DELTA TRIBUTARIES MERCURY COUNCIL
Tuesday, January 25, 2022

Via GoToMeeting virtual meeting

Facilitator: Stephen McCord, McCord Environmental, Inc. (MEI)
Meeting Summary by: Stephen McCord, MEI

Attendees

Stephen McCord, MEI
Greg Reller, Burleson Consulting
Jon Miller, Albemarle
Dan Griffin, Albemarle
Se Hye Kim, Albemarle
Zhaorong Zhang, Albemarle
David Royer, Albemarle
Kiara Edinbyrd, Albemarle
Carter Jessop, USEPA
Carolyn Yee, USEPA
Jennifer Crawford, US EPA
Peggy O'Day, UC Merced
Naivy Rodal Morales, UC Merced
Marc Beutel, UC Merced
Stefanie Helmrich, UC Merced
Jacob Fleck, USGS
Charlie Alpers, USGS
Mark Marvin-DiPasquale, USGS
Joseph L Domagalski, USGS
Le Kieu, USGS
Jim Rytuba, USGS
Jim Weigand, USGS
Kevin Brown, DWR
Dan Deeds, USBR
Dimitri Vlassopoulos, Anchor QEA
Mark Seelos, Valley Water
Julianna Manning, CV RWQCB
Leah Jones, CV RWQCB
Todd Muelhoefer, Kinder Morgan, Inc.
Peter Graves, BLM
Heidi Oriol, Regional San
Nan Bailey, Regional San
Sarah Acker, SF Bay RWQCB
Carrie Austin, SF Bay RWQCB
Lindsay Whalin, SF Bay RWQCB
Kent Parrish, Wood PLC
Khalil Abu-Saba, Wood PLC
Chris Stransky, Wood
Erik Ringelberg, The Freshwater Trust
Jennifer Spaletta, Spaletta Law
Jeff Gillow, Jacobs
Jeff Minchak, Jacobs
Scott Brooks, Oak Ridge National Lab
Doug Gray, AECOM
Will Neese, AECOM
Sharma, Bhawana/GNV
Christine O. BMRR
Rehab Elfadul, Albemarle
Charles Salocks, retired
Amanda Lopez, ??
Ben Heppard, ??
Grace Windler, ??

I. Introductions and Agenda Review

No comments on the summary of the September 28, 2021 meeting.

II. Project Updates & Upcoming Events

Announcements are attributed to Stephen McCord (MEI) unless otherwise noted. Our "live" table of mercury-related projects in the region: https://docs.google.com/document/d/1EzeDOiS-vrM1MsjfNZC18Zoz9XWOSiorPSI3RJxrS9s/edit?usp=sharing.

Mine Site Cleanups

- Following up recently completed field trials of proprietary treatments for mercury-rich soils (see presentation summary below) MEI is now seeking new field trial sites in aqueous systems and at other mine sites in the region.
- Carter Jessop (USEPA) – USEPA is preparing a plan for cleanup of Sulphur Bank Mercury Mine's operable unit 1, to be proposed by spring 2022.
- Peter Graves (BLM) – EE/CA for Clyde Mine is completed. BLM is now awaiting funding from the Department of the Interior's Central Hazmat Fund to design and construct the cap in 2023. Molly Nillson (Ukiah Office) left for graduate school.
- Greg Reller – Cleanup of Reed Mine (adjacent to McLaughlin Reserve) was recently completed.
- Todd Muelhoefer – Abbott-Turkey Run annual sampling and site repairs were completed recently.

Mercury Studies and Monitoring Activities

- Jay Davis (SFEI): (1) Delta RMP mercury monitoring has been annual since 2016, but will take a pause for a year or two, possibly after the sampling of black bass and water this fall. (2) BOG (now known as the Safe to Eat Workgroup, or STEW) this year will be sampling the coast (central and north), some river stations in the Central Valley, and some stations (mainly coastal) selected by tribes and community-based organizations in the San Diego Region. For more information visit: https://mywaterquality.ca.gov/monitoring_council/bioaccumulation_oversight_group/.
- Charlie Alpers (USGS): USGS has started work on monitoring and modeling the tributaries to Clear Lake over the next 3 years. Monitoring will include suspended sediment, nutrients, and mercury species on selected tributaries, including 4 new gaging stations. A "sediment fingerprinting" approach will involve sampling soils, streambed sediment, streambanks, and roadside ditches to identify sources of fine sediment spatially and by land use. Modeling (SPARROW, HSPF) will estimate loads of suspended sediment, nutrients, and mercury as input to a 3-D lake model (Si3D) calibrated by UC Davis. Funding is pending from the California Natural Resources Agency to add mercury and methylmercury cycling and bioaccumulation to the lake model. Work continues on monitoring of water, sediment, and biota in Clear Lake as part of mercury source study (using mercury isotopes) in relation to Sulphur Bank Mercury Mine. (See **Other News** (below) for links to recent USGS data releases.)
- Marc Beutel (UC Merced) – Researchers recently completed the first year of post-HOS operation monitoring of Hodges Reservoir in San Diego, continuing for a second year.
- Peggy O'Day (UC Merced) – Wrapping up 2-year project at Los Banos Wildlife Area wetland ponds researching fill & drawdown effects on mercury cycling.

- Mark Seelos (Valley Water) – Staff submitted a 2-year summary report to RWQCB on monitoring and remediation for mercury in Valley Water's mercury-impaired reservoirs. Upcoming work will simulate bubble plumes from line diffusers to characterize their mixing effects. Peter Weiss-Penzias (UCSC) is funded to collect lichen around New Almaden Mining District. Staff are developing a study plan for mercury sorbent amendments in reservoirs.

Regional and Statewide Mercury Regulation

- The approved 2018 integrated report (a.k.a. the 303(d) list) is posted at https://www.waterboards.ca.gov/water_issues/programs/water_quality_assessment/2018_integrated_report.html. A 2020-2022 integrated report will be considered for adoption in early 2022. The 2024 report will be initiated soon.
- Leah Jones (RWQCB): Staff are reviewing source assessment and evaluating changes for phase two of the Delta MeHg TMDL. No date has been set for a public draft.

Recent & Upcoming Conferences

- Lindsay Whalin (SFB RWQCB) – The 15th bi-annual International Conference on Mercury as a Global Pollutant (ICMGP; https://www.ilmexhibitions.com/mercury2022/) will be virtual in 2022. Rob Mason from UC Santa Cruz will be given a lifetime achievement award. Abstracts are due in late February.

Grant Funding Opportunities

- See https://www.waterboards.ca.gov/water_issues/programs/grants_loans/scap/

Other News & Updates

- The draft 2022-2026 Delta Science Action Agenda (https://scienceactionagenda.deltacouncil.ca.gov/pdf/2021-11-17-2022-2026-saa-public-review-draft.pdf), which was developed with input from DTMC members, includes some references (direct or as a contaminant) to mercury:
    - Management Need Three (Expand multi-benefit approaches to managing the Delta as a social-ecological system)/ Additional Management Questions: What source control actions for contaminants (e.g., **mercury**, selenium, personal care products, or other emerging contaminants) would reduce health impacts to both fish and consumers of fish in the Delta?
    - Management Need Three: How do management actions (e.g., source control practices or managed flows) and habitat types influence nutrients, carbon, **contaminants**, and sediment fluxes in the Delta?
    - What are the interactions between flow and aquatic and tidal habitat, and how do other stressors influence those interactions (e.g., **contaminants**, other water quality changes, climate change issues or impacts)?
    - Management Need 5: Acquire new knowledge and synthesize existing knowledge of interacting stressors to support species recovery and ecosystem health. Quantify spatial and temporal "hotspots" of chemical contaminants and evaluate ecosystem effects through monitoring, modeling, and laboratory studies.

- Byran Fuhrmann, Marc Beutel, Priya Ganguli and others published in the journal Lake & Reservoir Management "Seasonal patterns of methylmercury production, release, and degradation in profundal sediment of a hypereutrophic reservoir"
- Stefanie Helmrich (UC Merced) and colleagues published a literature review on rates of MeHg (de)methylation in Critical Reviews in Envir. Sci. & Technology (https://doi.org/10.1080/10643389.2021.2013073).
- OEHHA recently issued new fish advisories with safe eating advice for several lakes (https://oehha.ca.gov/fish/advisories):
    - Little Rock Reservoir in Los Angeles County
    - Lake Webb in Kern County
    - Los Banos Reservoir in Merced County
- USGS published the following data releases:
    - Agee et al. (2021) Geochemical data including mercury for subsamples of deep cores from the Cache Creek Settling Basin, Yolo County, California. https://doi.org/10.5066/P91NXACC
    - Marvin-DiPasquale et al. (2021a) Shallow sediment geochemistry in a mercury-contaminated multi-habitat floodplain: Cache Creek Settling Basin, Yolo County, California (version 2.0, August 2021). https://doi.org/10.5066/P9MDXR3M
    - Marvin-DiPasquale et al. (2021b) Geochemical data for mercury and other constituents in redox-manipulated sediment cores from Clear Lake, Lake County, California. https://doi.org/10.5066/P9REF3QV
    - Pierce et al. (2022) Mercury in fishes from Clear Lake, California, 2019 and 2020. https://doi.org/10.5066/P96912PN

Presentations

Three presentations were given.

1 – Mercury Mine Remediation Pilot Study of a New Amendment Technology (Stephen McCord, MEI; Greg Reller, Burleson; Dan Griffin, Jon Miller & Se Hye Kim, Albemarle)

Albemarle is a global chemical company. One market branch is bromine specialties, whose R&D branch has developed MercLok™, a proprietary, powder-based amendment that preferentially reacts with and adsorbs ionic, organic, and elemental mercury. While targeting a market offering of MercLok™ Gen 1 in 2022, they are undertaking case studies as part of a pilot program to evaluate its effectiveness under a range of environmental conditions.

Albemarle funded a case study at an undisclosed abandoned mercury mine site in northern California in 2021. Mercury-contaminated mine waste from three areas of the site were amended in reactor buckets at two doses of two versions of MercLok (ALB1 and ALB2), in two techniques (repository and reactive barrier). The buckets were exposed to the weather from January to May. Because of the drought, rainfall was supplemented with deionized water for part of the period.

Tests of the most mercury-rich material (referred to as Area of Concern X, or AOC-X) were highlighted in the presentation. The amended material and its leachate in the reactor buckets were tested over the 5-month study period. Leachate mercury (both total and filtered) levels were immediately reduced more than an order of magnitude, and remained more than an order of magnitude lower than control (unamended) material leachate by the end of the study period. Likewise, leachable extraction tests (DI WET, SPLP and STLC) of the solids indicated significant reductions of amended material compared to controls, with higher doses being reduced more. A subset of buckets and leachate samples analyzed for methylmercury also found about 77% reductions versus controls.

Amendments did not impact total mercury content of the material, nor the pH of leachate.

Based on this pilot test, this new technology could offer environmentally protective options for on-site remediation of calcines at legacy mercury mines. Additional pilots and field applications for the amendment are in development. Albemarle is working on a case study white paper to share publicly. Additional case studies are being developed at: the same mine site and others, a hot spring, a gravel mine pit pond, and wetlands (seasonal freshwater and tidal brackish).

The presentation is available upon request from Albemarle.

For more information: Daniel Griffin (330.749.5404; daniel.griffin@albemarle.com)

2 – Cache Creek long-term mercury loads synthesis (Charlie Alpers, USGS)

USGS, in cooperation with DWR, compiled monitoring data and made load calculations for inflows and outflows of the Cache Creek Settling Basin (CCSB) for water years 2010-2019 to evaluate its trap efficiency for total mercury (THg), methylmercury (MeHg), and suspended sediment. The Cache Creek watershed is a significant contributor of mercury to the Yolo Bypass and downstream Delta, and the Delta MeHg TMDL calls for increased trapping of mercury by the CCSB and reduced MeHg loads in discharges. The basin was originally constructed in 1937 then modified (weir and levees raised) in 1993.

Put in a broader temporal context, the 2010-2019 study period was relatively dry compared to both the long-term record and the period used to estimate total Hg loads in the TMDL staff report. Most major and minor storms plus non-storm periods were effectively sampled to capture a range of discharge conditions. Load calculations were performed using the LOADEST model, which incorporates time and flowrate factors in 9 optional functions, from which the best fit is chosen. Overall, particulate THg, particulate MeHg, and suspended sediment concentrations increased with flow, whereas filtered MeHg decreased with flow at most sampling locations.

Trap efficiency of the basin, based on annual-average, flow-weighted load estimates, was 67% for suspended sediment; between about 60% and 65% for THg particulate and whole water; and between about 55% and 60% for MeHg particulate and whole water. However, filtered fraction loads actually increased slightly from basin inflow to outflow for THg (10%) and more substantially for MeHg (23%). Grain-size fractionation (smaller sizes preferentially pass through the basin whereas coarser sizes are trapped), and production of MeHg and DOC (which affects partitioning) within the basin appeared to play roles in the mass balances.

For perspective:

- The TMDL staff report (2010) estimated THg exports from the basin to be 118 kg/yr (based on WY 1984-2003, a period with flow near the long-term average from WY 1904-2019, at Yolo) and the basin plan amendment requires an increase in trapping from 50%

to 75% whereas this study found the 10-year average export (for WY 2010-2019, a period with flow below the long-term average) to be 31 kg/yr and trap efficiency around 62%.

- The TMDL staff report estimated MeHg loads to be 0.14 kg/yr (based on WY 2000-2003, a relatively dry period) and the basin plan amendment requires maximum MeHg export of 0.030 kg/yr whereas the 10-year average export (WY 2010-2019) of MeHg was 0.216 kg/yr.

Monitoring will continue through 2024. Approximately 340 acres in the southern part of the CCSB is being planned for conversion from floodplain to agriculture by the landowner (Conaway Ranch) during 2021-24; conversion of about 114 acres began in summer/fall 2021. This conversion may eventually result in lower MeHg exports from the basin because less MeHg is produced on agricultural fields compared with floodplain according to recent USGS studies. The US Army Corps of Engineers flood control project for the city of Woodland (Alternative 2A) is proposing to construct a new weir on the western levee of the CCSB to allow flood waters in northern Woodland to be routed through the basin. Basin management remains a topic of discussion between the Corps, DWR, and the Regional Water Quality Control Board.

The presentation file is not available, but a recording of the presentation may be available upon request.

For more information: Charlie Alpers at USGS (cnalpers@usgs.gov) or Kevin Brown at DWR (Kevin.Brown@water.ca.gov).

3 – Incubation experiments on Cache Creek Settling Basin sediments from coagulant-treated mesocosms (Naivy Rodal Morales, Marc Beutel & Peggy O'Day, UC Merced; Jacob Fleck, Mark Marvin-DiPasquale & Charlie Alpers, USGS)

To address the Delta MeHg TMDL requirement to decrease MeHg load exports from the CCSB to the Yolo Bypass and Delta (see previous presentation's summary), this study evaluated the use of commercial coagulants as a tool. Jar tests (2016) found that three different coagulants, ChitoVan (organic-shell based), Ferralyte (iron-sulfate based), and Ultrion (polyaluminum chloride based) removed >90%, 84%, and 83%% of MeHg, and >90%, 74%, and 61% of THg, respectively. An *in situ* mesocosm study (2016-2018), applying the coagulants to the soil, found MeHg increased in water (but total MeHg mass decreased), and MeHg increased in fish (but there was no significant difference among treatments). However, the experiment after the flooded conditions had some operational and performance issues, leaving open questions whether the results were representative of the basin, or if they had missed the optimal window for MeHg production. Thus, there was the need for a more controlled laboratory experiment. The study was developed in collaboration with UC Merced in 2021.

The concern studied was whether the soils treated with three different coagulants from the mesocosm field experiment would lead to increased MeHg production compared to an untreated control soil upon rewetting. 16-day incubation experiments were performed under "ambient" (anaerobic) conditions. The experiments were done for all three of the mesocosm areas (A, B, and C). An additional experiment called "stress test" was also developed by adding labile organic material (spirulina powder) only to mesocosm C soil samples.

Key findings were that the MeHg dynamics did not change with the coagulant-treated soils compared to the control (untreated) soils in the ambient and stress-test incubations. In general,

the coagulant-treated soils under ambient conditions did not enhance MeHg production upon rewetting. However, with the addition of labile organic material, short-lived net MeHg production was promoted and MeHg concentrations peaked at day 2-4. Sulfate concentration showed a steady decline through day 8, when it reached very low concentrations; however, sulfate levels remained well above those that limit the activity of sulfate-reducing bacteria. Thus, sulfate-reducing bacteria were still active after the MeHg peak at day 2-4. This suggests that enhanced demethylation and/or low Hg(II) bioavailability accounted for the drop in net MeHg production during the stress-test incubations.

Management implications are that coagulants appear to be an effective tool to further reduce THg and MeHg loads discharged from the CCSB without increasing the risk of enhanced MeHg production in treated soils. Reducing organic matter (algal blooms and crop residues/vegetation) and sulfate inputs could also limit net MeHg production.

The presentation file is not available, but a recording of the presentation may be available upon request.

For more information: Naivy Rodal Morales (nrodalmorales@ucmerced.edu) and Marc Beutel (mbeutel@ucmercced.edu).

III. Meeting Wrap-Up

Agenda items suggested for the next meeting included:

- Seasonal patterns of methylmercury production, release, and degradation in profundal sediment of a hypereutrophic reservoir (Byran Fuhrmann, SePro)
- MnO treatment for mercury-laden soil stabilization (Peggy O'Day and Marc Beutel, UC Merced)
- Measuring mercury loads across a tidal wetland inlet (Petra Lee, DWR)
- Mercury from SPACE—Development of high-resolution mapping of multiple parameters using field meters, satellite imagery, and more (Mark Marvin-DiPasquale, USGS)
- Due Diligence in the Sierra Nevada Gold Country (Carrie Monohan, TSF)
- Update and overview of USFS mine site cleanup activities (Rick Weaver (USFS)

Next Meeting Date: Tentatively May 2022 (online)