Tom Myers, Ph.D.
Hydrologic Consultant
P.O. Box 177
Laporte, PA 18626
775-530-1483
tommyers1872@gmail.com

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Technical Memorandum

Prepared for: Earthjustice

Subject: Surface Water Temperature Effects of the Proposed Donlin Project

BGC Engineering (BGC) completed the report, Analysis of Crooked Creek Stream Temperature (BGC 2021), to provide a quantitative analysis of the potential temperature effects of developing the Donlin Gold Mine on surface water temperatures in Crooked Creek. The Donlin Gold Project Final Environmental Impact Statement (FEIS) contained only qualitative discussion of stream temperatures. BGC analyzed the change in temperature in Crooked Creek due to dewatering and discharges from treated dewatering water at the Donlin Mine to determine if the mine would cause water temperatures to exceed 55.4°F for egg/fry incubation or 59.0°F for migration and rearing. Water temperatures could rise if colder groundwater or streams with colder inflow no longer discharge into the creek or if discharges to the creek are warm enough to raise the temperature.

BGC's analysis provided evidence that allowed BGC to conclude that stream temperatures would remain just below the permit requirement. However, the analysis is a simple water balance model that has assumptions which biased the analysis to predict lower stream temperatures. These assumptions include that flow increases as a linear function of drainage area, that 2005 recorded flows are the most critical stream flow period, the failure to consider thermal effects along Crooked Creek, the failure to consider thermal inputs from the water discharged into the creek, the failure to consider climate change, and the failure to consider the uncertainty in predicted dewatering effects on the streamflow. BGC also did not conduct any uncertainty analysis that would consider the effects of these assumptions. This memorandum presents a brief sensitivity analysis of the BGC predictions.

Site Description

BGC used temperature flow for 2005 through 2011 at sites on Crooked Creek, Anaconda Creek, and American Creek, shown on Figure 1. Crooked Creek flows north to south through a meandering channel just west of the Donlin Mine. American Creek enters about two miles upstream of Anaconda Creek. BGC presents temperature and flow data in Appendix A.

The year 2005 had the warmest recorded flow temperatures in both Crooked Creek and Anaconda Creek. BGC (p 5) claims that the 2005 air temperature at Camp Station was 58.3°F which is almost 7 degrees warmer than the 51.4° average temperature for May through September at that station. The year 2005 also had the lowest flows on most days at the three stations but most importantly at the Crooked Creek gage. A combination of high air temperatures and low flows likely caused 2005 to have the warmest water temperatures of the record. However, BGC presents no analysis as to the frequency that the low flows or high temperatures observed in summer 2005 have occurred so the predictive power of that knowledge is limited.

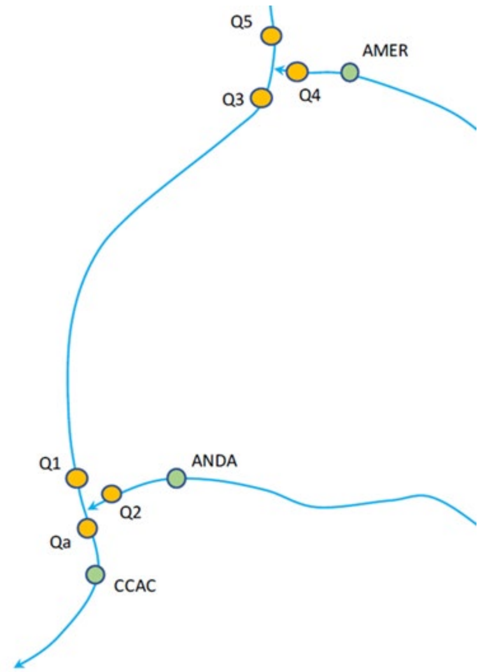

Figure 1: Figure 3-1 from BGC (2021). The green circles are measurement points for flow and temperature and the orange circles are calculation nodes.

Water Balance Model

The model used to predict temperatures caused by the mine is a simple mixing model of flows with specified temperatures without any consideration of thermal effects between the points on the creeks, or nodes, at which temperatures are estimated. Thermal effects are heat gain or loss as the water passes between nodes of their model as discussed in detail below. BGC used 2005 data as a critical year to calculate changes in streamflow temperature without considering the frequency with which those conditions would recur. Calculations as completed by BGC show the maximum temperature at the Crooked Creek site reaches 54.5°F in July, about 0.9°F below the limit. The arithmetic used for the calculations appears accurate, but the assumptions used for the model bias the results to underpredict stream temperatures.

Flow Assumptions

The first assumption is that stream flows will not be any lower than analyzed. The year 2005 had the lowest flows of the presented record but there is no indication as to the probability of those low flows being exceeded. If the background streamflow is lower than occurred in 2005, the mine would have more substantial effects on the stream temperatures than predicted by BGC.

BGC assumed a linear flow to area relationship which means the stream gains flow as a function of area. While correct on a broad scale in the Donlin area, the reality is that the relationship varies with length and with the wetness in the watershed. During dry periods, most flow enters in select gaining reaches or at points of inflow. During storm runoff periods, for streams of this size and topography, there are probably discrete inflow points but they probably spread along the stream reach so the area relationship may be more accurate. BGC should have done a synoptic analysis on Crooked Creek to determine the actual relationship of flow with area during both wet and dry conditions.

Failure to Consider Thermal Effects

The second assumption is there will be no thermal effects on the stream, meaning BGC ignored sources of heat that would add to stream temperatures. Sources of heat include shortwave solar radiation, longwave atmospheric radiation, conduction of heat from the atmosphere to the water, and direct heat inputs from an anthropogenic source (the effluent) (Thomann and Meuller 1987). Heat sinks, or losses of heat, include longwave radiation, evaporation, and conduction from water to the atmosphere (Id.). It is common to consider the net influx due to any of these sources, meaning, for example, the difference in incoming and outgoing radiation.

At the latitude of Donlin, longwave atmospheric radiation and conduction of heat from the atmosphere during warm days are likely to be the largest source of heating. Shortwave radiation, including direct sunlight onto the creek, reflects from surface water such that at lower than a 30-degree angle little heat would be absorbed. Reflected shortwave radiation however could hit the riparian vegetation thereby heating it thereby increasing long-wave radiation to the creek. At the low temperatures considered here, evaporation would remove only a small amount of heat. It seems likely that at least during warm weather periods with long days there would be a net gain of heat in the creek. Additionally, the stream meanders substantially, as seen on BGC (2021) Figure 2-4; the meandering increases the surface area of the stream exposed to the factors listed above. By ignoring thermal effects, BGC ignored a substantial source of heat and has underestimated the temperature at the downstream end of the stream reach affected by the mine.

Effluent Discharge to the Stream

The third unjustified assumption is that effluent temperatures would not be high enough to affect the stream. BGC provided no references to support the assumption. Effluent includes tailings decant water and runoff from waste rock and pit walls which could all be warmer than the stream temperatures during the summer due to radiation from the sun having warmed the source. There is also no discussion or evidence regarding heat that could be added to the water during treatment.

Climate Change

BGC also ignored the potential that climate change would affect the thermal factors considered above. It could affect the stream in two ways. It could decrease flows during warm, dry periods and increase the air temperature and therefore the flux of heat from the air to the water. Both would increase the stream temperature. Because climate change would affect the stream temperatures regardless of the mine, it is necessary to consider it as part of any analysis of the impacts of the mine.

Uncertainty in the Predictions

To test the effects of these assumptions including how they may have biased the results, I replicated the flow/temperature calculations for the Summer 2005 data. I also considered how small changes, related to the assumptions noted above, could affect the streamflow temperatures, as discussed in the following paragraphs.

BGC assumed inflow to the reach at Q5 would not be affected by mining, although it is possible the dewatering effects on groundwater flow to the stream could occur above this point. Mining eliminates flow at Q4 as the pit intercepts American Creek. Flow at Q2 would be reduced by the proportion of the watershed intercepted by the tailings impoundment on Anaconda Creek; the remaining drainage area is just 1.7 of the natural 7.7 square miles so the flow is just 22% of natural. At both Q5 and Q2, BGC assumed the water temperature equaled the natural flow temperatures (measured at ANDA for Q2 and that at Q5 had been calculated based on natural flow conditions). Dewatering was predicted to remove about 2 cfs of groundwater inflow to the streams; BGC applied this at Q3 by subtracting 2 cfs from the natural flow at Q5. BGC calculated mine-disturbed flow at Q1 by subtracting Q4 and 2 cfs from the calculated natural flow at Q1. BGC sets background temperature at Q1 to equal that at Q3 without considering thermal effects. The temperature at Qa is that at Q1 adjusted for flow from the disturbed Anaconda watershed.

Calculations performed by BGC and replicated herein show that mining disturbances would increase water temperatures during most of the summer. With mining disturbances using the base condition as observed during summer 2005, the highest temperature at Qa occurred July 23, 2005 (Figure 2). The temperature at Q1 was about 0.1°F higher, so the small 40.6°F inflow at Q2 cooled Crooked Creek slightly. Without the mine disturbance the tributary flow would have cooled the temperature even more. In fact, the highest water temperature presented for Anaconda Creek over a six-year period was 42.5°F in July 2005 (BGC (2021) Figure 2-7). If Q2 went to zero, the temperature at Qa would increase to 54.9°. Low temperature natural flow at Q4 also lowers natural flow temperatures on Crooked Creek, but the mine will eliminate that inflow. The temperature of groundwater inflow which supports Crooked Creek flow is 35.5°F so preventing groundwater from reaching the creek due to dewatering also causes it to warm. The primary effect of mine development is to remove inflows to Crooked Creek that decrease temperatures in that creek.

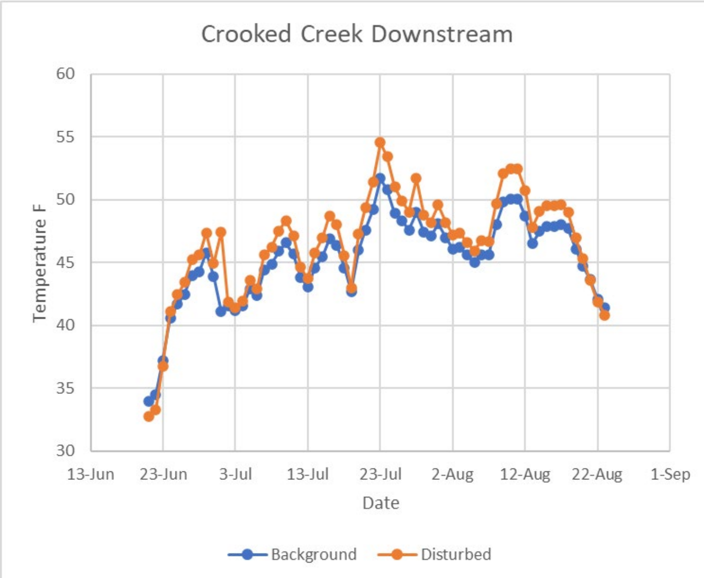

Figure 2: Crooked Creek stream temperatures for natural (background) and disturbed conditions.

BGC does not account for potential uncertainties in the dewatering forecast. The dewatering forecast is based on groundwater modeling which has inherent uncertainties in the parameters used for analysis. As part of the groundwater modeling analysis, these parameters are adjusted so that the sensitivity of the model can be determined. For example, adjusting the conductivity, K, allows the modeler to assess the range in predicted dewatering rates. The FEIS, based on these sensitivity analyses, reported that summer flow losses from Crooked Creek could increase from 25 percent in the base case to 61 percent for "High K" scenario (*See* FEIS App. G at G-64, G-68 (Crooked Cr. at American, June)). BGC failed to consider that flow conditions on Crooked Creek could be worse than predicted or that increased dewatering losses would have additional impacts to the temperatures on Crooked Creek.

Inflow to Crooked Creek from treatment processes at the mine could be as high as 4038 gallons per minute (gpm), or 9 cfs (FEIS Table 3-7.39). During Summer 2005, American Creek (Q4) averaged 6.7 cfs, but all of that would be lost to mining. Mining would reduce the flow at Q2 by about 4.2 cfs. The total loss of direct surface flow to Crooked Creek would be about 10.9 cfs. That would be replaced by 9 cfs of effluent. The FEIS does not provide effluent temperature estimates, but considering how close temperature is to the limit, if the effluent temperatures are substantially higher than the natural influent temperature, temperature limits on Crooked Creek would be exceeded. Using similar water balance equations to those used above, if 9 cfs of effluent has a 59°F temperature, the temperature at Qa would be 55.6°F, which exceeds the limit. The multitude of scenarios that could combine to increase the temperature at Qa is beyond the scope of this review to consider, but any serious consideration of unacceptable temperature impacts of this project a must consider them. The following is a brief list of flow variables that must be considered:

- Higher effluent temperatures

- Lower flow on Crooked Creek which could make moderating temperatures on the effluent more difficult

- More very cold water removed due to dewatering

One given reason for ignoring thermal effects was the mine would not affect the stream cover. However, even if the mine does not affect cover, if BGC's temperature assumptions are wrong, and Crooked Creek temperature naturally rises a couple degrees between tributaries, the project could cause exceedances. In other words, BGC by ignoring thermal effects assumes the background temperatures to be so low that the project's impacts would not cause stream temperatures to exceed the limits. Using water balance calculations as for the effluent calculations, if the water temperature at Q2 is 55.6°F instead of the modeled 54.8°F, the temperature at Qa would reach 55.6°F under disturbed conditions. If thermal effects increase background water temperature by less than a degree during the warm July 23, 2005, conditions, the proposed mine would exceed temperature limits. BGC ignored potential thermal effects by simply assuming them away without any meaningful justification.

Conclusions

BGC (2021) does not provide evidence indicating that the development of the Donlin Mine would not cause stream temperatures that would exceed standards. In fact, there are so many assumptions necessary to keep the temperatures from exceeding the standards that it is likely that future stream temperatures will exceed the standards, especially as climate change increases the background temperatures that the mine will only increase with its effects.

Reference

Thomann RV, Mueller JA (1987) Principles of Surface Water Quality Modeling and Control. HarperCollins Publishers, New York.

Tom Myers, Ph.D.
Consultant, Hydrology and Water Resources
P.O. Box 177
Laporte, PA 18626
(775) 530-1483
Tommyers1872@gmail.com

Curriculum Vitae

Objective: To provide diverse research and consulting services to nonprofit, government, legal and industry clients focusing on hydrogeology specializing in mine dewatering, contaminant transport, natural gas development, groundwater modeling, NEPA analysis, federal and state regulatory review, and fluvial morphology.

Education

Years	Degree	University
1992-96	Ph.D. Hydrology/Hydrogeology	University of Nevada, Reno Dissertation: Stochastic Structure of Rangeland Streams
1990-92		University of Arizona, Tucson AZ Classes in pursuit of Ph.D. in Hydrology.
1988-90	M.S. Hydrology/Hydrogeology	University of Nevada, Reno Thesis: Stream Morphology, Stability and Habitat in Northern Nevada
1981-83		University of Colorado, Denver, CO Graduate level water resources engineering classes.
1977-81	B.S., Civil Engineering	University of Colorado, Boulder, CO

Professional Experience

Years	Position	Duties
1993-Pr.	Hydrologic Consultant	Completion of hydrogeology studies and testimony focusing on mine dewatering, groundwater modeling, natural gas development, contaminant transport, NEPA review, and water rights for nonprofit groups and government agencies.
1999-2004	Great Basin Mine Watch, Exec Director	Responsible for reviewing and commenting on mining projects with a focus on groundwater and surface water resources, preparing appeals and litigation, organizational development and personnel management.
1992-1997	Univ of NV, Reno, Res. Assoc.	Research on riparian area and watershed management including stream morphology, aquatic habitat, cattle grazing and low-flow and flood hydrology.
1990-1992	U of AZ, Res. and Teach. Assistant	Research on rainfall/runoff processes and climate models. Taught lab sections for sophomore level "Principles of Hydrology". Received 1992 Outstanding Graduate Teaching Assistant Award in the College of Engineering
1988-1990	U of NV, Reno Res. Asst	Research on aquatic habitat, stream morphology and livestock management.
1983-1988	US Bureau of Reclamation Hydraulic Eng.	Performed hydrology planning studies on topics including floodplains, water supply, flood control, salt balance, irrigation efficiencies, sediment transport, rainfall-runoff modeling and groundwater balances.

Peer-Reviewed Publications

Myers, T., 2016. A modeling approach to siting mine facilities in northern Minnesota USA. *J Hydrology* 533: 277-290. Doi: 10.1016/j.jhydrol.2015.12.020

Myers, T., 2013. Remediation scenarios for selenium contamination, Blackfoot Watershed, southeast Idaho, USA. *Hydrogeology J.* DOI 10.1007/s10040-013-0953-8

Myers, T., 2013. Reservoir loss rates from Lake Powell and their impact on management of the Colorado River. *Journal of the American Water Resources Association*. DOI: 10.1111/jawr.12081.

Myers, T., 2012. Potential contaminant pathways from hydraulically fractured shale to aquifers. *Ground Water* 50(6): 872-882. doi: 10.1111/j.1745-6584.2012.00933.x

Myers, T., 2009. Groundwater management and coal-bed methane development in the Powder River Basin of Montana. *J Hydrology* 368:178-193.

Myers, T.J. and S. Swanson, 1997. Variation of pool properties with stream type and ungulate damage in central Nevada, USA. *Journal of Hydrology* 201-62-81

Myers, T.J. and S. Swanson, 1997. Precision of channel width and pool area measurements. *Journal of the American Water Resources Association* 33:647-659.

Myers, T.J. and S. Swanson, 1997. Stochastic modeling of pool-to-pool structure in small Nevada rangeland streams. *Water Resources Research* 33(4):877-889.

Myers, T.J. and S. Swanson, 1997. Stochastic modeling of transect-to-transect properties of Great Basin rangeland streams. *Water Resources Research* 33(4):853-864.

Myers, T.J. and S. Swanson, 1996. Long-term aquatic habitat restoration: Mahogany Creek, NV as a case study. *Water Resources Bulletin* 32:241-252

Myers, T.J. and S. Swanson, 1996. Temporal and geomorphic variations of stream stability and morphology: Mahogany Creek, NV. *Water Resources Bulletin* 32:253-265.

Myers, T.J. and S. Swanson, 1996. Stream morphologic impact of and recovery from major flooding in north-central Nevada. *Physical Geography* 17:431-445.

Myers, T.J. and S. Swanson, 1995. Impact of deferred rotation grazing on stream characteristics in Central Nevada: A case study. *North American Journal of Fisheries Management* 15:428-439.

Myers, T.J. and S. Swanson, 1992. Variation of stream stability with stream type and livestock bank damage in northern Nevada. *Water Resources Bulletin* 28:743-754.

Myers, T.J. and S. Swanson, 1992. Aquatic habitat condition index, stream type, and livestock bank damage in northern Nevada. *Water Resources Bulletin* 27:667-677.

Zonge, K.L., S. Swanson, and T. Myers, 1996. Drought year changes in streambank profiles on incised streams in the Sierra Nevada Mountains. *Geomorphology* 15:47-56.

Representative Projects

Expert Witnessing

Myers, T., 2019. Expert Testimony/Report. In the Matter of the Administration and Management of the Lower White River Flow System …. In the Office of the State Engineer of the State of Nevada. Carson City NV. September 23 to October 4, 2019

Myers, T., 2018. Expert Testimony/Report. In the Matter of: The Application of New Mexico Copper Corporation for a Groundwater Discharge Permit for the Copper Flat Mine (DP-1840), Docket No. GWB-18-06(P). New Mexico Department of Environmental Protection, Hearing, Truth or Consequence, NM. September 2018.

Myers, T., 2018. Expert Testimony: In the Matter of the Application by New Mexico Copper Corporation for a Mine Permit for the Copper Flat Mine, Sierra County, New Mexico, Permit No. SI027RN. New Mexico Mining and Minerals Division. Hearing Truth or Consequences, NM, October 23, 24, 2018

Myers, T., 2017. Expert Report/Testimony. In the Matter of Applications 53987 through 53992, inclusive, and 54003 through 54021, inclusive, filed to appropriate the underground waters of Spring Valley, Cave Valley, Dry Lake Valley, and Delamar Valley (Hydrographic Basins 184, 180, 181, and 182), Lincoln County and White Pine County, Nevada. Nevada Division of Water Resources. Hearing September 25-October 6, 2017.

Myers, T., 2017. Expert Testimony. In the Matter of Application for Beneficial Water Use Permit No 76LJ-30102978 by Montana Artesian Water Company. Montana Department of Natural Resources. Hearing in Kalispell MT, Sept 19 -22, 2017

Myers, T., 2016. Expert Report/Testimony: In Re State Land Office Agriculture Lease No. GT-0447, Brininstool XL Ranch, LLC v. Devon Energy Production Company, Contest No. 15-006. Santa Fe, NM

Myers, T., 2014. Expert Report/Deposition: In the Matter of California Department of Parks and Recreation v. Newmont Mining Corporation, et al. US Distict Court, Eastern District of CA, No. 2:12-CV-01857-LKK-AC, Prepared for the California Department of Justice, February 2014

Myers, T., 2012. Expert Report/ Testimony at Aquifer Protection Permit Appeal Hearing, Rosemont Mine. Phoenix AZ, August and September, 2012.

Myers, T., 2011. Deposition: Northeast Natural Energy, LLC and Enroute Properties, LLC v. The City of Morgantown, WV, Civil Action No. 11-C-411, Circuit County of Monongalia County, WV.

Myers, T., 2011 and earlier. Expert Reports (some listed below) and Testimony. Water Rights Protest Hearings before the Nevada State Engineer, Southern Nevada Water Authority Applications for (1) Spring Valley, (2) Cave, Dry Lake, Delamar Valley, (3) Three Lakes/Tikapoo Valley.

Myers, T. 2006. Affidavit. Diamond Cross Properties, LLC, Northern Plains Resource Council, Tounge River Water Users Assoc v. State of Montana, Dept of Env Quality, Board of Oil and Gas Conservation, Dept of Natural Resources and Conservation, and Pinnacle Gas Resources, Inc, and Fidelity Exploration and Production Co., MT 22nd Judicial District Court Big Horn County, Civil Cause No. DV 05-70.

Myers, T. 2006. Expert Report/Deposition. Cole et al. v J.M. Huber Corp, and William DeLapp. U.S. Federal District Court Case No. 06-CV-0142J.

Myers, T., 2005. Nevada State Environmental Commission Appeal Hearing, Water Pollution Control Permit Renewal NEV0087001, Big Springs Mine. Prepared for Great Basin Mine Watch, Reno NV.

Myers, T. 2004. Nevada State Environmental Commission Appeal Hearing, Water Pollution Control Permit, Lone Tree Mine, Gold Quarry Mine. Prepared for Great Basin Mine Watch, Reno NV.

Reports, Reviews and Activities

Myers, T. 2021. Technical Memorandum: Review of Environmental Assessment and the Aquatic Resources Monitoring and Mitigation Plan. Prepared for Center for Biological Diversity. January 18, 2021.

Myers, T. 2021. Technical Memorandum: Review of Hydrogeology of the Long Canyon Mine, Prepared for Great Basin Resource Watch. Revised June 10, 2021.

Myers, T. 2021. Technical Memorandum: Review of Rhyolite Ridge Hydrogeology and Quarry Lake. Prepared for Center for Biological Diversity and Great Basin Resource Watch. April 23, 2021.

Myers, T. 2020. Technical Memorandum: Bishop Tube 2019 Remedial Investigation Report and Feasibility Study. Prepared for Delaware River Keeper Network

Myers, T. 2019. Technical Memorandum: Groundwater Management and the Muddy River Springs, Report in Response to Nevada State Engineer Order 1303. Prepared for Center for Biological Diversity

Myers, T. 2019. Technical Memorandum: Review of Draft Environmental Impact Statement, Black Butte Copper Project, Meagher County, Montana. Prepared for Montana Trout Unlimited and Montana Environmental Information Center. May 1, 2019

Myers, T. 2019. Technical Memorandum: Review of Slate Belt Heat Recovery Center, Discharge of Industrial Stormwater into the Former Doney II Quarry. Prepared for Delaware Riverkeeper Network. February 25, 2019

Myers, T. 2018. Development of a Conceptual and Numerical Flow Model, Black Butte Copper Project, Meagher County, Montana. Prepared for Montana Trout Unlimited and Montana Environmental Information Center. Reno NV. July 30, 2018

Myers, T. 2018. Water Management Plan, Duckwater Shoshone Indian Reservation. Prepared for the Duckwater Shoshone Tribe. Reno NV February 27, 2018

Myers, T. 2017. Technical Memorandum: Impact of Developing Dixie Meadows Geothermal Utilization Project on Springs and Surface Water. Prepared for Center for Biological Diversity. July 24, 2017.

Myers, T. 2017. Technical Memorandum: Review of Bishop Tube Superfund Site and an Assessment of the Site's Proposed Residential Development. Prepared for Delaware Riverkeeper Network. March 20, 2017.

Myers, T. 2017. Technical Memorandum: Review of Dinwoody Enhanced and Production Covers. Prepared for EarthWorks and Crow Creek Conservation Alliance. December 5, 2017.

Myers, T. 2017. Technical Memorandum: Review of Final Responsiveness Summary for Aquifer Project Permit Application, Gunnison Copper Project. Prepared for Amerind Foundation, Dragoon, AZ

Myers, T. 2016. Effect of Open-Pit Mine Dewatering and Cessation on Semi-Arid River Flows. Prepared for the Progressive Leadership Alliance of Nevada.

Myers, T. 2016. International Technology Exchange, Mongolia. Working with Mongolian and Russian NGOs regarding Mining and Energy Development.

Myers, T. 2016. Technical Memorandum: Completeness Review of the Mine Operating Permit Application, Black Butte Copper Project, Meagher County MT. Prepared for Montana Chapter, Trout Unlimited.

Myers, T. 2016. Technical Memorandum. Response to the US Fish and Wildlife Service Hydrologic Reasoning in its Response to the Center for Biological Diversity's Notice of Intent to Sue to Reopen Consultation on Various Memorandums of Agreement Regarding the Muddy River Springs. Prepared for the Center for Biological Diversity, September 10, 2016.

Myers, T., 2016. Technical Memorandum, Review of the Draft Environmental Impact Statement, Copper Flat, Sierra County, NM. Prepared for Ladder Ranch, Inc. and New Mexico Environmental Law Center

Myers, T., 2016. Technical Memorandum, Review of the Draft Supplemental Environmental Impact Statement for the Donlin Gold Project. Prepared for the Northern Alaska Environmental Center.

Myers, T., 2016. Technical Memorandum, Review of the Draft Supplemental Environmental Impact Statement for the Rock Creek Project, Sanders County, MT. Prepared for the Rock Creek Alliance.

Myers, T. 2016. Technical Memorandum, Twin Metals Mine and the Peter Mitchell Pit, Simulation of the Development of the Peter Mitchell Pit and Its Effects on the Proposed Twin Metals Tailings Impoundment. Prepared for Northeastern Minnesotans for Wilderness.

Myers, T., 2015. Conceptual Flow and Transport Model, Uranium Plume near the Homestake Millsite, Milan, NM. Prepared for Bluewater Valley Downstream Alliance. Marcy 16, 2015.

Myers, T., 2015. Hydrogeology of the Humboldt River Basin, Impacts of Open-pit Mine Dewatering and Pit Lake Formation. Prepared for the Progressive Leadership Alliance of Nevada and Great Basin Resource Watch, Revised June 2015.

Myers, T., 2015. Letter Report: Comments on the Draft Supplemental Environmental Impact Review for the Panoche Valley Solar Project. Prepared for Adams Broadwell Joseph and Cardozo, San Francisco CA

Myers, T., 2015. Technical Memorandum: Review of the Final Environmental Impact Statement, NorthMet Mining Project and Land Exchange. Prepared for Minnesota Center for Environmental Advocacy.

Myers, T., 2015. Technical Memorandum – Review of Assessment of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resources. Prepared for Delaware Riverkeeper Network. August 24, 2015.

Myers, T., 2015. Technical Memorandum – Review of Finger Lakes LPG Storage, LLC, Proposed LPG Storage Facility. Prepared for Earthjustice, New York. January 13, 2015

Myers, T., 2015. Technical Memorandum – Review of Pennsylvania Governor's Executive Order Concerning Hydraulic Fracturing in Pennsylvania State Parks and Forest. Prepared for Delaware River Keeper, January 9, 2015.

Myers, T., 2015. Technical Memorandum – Review of Water Supply Assessment, Village at Squaw Valley. Prepared for Sierra Watch, July 13, 2015.

Myers, T., 2014. Groundwater Flow and Transport Modeling, NorthMet Mine and Plant Site. Prepared for the Minnesota Center for Environmental Advocacy.

Myers, T., 2014. Letter Report: Comments on the Environmental Assessment for the Proposed Photovoltaic Array Proposed for Ft Irwin CA. Prepared for Adams Broadwell Joseph and Cardozo, San Francisco CA, October 13, 2014

Myers, T., 2014. Review of the Water Quality Modeling, NorthMet Mine and Plant Site, Minnesota. Prepared for Minnesota Center for Environmental Advocacy.

Myers, T. 2014. Technical Memorandum: Review of Performance Standards, Center for Sustainable Shale Development. Prepared for Delaware River Keeper. May 8, 2014.

Myers, T. 2014. Technical Memorandum: Review of the Hydrogeologic Aspects of the Draft Environmental Impact Statement, Haile Gold Mine, Lancaster County, South Carolina. Prepared for Southern Environmental Law Center, May 8 2014.

Myers, T., 2014. Technical Memorandum: Review of the Supplemental Draft Environmental Impact Statement, NorthMet Mining Project and Land Exchange. Prepared for Minnesota Center for Environmental Advocacy. March 10, 2014

Myers, T. 2014. Technical Memorandum: Twin Metals and the Boundary Waters Canoe Area Wilderness, Risk Assessment for Underground Metals Mining. Prepared for Northeastern Minnesotans for Wilderness. August 8 2014

Myers, T. 2012-3. Participation in EPA Potential Impacts of Hydraulic Fracturing on Drinking Water Resources Study. US Environmental Protection Agency, Washington DC.

Myers, T., 2013. DRAFT: Chapter 5.1: Water Quality. Initiative for Responsible Mining.

Myers, T., 2013. DRAFT: Chapter 5.2: Water Quantity. Initiative for Responsible Mining.

Myers, T., 2013. Technical Memorandum: Comments on Encana Oil and Gas Inc.'s Application for the Madison Aquifer to be Exempt Wyoming Oil and Gas Conservation Commission Docket No. 3-2013. Prepared for Natural Resources Defense Council, Powder River Basin Council. June 12, 2013.

Myers, T. 2013. Technical Memorandum: Impact Analysis: Wishbone Hill Water Right Application. Prepared for Trustees for Alaska

Myers, T, 2013. Technical Memorandum: Review of Montanore Mine Dewatering Instream Flow Methodology. Prepared for Save our Cabinets, Earthworks. March 26, 2013

Myers, T. 2012. Technical Memorandum: Chuitna Coal Mine Project, Review of Arcadis DRAFT Hydrogeologic Conceptual Site Model Update and Associated Documents. Prepared for Cook Inletkeeper. May 11, 2012.

Myers, T., 2012. Technical Memorandum, Review of DRAFT: Investigation of Ground Water Contamination near Pavillion Wyoming Prepared by the Environmental Protection Agency, Ada OK. April 19, 2012.

Myers, T., 2012. Participation in: Keystone Center Independent Science Panel, Pebble Mine. Anchorage AK, October 1-5, 2012.

Myers, T., 2012. Technical Memorandum, Review and Analysis, Revised Draft, Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program, Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs. Prepared for Natural Resources Defense Council.

Myers, T., 2012. Technical Memorandum, Review of the Special Use Permit PP2011-035-Camilletti 21-10, Groundwater Monitoring Requirements. Prepared for Routt County Board of Commissioners and the Routt County Planning Department. June 19, 2012.

Myers, T., 2012. Drawdown at U.S. Forest Service Selected Monitoring Points, Myers Rosemont Groundwater Model Report. Prepared for Pima County, AZ. March 22, 2012.

Myers, T. 2011. Baseflow Conditions in the Chuitna River and Watersheds 2002, 2003, and 2004 and the Suitability of the Area for Surface Coal Mining. January 14, 2011.

Myers, T., 2011. Hydrogeology of Cave, Dry Lake and Delamar Valleys, Impacts of pumping underground water right applications #53987 through 53092. Presented to the Office of the Nevada State Engineer On behalf of Great Basin Water Network.

Myers, T., 2011. Hydrogeology of Spring Valley and Surrounding Areas, Part A: Conceptual Flow Model. Presented to the Nevada State Engineer on behalf of Great Basin Water Network and the Confederated Tribes of the Goshute Reservation.

Myers, T., 2011. Hydrogeology of Spring Valley and Surrounding Areas, Part B: Groundwater Model of Snake Valley and Surrounding Area. Presented to the Nevada State Engineer on behalf of Great Basin Water Network and the Confederated Tribes of the Goshute Reservation.

Myers, T., 2011. Hydrogeology of Spring Valley and Surrounding Areas, PART C: IMPACTS OF PUMPING UNDERGROUND WATER RIGHT APPLICATIONS #54003 THROUGH 54021. Presented to the Nevada State Engineer on behalf of Great Basin Water Network and the Confederated Tribes of the Goshute Reservation.

Myers, T., 2011. Rebuttal Report: Part 2, Review of Groundwater Model Submitted by Southern Nevada Authority and Comparison with the Myers Model. Presented to the Nevada State Engineer on behalf of Great Basin Water Network and the Confederated Tribes of the Goshute Reservation.

Myers, T. 2011. Rebuttal Report: Part 3, Prediction of Impacts Caused by Southern Nevada Water Authority Pumping Groundwater From Distributed Pumping Options for Spring Valley, Cave Valley, Dry Lake Valley, and Delamar Valley. Presented to the Nevada State Engineer on behalf of Great Basin Water Network and the Confederated Tribes of the Goshute Reservation.

Myers, T., 2011. Baseflow Selenium Transport from Phosphate Mines in the Blackfoot River Watershed Through the Wells Formation to the Blackfoot River, Prepared for the Greater Yellowstone Coalition.

Myers, T., 2011. Blackfoot River Watershed, Groundwater Selenium Loading and Remediation. Prepared for the Greater Yellowstone Coalition.

Myers, T., 2011. Technical Memorandum Review of the Proposed Montanore Mine Supplemental Draft Environmental Impact Statement and Supporting Groundwater Models

Myers, T., 2010. Planning the Colorado River in a Changing Climate, Colorado River Simulation System (CRSS) Reservoir Loss Rates in Lakes Powell and Mead and their Use in CRSS. Prepared for Glen Canyon Institute.

Myers, T., 2010. Technical Memorandum, Updated Groundwater Modeling Report, Proposed Rosemont Open Pit Mining Project. Prepared for Pima County and Pima County Regional Flood Control District

Myers, T., 2009. Monitoring Groundwater Quality Near Unconventional Methane Gas Development Projects, A Primer for Residents Concerned about Their Water. Prepared for Natural Resources Defense Council. New York, New York.

Myers, T., 2009. Technical Memorandum, Review and Analysis of the Hydrology and Groundwater and Contaminant Transport Modeling of the Draft Environmental Impact Statement Blackfoot Bridge Mine, July 2009. Prepared for Greater Yellowstone Coalition, Idaho Falls, Idaho.

Myers, T., 2008. Hydrogeology of the Carbonate Aquifer System, Nevada and Utah With Emphasize on Regional Springs and Impacts of Water Rights Development. Prepared for: Defenders of Wildlife, Washington, D.C. June 1, 2008.

Myers, T., 2008. Hydrogeology of the Muddy River Springs Area, Impacts of Water Rights Development. Prepared for: Defenders of Wildlife, Washington, D.C. May 1, 2008

Myers, T., 2008. Hydrogeology of the Santa Rita Rosemont Project Site, Numerical Groundwater Modeling of the Conceptual Flow Model and Effects of the Construction of the Proposed Open Pit, April 2008. Prepared for: Pima County Regional Flood Control District, Tucson AZ.

Myers, T., 2008. Technical Memorandum, Review, Record of Decision, Environmental Impact Statement Smoky Canyon Mine, Panels F&G, U.S. Department of the Interior, Bureau of Land Management. Prepared for Natural Resources Defense Council, San Francisco, CA and Greater Yellowstone Coalition, Idaho Falls, ID. Reno NV.

Myers, T., 2007. Groundwater Flow and Contaminant Transport at the Smoky Canyon Mine, Proposed Panels F and G. Prepared for Natural Resources Defense Council, San Francisco, CA and Greater Yellowstone Coalition, Idaho Falls, ID. Reno NV. December 11, 2007.

Myers, T., 2007. Hydrogeology, Groundwater Flow and Contaminant Transport at the Smoky Canyon Mine, Documentation of a Groundwater Flow and Contaminant Transport Model. Prepared for Natural Resources Defense Council, San Francisco, CA and Greater Yellowstone Coalition, Idaho Falls, ID. Reno NV, December 7, 2007.

Myers, T., 2007. Review of Hydrogeology and Water Resources for the Final Environmental Impact Statement, Smoky Canyon Mine, Panels F and G and Supporting Documents. Prepared for Natural Resources Defense Council, San Francisco, CA and Greater Yellowstone Coalition, Idaho Falls, ID. Reno, NV. December 12, 2007.

Myers, T., 2007. Hydrogeology of the Powder River Basin of Southeast Montana Development of a Three-Dimensional Groundwater Flow Model. Prepared for Northern Plains Resource Council. February 12 2007.

Myers, T., 2007. Hydrogeology of the Santa Rita Rosemont Project Site, Conceptual Flow Model and Water Balance, Prepared for: Pima County Flood Control District, Tucson AZ

Myers, T., 2006. Review of Mine Dewatering on the Carlin Trend, Predictions and Reality. Prepared for Great Basin Mine Watch, Reno, NV

Myers, T., 2006. Hydrogeology of Spring Valley and Effects of Groundwater Development Proposed by the Southern Nevada Water Authority, White Pine and Lincoln County, Nevada. Prepared for Western Environmental Law Center for Water Rights Protest Hearing.

Myers, T., 2006. Potential Effects of Coal Bed Methane Development on Water Levels, Wells and Springs of the Pinnacle Gas Resource, Dietz Project In the Powder River Basin of Southeast Montana. Affidavit prepared for Northern Plains Resource Council, April 4 2006.

Myers, T., 2006. Review of Hydrogeology and Water Resources for the Draft Environmental Impact Statement, Smoky Canyon Mine, Panels F and G, Technical Report 2006-01-Smoky Canyon. Prepared for Natural Resources Defense Council.

Myers, T., 2006. Review of Nestle Waters North America Inc. Water Bottling Project Draft Environmental Impact Report / Environmental Assessment. Prepared for McCloud Watershed Council, McCloud CA.

Myers, T., 2005. Hydrology Report Regarding Potential Effects of Southern Nevada Water Authority's Proposed Change in the Point of Diversion of Water Rights from Tikapoo Valley South and Three Lakes Valley North to Three Lakes Valley South. Prepared for Western Environmental Law Center for Water Rights Protest Hearing

Myers, T., 2005. Review of Draft Supplemental Environmental Impact Statement, Ruby Hill Mine Expansion: East Archimedes Project NV063-EIS04-34, Technical Report 2005-05-GBMW. Prepared for Great Basin Mine Watch.

Myers, T., 2005. Hydrogeology of the Powder River Basin of Southeast Montana, Development of a Three-Dimensional Groundwater Flow Model. Prepared for Northern Plains Resource Council, Billings, MT in support of pending litigation.

Myers, T., 2005. Potential Effects of Coal Bed Methane Development on Water Levels, Wells and Springs In the Powder River Basin of Southeast Montana. Prepared for Northern Plains Resource Council, Billings, MT.

Myers, T., 2004. An Assessment of Contaminant Transport, Sunset Hills Subdivision and the Anaconda Yerington Copper Mine, Technical Report 2004-01-GBMW. Prepared for Great Basin Mine Watch.

Myers, T., 2004. Technical Memorandum: Pipeline Infiltration Project Groundwater Contamination. Prepared for Great Basin Mine Watch.

Myers, T., 2004. Technical Report Seepage From Waste Rock Dump to Surface Water The Jerritt Canyon Mine, Technical Report 2004-03-GBMW. Prepared for Great Basin Mine Watch.

Myers, T., 2001. An Assessment of Diversions and Water Rights: Smith and Mason Valleys, NV. Prepared for the Bureau of Land Management, Carson City, NV.

Myers, T., 2001. Hydrogeology of the Basin Fill Aquifer in Mason Valley, Nevada: Effects of Water Rights Transfers. Prepared for the Bureau of Land Management, Carson City, NV.

Myers, T., 2001. Hydrology and Water Balance, Smith Valley, NV: Impacts of Water Rights Transfers. Prepared for the Bureau of Land Management, Carson City, NV

Myers, T., 2000. Alternative Modeling of the Gold Quarry Mine, Documentation of the Model, Comparison of Mitigation Scenarios, and Analysis of Assumptions. Prepared for Great Basin Mine Watch. Center for Science in Public Participation, Bozeman MT.

Myers, T., 2000. Environmental and Economic Impacts of Mining in Eureka County. Prepared for the Dept. Of Applied Statistics and Economics, University of Nevada, Reno.

Myers, T., 1999. Water Balance of Lake Powell, An Assessment of Groundwater Seepage and Evaporation. Prepared for the Glen Canyon Institute, Salt Lake City, UT.

Myers, T., 1998. Hydrogeology of the Humboldt River: Impacts of Open-pit Mine Dewatering and Pit Lake Formation. Prepared for Great Basin Mine Watch, Reno, NV.

Select Abstracts, Magazine and Proceedings Articles

Myers, T., 2014. Reservoir Loss Rates, Lakes Mead and Powell and Fill Mead First. INVITED PRESENTATION at 2014 Future of the Colorado Plateau Forum – Drought and the Colorado River. http://musnaz.org/educational-programs/public-programs/future-of-the-colorado-plateau-forums/

Myers, T., 2013. Three-dimensional Groundwater and Contaminant Flow around Marcellus Gas Development. INVITED PRESENTATION at 2013 Associated Engineering Geologists Conference, Seattle WA.

Myers, T., 2012. Mine Dewatering: Humboldt River Update. INVITED PRESENTATION at 2012 Nevada Water Resources Association Annual Conference.

Myers, T., 2012. Reservoir loss rates from Lake Powell, and long-term management of the Colorado River system. 2012 Nevada Water Resources Association Annual Conference

Myers, T., 2011. Reservoir loss rates from Lake Powell, and long-term management of the Colorado River system. 2011 Fall Conference, American Geophysical Union.

Myers, T., 2006. Modeling Coal Bed Methane Well Pumpage with a MODFLOW DRAIN Boundary. In MODFLOW and More 2006 Managing Ground Water Systems, Proceedings. International Groundwater Modeling Center, Golden CO. May 21-24, 2006.

Myers, T., 2006. Proceed Carefully: Much Remains Unknown, *Southwest Hydrology 5(3)*, May/June 2006, pages 14-16.

Myers, T., 2004. Monitoring Well Screening and the Determination of Groundwater Degradation, Annual Meeting of the Nevada Water Resources Association, Mesquite, NV. February 27-28, 2004.

Myers, T., 2001. Impacts of the conceptual model of mine dewatering pumpage on predicted fluxes and drawdown. In MODFLOW 2001 and Other Modeling Odysseys, Proceedings, Volume 1. September 11-14, 2001. International Ground Water Modeling Center, Golden, Colorado.

Myers, T., 1997. Groundwater management implications of open-pit mine dewatering in northern Nevada. In Kendall, D.R. (ed.), Conjunctive Use of Water Resources: Aquifer Storage and Recovery. AWRA Symposium, Long Beach California. October 19-23, 1997

Myers, T., 1997. Groundwater management implications of open-pit mine dewatering in northern Nevada. In Life in a Closed Basin, Nevada Water Resources Association, October 8-10, 1997, Elko, NV.

Myers, T., 1997. Uncertainties in the hydrologic modeling of pit lake refill. American Chemical Society Annual Meeting, Las Vegas, NV, Sept. 8-12, 1997.

Myers, T., 1997. Use of groundwater modeling and geographic information systems in water marketing. In Warwick, J.J. (ed.), Water Resources Education, Training, and Practice: Opportunities for the Next Century. AWRA Symposium, Keystone, Colo. June 29-July 3, 1997.

Myers, T., 1995. Decreased surface water flows due to alluvial pumping in the Walker River valley. Annual Meeting of the Nevada Water Resources Association, Reno, NV, March 14-15, 1995.

Special Coursework

Years	Course	Sponsor
2011	Hydraulic Fracturing of the Marcellus Shale	National Groundwater Association
2008	Fractured Rock Analysis	MidWest Geoscience
2005	Groundwater Sampling Field Course	Nielson Environmental Field School
2004	Environmental Forensics	National Groundwater Association
2004 and -5	Groundwater and Environmental Law	National Groundwater Association