APPENDIX B.-CYANIDE DETOXIFICATION REGULATIONS

CYANIDE TOXICITY AND CHEMISTRY

A discussion on cyanide detoxification regulations is not complete without providing some background on cyanide toxicity and chemistry. A basic understanding of cyanide toxicity and how cyanide chemically interacts in the environment are prerequisites to understanding if cyanide detoxification requirements are appropriate for heap leach operations. The following discussion is not intended to be a treatise on cyanide toxicity and chemistry, but it will provide some basic data on these topics.

The chemistry of cyanide is complex. Cyanide can exist as a gas adsorbed on solid matrices, or dissolved in aqueous solutions. Cyanide and cyanide-related compounds can also exist in cyanide leach solutions as molecular hydrogen cyanide, free cyanide ions, thiocyanate, various metal complexes, and cyanate. Each of these compounds is subject to a variety of mechanisms that control its fate and transport in the environment.

To understand information about cyanide toxicity and chemistry requires a rudimentary understanding of the terminology used to refer to cyanide and cyanide compounds. Table B-1 presents a listing of cyanide definitions often used in discussions about toxicity and regulations. The definitions are based on analytical techniques used to determine cyanide concentrations in solutions.

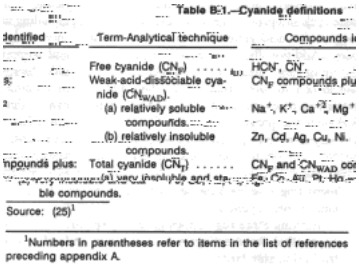

Table B-1.–Cyanide definitions

dentified	Term-Analytical technique	Compounds i
	Free cyanide (CN_f)	HCN, CN^-
9)	Weak-acid-dissociable cyanide (CN_{WAD}).	CN_f compounds plu
2	(a) relatively soluble compounds.	Na^+, K^+, Ca^{+2}, Mg^+
	(b) relatively insoluble compounds.	Zn, Cd, Ag, Cu, Ni.
hpounds plus:	Total cyanide (CN_T)	CN_f and CN_{WAD} co
	(a) very insoluble and stable compounds.	Fe, Co, Au, Pt, Hg

Source: (25)[1]

[1]Numbers in parentheses refer to items in the list of references preceding appendix A.

Free cyanides are the most toxic and unstable forms of cyanide and include simple cyanide compounds. Free cyanides are referred to as "ephemeral toxins" because they are transient and tend to form more stable and less toxic compounds rapidly in ambient conditions. Free cyanides are rapidly detoxified using natural and chemical degradation processes. The analytical technique for determining free cyanide is subject to interference from thiocyanates, sulfates, oxidizing agents, nitrates, urea, and other organic compounds.

As shown in table B-1, WAD (weak-acid-dissociable) cyanides include all of the free cyanides as well as most simple cyanide complexes that are less toxic and more stable than free cyanides. WAD cyanides as a group can be detoxified using natural and chemical detoxification methods, however, they do not react as readily as the free cyanide components of the WAD cyanides. Of all cyanide analyses, WAD cyanide analyses are least effected by interferences and more reliable.

Total cyanides include cyanides detected with the WAD cyanide and free cyanide analyses, as well as cyanide compounds that are less toxic and more stable than WAD cyanides. By and large, the additional compounds detected with the total cyanide analysis can be considered stable under ambient conditions and react to a few aggressive chemical and natural detoxification processes. Total cyanide analysis is subject to interference from