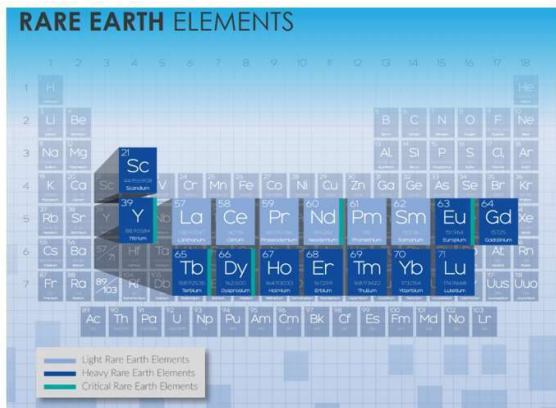


### Rare Earth Elements (REEs) – What Are They?

Rare earth elements – while not actually all that rare at all, existing on every continent in very small amounts – are 18 of the transition metals from the Periodic Table (PT). They comprise the Lanthanide and Actinide series, the elements that are typically printed below the PT. In addition to the Lanthanides and Actinides, the two transition metals preceding them in the PT, Scandium and Yttrium, are also considered to be part of the REEs. These Critical Metals are in many new technology platforms and many renewable energy sources.

Unfortunately, only one current US resource exists at Mountain Pass, California. Ore mined from that location is shipped to China for REE extraction. China, with a market share of over 90%, and Australia dominate the global supply of REEs, which leaves the US in a vulnerable strategic position moving forward – so much so that the US Department of Energy and US Department of Defense has indicated that these are critical items to the Nation’s National Security!



Graphic courtesy of NETL

### REEs in Coal and Coal By-Products

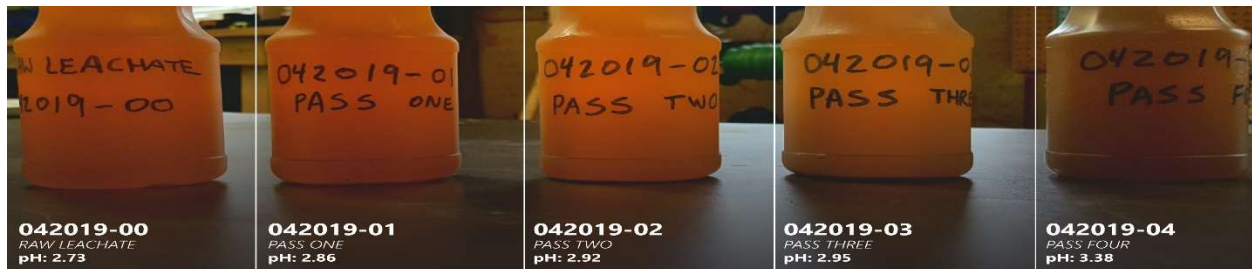
REEs have been known to exist in Coal and Coal By-Products for over 30 years but there has been no commercial development of the resource. That is where we at Epic Element Recovery (Epic) look to interject our new extraction method. Our process focuses on Acid Mine Drainage (AMD) and coal refuse; it is economical and environmentally benign.

The AMD, where we begin the concentration and extraction process, has small amounts of all 18 REEs dissolved in it (along with other critical metals like nickel, cobalt and others). We seek sites such as deep-mine seals, tipples/loadout/cleaning plant runoff sites and coal refuse pits as our source water because of the unique chemical characteristics of the AMD that is generated by these specific locations.

The second piece to the puzzle is the coal refuse, which is the low-value partings generated when coal is cleaned. This feedstock can have Total REE (TREE) concentrations of over 1,000 mg/kg, depending on the site. TREE concentrations in reuse (or partings) have been noted by USGS, and other surveys, to exceed any other coal products such as whole coal and/or coal fly ash in TREE concentration.

### Concentrating the REEs – the Epic Recovery Process

While exciting that REEs and Critical Metals exist in AMD and coal refuse, the key is the release of these REEs into some usable/recoverable form. The Epic Process is where the intrinsic value in both of these raw feedstocks can be released.



**5-Pass PLS from Epic Process**  
Raw AMD 0.36 mg/L TREE; Pass 4 PLS 9.1 mg/L TREE

First, we ionically-concentrate the AMD into a retentate water and a discharge water (i.e. clean water, NPDES-compliant) essentially free of ionic species. The retentate is an ideal REE leaching fluid because the concentrations of cations such as iron, aluminum and manganese and anions such as sulfate provide ionic “swapping” points for REEs when used as a leaching fluid irrigated over the refuse.

In the leaching process, the REEs are “pulled” from their ionic bonds in the refuse and swapped out for the dissolved iron, aluminum and manganese in the retentate thereby enriching the leaching fluid with the REEs. This can be done in a single stage or multiple stages with retentate recirculation.

We increase the concentration of the REEs in the retentate to a given level, typically 3 to 10 times that of the initial pre-leached retentate, to create a pregnant liquor solution, or PLS. This PLS is pulled off (in continuous fashion) as the final product of the Epic Process. The PLS can then be taken to any typical downstream process, like solvent extraction, for further refinement to REE oxides or metals. Shown below is a graphical representation of our REE leaching process:

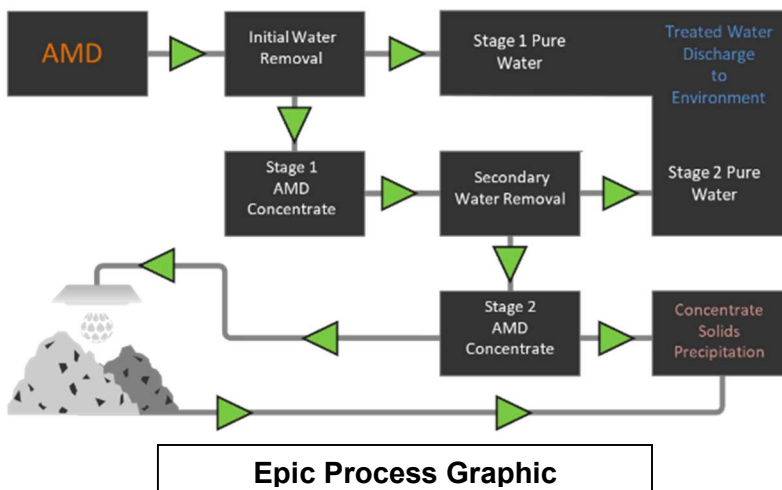
### Why is this different and better?

Previous efforts into REE extraction from AMD and coal refuse have focused on the AMD treatment “sludge”.

To extract REEs from sludge is a chemically intensive process and requires significant acid usage to break the oxide-hydroxide bonds created when AMD is treated with alkaline chemicals. This process ends up recreating the AMD in aqueous form as a PLS, essentially using chemical to create the sludge and then using chemicals to recreate the AMD.

Compare that to the Epic Process where we skip the “adding alkaline chemicals” step. We go straight from raw AMD to PLS – a significant process change! Our discharges are all better environmentally as well; the AMD is remediated and the “cleaned” water is discharged to the environment, the refuse’s acid-generating capacity is greatly reduced because retentate “burns out” the acid generating components of the refuse, and the PLS is the valuable product at the end of the chain. This technology stands to disrupt the current status-quo for an operator and provide a new revenue stream.

It is estimated that in Pennsylvania alone, enough Neodymium exists in AMD and refuse to satisfy the TOTAL US DEMAND per year! These significant findings are not just borne out by our own internal research but also presented in research done by the USGS, the Department of Energy, and the Department of Defense. The Epic Process is a cost effective and environmentally safe way to achieve the first step of Critical Material independence for the United States!



### For More Information Contact:

Mike McCluskey, Member & CTO  
[www.epicelementrecovery.com](http://www.epicelementrecovery.com)  
[mike@epicelementrecovery.com](mailto:mike@epicelementrecovery.com)  
 814-445-4491