Memorandum
Drain Down Model Predictions – Baseline and Contingency

Drain Down Model Concept and Introduction

The Drain Down Model (DDM) utilized for predictions presented in this memorandum has replaced the Reformulated Mixing Model (RMM), which was developed as a mechanism to estimate or forecast water and constituent of concern (COC) mass balance and exchange within the Large Tailings Pile (LTP) at the Grants Reclamation Project (GRP) site. The DDM incorporates the Brooks and Corey (1964) method to estimate seepage and toe drain rates as described in *Memorandum – Drain Down Model Modifications and Predictions (3/26/2020)*. In conjunction with the updated method for estimating seepage and toe drain rates, the DDM also includes refined estimates of the long-term infiltration rate and an updated mass balance for predicting COC concentrations in the LTP.

Baseline and Contingency Scenarios

With the flushing program ending in 2015 and no future dewatering effort anticipated, the water and COC mass balance in the LTP has been simplified with the input to the LTP limited to a small rate of recharge and the output from the LTP occurring as seepage and discharge to the toe drains. The toe drain discharge is effectively seepage that is intercepted by a drainage system on the periphery of the LTP, and the discharge rates have declined to levels where the operation of pumping systems will likely be terminated by 2022 or 2023. Thereafter, the toe drain discharge will occur as additional seepage reporting to the alluvium.

There is a finite volume of drainable water remaining in the tailings, and that volume is being continually reduced by a declining rate of seepage and toe drain discharge. As that residual drainable water volume is reduced, the long-term composite seepage rate will asymptotically approach the long-term infiltration rate.

The baseline scenario was developed to predict seepage impacts to the alluvium under conditions of an expected infiltration rate with relatively constant COC concentrations in the LTP. For comparison as a very conservative bounding condition or scenario, a prediction was developed with a very large long-term infiltration rate combined with equilibrated COC concentrations in the infiltrate that are dramatically larger than expected concentrations (contingency scenario). Both the baseline and contingency scenarios described in this memorandum also include an abbreviated or modified groundwater restoration program that allows the cover to be completed on the top of the LTP by 2025.

Infiltration Rate Estimation

The infiltration to the pile is currently limited by the presence of interim cover over the top of the pile and final cover on the side slopes, and topography on the top of the pile that limits ponding of water. When the final cover is completed on the top of the LTP, the infiltration rate will be further reduced because the final cover includes a thick compacted clay layer with reclamation topography on the surface of the LTP that results in positive drainage with no ponding of water.

For the baseline prediction described herein, the long-term infiltration rate was estimated at an expected rate of 0.6 gpm. The estimation of this long-term infiltration rate was described in the *Memorandum – Drain Down Model Modifications and Predictions (3/26/2020)*, and a variety of methods and/or references were analyzed or reviewed in developing the estimate of 0.6 gpm. The key factors in limiting the long-term infiltration into the LTP are the semi-arid climate, the presence of a large thickness of compacted clay in the final cover and the creation of a final reclamation topographic surface with positive drainage over the entire LTP. The contingency prediction includes a very conservative estimated long-term infiltration rate of 2.4 gpm, or a factor of four greater than the expected long-term infiltration rate.

Prior to completion of the final cover on the top of the LTP, the infiltration rate through the interim cover is estimated at a conservatively large 4.0 gpm. This interim infiltration rate is considered conservative because there is interim cover on the top of the LTP and the surface has been graded to reduce ponding of water. For the contingency predictions, the LTP cover is assumed to be completed by 2025.

COC Concentration Estimation

The infiltrate through the cover will be fresh water but the COC concentrations in the infiltrate are expected to increase as the infiltrate passes through the partially saturated tailings. These increases may be a result of exchange with less mobile residual water in the partially saturated tailings or geochemical processes that mobilize constituents. For the purposes of the DDM, this equilibration of the infiltrate COC concentrations requires estimation of the "effective" COC concentrations in the infiltrate by the time it is discharged as seepage or mixes with the residual tailings water. The predicted infiltrate COC concentrations described in *Memorandum – Drain Down Model Modifications and Predictions (3/26/2020)* ranged up to 1.26 mg/L for uranium and 0.28 mg/L for molybdenum. For the following baseline predictions, the assumed infiltrate equilibration concentrations were 5.16 mg/L and 12.96 mg/L for molybdenum. These uranium and molybdenum concentrations are the measured average concentrations in the residual tailings solution in 2019, and are very similar to the DDM starting 2015 residual tailings solution concentrations of 5.34 mg/L for uranium and 13.4 mg/L for molybdenum. Therefore, the baseline prediction incorporates estimates of COC concentrations in the LTP that will remain nearly constant at present levels for the foreseeable future. The contingency predictions include a uranium concentration in the infiltrate of 10 mg/L and a molybdenum concentration in the infiltrate of 25 mg/L.

Conservatisms in the Contingency Prediction

There are generally two factors that incorporate a degree of conservatism into the prediction of COC's conveyed to the alluvium in seepage from the LTP for the contingency predictions over that of the baseline predictions. The first of these factors is the estimated long-term infiltration rate. A long-term infiltration rate of 0.6 gpm is considered appropriate or modestly conservative for the LTP with final cover including compacted clay. A long-term infiltration rate estimate of 2.4 gpm is considered very conservative because it is far greater than typical infiltration/recharge rates for similar conditions as described in *Memorandum – Drain Down Model Modifications and Predictions (3/26/2020)*, and it effectively quadruples the long-term COC loading to the alluvium under similar COC concentrations. Nearly all of the infiltration to the LTP is expected to occur on

the top surface of the LTP with very little infiltration expected on the more steeply sloped sides of the LTP. A long-term infiltration rate of 2.4 gpm is equal to approximately 4.3% of the average annual precipitation depth occurring over the top surface of the LTP. While this a moderately high but plausible recharge rate for permeable natural soils with topography that results in ponding, it is dramatically greater than expected recharge to the LTP with a compacted clay cover and reclamation topography specifically intended to shed runoff and limit infiltration.

The second factor in making the contingency predictions very conservative is the estimated COC concentrations in the infiltrate after equilibration during passage through the tailings. The baseline prediction used an infiltrate uranium concentration of 5.16 mg/L (the average concentration in the residual LTP water in 2019) while the contingency prediction used a uranium concentration of 10 mg/L. The corresponding estimated infiltrate molybdenum concentrations were 12.96 mg/L for the baseline prediction and 25 mg/L for the contingency prediction.

The average COC concentrations in the residual water in the saturated tailings have been calculated for several years using annual or more frequent water samples from various tailings wells. The average COC concentrations have a slight downward trend since mid-2015 when the tailings flushing program ended. Prior to mid-2015, there were dramatic reductions in COC concentrations in the LTP attributable to the flushing. There have been no significant increases in observed COC concentrations that would indicate a rebound or increased mobilization of COCs after the flushing ended. The LTP was subjected to nearly 15 years of tailings flushing injection with concurrent flushing by natural infiltration on the top of the LTP. This flushing with water that had much lower COC concentration has likely removed much of the soluble, exchangeable or readily mobilizable COC mass from the partially saturated tailings. Therefore, the assumption that the COC concentrations in infiltrate will equilibrate to levels similar to those measured in 2019 for the baseline predictions is considered reasonable and possibly somewhat conservative. In contrast, the contingency prediction incorporates equilibrated COC concentrations in the infiltrate that are nearly twice the observed average concentrations in 2019, and this is considered very conservative.

A geochemical study of the tailings and alluvial materials was performed by Worthington Miller Environmental LLC (WME, 2020) and included evaluation of the potential for post-flushing rebound of COC concentrations in the LTP. The conclusions of the geochemical study were that no significant rebound is expected based on the results of a controlled column study and the trends in observed volume-weighted COC concentrations for the LTP. This supports the interpretation that the contingency predictions using COC concentrations significantly greater than average observed concentrations in 2019 are conservative.

Baseline and Contingency Predictions

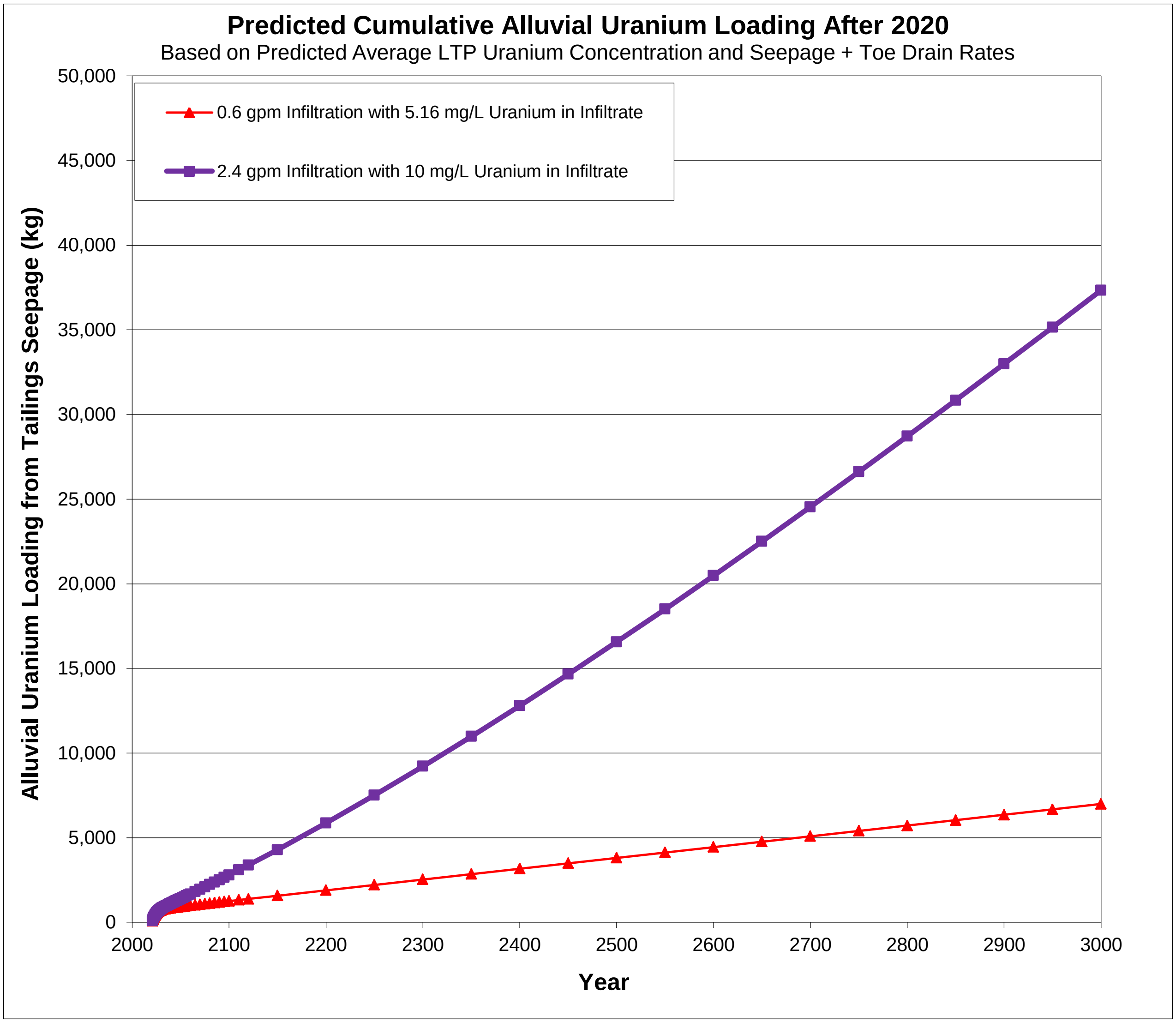
A baseline DDM prediction was developed for the COC's of uranium and molybdenum. The combination of an estimated long-term infiltration rate of 0.6 gpm and an infiltrate COC concentration equal to the average 2019 concentration in the residual LTP water was used for the baseline prediction. A dramatically increased long-term infiltration rate of 2.4 gpm and an infiltrate COC concentration nearly twice that of the average 2019 concentration was used for the contingency prediction.

Uranium Predictions

Figure 1 presents graphs and a tabulation of the seepage and toe drain rates and the predicted uranium concentration in the seepage with time for the baseline scenario. The assumed long-term infiltration rate is 0.6 gpm and the infiltrate is assumed to equilibrate to the 2019 average LTP concentration of 5.16 mg/L. With an average LTP uranium concentration of 5.34 mg/L as the effective starting point for the prediction in 2015, the uranium concentration in the seepage remains relatively constant throughout the prediction period. For previous DDM predictions included in *Memorandum – Drain Down Model Modifications and Predictions (3/26/2020)*, the significantly lower estimated uranium concentration in infiltrate resulted in a downward trend in predicted concentration.

Figure 2 presents graphs and a tabulation of the prediction with an assumed long-term infiltration rate of 2.4 gpm and an assumed equilibration of the infiltrate to 10.0 mg/L uranium. The average LTP uranium concentration of 5.34 mg/L is significantly lower than the assumed infiltrate concentration, and the predicted uranium concentration in seepage from the LTP increases over the period of the prediction. It is very unlikely that uranium concentration in the residual tailings water will continually increase with long-term infiltration of fresh water through the cover for reasons discussed previously, so the prediction is considered extremely conservative.

The graph below presents the cumulative uranium loading to the alluvium by seepage from the tailings after 2020 for the baseline and contingency DDM predictions. As shown, the predicted loading for the contingency prediction with much greater infiltration rate and increased infiltrate uranium concentration is dramatically greater than the baseline prediction with 0.6 gpm of estimated infiltration.

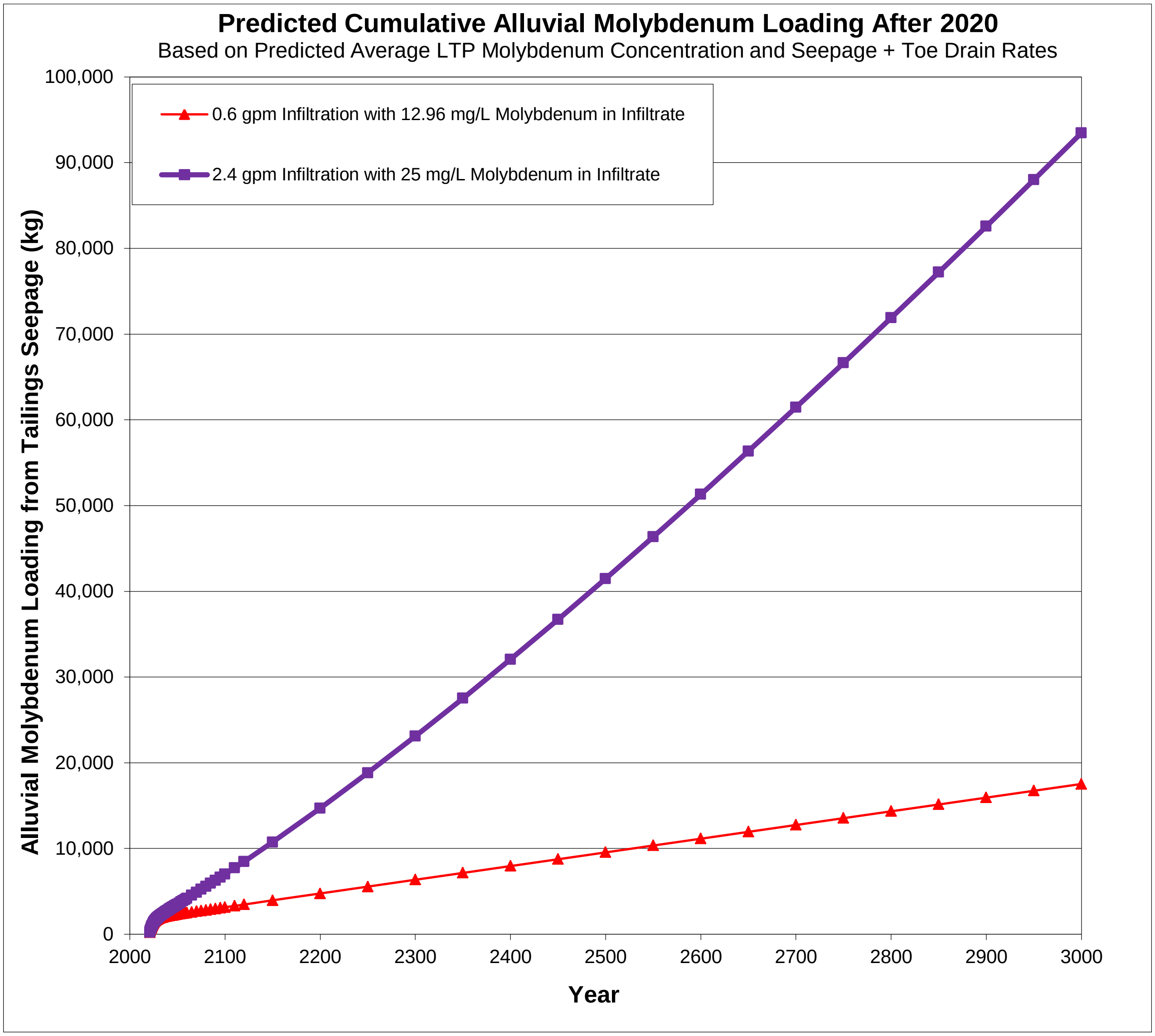


Molybdenum Predictions

Figure 3 presents graphs and a tabulation of the seepage and toe drain rates and the predicted molybdenum concentration in the seepage with time for the baseline prediction. The assumed long-term infiltration rate is 0.6 gpm and the infiltrate is assumed to equilibrate to the 2019 average LTP concentration of 12.96 mg/L. At the effective starting point for the prediction in 2015, the molybdenum concentration in the LTP was 13.40 mg/L so the prediction shows a slight decreasing trend in molybdenum concentration. Like uranium, previous DDM predictions used a much lower molybdenum concentration in the infiltrate resulting in a downward trend in predicted concentrations.

Figure 4 presents graphs and a tabulation of the prediction with an assumed long-term infiltration rate of 2.4 gpm and an assumed equilibration of the infiltrate to 25.0 mg/L molybdenum. With the infiltrate at a much higher estimated molybdenum concentration, the predicted molybdenum concentration in seepage from the LTP increases over the period of the prediction and the prediction is considered extremely conservative to the point of being implausible.

The graph below presents the cumulative molybdenum loading to the alluvium by seepage from the tailings after 2020 for the two DDM predictions. The divergence between the curves for the baseline and contingency predictions is similar to that of uranium with a dramatically greater molybdenum loading at the higher infiltration rate and greater infiltrate molybdenum concentration.



Summary of Model Predictions

The DDM predictions included in the attached Figure 1 and Figure 3 are for the baseline prediction and those in Figure 2 and Figure 4 are for the contingency scenarios with very conservative assumptions. The baseline predictions with assumed uranium or molybdenum concentrations in the infiltrate that are similar to measured average concentrations in 2019 are considered reasonable or modestly conservative. Both the average uranium and average molybdenum concentrations in the LTP have a slight downward trend since 2016 and this is

supportive of the assumption that COC concentrations will either remain relatively steady. The tailings were flushed with nearly two billion gallons of mildly impacted water during the tailings flushing program which ended in 2015. The tailings have also been flushed by natural recharge for the roughly 25 years since regrading of the LTP and coverage of the side slopes was done. Therefore, increases in the COC concentrations in the residual tailings water are unlikely because much of the soluble or mobilizable COC mass in the LTP has been removed.

For the contingency scenario, the assumption of uranium and molybdenum concentrations in the infiltrate that exceed the present average LTP concentrations results in predictions with increasing uranium or molybdenum concentrations in the seepage from the LTP for the foreseeable future (see Figure 2 and Figure 4). Over the roughly 1000 year predictions shown for the 2.4 gpm assumed long-term infiltration rate, more than a billion gallons of infiltrate will have passed through tailings. With this quantity of water flushing the tailings over many years, it is highly improbable that the constituent concentrations in seepage from the tailings would continue to increase. The assumed long-term infiltration rate of 2.4 gpm is also considered conservatively large because modeling and other analyses have indicated the likely infiltration rate for the compacted clay cover with positive drainage over the surface of the LTP is a fraction of a gpm.

Reference

Worthington Miller Environmental, LLC (WME). 2020. Geochemical Characterization of Tailings, Alluvial Solids and Groundwater – Grants Reclamation Project. Prepared for Homestake Mining Company of California. May.