WORKSHOP--PHREEQ-N-AMDTreat model to evaluate water-quality effects from passive and active treatment of mine drainage

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Agenda for Workshop (October 5, 2022, 1 - 3:00 pm):

12:00 pm   Box lunch provided to registered participants

1:00 pm   Overview of PHREEQ-N-AMDTreat water-quality modeling tools (Power Point)

1:40 pm   Overview of AMDTreat 6.0 Beta cost-analysis software (Power Point or
                 YouTube video)

2:00 pm   Break

2:10 pm   Live demonstrations of corresponding cost and water-quality models for
                 example passive and active treatment systems

2:30 pm   Group Q&A

2:40 pm   Hands-on participant trials for provided case studies or their own AMD case

3:00 pm   Adjourn

Abstract for Workshop:

AMDTreat 6.0 Beta (2022) is a newly updated computer application for estimating costs and sizing of facilities to abate acid mine drainage (AMD) through application of passive or active treatment technologies. The software has comprehensive cost-analysis modules for passive systems, including vertical flow pond, oxic or anoxic limestone drains, manganese removal bed, aerobic or anaerobic wetlands, and bioreactors, plus active systems, including caustic soda, soda ash, lime products, hydrogen peroxide, permanganate, polymer, and ancillary components such as decarbonation (aeration), conveyance channels, ponds, and clarifiers. The software provides over 400 user modifiable variables for excavation, construction, revegetation, piping, road construction, land acquisition, system maintenance, labor, water sampling, design, surveying, pumping, sludge removal, chemical consumption, and other functions. The default cost data can be modified to adjust for inflation or site-specific requirements. AMDTreat 6.0 also contains several financial and scientific tools to help select and plan treatment systems. These tools include a long-term financial forecasting module, an acidity calculator, a sulfate reduction calculator, a Langelier saturation index calculator, a mass-balance calculator, and iron oxidation tools, plus an integrated version of the PHREEQ-N-AMDTreat "TreatTrainMix2" water-quality modeling tool (Cravotta, 2020, 2021). The integrated PHREEQ-N-AMDTreat tool incorporates all the other scientific tools into a single program to evaluate potential changes in pH, dissolved metals, and associated solute concentrations resulting through sequential steps of passive and active treatment of AMD.

The integrated PHREEQ-N-AMDTreat (TreatTrainMix2) tool and stand-alone PHREEQ-N-AMDTreat tool sets (CausticTitration.exe, ParallelTreatment.exe, and TreatTrainMix2.exe) utilize PHREEQC equilibrium (aqueous and surface speciation) and kinetics models for gas exchange, iron and manganese oxidation and precipitation, limestone dissolution, and organic carbon oxidation combined with reduction of nitrate, sulfate, and ferric iron. Reactions with caustic chemicals (CaO, $Ca(OH)_2$, $NaOH$, Na_2CO_3) or oxidizing agents (H_2O_2) also may be simulated separately or combined with sequential kinetic steps. A user interface for each stand-alone tool facilitates input of water chemistry and flow data for one or two influent solutions and adjustment of system variables, such as gas-exchange kinetics, abiotic and biological contributions to iron oxidation kinetics, and limestone kinetic properties, without changing the basic PHREEQC coding. Similar adjustments to key variables can be made with the integrated tool. Graphical and tabular output indicates the changes in pH, specific conductance, total dissolved solids, alkalinity, net acidity, metals, and other solute concentrations of treated effluent plus the cumulative quantity of precipitated solids as a function of retention time or the amount of caustic agent added. By adjusting kinetic variables or chemical dosing, the effects of independent or sequential treatment steps that have different retention times (volume/flow rate), aeration rates, quantities of reactive solids, and temperatures can be simulated for the specified influent quality. The size (land area) of a treatment system can be estimated using reaction time estimates for each of the treatment system components considered in the PHREEQ-N-AMDTreat model. Volume for a corresponding treatment step is computed as the product of reaction time and flow rate; area is computed as the volume divided by depth. Alternatively, given the estimated reaction time to achieve the desired effluent quality, the AMDTreat cost-analysis model may be used to compute the size for each system component and the corresponding costs for installation (capital) and annual operations and maintenance (O&M), with summary results for the net present value of the treatment system as a whole. Thus, various passive and/or active treatment strategies can be identified that could potentially achieve the desired effluent quality, but could require different land areas, equipment, and costs for construction and O&M.

References:

AMDTreat 6.0 Beta (2022) https://www.osmre.gov/programs/reclaiming-abandoned-mine-lands/amdtreat

Cravotta, C.A. III (2020) Interactive PHREEQ-N-AMDTreat water-quality modeling tools to evaluate performance and design of treatment systems for acid mine drainage (software download): U.S. Geological Survey Software Release (https://doi.org/10.5066/P9QEE3D5)

Cravotta, C.A. III (2021) Interactive PHREEQ-N-AMDTreat water-quality modeling tools to evaluate performance and design of treatment systems for acid mine drainage: Applied Geochemistry, v 126, 10845 (https://doi.org/10.1016/j.apgeochem.2020.104845)

AMDTreat 6.0 Beta and PHREEQ-N-AMDTreat Software Access and Installation:

AMDTreat 6.0 Official Web page:

The official web page for AMDTreat 6.0 has links for download of the AMDTreat software, help files, tutorial videos, bug list, and other relevant information.
AMDTreat | Office of Surface Mining Reclamation and Enforcement (osmre.gov)
https://www.osmre.gov/programs/reclaiming-abandoned-mine-lands/amdtreat

AMDTreat 6.0 tutorials, YouTube by AMDTreat team members available online.
https://www.youtube.com/playlist?list=PL-UVrc-RbMgT-Le9ITND0kenZG2muGvFl

Important:

Prior to installing and running AMDTreat Beta 6.0 or PHREEQ-N-AMDTreat software packages, the following prerequisites must be installed:

- Microsoft .NET Framework 4.8 (x86 and x64) Download here

- Install both 32- and 64-bit versions of IPhreeqcCOM Modules:
  IPhreeqcCOM-3.7.3-15968-win32.msi
  IPhreeqcCOM-3.7.3-15968-x64.msi

Administrative privileges may be required to install the above pre-requisites.

Next, the zip files, below, that include the AMDTreat 6.0 Beta and PHREEQ-N-AMDTreat software need to be downloaded and extracted to your computer.

PHREEQ-N-AMDTreat and AMDTreat 6.0 Software for download:

AMDTreat 6.0 Beta and the stand-alone PHREEQ-N-AMDTreat software packages that complement the integrated tool in AMDTreat 6.0 are available at the ftp link below:
ftp://ftpext.usgs.gov/pub/er/pa/new.cumberland/cravotta/

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PHREEQ-N-AMDTreatFiles_2021_v1.4.5.zip	*TreatTrainMix2.exe, ParallelTreatment.exe, and CausticTitration.exe tools.*
PHREEQ-N-AMDTreat+REYsFiles_2022_v1.0.1.zip	*TreatTrainMix2REYs.exe and CausticTitrationMix2REYs.exe tools include rare-earth and selected trace elements.*
AMDTreat 6.0 Beta Release_cac.zip	*Same as AMDTreat 6.0 Beta at OSMRE web page but includes all currently available help files in pdf.*

To access any of the above zip files on ftp: Use Windows Explorer to open any folder (e.g. Documents) on your computer. Copy the above ftp link and paste it into the Documents folder address bar, then hit return. Contents of the ftp folder should now show. Copy the selected files and paste on your computer. Administrative privileges should not be needed.

Once downloaded, users should unzip or copy contents of the AMDTreat 6.0 Beta.zip to a user directory on their local computer, and then find the file called **AMDTreat 6.0 Beta.exe** and double click on it to run. The screenshot below shows the directory tree that will be created and the location of the executable file.
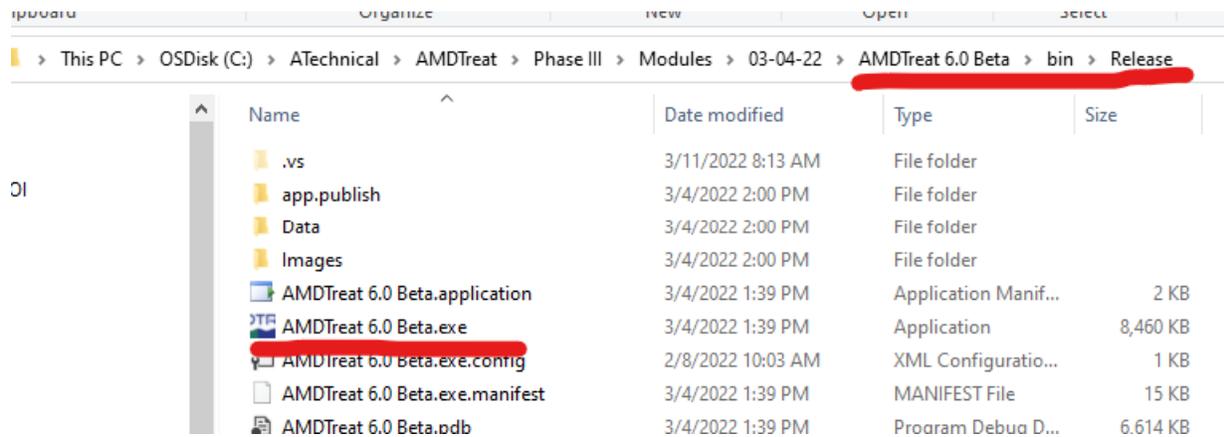
Optional – create a shortcut to the executable program on your desktop:

Navigate to the directory where installed and find the file named AMDTreat 6.0 Beta.exe. Right click on the file and select "send to" from the menu and choose "Desktop". You can now run the program from this icon that has been created on your desktop