C. Boyle dams, provide significant head loss (reduction in pore pressures) during reservoir operation as the seepage slowly works its way downstream through the very small pore spaces in the soil. Thus, the vast majority of the core at these two dams will not have pore pressures anywhere near 174 feet of water pressure.

Mr. Koshy's Review Comment: *"Below are a few more characteristics of clay.*

- *Individual clay particles are less than 2 microns in size, with microscopic space in between.*
- *Clay becomes weaker and softer with more water and its particles slide more easily over each other. Clay gradually becomes "plastic-like" and then "liquid-like". The Swedish scientist Atterberg defined the "plastic" and "liquid" limits that are universally accepted.*
- *Clay's strength decreases when it changes from a "confined" state (i.e., restrained on all sides, so that it will not yield to external pressure or be squeezed out) to an "unconfined" state (i.e., not restrained on all sides so that it will yield to external pressure and be squeezed out)."*

Reclamation Response: The core materials of the subject dams do not generally classify as clay. The silt and sandy silt core materials at the dams derive their shear strength largely from frictional resistance, which is typically described in terms of friction angle (phi). The friction angle will remain essentially constant both before and during dam removal activities. Stability considerations during reservoir drawdown when undrained loading conditions are possible are discussed later under the Reclamation Response to Paragraph 2.3.

In well compacted soils there is limited void space available to accept water; therefore, the soil does not experience a major strength loss upon saturation. The saturated moisture content of well compacted soils is typically well below the liquid limit, particularly for clay soils. Thus, well compacted embankment cores do not exhibit fluid-like behavior.

Mr. Koshy's Review Comment: *"The clay's pore pressure is kept low during construction by optimizing its moisture content, by limiting the compacting rollers' weight, and by constant monitoring. It is safe to fill the reservoir, only after "confining" the clay under the weight of the dry earth on top."*

Reclamation Response: An attempt is made to minimize excess pore pressure during construction for "end of construction" stability concerns. As more fill is placed, the soils in the lower part of the embankment consolidate, which reduces the void space and increases pore pressures. If excess pore pressures get high enough, it could cause instability of the embankment. Often the pore pressures during construction are monitored, especially for large dams, and construction can be temporarily halted to allow dissipation if excess pore pressures become too high. The concern for pore pressure buildup leading to instability is often greatest during construction, and the stability gradually increases after construction because excess pore pressures slowly dissipate to reservoir (seepage) induced pressures that are lower than construction pore pressures.

There is no need to confine the core "under the weight of the dry earth on top." The core materials will be stable upon removal of the overlying embankment. Removal of the upper embankment will actually increase the stability by reducing the forces tending to cause slope instability.

Mr. Koshy's Review Comment: *Paragraph 1.3. After reservoir draw down, clay will take years to dissipate its pore pressure and to dry, consistent with its low permeability. If the clay's permeability is of the order of 10 to the power -8 (i.e., 10^{-8}) the pore pressure dissipates only at the rate of a few inches per year. This is due to the "viscosity" of water and the microscopic pore space in between the microscopic clay particles.*

Reclamation Response: First, the cores at the two dams in question do not appear to consist of clay. Rather, they are believed to consist of silt and sandy silt materials, which will have a higher permeability than clay, and therefore will dissipate pore pressures more quickly.

Second, pore water pressure in an embankment is caused by the pressure exerted by the overlying soil and water. Lower portions of the embankment experience greater pore pressure than the upper portions of the embankment.

During initial reservoir drawdown, the pore water pressure in the core of an embankment dam could remain at an elevated pressure and dissipate slowly. The reason for this behavior is that a tall column of saturated soil is still present in the embankment and the pressure of the water is still acting to produce elevated pore water pressure in the lower portions of the embankment soil. As the water drains out of the core, the phreatic surface (upper boundary of saturation within the core) lowers, and a corresponding reduction in the pore pressure is experienced. If the water drains slowly from a low permeability soil, the corresponding pore water pressure dissipates slowly as well.

If on the other hand, one excavates and removes a layer of soil from the top of an embankment, the pore water pressure in the underlying soil is immediately reduced. The reduction in the pore water pressure is unrelated to the drainage characteristics of the soil. If weight is removed from the column of soil, pore pressure must decline. The change is immediate and is not a function of soil permeability. It does not matter if the soil being removed is dry, partially saturated, or fully saturated, the underlying saturated soil will experience a sudden reduction in pore water pressure when weight is reduced.

In the first case, pore pressures decrease due to the drainage of water from the soil, and in the second case, both water and soil weight (pressure) are removed by physical excavation. By excavating the embankment from the top down, the pore water pressure is kept at a safe level within the embankment and thus stability of the remaining portion of the embankment is enhanced.

Mr. Koshy's Review Comment: *Paragraph 1.4. "Prior to breaching, clay core is "confined" (i.e., restrained on all sides, so that it will not yield to external pressure or be squeezed out). It is designed to resist the Gravel shell's pressure and the dam is safe."*

Reclamation Response: This description does not present the true concept of the design of an embankment dam. It is worth pointing out that there are a large number of homogeneous dams comprised solely of clay soils (with no supporting shells). These dams do not suffer catastrophic failure once the reservoir saturates portions of the dam.

Frequently an earth dam will be designed as a zoned embankment with a relatively thin core (compared to a homogeneous dam) for a number of reasons, including; a short supply of impervious materials for the core, or the desire to provide upstream and downstream "shells" of coarser grained soils (sands, gravels, cobbles) to promote drainage and lowering of the phreatic surface and provide an unsaturated, strong "buttress" to the core. In these cases, the shells are not "confining" the core but rather "supporting" it. There is no validity to the concept that the core would "squeeze out" if the shells were not there. Instead, the clay core would simply be more likely to experience a slope failure because it was constructed with over-steepened side slopes.

Mr. Koshy's Review Comment: *Paragraph 1.5. "During the "proposed action" the wet clay core will become "unconfined" (i.e., not restrained on all sides so that it will yield to external pressure and be squeezed out). It will yield to the Gravel shell's pressure and the dam will collapse catastrophically."*

Reclamation Response: We disagree with this comment and note that no actual engineering analysis is provided. During removal of the embankments, the core material will never be laterally unconfined. The proposed removal method will be from the crest down, and the supporting gravel shells will be kept at the same level as the excavation of the core during the removal process. As stated previously, the gravel shells provide support for the core, maintaining stability of the structure. As the embankment soils are removed from the crest down, the total vertical stress in the remaining embankment is reduced, so the lateral pressure between the shells and the impervious core is also reduced. In fact, a reduction in height of the dams would only increase the stability of the remaining embankments due to reduced pore pressures and reduced driving forces, as discussed in the Reclamation Responses to Paragraphs 1.2 and 1.3 above.

The core materials are engineered fill and were well compacted when placed. Although the core materials will be saturated in the lower part of the embankment, the soil will be stiff, have significant shear strength, and will be able to maintain its structure. Mr. Koshy's described failure mode would require the soil to be of a soft consistency to "squeeze out," and this is certainly not the case. Saturated soil does not necessarily mean soft soil.

Finally, it is worth noting that embankment dams, including some constructed partially or totally with clay soils, have been breached by Reclamation and others, without incident. In other cases, the protective shells have been removed as part of dam modifications, exposing the embankment core, again without incident. We are aware of no catastrophic failures that have occurred with past embankment dam breachings.

Mr. Koshy's Review Comment: *"A general cross section of an earth dam, during breaching, (with the Iron Gate's Elevations) is on page 2 of my enclosed letter dated November 18, 2011 to the Bureau of Reclamation."*

Reclamation Response: The general cross section provided in the letter is not representative of the zoning or geometry for either Iron Gate or J.C. Boyle dams. Although specific details cannot be provided due to security requirements, the two dams do not have upstream and downstream horizontal clay blankets under the shells of the dam as shown in Mr. Koshy's cross section.

Mr. Koshy's Review Comment: *Paragraph 1.6. "Consequences of catastrophic collapse. The dam will collapse catastrophically. It will be a disaster of epic proportions. The lives of machinery operators on the dam's top and of people below, will be in peril.*

Expensive models could predict the debris' specific shape after the dams' collapse. The debris will certainly envelope the diversion tunnel's "inlet" and "outlet". The reservoir levels will rebuild. Water will pressure its way through and over the collapsed debris. Expensive overhead cable ways will be hastily required to remove the debris, bucket by bucket. The future of Salmon will be adversely impacted."

Reclamation Response: It can be assured that all measures will be taken to prevent a catastrophic collapse of the dam. A critical failure mode for the dam will be during drawdown of the reservoir, generally called the "rapid drawdown" stability case. This is because as the reservoir is drawn down, the pore pressures in the core remain elevated for a period of time, and the support of the upstream slope by the weight of the reservoir is reduced. Conservative stability analyses for this case have been performed for both Iron Gate and J.C. Boyle dams, and the results show that instability for this case is not a concern at either structure.

Mr. Koshy's Review Comment: *Paragraph 2.0. and Paragraph 2.1. "Other issues: The earth dams' catastrophic collapse is the main issue. It makes other issues moot. However, I mentioned a few more errors and omissions to the BOR, both technological and administrative:*

Stability of slopes. The earth dam's carefully graded "Gravel shell" is designed to withstand draw down, but the slopes aren't. Ground water levels have risen and will take years to come down to original levels. The side slopes are saturated with high pore pressure. The 174 ft deep reservoir will draw down in 58 days. The clays within the slopes could be similar to the fine sediment load, with low resistance and fail. The EIS/EIR failed to investigate slope stability during draw down."

Reclamation Response: The potential instability of the natural slopes around the reservoir rim as a result of reservoir drawdown was a concern during the development of the proposed removal plan, and this was qualitatively addressed for the EIS/EIR. No formal stability analyses were performed. The topography around Iron Gate reservoir consists of moderate to steep slopes, primarily with no to thin residual soil layers covering rock that originated from volcanic events. There is no infrastructure development around the reservoir rim, so it was assumed that limited instability could be tolerated. Instability of some of the steeper natural slopes is likely; however, the sliding is expected to be very shallow and inconsequential. The topography around J.C. Boyle reservoir is shallow to moderately steep slopes. There is also no infrastructure development around the reservoir rim, so it was also assumed limited instability can be tolerated. Limited sliding of the slopes around the reservoir rim would not cause overtopping or otherwise failure of the dam. Debris from such sliding could be removed as the dam is removed or after the dam is removed as non-emergency work.

If the proposed dam removal project is approved, additional analyses will be performed at that time to ensure the proposed reservoir drawdown rates do not cause unacceptable instability around the rims of the reservoirs. During construction, a monitoring program would also be implemented to evaluate the stability of the slopes around the reservoirs, and drawdown rates could be adjusted if actual conditions vary from those expected.

Regarding the stability of the embankments during drawdown of the reservoir, please refer to Reclamation's response to paragraph 1.6 and 2.3.

Mr. Koshy's Review Comment: *"World renowned Prof. A.W. Skempton's 4th Rankine Memorial lecture, in 1964 (Long Term Stability of Slopes, Geotechnique 14, 75-102) and State of the Art Report 1969 (7th Int. Conf. Soil Mech. Found. Eng., Mexico,) are classics on the subject."*

Reclamation Response: The papers cited are excellent references when evaluating the long term stability of clay slopes. The controlling case for instability caused by a rapid drawdown of the reservoirs, however, would be an undrained, or short term, condition. As time progresses and drainage from the surrounding hillsides occur, stability of the slopes would increase for long term conditions.

Mr. Koshy's Review Comment: *Paragraph 2.2. "The sediment behind the dams. The EIS/EIR considers the sediment till Year 2002. It omits 18 years of sediment till 2020, when it proposes dam removal."*

Reclamation Response: This additional volume of sediment has been estimated for the analyses that were performed. The design team estimated the volume of sediment from samples taken in the four reservoirs between 2006 and 2009 to be 13.1 million cubic yards. The volume of sediment that would be behind the dams at the year 2020 was projected based on the current sediment volume, and it was estimated that an additional 1.9 million cubic yards of sediment would be deposited. For analysis purposes then it was estimated that a total of 15 million cubic yards of sediment would be in place at the year 2020.

Mr. Koshy's Review Comment: *Paragraph 2.3. "The rate of draw down. The EIS/EIR proposes an arbitrary draw down rate of 3 ft per day, it is not supported by any calculations or any experimental draw down."*

Reclamation Response: As stated previously, stability of the dams during drawdown of the reservoir was of utmost concern to the design team. Though not discussed in the EIS/EIR, rapid drawdown analyses for both Iron Gate and J. C. Boyle dams have been performed. The Iron Gate Dam stability analysis was performed by PanGEO in 2008 as part of a geotechnical report for the proposed dam removal project. The analysis assumed an immediate drawdown of the full reservoir, which allowed no time for pore pressures in the dam to dissipate (even in the free draining shells). This is a very conservative assumption considering the upstream shell will drain rapidly. The J. C. Boyle Dam stability analysis was performed by Reclamation in 2011; however, the results are not published. This analysis also assumed an immediate drawdown of the full reservoir. Both analyses showed adequate factors of safety against embankment instability for these conservative assumptions. Thus, the proposed drawdown rates in the EIS/EIR were not arbitrary, but were given a significant amount of thought by the design team, which included qualitative consideration for the natural slopes around the reservoir rim. If the proposed dam removal project is approved, additional analyses will be performed at that time to ensure the proposed reservoir drawdown rates are safe for both the embankments and the natural slopes around the reservoir rim. During construction, a monitoring program would be implemented to ensure the stability of the dam. Drawdown rates could be adjusted if the performance is different than expected.

Mr. Koshy's Review Comment: *Paragraph 2.4. "Preparation and review. The management assigned a concrete specialist to prepare the Chapter on earth dam removal and a hydrology specialist to review it. The earth dam design and geo-technical sections have not applied their insight to avoid this costly error."*

Reclamation Response: The geotechnical aspects of the proposed dam removal project were evaluated and peer reviewed by geotechnical engineers that were on the design team throughout the preparation of the EIS/EIR. Although credit was not explicitly given to these team members for the writing of the chapter related to the earth dam removals, the geotechnical engineers played a major role in the report documentation.

Mr. Koshy's Review Comment: *Paragraph 3.0 "Conclusion: The "proposed action" is certain to cause the dam's catastrophic collapse. It is a certainty since the earth dam's wet clay core will yield to outer Gravel shell's pressure. It is not just a probability.*

The fatal error of catastrophic collapse, invalidates all those Alternatives that involve earth dam removal. The Alternative Four involving cutting a fish passage through the Iron Gate dams' saturated clay core is also not safe or doable for the same reason.

The EIS/EIR would contravene the National Environmental Policy Act (NEPA), the California Environmental Quality Act (CEQA), the Klamath Hydroelectric Settlement Agreement (KHSA), the Klamath Basin Restoration Agreement (KBRA) as well as many more statutes under the Oregon Department of Environmental Quality, the California Department of Fish and Game (CDFE), the US Environmental Protection Agency (EPA), etc.

The significant Impact of the earth dams' catastrophic collapse, can not be avoided or mitigated. The Facilities Removal would not be completed within the State Cost Cap, since the collapsed debris cannot be left below running water in the river bed. Expensive overhead cable ways or other contrivances will be hastily required to remove the debris. The entire expense would be counter productive.

It is critical to inform Honorable Jerry Brown, Honorable Kitzhaber, Honorable Ken Salazar and concerned others in a timely manner, since a determination is due by March 31, 2012. Their Honors may please review my analysis, if necessary, with help from those without any conflict of Interest and also enquire as to how the EIS/EIR's fatal error was allowed to happen."

Reclamation Response: We believe the above responses to the comments provided prove that the claims made are without basis in fact and that the two embankment dams can be removed safely.

The design team would be extremely interested in reviewing Mr. Koshy's analysis, as referenced in the last paragraph, so this matter can be finally resolved.

The Secretarial determination date for this project has been postponed, and a new target date has not yet been established.

Mr. Koshy's Review Comment: *Paragraph 4.0 "Recommendation. My purpose is not merely to say that something has been wrong, but that something can be done about it. The DOI/BOR engineers can review the topography of the 4 dams and reservoirs, consider the data and innovate a new hydro-system passage.*

The new hydro-system passage should provide the bulk of the Juveniles and the adult spawners a safe passage. This is an engineering problem and demands an engineering solution. The dams are to stay, the farmers get the irrigation water, hydro power to be retained and the Salmon to recover. I think, it is possible."

Reclamation Response: This is not a decision for the Reclamation design team.

Mr. Koshy's Review Comment: *Paragraph 5.0 My experience in the subject, and Paragraph 6.0 Acknowledgments, included in the letter*

Reclamation Response: We appreciate Mr. Koshy providing information about his technical training. No technical response is needed regarding this portion of the letter.