Exhibit A: Project Description
(Scope of Work, Special Requirements)

Project Title: Recovery of Metal Contaminants from Industrial Wastewaters with Magnetic NanoComposites in a Novel Continuous Flow Process System

In Montana, remediation is needed at hundreds of acid rock drainage (ARD) sites that exist throughout the state, and the burgeoning manufacturing industry is expected to produce aqueous effluents that require continuous treatment to avoid release of contaminants. Thus, contamination of surface and ground waters by heavy metals remains one of the most important issues facing the state of Montana. The recent accidental release of contaminated waters into the Animas River in the Southwestern US exemplifies a situation that must be prevented in Montana. This proposal builds on parent technology developed at UM, which is currently in use industrially and has proven to be suitable for scale-up. The proposed project will take the original IP to a new level, resulting in a new product that couples metal-selective magnetic nanoparticles with a novel, mechanically simple and relatively inexpensive aqueous processing system (a "pipeline reactor") that will allow rapid continuous extraction of valuable and/or toxic metals from a broad range of contaminated industrial effluents, surface waters, and ground waters and provide a cost-effective alternative to the less flexible technologies in use today. The coupling of the pipeline reactor with the magnetic composites represents a powerful and innovative technology. Ultimately, the technology could be applied to a wide variety of industrial manufacturing wastewater streams—extracting marketable products while cleaning the wastewater to a more acceptable level for release.

Ion exchange (IX) is a commercially proven technique for transferring dissolved metals from an aqueous solution to a specific binding agent that is immobilized on a polymer or composite substrate. IX is especially well-suited to treatment of relatively dilute metal concentrations found in wastewater because it can be sequentially staged to attain more complete capture metals from solution. The proposed project will investigate the feasibility of combining state-of-the-art IX resins, novel substrate materials, and an innovative IX system design to recover resources. The process concept involves flowing the fluid through a novel pipe reactor to continuously extract metal contaminants. Wastewater is pumped through the reactor along with IX resin that has been implanted on the surface of very small magnetic particles. When energized, the electromagnets positioned on the pipe reactor capture and retain the magnetic particles without impairing fluid flow. The captured metals are subsequently eluted to produce a concentrated high-purity metal solution that is suited for a conventional metal-recovery process such as electrowinning.

The project goal is to develop the chemistry of the magnetic nanoparticles for metal recovery and optimize their utilization in the pipeline reactor. The benefit of this technological coupling is that it can be readily scaled to the size needed for commercial implementation.

1. Identify candidate wastewater streams in Montana, obtain and characterize representative samples, and develop site-specific neutralization curves.
2. Develop resin and magnetic substrates tailored for selected metals extraction.
3. Optimize operating parameters through computational modeling and bench-scale experimentation.
4. Evaluate electrowinning as a means of producing commercially saleable commodities.