WHARF EXPANSION PROJECT

MINE PERMIT APPLICATION

Revision 1.0

Topical Report RSI-2184

Prepared in conjunction by

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LIST OF ABBREVIATIONS

ABA	acid base accounting
ADB	air-dry basis
AGP	acid generation potential
ANP	acid neutralization potential
ARD	acid rock drainage
ARSD	Administrative Rules of South Dakota
BHM	Black Hills Meridian
BHP	Black Hills Power
BKS	BKS Environmental Associates, Inc.
BLM	Bureau of Land Management
Cdlc	Lower Deadwood
CUP	Conditional Use Permit
dB	decibels
DTH	down-the-hole
EC	electrical conductivity
EPA	U.S. Environmental Protection Agency
ERM	Environmental Resources Management Consultants
GF&P	Game, Fish and Parks
GPM	gallons per minute
GWD	Groundwater Discharge Permit
HCN	hydrogen cyanide
hivol	high volume
HSC	Highway Service Commercial
JMM	J.M. Montgomery Engineers Inc.
lbs/ton	pounds per ton
$\mu g/m^3$	micrograms per cubic meters
ml	milliliters
mph	miles per hour
mg/L	milligrams per LITER
MT	million tons
MSHA	Mine Safety and Health Administration
MW	monitoring well
MWMP	meteoric water mobility pathway
MWMT	Meteoric Water Mobility Test
NESHAP	National Emissions Standard for Hazardous Air Pollutants
NNP	net neutralization potential
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places

LIST OF ABBREVIATIONS
(Continued)

PAG	Potential Acid Generating
PF	Park Forest District
PFR	Park Forest Residential
pls/acre	pure live seed per acre
POP	Perimeter of Pollution
ppm	parts per million
PVC	polyvinyl chloride
QA	quality assurance
RUC	reverse circulation
SAR	sodium adsorption ratio
SARC	State Archaeological Research Center
SD BME	South Dakota Board of Minerals and Environment
SDCL	South Dakota Codified Law
SD DENR	South Dakota Department of Environment and Natural Resources
SD DOT	South Dakota Department of Transportation
SD GFP	South Dakota Game, Fish, and Parks
SDNHP	South Dakota Natural Heritage Program
SHM	Special Handling Material
SRD	Suburban Residential
SWD	surface water discharge
TDS	total dissolved solids
TSP	total suspended particulates
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WAD	weak acid dissociable

1.0 APPLICATION

The contents of this document were prepared to address the requirements of Title 74, Article 29 of the Administrative Rules of South Dakota (ARSD). Completeness of this document was addressed pursuant to ARSD 74:29:02:01. Copies of the application were submitted to the South Dakota Department of Environment and Natural Resources (SD DENR) pursuant to South Dakota Codified Law (SDCL) 45-6B-5 and 45-6B-15. Copies of the application have also been provided to the other South Dakota state governmental agencies, federal agencies, and the local conservation district as described in ARSD 74:29:01:04 (1, 2, and 3 [a-g]). Proof of filing with the Lawrence County Register of Deeds office will be provided to the SD DENR upon receipt. Appendix 1 contains permit application forms, proof of submission forms, proof of consultation with adjacent landowners, approval of consultants, instruments of consultation, and commitments from public agencies.

Pursuant to SDCL 4-6B-32 (1-8), Wharf Resources (U.S.A.), Inc. (Wharf) submits the following:

1. As all applicable codes and rules have been addressed in this application, Wharf considers it to be complete, and the required surety will be posted on acceptance of the permit application and just before issuance of the permit.
2. The Large-Scale Mining Permit application fee of $50,000 was paid by Wharf, check number 104262, dated February 3, 2011. A copy of the check is included with the application form in Appendix 1.
3. No part of the proposed mining operation, the reclamation program, or the proposed future use is contrary to the laws and regulations of this state or of the United States.
4. This mining operation, including the temporary haul road from Golden Reward to Wharf Resources, will not adversely affect the stability of any significant, valuable, and permanent man-made structures located within 200 feet of the affected land, including the Terry Cemetery (see Section 3.10.3). State Highway 473 and Stewart Lodge Road will be modified but remain stable. Also, a small outbuilding owned by Black Hills Chairlift Company, located on the eastern side of Terry Peak, will be torn down as approved by Black Hills Chairlift Company. The Lead Fire Department has a building used for firefighting equipment that is located within 500 feet of the proposed permit boundary, and blasting will be conducted so not to incur vibration or shock onto the structure (Section 3.10.3).
5. The proposed mining operation is not in violation of any county zoning or subdivision regulations. The area is zoned Park Forest District (PF) and Suburban Residential (SRD). Pursuant to Lawrence County Comprehensive Plan Section 5.11.6A.2, “Extractive industry and associated activities and facilities may be allowed in all zoning districts, subject to the provisions and regulations set forth in this section.” The

Lawrence County Planning Board and County Commission approved a large-scale extractive industry Conditional Use Permit (CUP) for Wharf Resources' Expansion Project on June 14, 2011 (included in Appendix 1). Wharf is also aware the county needs to approve the postmining land uses including industrial and home sites.

6. The proposed mining operation and reclamation can and will be carried out in conformance with the requirements of SDCL 45-6B-35.

7. Wharf Resources has no outstanding violations. However, there are areas in Wharf's existing process area where nitrate levels exceed the groundwater standard of 10 milligrams per liter (mg/L). These areas are not covered under any existing Ground Water Discharge Permit Perimeter of Pollution (POP). Wharf has, however, taken actions to identify and remove the potential sources of nitrate contamination and is engaged in an active remediation strategy to clean up the affected areas (see Section 3.3.2.2 of this report).

8. The land under application is suitable for a mining operation, as determined pursuant to SDCL 45-6B-33. The land was previously mined by underground and surface methods beginning in the late 1800s and continued on a somewhat sporadic basis until 1959.

9. This application provides for a continuation of current operations to include 298 total disturbance acres, comprised of 249 acres of mining areas; 30 acres for topsoil stockpiles; and 19 acres for haulage routes, roads, and facilities. Approximately 189 of these acres are located within the Golden Reward permitted mine area. Wharf Resources (Wharf and Golden Reward) currently has five active State Mining Permits (Permit Nos. 356, 434, 435, 450, and 464). The operation will require modification of an existing state road, State Highway 473, as well as reorganization of utilities that service the communities surrounding Terry Peak.

10. The additional mine areas will provide approximately 7 years of continuation of the current permitted life of the Wharf Mine. Wharf will mine between 10 and 15 million tons of ore and rock per year. The work force of 155 direct employees will remain consistent. Reclamation of the affected areas will be conducted pursuant to the enclosed plan and ARSD 74:29:07.

11. Reclamation will be concurrent with mining where practicable and final reclamation efforts should be complete within 3 to 4 years of the cessation of the mining/leaching (Section 6.8).

1.1 STATEMENT OF PROCEDURAL COMPLETENESS

This permit application includes items required under SDCL 45-6B and ARSD 74:29. Tables 1-1 and 1-2 list the applicable South Dakota Codified Laws and Administrative Rules of South Dakota along with the section of this permit application that fulfills the statute and regulations.

Table 1-1. South Dakota Codified Law (Page 1 of 4)

Statute	Information Required	Permit Application Reference
SDCL-45-6B-4	Local government permits	Section 2.1
SDCL-45-6B-5 (1)	Application for permit–form/copy	Volumes I, II, III
SDCL-45-6B-5 (2)	Reclamation Plan	Chapter 6.0
SDCL-45-6B-5 (3)	Map of affected land	Exhibit 3, Appendix 2
SDCL-45-6B-5 (4)	Application fee	Submitted with application
SDCL-45-6B-5 (5)	Postclosure Plan	Section 6.10.2
SDCL-45-6B-6 (1)	Legal description and area of affected land	Chapter 2.0 and Appendix 3
SDCL-45-6B-6 (2)	Owner of the surface area of affected land	Section 2.2 and Appendix 3
SDCL-45-6B-6 (3)	Owner of the substance to be mined	Section 2.2 and Appendix 3
SDCL-45-6B-6 (4)	Applicant's legal right to enter and mine	Section 2.2 and Appendix 3
SDCL-45-6B-6 (5)	Applicant's legal right to dispose of tailings	Section 5.4
SDCL-45-6B-6 (6)	Address and telephone number of the general office and local address and telephone number of applicant	See application form in Appendix 1
SDCL-45-6B-6 (7)	Minerals to be extracted and milled	Section 1.2, application form in Appendix 1
SDCL-45-6B-6 (8)	Description of method of mining and milling	Section 3.10.3, and Sections 5.2 through 5.3.4
SDCL-45-6B-6 (8) a	Contour basis of mining operation	Section 5.3.4
SDCL-45-6B-6 (8) b	Depth and direction of mining	Section 5.3.4
SDCL-45-6B-6 (8) c	Disposition of mine spoil and tailings	Sections 5.3.6 and 5.4
SDCL-45-6B-6 (8) d	Method of blasting and control thereof	Section 3.10.3
SDCL-45-6B-6 (9)	Size of the area to be worked at one time	Section 5.2
SDCL-45-6B-6 (10)	Timetable of proposed duration of mining operation	Section 5.3.4 and Table 6-4
SDCL-45-6B-6 (11)	Written consent to grant access to the Board of Minerals and Environment	See application form in Appendix 1
SDCL-45-6B-7	Reclamation Plan	Section 6.0
SDCL-45-6B-7 (1)	Description of reclamation types	Section 6.2
SDCL-45-6B-7 (2)	Standard soil survey	Section 3.2, Appendix 5
SDCL-45-6B-7 (3)	Vegetative survey	Section 3.6, Appendix 9
SDCL-45-6B-7 (4)	Preliminary wildlife study	Section 3.7, Appendix 10
SDCL-45-6B-7 (5)	Characteristics of affected land of historic, archaeological, geologic, scientific, or recreational significance	Sections 2.3, 3.1, 3.9, and 4.6
SDCL-45-6B-7 (6)	Description of implementation plan of Reclamation Plan to meet requirements of SDCL 45-6B-37 to SDCL 45-6B-46	Section 6.2
SDCL-45-6B-7 (7)	Description of how the Reclamation Plan will rehabilitate the affected land	Sections 5.3.4 and 6.2

Table 1-1. South Dakota Codified Law (Page 2 of 4)

Statute	Information Required	Permit Application Reference
SDCL-45-6B-7 (8) (a) and (b)	Map of all the proposed affected land	Exhibits 3, 21, and 23 in Appendix 2
SDCL-45-6B-7 (9) (a–mm)	Baseline water quality and level of aquifers	Sections 3.3 and 3.4, Appendices 6 and 7
SDCL-45-6B-7 (10)	Location of proposed reservoirs, tailings ponds, tailings disposal sites, dams, dikes, and diversion canals	Exhibits 21 and 28 in Appendix 2
SDCL-45-6B-7 (11)	Provisions for stripping, storage, and replacement of overburden and topsoil	Sections 5.3.3 and 6.4
SDCL-45-6B-7 (12)	Estimated cost of implementing and completing the proposed reclamation	Section 6.10.1
SDCL-45-6B-8	Identification of previously mined land	Exhibits 30 and 31 in Appendix 2
SDCL-45-6B-9	Reclamation not required for underground mining before July 1, 1980.	Section 6.1, Exhibit 30 in Appendix 2
SDCL-45-6B-10	Accurate map of affected area	See below
SDCL-45-6B-10 (1)	Identify the area corresponding with application	Exhibit 2
SDCL-45-6B-10 (2)	Show adjoining surface owners of record	Exhibit 3
SDCL-45-6B-10 (3)	Map scale not more than 1:25,000	Scale about 1:6,000
SDCL-45-6B-10 (4)	Show water wells, creeks, roads, buildings, pipelines, power and communication lines on and within 200 feet of all boundaries of affected land	Exhibits 2, 3, 22, and 23 in Appendix 2; Appendix 6
SDCL-45-6B-10 (5)	Show total area involved in operation	Exhibit 2
SDCL-45-6B-10 (6)	Indicate on map or by statement the general type, thickness, and distribution of soil	Section 3.2, Appendix 5
SDCL-45-6B-12	Instrument of consultation from the surface landowner if different from mineral owner (permission to enter and commence operations and written receipt of operating and Reclamation Plans)	Section 2.2, Appendix 3
SDCL-45-6B-14	Application fee	Appendix 1
SDCL-45-6B-15	Copy of application with SD DENR and Lawrence County Register of Deeds	Appendix 1, proof of submission will be forwarded upon receipt
SDCL-45-6B-19	Confidential information	Section 6.10.1 and Appendix 12
SDCL-45-6B-32 (1→8)	Compliance with this chapter	Chapter 1.0
SDCL-45-6B-33 (1→6)	Statement land is suitable for mining	Chapter 1.2
SDCL-45-6B-33.1 (1→6)	Socioeconomic impact study	Chapter 4.0, Appendix 15
SDCL-45-6B-33.3	Special, exceptional, critical, or unique land	Section 2.3

Table 1-1. South Dakota Codified Law (Page 3 of 4)

Statute	Information Required	Permit Application Reference
SDCL-45-6B-37	Grading final topography appropriate to final land use	Sections 6.7 and 6.9.2, and Exhibits 23 through 26 in Appendix 2
SDCL-45-6B-38	Disposal of refuse	Sections 5.3.6, 6.2.1, and 6.6
SDCL-45-6B-39	Revegetation	Sections 6.5 and 6.9.1
SDCL-45-6B-40	Overburden removal and topsoil storage and protection	Section 5.3.3
SDCL-45-6B-41	Minimize disturbance to prevailing hydrologic balance	Sections 3.3.4, 3.4.3, and 3.4.4
SDCL-45-6B-42	Protection of areas outside of affected land	Sections 5.2, 5.3.1, and 6.7.1
SDCL-45-6B-43	Stabilization of affected land-control erosion and air and water pollution—noxious weed control	Sections 5.3.3 and 6.6
SDCL-45-6B-44	Reclamation Plan developed by the operator, department, and landowner	Chapter 6.0, Appendix 16
SDCL-45-6B-45	Choices of reclamation	Chapter 6.0 through Section 6.2.2.4
SDCL-45-6B-46	Time for completion of reclamation plantings	Section 6.5
SDCL-45-6B-91	Detailed Postclosure Plan	Section 6.10.2
SDCL-45-6B-91 (1)	Treatment of tailings	Sections 5.4 and 6.10.2.5
SDCL-45-6B-91 (2)	Operation of monitoring systems	Section 6.10.2
SDCL-45-6B-91 (3)	Inspection and maintenance activities to ensure compliance with reclamation design and operating criteria	Section 6.10.2
SDCL-45-6B-91 (4)	Procedures for maintaining the final cover, erosion and fugitive dust	Section 6.10.2.4
SDCL-45-6B-92	Description of all critical resources	See below
SDCL-45-6B-92 (1)	Wildlife	Section 3.7, Appendix 10
SDCL-45-6B-92 (2)	Aquatic resources	Section 3.8, Appendix 11
SDCL-45-6B-92 (3)	Vegetation	Section 3.6, Appendix 9
SDCL-45-6B-92 (4)	Water: direct or indirect sources of drinking water	Sections 3.3 and 3.4, Appendices 6 and 7
SDCL-45-6B-92 (5)	Visual resources	Section 3.11, Appendix 14
SDCL-45-6B-92 (6)	Soils	Section 3.2, Appendix 5
SDCL-45-6B-92 (7)	Cultural resources	Section 3.9, Appendix 12
SDCL-45-6B-92 (8)	Air quality	Section 3.5
SDCL-45-6B-92 (9)	Noise	Section 3.10, Appendix 13
SDCL-45-6B-92 (10)	Special, exceptional, critical, or unique lands	Section 2.3
SDCL-45-6B-96	Additional permits	Section 1.4
SDCL-45-6B-104	Spearfish Canyon—surface mining prohibition	Not applicable

Table 1-2. Administrative Rules of South Dakota (Page 1 of 4)

Regulation	Information Required	Permit Application Reference
ARSD 74:29:01:03	Presubmission meeting	December 21, 2010
ARSD 74:29:01:04	Proof of submission of application to Register of Deeds, SD DENR, Game, Fish and Parks (GF&P), Department of Agriculture, Department of Education and Cultural Affairs, Bureau of Land Management (BLM), Department of Health	Appendix 1, proof of submission will be forwarded upon receipt
ARSD 74:29:01:17	Permit area boundaries	Exhibit 3 in Appendix 2
ARSD 74:29:01:17 (1)	County Cooperational Use Permit (CUP) area boundary	Exhibit 3 in Appendix 2
ARSD 74:29:01:17 (2)	Legal right to mine	Section 2.2
ARSD 74:29:01:17 (3)	Location of permit boundary in relation to scenic and unique land	Section 2.3, Exhibit 3 in Appendix 2
ARSD 74:29:01:17 (4)	Ratio of proposed permit area to affected land	Chapter 2.0
ARSD 74:29:02:02	Local zoning requirements	Section 2.1
ARSD 74:29:02:03	Surface and mineral owners	Section 2.2, Exhibit 3 in Appendix 2, Appendix 3
ARSD 74:29:02:04	Mining and milling methods	Sections 5.2 through 5.3.4, 5.5, 5.6
ARSD 74:29:02:04 (1)	Mining and milling methods	Sections 5.2 through 5.3.4, 5.5, 5.6
ARSD 74:29:02:04 (2)	Description and maps of premining and postmining contours	Sections 5.3 and 5.4; Exhibits 2 and 23 in Appendix 2
ARSD 74:29:02:04 (3)	Description of proposed depth and direction of mining and representative cross sections	Section 5.3.4, Exhibits 23 through 26
ARSD 74:29:02:04 (4)	Map of proposed spent ore disposal, waste facilities, ore stockpiles, and other mine spoil	Exhibits 2 and 21 in Appendix 2
ARSD 74:29:02:04 (5)	Stability analysis for all critical earth structures	Sections 5.2 and 6.7.1
ARSD 74:29:02:04 (6)	Description of proposed blast procedures and mitigation program for fugitive dust, noise, and potential structural or stability damage outside the permit area	Sections 3.10.2 and 3.10.3, Exhibit 19 in Appendix 2, Appendix 13
ARSD 74:29:02:05	Timetable with narrative description of existing plans for future exploration and mining in the area of the proposed operation	Section 3.1.2, Table 6-4

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Regulation	Information Required	Permit Application Reference
ARSD 74:29:02:06	Historic or archaeologic significance	Section 3.9
ARSD 74:29:02:07	Water-quality and water-level data	Sections 3.3 and 3.4, Appendices 6 and 7
ARSD 74:29:02:08	Reclamation costs	Section 6.10.1 (confidential) and Table 6-5
ARSD 74:29:02:09	Permit area boundary—map requirements	Appendix 2
ARSD 74:29:02:10	Revegetation	Section 6.5
ARSD 74:29:02:11	Effect on hydrologic balance on surface and groundwater	Sections 3.3 and 3.4, Appendices 6 and 7
ARSD 74:29:02:11 (1)	Baseline surface and groundwater reports	Appendices 6 and 7
ARSD 74:29:02:11 (2)	Representative geologic cross sections	Exhibits 5 through 7 in Appendix 2
ARSD 74:29:02:11 (3)	Surface water inventory map	Appendix 6 (Figure 2-2) and Appendix 7 (Figure 2-1 and plate in Appendix H)
ARSD 74:29:02:11 (4)	Well location inventory map	Appendix 6 (Plate 1)
ARSD 74:29:02:11 (5)	Potentiometric surface map	Exhibit 20 in Appendix 2
ARSD 74:29:02:11 (6)	Geochemical characterization of ore and waste rock	Section 3.1.3, Appendix 4
ARSD 74:29:02:11 (7)	Surface and groundwater monitoring plan for life of mine	Sections 3.3.1 and 3.4.1
ARSD 74:29:02:11 (8)	Meteorologic monitoring plan	Section 3.5.6
ARSD 74:29:02:11 (9)	Drainage, erosion, and sedimentation control plan	Section 5.3.5, Exhibit 28 in Appendix 2
ARSD 74:29:02:11 (10)	Chemicals in the milling process – proposed methods to monitor and collect leaks and spills and a spill contingency plan	Sections 5.4 and 5.6, Appendix 17
ARSD 74:29:02:11 (11)	Estimate of project water requirements	Section 5.7
ARSD 74:29:02:11 (12)	Chemical characteristics of process solutions	Section 5.6
ARSD 74:29:02:11 (13)	Pollution control facilities	Section 5.3.5, Exhibit 28 in Appendix 2
ARSD 74:29:02:12	Map requirements for large-scale mining operations	Appendix 2
ARSD 74:29:05:01	Reclamation of millsites	Section 5.2
ARSD 74:29:05:02	Choice of reclamation	Section 5.4 and Chapter 6.0
ARSD 74:29:05:03	Process pond reclamation	Section 5.2
ARSD 74:29:05:04	Removal of equipment and buildings	Section 6.7.3
ARSD 74:29:05:05 (1–6)	Reclamation of tailings impoundments	Section 5.4

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Regulation	Information Required	Permit Application Reference
ARSD 74:29:05:06	Treatment of tailings	Section 5.4
ARSD 74:29:06:02	Determination of reclamation type	Section 6.2
ARSD 74:29:07:01	General requirements for all reclamation types	Section 6.2.1
ARSD 74:29:07:02	Minimizing of adverse impacts	See below
ARSD 74:29:07:02 (1)	Design of facilities to minimize surface disturbance	Section 5.5
ARSD 74:29:07:02 (2)	Clearing of land in small sections	Section 5.3.2
ARSD 74:29:07:02 (3)	Visual screening	Section 3.11.1
ARSD 74:29:07:02 (4)	Minimize impacts to surface and groundwater	Sections 3.3.4, 3.4.3, 3.4.4, and 5.3.5
ARSD 74:29:07:02 (5)	Control of access	Section 5.3.1
ARSD 74:29:07:02 (6)	Preventative measures to minimize harmful impacts to wildlife	Section 3.7.6
ARSD 74:29:07:02 (7)	Location of waste facilities, spoil piles, and topsoil stockpiles to facilitate implementation of reclamation and to minimize environmental impacts	Section 5.3.3, Exhibit 21
ARSD 74:29:07:02 (8)	Minimizing the production of mine waste and spoil	Section 5.2
ARSD 74:29:07:02 (9)	Design and location of facilities so they are compatible with surrounding land uses (i.e., waste facility and haul road)	Section 6.2
ARSD 74:29:07:02 (10)	Integration of mine operations planning with the Reclamation Plan	Section 6.7, Table 6-4
ARSD 74:29:07:03	Grading and backfilling—necessity	Section 6.7.1
ARSD 74:29:07:04	Grading and backfilling—criteria	Section 6.7.1
ARSD 74:29:07:04 (1a–1d)	Grading and backfilling requirements	Sections 6.2.1 and 6.7.1
ARSD 74:29:07:04 (2)	Detailed plans—erosion control	Sections 5.3.5 and 6.2.1, Exhibits 28 and 29
ARSD 74:29:07:04 (3)	Time table—grading and backfilling	Section 6.2.1 and Table 6-4
ARSD 74:29:07:04 (4)	Depressions for accumulation of water	Section 6.2.1
ARSD 74:29:07:04 (5)	Original drainage preserved as much as possible	Section 6.2.1
ARSD 74:29:07:04 (6)	Highwall reduction impractical	Section 6.7.1
ARSD 74:29:07:04 (7)	Minimize negative visual impacts	Section 3.11.1
ARSD 74:29:07:05	Disposal of refuse	Sections 6.2.1 and 6.6
ARSD 74:29:07:06 (1)	Vegetative species and composition—postmining land use	Section 6.5, Tables 6-2 and 6-3
ARSD 74:29:07:06 (2)	Vegetative success—reference areas	Section 6.9.1
ARSD 74:29:07:06 (2)	Vegetative success—reference areas	Section 6.9.1

Table 1-2. Administrative Rules of South Dakota (Page 4 of 4)

Regulation	Information Required	Permit Application Reference
ARSD 74:29:07:06 (4)	Seeding and planting	Section 6.5
ARSD 74:29:07:07 (1)	Salvageable topsoil	Section 5.3.3
ARSD 74:29:07:07 (2)	Interim reclamation	Sections 5.3.3 and 6.3
ARSD 74:29:07:07 (4)	Signing of topsoil stockpiles	Section 5.3.3
ARSD 74:29:07:07 (5)	Estimate of topsoil to complete reclamation	Section 5.3.3
ARSD 74:29:07:07 (7)	Separation of rocks and trees from topsoil	Section 5.3.3
ARSD 74:29:07:07 (8a)	Segregation of topsoil and subsoil stockpiles	Section 5.3.3
ARSD 74:29:07:08	Hydrologic balance—water quality	Sections 3.3.2, 3.4.2, 3.4.4, and 5.3.5
ARSD 74:29:07:09	Surface runoff diversions	Sections 3.4.4 and 5.3.5, Exhibits 28 and 29
ARSD 74:29:07:10	Diversions of intermittent and perennial streams	Section 5.3.5
ARSD 74:29:07:11	Tailings impoundments	Section 5.4
ARSD 74:29:07:12	Roads and railroad spurs—riparian zones	Section 5.3.5
ARSD 74:29:07:13	Buildings and structures	Section 6.7.3
ARSD 74:29:07:14 (1)	Spoil location	Section 6.2.1 and Exhibits 2, 21, and 28
ARSD 74:29:07:14 (2)	Stability analysis of spoil	Section 5.2
ARSD 74:29:07:14 (3 and 4)	Potential toxic or acid-forming spoil	Sections 3.1.3.7, 3.3.4, and 3.4.3
ARSD 74:29:07:15	Noxious weed control plan	Section 6.6
ARSD 74:29:07:16	Subsidence from mining activities—prevent or minimize	Section 6.2.1
ARSD 74:29:07:17	Underground mines—sealed during reclamation	Section 6.2.1
ARSD 74:29:07:18	Reclamation plan developed by competent individuals	Section 6.1
ARSD 74:29:07:20	Rangeland	Section 6.2.2.1
ARSD 74:29:07:23	Recreation	Section 6.2.2.2
ARSD 74:29:07:24	Industrial use	Section 6.2.2.3
ARSD 74:29:07:25	Home sites	Section 6.2.2.4
ARSD 74:29:08:01	Requirements for concurrent reclamation	Sections 5.3.4 and 6.1, Table 6-4
ARSD 74:29:08:02	Requirements for interim reclamation	Sections 5.3.3, 6.3, 6.5.1, Table 6-1
ARSD 74:29:08:03	Requirements for final reclamation	Sections 6.0, 6.5.2, 6.7, 6.8, and 6.9, Table 6-1
ARSD 74:29:10	Special, exceptional, critical, or unique lands	Section 2.3, Appendix 3

1.2 PROJECT OVERVIEW

The project area is located approximately 4 miles west of Lead, South Dakota, in the Bald Mountain Mining District (see Exhibit 1 Project Location Map in Appendix 2). The existing Wharf Mine is located in Sections 1, 2, 3, and 4, T4N, R2E, and Sections 25, 26, 33, 34, 35, and 36, T5N, R2E of the Black Hills Meridian (BHM), Lawrence County, South Dakota. Golden Reward Mine is located in Sections 1 and 12, T4N, R2E, and Sections 6 and 7, T4N, R3E of the BHM. The proposed expansion is primarily located to the south and west of the existing Wharf and Golden Reward Mines, respectively, but a small section is also located north of the Wharf Mine. The property is accessed by Wharf Road and State Highway 473 (Nevada Gulch Road), which leads west from Lead through the proposed Expansion Area. The proposed Expansion Area covers approximately 528 acres of private land, including portions in Sections 1, 2, 3, and 12, T4N, R2E, Sections 6 and 7, T4N, R3E, and Sections 33 and 36, T5N, R2E of the BHM (see Exhibit 2 Current Facilities Map in Appendix 2) (SDCL 45-6B-54(6)).

Mining in the Expansion Area will be an open-pit, truck-and-shovel operation similar to ongoing operations at Wharf Mine. Total production is estimated to be about 175 million tons of material (see Section 3.1.3.1). Both gold and silver will be produced (SDCL 45-6B-54(3)). It is anticipated that mining the Expansion Area at Wharf will increase the life of the mine by 7 years, extending the total life of the mine from 2012 at current to 2019 to 2020.

The proposed project will involve open-pit mining and disposal of overburden. Ore extracted from the Expansion Area will be trucked to the existing permitted Wharf Mine heap-leaching facility for processing. The operation will require modification of State Highway 473 and Lawrence County Road, the costs of which will be at Wharf's expense and subject to the approval of the South Dakota Department of Transportation (SD DOT) and Lawrence County. The highway and road modification will result in surface disturbance but will not be located within a mining disturbance area. The proposed project does not require the movement or relocation of any processing equipment. Processing of gold and silver at the Wharf Mine process plant will not substantially change as a result of the Expansion Project. However, additional area is being permitted near the process area for construction if needed. Ore will continue to be milled at Wharf's crushing plants and gold will be heap leached on heap-leach pads. The process solution, percolated through the leach pad designed to dissolve the gold, will be a liquid sodium cyanide, as is currently used.

As new mine areas are developed, waste rock and additional overburden material will be used to backfill previously mined areas. Neutralized spent ore will primarily be deposited in the permitted localities that may include the American Eagle Pits, Upper Reliance Depository, and/or denitrification pads (see Section 6.10.3.5). Spent ore off-loaded will be deposited within current POP zones or proposed new POP zones (American Eagle) and will meet all off-load standards. Wharf's legal right to dispose of spent ore is evidenced by State Mine Permits 356,

434, 435, 450, and 464 and Groundwater Discharge Permits (GWD) GWD 1-88, GWD 1-94, GWD 1-98, and GWD 5-88.

The postmining land use planned is a mixture of rangeland or woodland grazing, recreation, home sites, and industrial or commercial development. Woodland grazing is the land use that Wharf has reclaimed to in the past and has provided beneficial uses such as habitat for many species. Recreation and development will primarily revolve around Terry Peak ski area and allow for expansion of existing ski runs and facilities. Additionally, a portion of the existing Golden Reward Permit that was recently released from reclamation is being repermitted under this application for the purpose of conducting additional mining and changing the designated postmining land use for areas within Golden Reward. Reclamation of disturbed areas will be accomplished by recontouring, resoiling, and revegetating the land in accordance with accepted reclamation techniques. Further reclamation details are provided in Chapter 6.0 of this application.

Pursuant to SDCL 45-6B-33, Wharf Resources' proposed mining operation is not located on unsuitable land and submits that the following conditions can be mitigated:

1. Reclamation of the affected land pursuant to the requirements of Chapter 45-6B is physically or economically feasible as described in Chapter 6.0 of this submittal.
2. Substantial deposition of sediment in stream or lake beds, landslides, or water pollution can feasibly be prevented as described in Chapter 5.0 of this submittal.
3. The land to be affected by this mining application does not include land that is special, exceptional, critical, or unique as defined in SDCL 45-6B-33.3, and satisfactory mitigation is possible (see Section 2.3 of this submittal).
4. The proposed mining operation will not result in the loss or reduction of long-range productivity of aquifer, public and domestic water wells, watershed lands, aquifer recharge areas, or significant agricultural areas (see Sections 3.3 through 3.4.2 of this submittal).
5. The biological productivity of the land is such that the loss will not jeopardize threatened or endangered species of wildlife indigenous to the area. In fact, no state or federally listed threatened or endangered species were identified within the proposed permit area (see Section 3.7.10 of this submittal).
6. No adverse socioeconomic impacts of the proposed mining operation were identified that outweigh the beneficial impacts of the operation (see Chapter 4.0 of this submittal).

1.3 PERMITTING HISTORY

Wharf Resources currently has several active state and county mining permits. These permits are listed in chronological order in Table 1-3.

1.4 PROJECT DESCRIPTION PER SDCL 45-6B-96

The proposed project will not be affected by SDCL 45-6B-96, which allows extension of up to 200 acres of surface-mining disturbed land for each active Large-Scale Mine Permit. As in Table 1-3, Wharf Resources has maintained three active mine permits and is allowed to expand by up to 600 additional acres of new surface mining disturbance. The haul road, other roads, and the topsoil stockpiles are not considered surface mining disturbed lands. As of December 31, 2009, 420 acres of land at Wharf and 408 acres of land at Golden Reward have been reclaimed; those acres are also available to be applied to the expansion limit minus about 143 acres of reclaimed land that will be redisturbed during the Expansion Project (about 63 acres at Golden Reward, 70 acres in Portland Pit, and 10 acres at Green Mountain). The total allowable expansion limit is therefore approximately 1,285 acres, higher than the proposed surface mining disturbance of only 249 acres.

Table 1-3. Chronology of Wharf State and County Mining Permits (Page 1 of 2)

Date	County Conditional Use Permit	State Permit Number	Comments
12/7/82		Annie Creek # 356	Mining and milling of gold ores by open pit methods; 400,000 tons per year; $732,000 cash bond
12/8/82	CUP #63 Annie Creek		Mining and milling operation
12/9/83	CUP #63 Annie Creek		Mining and milling operation
2/17/83		Amendment to #356	Inclusion of three additional mining claims; relocation of plant facilities; haul road and leach pad
7/20/83		Amendment to #356	Inclusion of 18 additional mining claims; relocation of proposed overburden facility
8/10/83	CUP #70 Annie Creek		Mining and milling
9/20/84		Amendment to #356	Increased production to 800,000 tons per year; added 14 acres for low-grade ore stockpile; modified stripping/stockpiling method; and allowed for developmental drilling of up to 230 holes up to 100 feet deep
12/20/84		Amendment to #356	Extended duration of leach season from 180 to 365 days per year
12/11/85	CUP #99A Foley Ridge		Mining and related activities, subject to conditions
2/12/86	CUP #100B Foley Ridge		Mining and related activities, subject to conditions
312/86	CUP #102 (Amend–Annie Creek)		Amending CUP #63 to correct original application
3/12/86		Foley Ridge #434	Amending CUP #63 to correct original application, subject to conditions
3/21/86		Foley Ridge #434	Mining permit for 800,000 tons per year each rock/ore; $141,000 cash for reclamation bond
3/31/86		Annie Arm #435	Mining permit for 800,000 tons per year each rock/ore; $47,955 cash for reclamation bond
11/5/86	Amend CUPs #99A and #100B		Conditions 7 and 10 amended clarifying requirements
5/21/87		Amendment to #434	Increased annual ore production to 1.5 million tons per year

Table 1-3. Chronology of Wharf State and County Mining Permits (Page 2 of 2)

Date	County Conditional Use Permit	State Permit Number	Comments
9/14/87	CUP #122		Amending CUP #63 and CUP #102 for expansion of Annie Arm mine area, revision of CUP boundary
3/16/88		Amendment to #356	Approved pad #4 and load, unload
4/16/88		Amendment to #356	Plant expansion
5/11/88	CUP #126		Golden Reward
5/19/88		Permits #356, 434, and 435	Mine boundary established
6/30/88		Golden Reward #450	Golden Reward
9/1/88	CUP #132		All CUPs combined
11/17/88		Amendment to #356, 434, and 435	Mine expansion amendment, Annie Arm Extension
8/21/89		Amendment to #356, 434, and 435	Reliance Rock Disposal, Land Application
11/12/91		Amendment to #356, 434, and 435	Increase ore production to 3.5 million tons
8/18/92		Mining License #90-400	Foley Gravel Pit license expires 5/3/2011
3/1/93		Amendment to #356, 434, and 435	Increase ore production to 4.5 million tons
3/1/94		Permit #SD-0025852	Surface Water Discharge Permit
3/4/96		Amendment to #356, 434, and 435	SD DOT Project (Altering State Highway 473)
4/7/98	CUP #224		Mining and milling operations for Clinton Project for 8 additional years of mine life.
6/18/98		Clinton Expansion #464	Clinton Expansion Area
9/17/07		Amendment to #464	American Eagle Expansion
4/6/10		Amendment to #464	Mine expansion amendment, American Eagle pushback (adds 18 acres to existing permit)

2.0 PROPERTY DESCRIPTION

The Wharf Expansion Project, consisting of 96 patented and 11 unpatented mining claims, is located in Lawrence County, South Dakota, in Sections 1, 2, 3 and 12, of T4N, R2E; Sections 6 and 7, T4N, R3E, BHM; and Sections 33 and 36, T5N, R2E of the BHM. The proposed permit boundary is shown on Exhibit 3 in Appendix 2. The Wharf Expansion Project has a permit area estimated to be 528 acres in size, of which 298 acres will be affected (249 surface mining disturbance acres, 19 acres of roads and facilities, and 30 acres of topsoil stockpiles). Undisturbed areas are reserved for potential expansion of operations, vegetation buffer zones, site continuity, and visual screening. As required by ARSD 74:29:01:17(4), the permitted to affected land ratio is 2.21:1.

2.1 COUNTY CONDITIONAL USE PERMIT BOUNDARY/ZONING

The Wharf Expansion Project is located predominantly on private land with a few small parcels of public land. The proposed permit area is zoned Park Forest District (PF), Park Forest Residential (PFR), Highway Service Commercial (HSC), and Suburban Residential (SRD) under terms set forth by the Lawrence County Zoning Ordinance. The project will not require a zoning change as mining activity is allowed in all zoning districts as described in Section 5.11.6.A.2 of the Lawrence County Comprehensive Plan (ARSD 74:29:02:02).

The application for the County Conditional Use Permit (CUP) will be submitted to Lawrence County in February or March of 2011 (SDCL 45-6B-4). The CUP boundary will follow the permit boundary and is shown on Exhibit 2 (Current Facilities Map) and Exhibit 3 (Impacted Lands Map) in Appendix 2.

The Lawrence County Comprehensive Plan requires all large-scale mines to implement a 500-foot minimum buffer zone between the disturbed land and any adjacent landowner. An exception to this requirement exists when an operator secures a waiver from the landowners. An ownership listing of those lands within and adjoining the proposed expansion mine permit area can be found in Appendix 3.

2.2 LEGAL RIGHT TO ENTER AND MINE

Wharf Resources has the legal right to conduct mining within the proposed permit area boundary (ARSD 74:29:01:17). Wharf Resources owns or controls all the mineral rights within the Expansion Project. Refer to Appendix 3 for details on mineral ownership. On November 18, 2010, the South Dakota Board of Minerals and Environment approved the transfer of Mine Permit No. 450 from the Golden Reward Mining Company, LP to Wharf Resources (USA), Inc. (Appendix 3).

Wharf Resources also owns or controls all the surface rights within the Expansion Area except for small fractions of BLM land, State Highway 473 (including the right-of-way), and parcels owned by Black Hills Chairlift Company. About 3.822 acres of BLM land will be affected by the project. Wharf submitted a letter to the BLM and is awaiting approval to affect the BLM parcels. In the interim, Wharf has secured the BLM's approval of the mining and Reclamation Plans. State Highway 473 will be modified by this Expansion Project; the applicant has notified the SD DOT and Lawrence County and is working with them to meet all requirements (the letter from SD DOT is included in Appendix 3). Refer to Appendix 1, Land Ownership, for details on surface ownership. Proof of consultation with adjacent landowners is located in Appendix 3 and includes BLM, SD DOT, and Black Hills Chairlift Company (SDCL 45-6B-12).

Wharf Resources, a Montana General Partnership, is the operator. In accordance with SDCL Chapter 37-11, the partnership has a current certificate on file at the Lawrence County Register of Deeds' office, which identifies its general partners as Wharf Resources (USA), Inc. and Wharf Resources Ltd. CT Corp. is the registered agent for the general partnership in the county records.

2.3 DETERMINATION OF SPECIAL, EXCEPTIONAL, CRITICAL, OR UNIQUE LANDS

Per South Dakota regulations, a Large-Scale Mine Permit is required for operations that mine and disturb more than 10 acres of land and extract more than 25,000 tons annually and for any operation that uses cyanide or other chemical or biological leaching agents. A prospective mining operator must request the SD DENR to determine whether or not the lands included in the proposed mining operation constitute special, exceptional, critical, or unique lands by submitting a Notice of Intent to Operate to the department. To fulfill the requirement, SDCL 45-6B-33.3 and ARSD 74:29:10:02 require the operator to submit a *Request for Determination of Special, Exceptional, Critical, or Unique Lands*.

A Notice of Intent to Operate and a Request for Determination of Special, Exceptional, Critical, or Unique Lands were submitted to the SD DENR September 27, 2010. Wharf resubmitted the request with additional information on October 27 and November 2, 2010. The SD DENR conducted on-site inspections of the project area on September 30 and October 26, 2010. Notices were published on November 12, 2010, in the *Black Hills Pioneer* and the *Rapid City Journal*. The proposed permit boundary is entirely within the scenic and unique land study area as shown on Exhibit 3 in Appendix 2 (ARSD 74:29:01:17(3)).

Environmental and cultural resource studies have been conducted within the proposed Expansion Project to determine any characteristics of the affected land having historic, archaeologic, geologic, scientific, or recreational significance. These items were included in

Wharf Resource's Request for Determination of Special, Exceptional, Critical, or Unique Lands [Wharf Resources, 2010] and are summarized below.

- There were no significant cultural resources identified, although a segment of the railroad grade may be eligible for listing on the National Registry of Historic Places (NRHP).
- There are no threatened or endangered plants or animal species within the expansion area.
- Two sensitive plant species were identified near the expansion but are located outside the proposed mining disturbance area and will not be impacted.
- Eight vertebrate sensitive species or species of local concern were identified. All of the eight sensitive species documented are considered secure populations within their respective ranges and are common in the region. Additionally, no raptor nests were discovered within the expansion area.

On January 13, 2011, the SD DENR determined the Terry Cemetery is eligible for inclusion on the state's Preliminary List of Special, Exceptional, Critical, or Unique Lands [South Dakota Department of Environment and Natural Resources, 2011]. On March 17, 2011, the South Dakota Board of Minerals and Environment (SD BME) conducted a hearing to determine the status of the Terry Cemetery. They heard testimony from the SD DENR, two of the three nominating petitioners, Wharf Resources, and the Terry Cemetery Association. No parties were opposed to the nomination; therefore, the SD BME voted to include the Terry Cemetery on the state's Preliminary List of Special, Exceptional, Critical or Unique Lands. Wharf has since modified its proposed Expansion Project boundary to exclude the Terry Cemetery area as shown on Exhibit 1.1.

3.0 BASELINE

3.1 GENERAL GEOLOGY AND DEPOSITIONAL ENVIRONMENT

The Wharf Mine and proposed Expansion Area are located in the north-central portion of the Black Hills uplift in western South Dakota. Within the expansion area, the geology consists of Precambrian metamorphic rocks overlain by sediments of the Cambrian Deadwood Formation. All of these rocks have been intruded by Tertiary-age igneous stocks, sills, dikes, and porphyry breccias. Mineralization in the Expansion Project is primarily within the Deadwood Formation but also in and along the Tertiary intrusions. A general geologic plan map is shown on Exhibit 4 and cross sections are shown in Exhibits 5, 6, and 7, all in Appendix 2. Cross-section locations are shown on Exhibit 21 in Appendix 2. Additional details about the hydrogeology of each of the major formations in the expansion area are provided below.

The Precambrian Ellison Formation is the dominant rock unit within the area and underlies the entire project at depth. The formation consists of interbedded quartzites and phyllites that are strongly folded and foliated. Foliation dips near vertically and strikes approximately north-south. Surface exposures can be found along the western edge of the Bald Mountain area and in Nevada Gulch on the south flank of Green and Bald Mountains. Exploration work performed in the Precambrian to date has been extremely limited.

The Cambrian Deadwood Formation unconformably overlies the Precambrian and consists of quartz and limestone conglomerate, sandstone, quartzite, siltstone, shale, and limestone. Locally, a pebble conglomerate is present at the basal unconformity. The Deadwood Formation is informally divided into the lower, middle, and upper members based upon stratigraphy and preference for hosting mineralization. Within the Wharf Expansion Area, the dominant ore host is the lower member. This member generally consists of sandy dolomite interbedded with calcareous siltstone, sandstone, quartzite, limestone, limestone conglomerate, and shale.

Within the Wharf area, the Deadwood Formation is about 400 feet thick and dips southwesterly at 6 to 15 degrees [J. M. Montgomery Engineers, Inc., 1996]. In the Golden Reward area, the Deadwood Formation is cut by small faults, effectively compartmentalizing the aquifer into zones [Golden Reward Mining Company, 1990]. Ore localization in the Deadwood Formation is primarily controlled by north-northeast-trending, subvertical fractures called “verticals.” Ore zones are best described as hydrothermal replacement deposits adjacent to the fractures in favorable horizons such as carbonate-rich units with high permeability. In areas of closely spaced fractures, extensive manto-like deposits occur with intense silicification and decarbonization.

The Ordovician-age Winnipeg Shale consists of friable, green shale. Within the project area, the Winnipeg Shale lies conformably above the Deadwood Formation where present on Green Mountain and Foley Ridge.

All rock units within the project area have been intruded by a variety of igneous dikes and sills considered Tertiary in age (40 to 60 million years). The intrusions are locally subdivided into monzonite porphyry, phonolite porphyry, porphyry breccia, and trachyte. These rocks primarily intrude the Precambrian and Deadwood as sills, although dikes and stocks are also present within the area. The sills are typically more than 20 feet thick; local thicknesses may be 100 feet or greater. Ore grade mineralization within porphyry units is normally restricted to portions of the thick (20 to 100 feet) monzonite porphyry sill. This sill is located near the top of the lower member of the Deadwood Formation. Also, a phonolite porphyry sill overlies the Winnipeg Shale on Foley Ridge and Green Mountain. Tertiary breccias containing fragments of Precambrian metamorphic rocks, Deadwood Formation sedimentary rocks, and Tertiary igneous rocks have been identified along the northeastern side of Bald Mountain. Mineralization in these breccia pods appears to be limited and generally of no significance.

Colluvium and alluvium is of very limited extent across the Wharf Expansion Project area. Areas of this unconsolidated material are limited to springs and creek bottoms. Sediments consist of clay, silt, sand, and some gravel.

3.1.1 Historic Mine Workings

Within the entire Expansion Project Area lies sporadic historic mine workings that intersect the Cambrian Deadwood sediments and the porphyry igneous rocks. The workings consist of room-and-pillar type, shrinkage stopes, shafts, and small drifts. The room and pillar are mainly located within the upper and lower Deadwood sediments with the size usually ranging from 6 feet to 10 feet in height and approximately 10 feet to 40 feet in width. The room-and-pillar type workings are seen within the upper Deadwood sediments directly above the current Deep Portland Pit, within the lower contact of the Deadwood sediments at the base of the designed pit in Green Mountain, and within the Harmony and Liberty Highwall pushback at Golden Reward (refer to Exhibit 6 in Appendix 2).

Shrinkage stopes are mainly located within the intermediate Deadwood sediment and usually are narrow workings of approximately 4 feet to 8 feet wide and can range from 15 feet to 80 feet in height. The majority of the shrinkage stopes are located within Green Mountain with a few stopes located along the Portland Ridgeline.

The majority of the Expansion Area has random shafts and exploratory drifts throughout the area that range in size and extents. Over the past 20 years, much time has been spent locating these historic workings so that remedial actions could be put into place to safeguard the public. Remedial actions ranged from fencing off and signing the workings to collapsing and/or filling in the workings to prevent unwarranted entrance.

Within active pit areas, measures have been put into place to limit miners' exposure to the workings. Historic mine working maps have been gathered and are used to locate the workings in a timely manner before active mining approaches them. The maps are used for the first pass to help locate the workings, drilling is then used to help pin down the location of the identified workings, and a down-the-hole laser instrument is then used to determine the size of the workings. The laser instrument is lowered into a blast hole or exploration drill hole when historic workings are intercepted. The instrument then takes a reading and record of the cavity which then will be used to interpret and determine remedial action. Once the location and size are validated, blasting of the historic working will be implemented to cave the working in so that safe access around the workings is established.

3.1.2 Future Exploration Potential

Future exploration activities within the proposed expansion area are not completely defined outside the known mineral deposits. It is expected that future exploration work will be similar to current operations and include drilling activity.

At present, future exploration activities or additional expansion is minimal. The change in geology, project economics, and the fact that adjoining areas have been previously mined limit the potential for any future expansion. Future exploration activities within the confines of the proposed Expansion Area will focus on the perimeter of the designed pit and pit bottom to fully identify economic mineralization (ARSD 74:29:02:05).

The potential to find an economic deposit within the Precambrian rocks, similar to that at the Homestake Mine, is considered poor. Because of the depth of the Precambrian, such a deposit, if identified, would most likely have to be exploited through underground mining methods. Wharf has been successful in identifying additional reserves within the permit boundaries which is primarily because of the geology underlying the initially identified deposits and favorable changes in project economics.

Precambrian rock units that underlie the majority of the Expansion Area are not conducive for hosting large-scale disseminated deposits similar to those found in the overlying Paleozoic sediments and Tertiary intrusives. Minor expansion potential does exist within the Paleozoic sediments and associated Tertiary intrusives on the margins of the area where such units have not been removed by erosional activity. Presently, subsurface information is not of sufficient quantity to make an accurate appraisal size of any future expansion, nor if any should be warranted.

The Portland Ridgeline area contains some potential to deepen beyond current pit designs on the far-western perimeter. The intermediate member of the Cambrian Deadwood Formation and the porphyry sill are known to host potentially economic mineral and are located immediately below the currently designed pit bottom of this area.

Along the western edge of the Green Mountain area, expansion potential is possible if the mineralized zones within the Deadwood Cambrian units and the main porphyry sill continue to the west. This could result in a slight pushback of the western highwall within the proposed new mine permit.

The potential for additional expansion on Bald Mountain is unlikely because property ownership to the east is predominately BLM land and private ownership. In addition, the geology on Bald Mountain moving east has the Precambrian rock units at the surface which are not susceptible to heap-leach mining.

Exploration potential at the Golden Reward property is minimal because of its previous mining history. The western highwall of the Liberty and Harmony Pits will not advance to the west because of the Terry Peak Ski area boundary. To the east of these pits, mineralization is very minimal and currently does not show promise for expansion past what is currently designed. There is limited potential at the Terry Cemetery location; drilling will be required around the perimeter of the cemetery to sufficiently identify the extent of the mineralization. Drilling the perimeter of the Terry Cemetery is scheduled for late 2011–2012 to identify any mineralization that could lead to potential mining.

3.1.3 Geochemical Characterization of Ore and Discard Rock

Numerous sampling throughout the Expansion Area was completed for analysis for geochemical characterization of ore and discard rock for the project (ARSD 74:29:02:11(6)). This level of analysis is considered to be adequate for geochemical characterization. The Expansion Area geochemical database analysis consists of the following: 2,064 acid base accounting samples (ABA), 464 whole rock samples, 67 Meteoric Water Mobility Tests (MWMT), and 8 humidity cell samples. The physical locations of the geochemical samples are plotted on Exhibits 8 through 12 in Appendix 2. As indicated on these maps, the samples were initially randomly selected throughout the Expansion Area based on a grid pattern that was indicated within the baseline requirements. The samples represent intervals of 10 feet in length and consist of one rock type. No mixed rock type samples were composited.

The ABA and nitrate samples were analyzed by Energy Laboratories, Inc. of Rapid City, South Dakota. The whole rock analysis and humidity cell testing were completed by ALS Laboratory Group of Reno, Nevada. The MWMT were completed by Inter-Mountain Labs of Sheridan, Wyoming. See Appendix 4 for the procedural methods for the analysis and the analysis results for all geochemical testing.

The Expansion Project encompasses the movement of approximately 175,554,000 tons of rock, including 149,974,000 tons of discard rock and 25,580,000 tons of ore. The various rock types and corresponding tonnage of rock and ore-bearing rock which will be encountered over the life of the project are outlined in Table 3-1.

Table 3-1. Rock Types and Tonnage

Rock Type	Wharf Resources		Golden Reward		Totals		Percentage Totals		Total
	Ore (Tons)	Discard (Tons)	Ore (Tons)	Discard (Tons)	Ore (Tons)	Discard (Tons)	Discard (Tons)	Ore (Tons)	
Deadwood Upper Contact and Glauconitic Sandstone Sediments	2,130,000	21,400,000		130,000	2,130,000	21,530,000	8%	14%	13%
Deadwood Intermediate Sediments	1,950,000	48,000,000	1,200,000	7,400,000	3,150,000	55,400,000	12%	37%	33%
Deadwood Lower Contact Sediments	4,600,000	2,115,000	1,000,000	510,000	5,600,000	2,625,000	22%	2%	5%
Monzonite Porphyry	12,700,000	27,200,000	2,000,000	6,700,000	14,700,000	33,900,000	57%	23%	28%
Phonolite Porphyry		9,200,000		19,000		9,219,000		6%	5%
Discard Fill		21,500,000		3,800,000		25,300,000		17%	14%
Spent Ore Rehandle		2,000,000				2,000,000		1%	1%
Precambrian Unit									
Total	**21,380,000**	**131,415,000**	**4,200,000**	**18,559,000**	**25,580,000**	**149,974,000**	**100%**	**100%**	**100%**

3.1.3.1 Acid Base Accounting (ABA) Test Results

Samples were collected on approximately a 100-foot × 100-foot grid with greater spacing dependent upon the rock unit; greater spacing was used within the upper and middle Deadwood sediments and the porphyry units, and closer spacing was used on the lower Deadwood (Cdlc). This spacing was determined through past acid rock drainage (ARD) protocol that was determined by previous work completed from the Clinton Expansion Permit in 1998 concerning the Trojan Pit and agreed upon between Wharf Resources and the SD DENR for the baseline study needs. This spacing provided 2,064 ABA samples, representing the affected rock units with 956 samples located within proposed pits. The numbers of samples by rock unit are listed in Table 3-2. The samples generally distributed with two-thirds of the samples located at Wharf and one-third of the samples located at Golden Reward. ABA sample locations are shown on Exhibits 10, 10-1, 10-2, and 10-3 in Appendix 2.

The results for both recent and historic acid base accounting testing are listed in Appendix 4 (Tables 1 to 11). Test results indicate that portions of the Precambrian rock units may be amenable to acid generation, athough no Precambrian rock is scheduled or planned to be mined. Mitigation plans for any potential acid generating material are detailed in Section 3.1.3.7 and include special handling, encapsulation, or leaving the material in place and undisturbed. The following sections detail the results of acid base test work by rock unit.

3.1.3.1.1 Glauconitic Sandstone and Upper Contact Unit of the Deadwood Formation. As indicated in Table 3-1, the Cambrian Deadwood Formation glauconitic sandstone and upper contact units represent 14 percent or 21,530,000 tons of the total Expansion Area discard rock production. The current data in Appendix 4 (Tables 1 to 7) indicate that this unit has a very low percentage of nonsulfate sulfur—an average of 0.136 percent within the ore and 0.066 percent within the barren rock. The average acid neutralization potential to acid generation potential (ANP/AGP) ratio for the glauconitic sandstone and upper contact units is 13:1 for ore and 53:1 for barren material, with a 77 net neutralization potential (NNP) for ore and 136 NNP for barren rock for material in the pit boundaries.

The California standard ratio of 3 to 1 (3:1) is used as an industry standard in prediction of AGP. If a sample has an ANP/AGP ratio that is above 3:1, then the sample has a very low potential for acid production. This standard is used for the interpretation of all rock types.

The glauconitic sandstone and upper contact units have a low acid generation potential and a high neutralization potential. These units will add to the neutralization potential of any area where rock is deposited.

3.1.3.1.2 Intermediate Unit of the Deadwood Formation. The intermediate unit of the Deadwood Formation is composed of carbonate-rich shale, siltstone, and limestone. As indicated in Table 3-1, this unit comprises 37 percent or 55,400,000 tons of the total discard rock

Table 3-2. Weighted ABA Data by Rock Type

Rock Type	Total			No. of samples	In Pit			No. of samples	Outside of Pit			No. of Samples
	NP:AP Ratio	NNP	Nonsulfate S (%)		NP:AP Ratio	NNP	Nonsulfate S (%)		NP:AP Ratio	NNP	Nonsulfate S (%)	
Cdu/Glss (ore)	23	84	0.146	70	13	77	0.136	48	41	104	0.118	22
Cdu/Glss (barren)	78	154	0.075	189	53	136	0.066	112	126	172	0.041	77
Cdi (ore)	18	74	0.194	158	13	53	0.194	75	23	90	0.179	83
Cdi (barren)	32	154	0.170	478	17	73	0.164	191	38	193	0.159	287
Tm (ore)	5	19	0.113	152	2.2	10	0.155	87	9	31	0.089	65
Tm (barren)	9	28	0.073	568	5	18	0.063	308	17	39	0.071	260
Tp (ore)												
Tp (barren)	27	32	0.034	133	10	22	0.051	28	259	52	0.017	105
Cdlc (ore)	5	18	0.197	152	11	16	0.060	75	2.0	18	0.314	77
Cdlc (barren)	17	80	0.083	154	89	103	0.032	26	16.0	78	0.102	128
Total Samples				**2,064**	**Total Samples in Pit**			**956**	**Total Samples Outside of Pit**			**1,108**

production and 12 percent of ore material. The current data in Appendix 4 (Tables 2 and 8) along with Tables 3-2 and 3-2A indicate that Cdi has a net neutralizing potential of 53 and a ratio of 13:1 for the ore. The discard material shows a NNP of 73 and a ratio of 17:1.

Because of the small number of samples which have a low ANP/AGP ratio and the large neutralizing capacity of the other samples in this unit, the intermediate unit of the Deadwood Formation will not have an acid generation potential and, in fact, will have a significant neutralizing capacity.

Table 3-2A. In-Pit Weighted ABA Data by Rock Type and Tonnage

Rock Type	In Pit			Total Tons Mined
	NP:AP Ratio	NNP	Nonsulfate S (%)	
Cdu/Glss (ore)	13	77	0.136	2,130,000
Cdu/Glss (barren)	53	136	0.066	21,530,000
Cdi (ore)	13	53	0.194	3,150,000
Cdi (barren)	17	73	0.164	55,400,000
Tm (ore)	2.2	10	0.155	14,700,000
Tm (barren)	5	18	0.063	33,900,000
Tp (ore)				
Tp (barren)	10	22	0.051	9,219,000
Cdlc (ore)	11	16	0.060	5,600,000
Cdlc (barren)	89	103	0.032	2,625,000

3.1.3.1.3 Lower Contact Unit of the Deadwood Formation. The Cambrian Deadwood Formation lower contact unit comprises 2 percent or 2,625,000 tons of the total Expansion Project discard rock production and 22 percent of ore material. The data in Tables 3-2 and 3-2A and Tables 3 and 9 in Appendix 4 show the results of the ABA analysis. Overall, the Cdlc rock unit has low nonsulfate sulfur content and a good NP:AP ratio of 89:1 in barren rock, with a 16 NNP for ore and 103 NNP within the barren rock. The ABA data for the Deadwood lower contact does show isolated samples outside of the pit limits that have a low NNP and NP:AP ratio values; these tend to be in contact with the Precambrian rock at pit bottom. The pits have been designed to be above these zones of contact so not to need to deal with possible areas of ARD potential.

Table 3-2B. Rock Type and ABA Data by Area (Page 1 of 2)

Location	Total				No. of Samples	In Pit					Outside of Pit			
	Rock Type	Ratio	NNP	Nonsulfate S (%)		Ratio	NNP	Nonsulfate S (%)	No. of Samples	Total Tons Mined	Ratio	NNP	Nonsulfate S (%)	No. of Samples
Golden Reward	Cdu/Glss (ore)	102	102	0.100	5	105	105	0.012	5					
	Cdu/Glss (barren)	223	223	0.050	13	284	284	0.000	4	130,000	199	199	0.005	9
	Cdi (ore)	33	90	0.075	48	29	84	0.082	25	1,200,000	37	97	0.067	23
	Cdi (barren)	55	183	0.089	165	43	96	0.052	57	7,400,000	59	231	0.109	108
	Tm (ore)	3.3	20	0.254	79	1.6	6	0.313	52	2,000,000	6.5	37	0.190	27
	Tm (barren)	8.0	29	0.119	302	9.8	31	0.101	173	6,700,000	6	27	0.150	129
	Cdlc (ore)	15	42	0.088	16	16	16	0.040	4	1,000,000	16	51	0.104	12
	Cdlc (barren)	31	114	0.118	72	133	133	0.028	9	510,000	27	111	0.130	63
Total					**700**	**In Pit**			**329**		**Outside of Pit**			**371**
Green Mtn	Cdu/Glss (ore)	43	101	0.040	33	39	97	0.044	29	750,000	150	166	0.020	4
	Cdu/Glss (barren)	190	211	0.026	72	190	211	0.021	62	13,500,000	189	202	0.005	10
	Cdi (ore)	18	51	0.077	43	9	27	0.065	23	1,335,000	25	122	0.145	20
	Cdi (barren)	19	125	0.207	206	19	110	0.199	115	24,473,000	20	90	0.145	91
	Tm (ore)	10	13	0.039	61	9	12	0.029	27	8,500,000	10	11	0.041	34
	Tm (barren)	12	25	0.070	173	9	21	0.087	81	18,900,000	16	23	0.061	92
	Tp (ore)													
	Tp (barren)	17	42	0.057	41	10	32	0.105	25	2,100,000	44	52	0.009	16
	Cdlc (ore)	4	26	0.403	125	14	43	0.041	60	3,400,000	1.4	7	0.525	65
	Cdlc (barren)	8	35	0.139	74	15	22	0.065	14	700,000	8	30	0.151	60
Total					**828**	**In Pit**			**436**		**Outside of Pit**			**392**

Table 3-2B. Rock Type and ABA Data by Area (Page 2 of 2)

Location	Total				No. of Samples	In Pit					Outside of Pit			
	Rock Type	Ratio	NNP	Nonsulfate S (%)		Ratio	NNP	Nonsulfate S (%)	No. of Samples	Total Tons Mined	Ratio	NNP	Nonsulfate S (%)	No. of Samples
Portland	Cdu/Glss (ore)	78	138	0.044	19	92	156	0.050	4	940,000	72	127	0.057	15
	Cdu/Glss (barren)	146	230	0.021	53	130	246	0.030	11	7,535,000	149	239	0.021	42
	Cdi (ore)	12	32	0.087	29	31	45	0.038	2	600,000	11	31	0.091	27
	Cdi (barren)	62	112	0.066	80	101	142	0.093	2	23,453,852	62	113	0.065	78
	Tm (ore)	20	30	0.036	4					4,000,000	20	30	0.036	4
	Tm (barren)	11	15	0.041	27	28	40	0.000	1	8,000,000	10	13	0.042	26
	Tp (ore)													
	Tp (barren)	36	52	0.027	97	20	33	0.030	4	7,100,000	35	52	0.025	93
	Cdlc (ore)	25	105	0.100	11	25	105	0.100	11	1,200,000				
	Cdlc (barren)	42	108	0.026	8	74	190	0.000	3	1,415,000	0.0	26	0.052	5
Total					**328**	**In Pit**			**38**		**Outside of Pit**			**290**
Flossie	Cdu/Glss (ore)	1	-5	0.402	13	1	-4	0.439	10	440,000	0	3	0.277	3
	Cdu/Glss (barren)	4	8	0.204	51	2	0	0.213	35	815,000	12	16	0.134	16
	Cdi (ore)	0.2	-13	0.538	38	0.2	-14	0.592	25	15,000	0	-11	0.415	13
	Cdi (barren)	1	-4	0.319	27	0	-5	0.313	17	73,078	1	-1	0.314	10
	Tm (ore)	0.4	-2	0.124	8	0.9	-2	0.124	8	200,000				
	Tm (barren)	1.6	0.25	0.064	66	2.2	0	0.066	53	300,000	4	5	0.030	13
	Tp (ore)													
	Tp (barren)	3	2	0.018	5	3	2	0.018	5	400,000				
Total					**208**	**In Pit**			**153**		**Outside of Pit**			**345**

There are seven samples within the Deadwood lower contact found within the pit limits that result in a less than 3:1 NP:AP ratio and less than 20 NNP values that categorize these samples of having an ARD potential. These seven samples are not clustered within one area and are random throughout the pits, which do not present any problem because of their isolation; in addition, these samples are surrounded by material with a sufficient NNP to negate any problem. Through the normal blending of blasting, mining, and loading sequence, these areas will result in no ARD potential problem.

3.1.3.1.4 Monzonite Porphyry. Monzonite porphyry comprises 33,900,000 tons or 23 percent of the Expansion Project discard rock production and 57 percent or 14.7 million tons (MT) ore production. The data in Appendix 4 (Table 4) indicate that the monzonite porphyry rock units have a low percentage of sulfur (an average of 0.155 percent for ore and 0.063 percent for discard) overall for a rock unit and will not behave as an acid material when mined. There is one area within the Golden Reward Harmony Highwall pushback that indicates low NNP and ratio values; this area will be discussed in Section 3.1.3.1.7 (ARD Potential by Area).

3.1.3.1.5 Phonolite Porphyry. Phonolite porphyry comprises 6 percent or 9,219,000 tons of total the Expansion Project discard rock production. Sample results for the phonolite porphyry are summarized in Appendix 4 (Table 5) and Tables 3-2, 3-2A, and 3-2B. This unit has a high NNP value of 22 and a ratio of 10:1 with a low nonsulfate sulfur content. Given this, the unit will not have an acid generation potential.

3.1.3.1.6 Precambrian Ellison Formation. Precambrian ABA results are provided in Appendix 4 (Tables 6 and 11). The Precambrian unit is found at both sites but is not planned to be mined as an orebody or a discard product. This unit will be found in areas along the final pit floors and will be delineated during the mining phase with in-pit drilling. The delineation completed within the pit will enable the mine planning to avoid the Precambrian rock units for the most part, keeping a large majority of it undisturbed. A mitigation system for any exposed material with the potential for acid generation is outlined in Section 3.1.3.7.

3.1.3.1.7 ARD Potential by Area. Overall, the Expansion Area pits indicate little ARD potential except for two areas that will be marked as Special Handling Material (SHM). The first SHM #1 is located in the western end of the Portland Pit and is indicated by the name Flossie; the other SHM #2 is a small area within the Harmony Highwall. Both will be discussed subsequently.

As shown in Table 3-2B (Rock Type and ABA Data by Area), each area of interest within the Expansion Area is listed concerning the potential for ARD and have corresponding NP:AP Ratio, NNP, and nonsulfate sulfur values along with mined tonnages.

The first, Golden Reward mine site overall has adequate NNP material to sufficiently blend out the small pods of potential ARD material that is indicated by the ABA data. The SHM #2 is

located in the Harmony Highwall and is comprised of four samples that indicate potential for ARD. SHM #2 has a projected size of less than 10,000 tons and consists of four samples that are surrounded by adjacent material so that it can be mined and blended to ensure a 3:1 NP:AP ratio and 20 NNP value. This and all other SHM areas will abide by the current ARD Management Plan. There are random samples within the Golden Reward area that indicates potential for ARD but given that they are outliers and surrounded by sufficiently neutralizing material, they do not represent a problem. In addition, the normal mining practices will ensure sufficient blending before being processed as ore or put within a waste dump.

The Green Mountain area overall has a very large NNP and NP:AP ratio within all rock types to be mined, with a low nonsulfate sulfur content indicating low ARD potential. There are random hits within the pit boundary that indicate a potential for ARD under the California criteria, but these samples are isolated and not clustered together. The Green Mountain Pit took into consideration the ARD potential of the Deadwood lower contact when the pit was designed so as not to include any clusters of ARD potential material. Much of the ARD material was located on the eastern edge of the pit along Bald Mountain where the Deadwood lower contact comes in contact with the Precambrian rocks; in this area the pit was finalized above these areas so as not to mine any ARD potential material. As Table 3-2B indicates, the NP:AP ratio, NNP, and low nonsulfate sulfur values for material being mined within each rock type show a low ARD potential and sufficient neutralizing material adjacent to the random samples that indicate an ARD potential that will be blended out during the normal mining sequence.

The Flossie area is part of the Portland Pit and is located on the farthest most western edge of the Portland Pit. This area consists of a high-grade structure that continues from the previous mined-out Maria Pit from the late 1990s and early 2000s. This entire area has been identified as SHM #1, and test results indicate that there is a high potential for ARD; however, no ARD indication was realized with the adjacent Maria Pit. This area will require additional testing with humidity cells to determine if there is a true ARD potential. This area is not planned to be mined until late in the year 2018 and will require additional study and determination if mining of this area is warranted.

3.1.3.1.8 Whole Rock Analysis Results. Samples for whole rock analysis were collected on approximately a 450-foot × 450-foot grid with greater spacing dependent upon the rock unit; greater spacing was used within the upper and middle Deadwood sediments and the porphyry units, and closer spacing was used on the lower Deadwood. A total of 343 whole rock samples representing the affected rock units were analyzed. Whole rock sample locations are shown on Exhibit 9 in Appendix 2.

Both recent and historic data for the whole rock analysis are listed in Tables 12 and 21 in Appendix 4. The results for individual elements are somewhat variable and the data indicate enrichment in semimetals which appear to be associated with the gold values. The elements which are enriched with gold values for all rock types are predominantly arsenic. Elevated

levels of semimetals and metals are common within the Tertiary gold deposits of the Northern Black Hills. This enrichment probably occurred because the Deadwood Formation basal quartzite unit was the first cool aquifer that the Tertiary hydrothermal fluids encountered. This caused the elements to precipitate out of solution and become deposited in that unit. As the fluids flowed up through the Deadwood Formation, they cooled even further and precipitated more elements out of solution. The concentrations of the elements are very consistent with similar rock units found in the Northern Black Hills.

In reviewing whole rock analysis results (Appendix 4), ore grade values are all samples with gold grades greater than 0.012 ounce per ton. This ore grade material will be processed at the existing Wharf Resources processing facilities. In general, all samples with gold grades of less than 0.012 ounce per ton indicate rock material that will not be processed and will be placed in one of the rock facilities as pit backfill.

3.1.3.2 Meteoric Water Mobility Test Results

A total of 67 samples were taken throughout the Expansion Project, with 52 samples from the Wharf site and 15 samples from Golden Reward. Locations are shown on Exhibit 8 in Appendix 2. Results from the MWMT analysis are listed in Table 22 of Appendix 4, and the MWMT procedure can also be found in Appendix 4.

The effluent is not filtered so the results for each element are presented as total. This data is compared to drinking water standards and results outside of the standard, if any, are determined. The results can be somewhat misleading because the MWMT effluent test results represent the total amount of each element in the water; whereas, the drinking water standards are for dissolved amounts.

One MWMT sample was completed on the Precambrian unit and did not indicate elevated levels exceeding the groundwater standards. As stated previously, the current pit design and mine plan excludes mining any Precambrian material.

The lower contact unit of the Deadwood Formation had elevated levels of arsenic in one sample and no other noted levels above the groundwater standard. Although consistent with the whole rock data from the Clinton Project, the lower contact unit shows to be enriched in arsenic.

The Tertiary Igneous rock units, monzonite porphyry and phonolite porphyry had 33 MWMT samples run. Results showed arsenic values that exceeded the drinking water standards.

There were 22 MWMT samples run on the intermediate unit of the Deadwood Formation, with 8 samples collected at Wharf Resources and 14 samples at Golden Reward. Elevated levels of arsenic, and one sample with elevated selenium, were found in 11 of the samples.

There were nine MWMT samples run on the upper contact and glauconitic sandstone units and all had elevated levels of arsenic. The arsenic was derived from the natural enrichment of arsenic in these two units associated with ore deposition processes.

As would be expected, the ore grade and subore grade samples contain enrichments from hydrothermal solutions related to the original ore deposition processes. The test results indicate that arsenic is elevated in the rock from the Expansion Project.

3.1.3.3 Humidity Cell Test Results

Six humidity cell tests were completed on the lower unit of the Deadwood Formation (Cdlc). The data for the humidity cells are listed in Tables 23 through 28 in Appendix 4. Humidity cell sample locations are shown on Exhibit 11 in Appendix 2. The data presented are the analysis of the leachate of the humidity cells. Five hundred milliliters (mL) of water are used weekly for the leaching of the solids. The starting solids for each of these six cells are 1.0 kilogram when dry. All samples were conducted within recommended holding times.

As indicated in the tables, five of the samples had no drop in pH and did not have an acid generation potential. Sample FX3527, taken from the eastern side of Bald Mountain, had an initial pH value of 7.42 and produced acid during continued flushes to a low value of 5.43. In comparison to ABA test results (Section 3.1.3.1.2), the lower Deadwood ore can contain small pods of unoxided material with minor sulfides. Since the ore from the lower contact unit will be mixed with other ore with a large neutralizing capacity during processing and lime, any acid potential from the lower contact will be negated. Section 3.1.3.7 contains alternative mitigation effort associated with the identified materials that may generate acid drainage.

3.1.3.4 Nitrate Test Results

A total of 53 samples were analyzed for nitrate concentrations. Sample locations are shown on Exhibit 12 in Appendix 2 and results are provided in Table 29 of Appendix 4. Nitrate samples were analyzed by Energy Laboratories using procedures described by Page et al. [1982] (provided in Appendix 4).

All nitrate samples analyzed had values less than 4 milligrams per liter (mg/L). The highest nitrate value of 3.4 mg/L was analyzed from a sample in the middle Deadwood Formation. The average value among all samples is about 1.0 mg/L.

3.1.3.5 Conclusions and Additional Testing

As indicated in Table 3-2, the ABA sample results indicate that the vast majority of the rock units for the Expansion Area are nonreactive and will not generate acid. Most of the rock types present, comprising a large percentage of the unmineralized rock, have a large neutralization

capacity. The Tertiary intrusive rock units (monzonite porphyry and phonolite porphyry) are generally inert in nature and do not have an acid generation potential.

The Deadwood lower contact is the main stratigraphic unit of the current mine areas and expansion area that indicates a possibility for acid generation. This has been identified as a result of mainly being in contact with the Precambrian rock units which have known ARD potential and so the Deadwood lower contact is the main focus concerning acid generating potential. The other rock units (Deadwood sediments and porphyry units) within very few samples have shown to have very small potential for acid generation potential. However, within the Deadwood sediments (intermediate and upper units) the neutralizing potential is very large compared to the acid potential. The few porphyry samples that have indicated a potential for ARD have been verified through humidity cell tests not to generate acid, which has been determined to be because of the high silica content encapsulating the sulfides. In addition, the select few samples that show a potential for ARD are outweighted by adjacent neutralizing potential material. In addition, the ARD Mitigation Plan at Wharf Resources is a proactive procedure/system that delineates the mining bodies in advance of mining and this process is successful and has not shown any ARD potential in the other rock units to be mined.

The largest potential acid generation area defined by ABA data is located on the far west end of the Portland Ridgeline in the area referred to as Flossie and SHM #1. This area will require two additional humidity cells and additional evaluation before decision is made to mine. All SHM areas will follow one of the mitigation plans stated under the AGP Mitigation section (Section 3.1.3.7).

The whole rock analysis results indicate that individual elements are variable in concentrations and the results are geochemically similar to related rock types found currently in the American Eagle Pit, Deep Portland Pit, Trojan Pit, Portland area, and Golden Reward. All of the rock units are elevated in arsenic in varied degrees but at a wide range of variability. These elements are elevated because of association with the gold in the original mineralized hydrothermal fluids.

The MWMT test results for the rock units indicate that there are elevated levels in arsenic in samples from each rock type, which is normal for this area. There was one sample with elevated selenium above the groundwater standard (Sample #60979) found within the Deadwood intermediate shale unit. This sample's selenium value was 0.117 mg/L compared to the groundwater standard of 0.05 mg/L.

The interbedded siltstone and shale units of the Deadwood Formation had several samples elevated in arsenic, one sample with the groundwater standard of nickel, one sample above the groundwater standard for selenium, and two samples above the groundwater standard for total dissolved solids (TDS). These units are also being currently mined at the adjacent American Eagle Pit, and no exceedances of drinking or groundwater standards were found in the

groundwater for this area. It is believed that the elevated elements which were identified during the MWMT testing are attached to very small clay particles in the shales and siltstones and will remain trapped in the discard dump.

The upper contact and glauconitic sandstone units contain elevated levels of arsenic. The arsenic is derived from natural enrichment by the hydrothermal processes that were responsible for the deposition of gold. These rock units are identical to the rock units currently being mined and since the rock depository will be constructed in a similar fashion to the current backfill areas, no exceedances of drinking water standards are expected in the groundwater.

All of the rock units found in the Expansion Area are also found in the Foley, American Eagle, and Trojan Pits. These rock units are chemically similar and were placed in existing discard dumps. The Expansion Area discard facilities will be constructed in the same fashion, and since there are no elevated levels of contaminants, none are expected within the Expansion Area.

One area within the proposed disturbance boundary for the Expansion Area is in need of additional geochemical testing; this area is located on the eastern side of the Golden Reward new disturbance area. The area is labeled on Exhibit 10-3 in Appendix 2. This area is planned for additional drilling in late 2011 and 2012, at which time, geochemical testing of the area will be conducted and will include ABA, whole rock, MWMT, and nitrogen sampling. All results, sample locations, and conclusions will be submitted to the SD DENR once completed and before mining commences in that area.

3.1.3.6 Mitigation Plan for AGP Rock

The mitigation plan provides for identifying potential ARD material before mining and handling and defines the blending protocol. It also details operational plans for mitigation of exposed AGP rock in final pit surfaces.

The identification of any potential acid generating material will use a combination of historical and future data, including geological interpretation of the rock types, drill hole information, geochemical testing, and computer modeling. This information will determine whether special handling and blending procedures are necessary to ensure that the material will contain a net neutralizing capacity. The plan will address the identification, handling, blending, and placement of acid forming rock throughout the life of the Wharf Expansion. The plan includes a set criteria to determine Potential Acid Generating (PAG) material based on historic and future drill hole data; geochemical data; visual identification of material; and if needed, future geochemical data.

Wharf Resources maintains a master drill hole database that contains exploration and developmental drill holes, monitor well holes, water well holes, and specific deep production

blast holes. In addition, the drill hole database contains all muckface mapping and quality assurance (QA) information that is collected. The drilling was completed by one of the following techniques: percussion, reverse circulation (RVC), down-the-hole (DTH) hammer, and diamond core. The database contains the following information for each drill hole: muckface mapping and quality assurance work, location, azimuth, dip and lithology (rock type) information, geochemical data, and mineral logging information.

The drilling within the current permit area and the Expansion Areas has yielded a high density of drill coverage. Hole spacing has been designed to cover an area 100' along strike and 50–100 feet across strike of the orebody. The majority of the drilling completed to date consists of angle holes that provide the bulk of information concerning the widths of the vertical structures that control the mineralization. This coverage provides the information needed to develop the Reserve Model. Annual drilling campaigns are completed to continually refine the Reserve Model for possible gains and for additional geological information.

The geochemical data include any geochemical testing that was completed on a drill hole, be it a single sample interval, multiple sample intervals, or a rock material sample. The type of testing conducted can include humidity cells, acid base accounting (ABA), meteoric water mobility pathway (MWMP) and NAG pH.

The logging data of drill holes include geological and mineral information on the samples from each hole. Sample size can range from 1 foot to 10 feet in length, although typically it is a 10-foot composite sample. The information includes, but is not limited to, the following: rock-type, color, percentage of clay, sericite, quartz veining, silicification, iron oxide, manganese oxide, copper oxide, calcite, pyrite, and sulfide veins.

A two-phased approach is used to collect samples for the ABA testing. The first phase uses a grid system, so that a sufficient number of samples are collected to represent each rock type per area of interest. The second phase of sampling is based on targeting areas and/or samples that show a potential for ARD based on the first phase of the ABA results.

The industry standard for interpretation of ABA data was used. These standards categorize the ARD potential into three categories, using the following variables, ANP = acid neutralizing potential, AGP = acid generation potential, ABA or NNP = acid base accounting or net neutralizing potential, respectively. In addition, the percent sulfur content calculated from the ABA testing for each sample is taken into account. The industry standardizes the ABA data into three groups that categorize the potential for ARD as follows:

Low Potential = 3:1 NP:AP ratio, with an ABA>20

Moderate/Unclear Potential = 2:1 NP:AP ratio, with an 20>ABA>-20

High Potential = 1:1 NP:AP ratio, with ABA<-20.

The sulfur content helps to further classify samples that fall in the moderate/unclear potential for ARD. In addition, samples can be recategorized as having low or high ARD potential, depending upon the sulfur content, ABA values, and other pertinent information, such as geological characteristics, and geochemical information. For samples that can not be recategorized, further testing may be needed either on the individual samples or a selected area. Samples that fall into the high potential ARD category are reviewed, using all information from testing and geological data to verify the ARD potential.

Tables 3-2, 3-2A, 3-2B, and Table 4 contains the updated information on ABA calculations for samples within the Wharf Expansion Areas. The table categorizes each rock type into ore or barren rock along with the correlating weighted average for the neutralizing potential: acid potential ratio, net neutralizing potential, the nonsulfate sulfur percent, if the sample is located within the pit or out of the pit, and breaks down into specific areas of interest within the Expansion Area.

The nonsulfate sulfur percent is a combination of the pyritic sulfur percent and residual sulfur percent. Calculating the acid generating potential of a rock can be done several ways. Three of the more popular scientifically accepted methods are using total sulfur percent, nonsulfate sulfur percent, or pyritic sulfur percent. Using the total sulfur percent includes all sulfur species, some of which are not acid generating. Using total sulfur percent results in overestimating the acid generating potential. Nonsulfate sulfur is calculated by subtracting the nonsulfate sulfur from the total sulfur content, leaving only the pyritic sulfur and the inert residual sulfur. Using the nonsulfate sulfur for calculating acid generating potential is more precise than using total sulfur percent, but it still produces an inflated result because the addition of the inert residual sulfur is included.

The use of the pyritic sulfur percent contains only the most influential sulfur species in the production of acid generation. Past study at the Wharf Mine (Reference: ARD Mitigation Plan, November 2001) concerning sulfur speciation indicates that the acid generating potential calculated from nonsulfate sulfur is an overestimation of the true acid generating potential of the rock. This is because the amount of residual sulfur as a percentage of total sulfur in the rock varies from 70 percent in the Deadwood upper contact, 47 percent in the monzonite, and 28 percent in the Deadwood lower contact. The residual sulfur is essentially an inert form of sulfur that comprises a large percentage of the total sulfur used to calculate the acid generation potential. This leads to an overestimation of the acid generation potential for each rock type.

The summary of the geochemical analysis begins with the identification of all rock types with the geological logging of drill holes from the exploration and developmental drill programs. This information is used to build a rock model that will identify the deposit within the permit boundary. The model is the primary key to successfully delineating an accurate reserve and

understanding the orebody. The use of this information provides the basis to develop and implement the needed geochemical testing for an identified pit.

The samples procedure for ABA geochemical testing was to select samples that sufficiently covered each rock type area in a grid like fashion so that a representative number of samples per rock type collected. The ABA geochemical testing completed on selected samples resulted in a significant amount of information on each rock type and area as to the potential to create acid rock drainage. All rock types were focused on within the Expansion Area to ensure that all areas of mining would be covered and analyzed. Additional ABA testing was completed to infill gaps within the grid for each rock type and on samples that showed a potential for ARD; this testing helped in determining any areas that would require special handling during mining.

The combination of all the geochemical testing indicated that the rock types to be mined in the Wharf Expansion pits have little to no potential to produce acid rock drainage except within the Flossie Area of the Portland Pit (which will be discussed in detail). The majority of the Deadwood sediments of all three distinct groupings (Cdu, Cdi, and Cdlc) have a very high neutralizing capacity compared to the acid generating potential. In addition, the total pyritic sulfur percent of the Deadwood sediments have very low values that do not indicate a potential for acid generation. This is substantiated with the results from all testing but primarily based upon the results of the ABA and humidity cell testing.

In addition, the mapping, observations, geochemical testing, and the known geology from past mining in adjacent pits of Trojan, Deep Portland, Foley, Harmony, and Liberty Pits have realized no significant ARD zones. Although minor amounts of sulfides have been identified, they are principally small, isolated pods that are not of mineable size. Moreover, the majority of the geochemical testing, such as, ABA and humidity cells, have not had results indicating a potential to generate ARD.

It must also be pointed out that in the 28 years of mining, the adjacent Trojan, Foley, and Portland Pits at Wharf Resources and the Liberty and Harmony Pits at Golden Reward have not had any ARD problems. The exposed highwalls subjected to the natural elements for up to 20 plus years have given no indication of acid generation and are basically identical to those found in the Wharf Expansion pits. The only exceptions are the high-grade zone of the Flossie area within the Portland Pit and the capped area Golden Reward. Concerning the capped area at Golden Reward this area is not planned for any disturbance and ongoing analysis of this area continues. The Flossie area will be discussed in the upcoming section.

3.1.3.6.1 ARD Management Plan. The management plan for potential acid generating material will be based on having a sufficient volume of neutralizing material and ample blending of the material. The set criteria to determine net neutralizing capacity will be based on industry standards to categorize ABA data into low, moderate, and high potential acid generating categories. The standards are as follows:

Low AGP Material = 3:1 NP:AP ratio, and ABA (NNP)>20

Moderate AGP Material = 2:1 NP:AP ratio, and 20>ABA>–20

High AGP Material = 1:1 NP:AP ratio, and ABA<–20.

Additional information that may be used to categorize any AGP material will be sulfur percent data, NAG pH data, geological information, and geochemical data. Table 3-2 shows the weighted average of ABA data per rock type and the total tons of each rock type to be mined, Table 3-2A shows the in-pit weighted average aba data by rock type, and Table 3-2B shows ABA data by specific area to be mined. With this information, we are able to determine the needed amount of blending material to ensure a NNP for all material handled can be determined. It must be noted that the values used for the sulfur percent are nonsulfate sulfur percent, which includes both the pyritic sulfur and the inert residual sulfur, resulting in an overestimation of reactive sulfur.

3.1.3.6.2 Standard Blending Procedure of Mined Material. The mine plan for the remainder of the planned mine life is based on mining several different phases and areas at the same time. This will expose several different rock types that can be used in the blending of any PAG material that is identified to ensure that there will always be a sufficient amount of NNP material available for blending purposes.

The ARD Management Plan will begin with a standard blending procedure for the material mined. The blending procedure will help to ensure a positive net neutralizing potential capacity (NNP) through the normal mining procedures for blasting, mucking, crushing, and loading of the material.

The blending of the material begins with the blasting of the material. For the average shot, there is approximately 12 feet of movement at the crest of a 20-foot bench shot, with less at the toe; thus, creating blending. The next step in blending is the mucking of the material with the use of front-end loaders and 100-ton haul trucks. Blending is enhanced by the angle of the muck-face and the constant slumping of material off the crest, as well as the mucking and loading of the material by the loaders to the haul trucks. Once the material is loaded, it is transported to the crusher. The material is dumped either directly into the crusher hopper or to the crusher stockpile. Material is again blended as it is dumped, and additional material is dumped on top of it and as the material is worked to maintain a manageable stockpile. In addition, the stockpile will usually maintain a blend of Deadwood sediments and monzonite porphyry to maximize the crushing and leaching efficiency.

The material is again blended when mucked from the stockpile to the crusher hopper and again in the crushing process. In addition, the crushed ore has lime added to maintain an alkaline pH for processing. Once the rock goes through the crushing procedure, it is dumped from a conveyor belt into piles of approximately 10,000 tons in the form of cones, blending the material again as the cones are formed. From the crushed piles, the crushed ore is blended as it

is loaded into the haul trucks for dumping on the leach pads. Once on the leach pad, the material is blended for the final time as it is dozed to create 20-foot lifts to be dripped and leached.

3.1.3.6.3 Pad Off-Load Management Plan. It is highly unlikely and not expected that any material will have the ability to generate acid once the unload of the material begins. Constant monitoring of the ore material from pit to crusher, to pad load, and through the leaching process, will ensure that all the material is sufficiently blended and has neutralizing capacity.

The unload of the pads will begin another step in blending the material through normal mining practices. It begins with mucking and loading of the spent ore from the pads. The mucking procedure begins by cutting material out of the pad from the bottom lift to establish a loading area. The established muckface will range in height from one to several lifts exposed, each lift being 20 feet in height. A dozer is used to push material from the top lift over the muckface to the loading area, where the loader will begin loading the trucks. This standard practice creates blending through the constant moving and loading of the material. Once the material is loaded, it is transported to the designated spent ore depository. The depositories are designed to have the material dumped over a dump face, creating an advancing face. This process finishes the blending and reworking of the spent ore material.

3.1.3.6.4 Ore Management Plan. If ore material is identified as having the potential to generate ARD, it will be segregated at the time of mucking. The material will be transported to the crusher hopper hill where it will be blended by a loader and/or dozer with material of a net neutralizing capacity to obtain a weighted NP:AP ratio of greater than 3. The blending of the materials will ensure that the net neutralizing capacity is adequate to suppress any acid generation. The material selected for blending will be based on geological knowledge of the rock types and can include the ABA modeling, rock types NP, AP, Ratio, and NAG pH testing.

3.1.3.6.5 Nonore Management Plan. The management plan for nonore material that shows a potential to generate acid will go through the standard blending that results from normal mining procedures, except the material will go to a backfill or dispository area. It will see additional blending as it is deposited over the dump embankment. The material is then dozed to maintain an advancing dump face where additional blending will occur. Identified PAG material will undergo additional blending at the backfill/dispository area or at the active mining area with material of an NNP value to ensure an NNP blend and 3:1 NP:AP ratio for all the material. The material used for blending will be stockpiled either at the depository or at the active mining area. This material will be identified with sufficient NNP to maintain proper blending with PAG material. The PAG material will be thoroughly blended at the site with the use of a dozer, spreading the material out and working in additional NNP material.

3.1.3.6.6 Highwall and Pit Floor Management Plan. Highwalls and pit floors that have identified PAG material exposed will be covered with material that has a net neutralizing

capacity to ensure no generation of acid. The material will either come directly from the active mine area where identified NNP material is available or from a net neutralizing potential material stockpile. The information combined with computer modeling will ensure the implementation of a proper mitigation plan for any identified PAG material.

Located in the west Liberty Pit at Golden Reward is a capped depository of sulfidic uneconomic rock that has been mixed with buffering rock. The area that the capped material is located is part of an ongoing study to determine the location or cause of elevated sulfate in several monitoring wells within the Golden Reward area. Part of the current mine plan for Golden Reward is a pushback of the Liberty Highwall directly west and adjacent of the capped material. The mine plan currently does not disturb the liner cap of the depository but will take place immediately adjacent to it. Once mining begins in this area, additional mitigation plans may need to be developed, based on current study findings, to mitigate the elevated sulfate concern and to tailor the mining adjacent to the capped material.

3.2 SOILS

3.2.1 Introduction

BKS Environmental Associates, Inc. (BKS) of Gillette, Wyoming, completed the soil evaluation of the Expansion Area in August and October 2010. Approximately 600 acres were included in the final soil mapping. A detailed report on the soils study (Appendix 5) characterizes the project area soils in terms of topsoil salvage depths and related physical and chemical properties (SDCL 45-6B-7(2) and 45-6B-92(6)). The soil mapping included descriptions of 32 soil profiles and 2 road cuts. The general topography of the area ranges from valleys to steep hills and mountainous slopes. Loamy soils and deep rocky soils generally occur throughout most of the area.

Soils within the proposed Expansion Area are not remarkably different from soils within other areas permitted by Wharf Resources. Hisega loam, Goldmine loam, and Grizzly very gravelly silt loam mapping units make up a majority of the study area (84 percent) [BKS Environmental Associates, Inc., 2010a]. The soils map is provided in Appendix 5 and Exhibit 13.

3.2.2 Discussion

Soils in the Expansion Area are typical for soils formed under a mixed coniferous and deciduous forest occurring on the mountainous hillslopes of the Black Hills. Parent material include colluvium, residuum, and alluvium. The surveyed area is dominated by Hisega loam (35 percent of the total area and 52 percent of the total topsoil volume), Goldmine loam (29 percent of the total area and 27 percent of the total topsoil volume), and Grizzly very gravelly silt loam (20 percent of the total area and 7 percent of the total topsoil volume) map

units. Other map units in the area include rock outcrop/rubble land, Winetti gravelly sandy loam, Trebor silt loam, Sawdust channery loam, Citadel silt loam, Vanocker gravely silt loam, and Virkula silt loam [BKS Environmental Associates, Inc., 2010a].

The Hisega loam map unit consists of deep and very deep, well-drained soils formed in residuum from micaceous metamorphic rocks. Slopes for this map unit range from 15 to 65 percent, and the Hisega soil occurs on mountains at elevations between 3,600 and 6,300 feet. Permeability within Hisega soil is moderate, available water capacity is low, and surface runoff is medium to very high. The effective rooting depth is greater than 60 inches, and the hazard of water or wind erosion is slight. The Hisega loam map unit is a fair source of topsoil to 8 inches based on an average 2010 sample locations [BKS Environmental Associates, Inc., 2010a].

The Goldmine loam map unit consists of very deep, well-drained soils that formed in colluviums and residuum derived from igneous rocks. Slopes for this map unit range from 3 to 75 percent, and the Goldmine soil occurs on mountain hillslopes at elevations between 5,100 and 7,000 feet. Permeability within Goldmine soil is moderate, available water capacity is moderate, and surface runoff is high. The effective rooting depth is greater than 60 inches, and the hazard of water or wind erosion is slight. The Goldmine loam map unit is a fair source of topsoil to 5 inches based on average 2010 sample locations [BKS Environmental Associates, Inc., 2010a].

The Grizzly very gravelly silt loam consists of very deep, well-drained soils formed in residuum from igneous rocks. Slopes for this map unit range from 6 to 80 percent, and the Grizzly soil occurs on mountains at elevations between 4,400 and 6,400 feet. Permeability within the Grizzly soil is moderately low to moderately high, available water capacity is moderate, and surface runoff is medium to very rapid. The effective rooting depth is greater than 60 inches, and the hazard of water or wind erosion is negligible. The Grizzly very gravelly silt loam map unit is a fair source of topsoil to 2 inches based on average 2010 sample locations [BKS Environmental Associates, Inc., 2010a].

The proposed topsoil salvage depths are based on field observations of soil profiles (SDCL 45-6B-10(6)). Approximate salvage depths of each map unit series ranged from 0 to 18 inches. Based on field observations, the recommended topsoil average salvage depth for the study area is 5.39 inches. Besides rock outcrops and rubble land, some suitable topsoil and/or subsoil exists throughout the study area. The soil suitability as a plant growth medium is generally affected by the physical factor of coarse fragments, as rocks inhibited soil auguring on every hole except for one which contained paralithic material. Chemical limiting factors, such as electrical conductivity (EC) and sodium adsorption ratio (SAR), are not considered to be an issue because of the lack of salts in the profiles. The pH levels are assumed to be strongly acidic to moderately alkaline. Calcium carbonate was only noted in two profiles within the Winetti soil series. The hazard for wind and water erosion, which is mainly a factor of soil surface characteristics such as texture and organic matter content, varied from negligible to moderate.

The soils are more susceptible to water erosion than wind erosion because of the surface horizon's loamy texture [BKS Environmental Associates, Inc., 2010a].

Topsoil and suitable subsoil will be salvaged wherever possible. This material will be stockpiled, stabilized through erosion control measures, revegetated, surveyed, and labeled in the field for future use in the final reclamation phases of the project. The 2010 surveys indicate that approximately 270 acre-feet (434,940 yd^3) of salvageable topsoil will be available within the baseline study area (or about 215,947 yd^3 within the disturbance area, see Section 5.3.3) for recovery over the life of the project. There are certain areas where topsoil will be unsalvageable because of circumstances such as rocky conditions, the safety concerns for the operator or equipment from excessively steep slopes, "near-surface" underground workings, or open cuts. Every attempt will be made to salvage topsoil wherever possible.

3.3 GROUNDWATER

The characterization of the groundwater environment was conducted for the proposed Expansion Area based on available hydrogeologic and water-quality data. Identification of baseline groundwater conditions is critical to the understanding of the groundwater system, including any potential impacts to the actual mining operation and any associated impacts to subsurface water quality and quantity.

Numerous historical studies were conducted for the area, including a study for the Clinton Expansion by J. M. Montgomery Engineers Inc. (JMM) [1996]. The JMM report included a complete hydrogeological investigation in a 4 square-mile area around the Clinton Project, including areas now considered as part of this expansion. All baseline water level and water-quality information was supplied to RESPEC for baseline evaluation and is included in Appendix 6.

A review of groundwater wells was conducted by combining Wharf's location information with SD DENR well completion report information. Within the Wharf and Golden Reward mines and surrounding area, there are several wells. The majority of these wells are monitoring wells (MW) or other wells owned and operated by Wharf Resources. There are no water supply wells within the Expansion Area. The majority of private wells are residential wells that are located on the periphery of the Expansion Project within Nevada Gulch. Additionally, Black Hills Chairlift Company owns wells located on Terry Peak. Groundwater uses in the area are related to mining, housing development, and snow making.

The occurrence of groundwater in the Expansion Project Area can be evaluated through drilling and knowledge of historic underground and surface workings in the Wharf and Golden Reward areas. All evaluations of historic records and the results of recent drilling programs indicate this region is devoid of any significant water at the depths projected for surface mining.

Historical records show that underground workings in the Wharf area are essentially dry. During exploration activities in the Expansion Area, no exploration holes encountered water. Water-level data collected in 2010 was used to update existing potentiometric maps of the Expansion Area. August 2010 water level measurements are provided in Appendix 6 and a potentiometric map of the area is shown on Exhibit 20 in Appendix 2.

3.3.1 Proposed Groundwater Monitoring Program

Groundwater monitoring for the proposed Expansion Project will continue at those sites used for baseline sampling. In addition to the existing monitoring programs at Wharf and Golden Reward Mines, newly added groundwater monitoring sites that will continue to be monitored include PW-2, Foley Shaft, Nevada Gulch MW, Railroad MW, Terry Peak Water Well, the Horse Shoe MW, and MW-59. During baseline sampling from December 2009 through December 2010, these wells were sampled on a monthly basis, with the schedule somewhat influenced by site accessibility during winter months. It is proposed that these new monitoring sites be sampled four times per year, on a similar schedule as other monitoring sites at Wharf.

The location of wells in the existing Wharf and Golden Reward groundwater monitoring plans is included in Appendix 6. Wells used as baseline for this Expansion Project are depicted in Exhibit 14 of Appendix 2 and Appendix 6. Available well completion reports for Wells PW-2, MW-59, Horse Shoe MW, and Railroad MW are also provided in Appendix 6.

The current operational groundwater and surface water monitoring schedule and parameter lists are provided in Appendix 6. Wharf will review the groundwater monitoring program with the SD DENR upon request and determine any changes to the sampling program that may be necessary (74:29:02:11(7)).

3.3.2 Groundwater Quality

Baseline data for the evaluation of the groundwater quality in potentially impacted areas were obtained from 17 monitoring wells—Horse Shoe MW, Nevada Gulch MW, Foley Shaft, Terry Peak Water Well, Railroad MW, PW-2, MW-19, MW-33, MW-40, MM04A, OM-05, SM01A, SM02A, SM03A, SM06, SM09, and SM10. One year of monthly baseline data was collected from new wells. Sites already part of Wharf or Golden Reward's monitoring program had samples collected on their scheduled frequency (ARSD 74:29:02:07). All the new monitoring sites, except PW-2, were sampled monthly (depending upon site accessibility) from December 2009 through December 2010. Well PW-2 was installed in August 2010 with monthly sampling beginning in October 2010. Parameters analyzed for the baseline sampling program are the same parameters as those required for the existing Wharf water-quality program and those required by SDCL 45-6B-7(9). Additional information about the baseline and existing groundwater monitoring programs are included in the baseline groundwater report (Appendix 6).

In general, the groundwater-quality results at baseline sampling sites are similar to results from existing sampling sites and are representative for groundwater in the area. Most baseline wells have similar concentrations of most major anions and cations, including calcium, chloride, fluoride, sodium, and sulfate. Field pH values range from 6 to 12, with the median value among baseline wells of 7.21.

Some outstanding water-quality characteristics are noted here. The Horse Shoe MW has the highest carbonate concentrations with a median value of 26.35 mg/L, compared to most sites with undetected carbonate concentrations. Well SM09 stands out in its high median chloride value of 90 mg/L and as having the highest median and maximum dissolved selenium concentrations. The Railroad MW has the highest median concentration of arsenic with a value just over 0.2 mg/L; the majority of samples had arsenic levels below 0.025 mg/L. SM01A generally has higher concentrations of calcium, iron, magnesium, manganese, sulfate, anions, and cations.

Presently, there are locations, not included in to Groundwater Discharge Perimeter of Pollution (POP) zones, near the proposed permit areas where groundwater exceeds the groundwater criteria in existing monitoring wells. Arsenic is elevated in some locations because of natural background conditions. Slightly elevated arsenic is common in the area and not related to Wharf's mining activities.

Nitrate and cyanide are typically of concern at Wharf as nitrate is used in rock blasting and cyanide primarily results from the heap-leach process. All but four of the nitrate samples have concentrations below the U.S. Environmental Protection Agency (EPA) drinking water standard of 10 mg/L. Wells, including Horse Shoe MW, Nevada Gulch MW, Foley Shaft, Railroad MW, MW-33, SM01A, SM03A, SM09, SM10, and PW-2, have background nitrate concentrations less than 1 mg/L. The Terry Peak well, upgradient of Wharf mining activities, has a median nitrate concentration of about 2.4 mg/L; however, a recent sample collected in August 2010 has a value of 10.7 mg/L. A single sample from MW-19, collected in 2006, exceeded the drinking water standard with a value of 11.3 mg/L; nitrate concentrations have decreased since that time. Well OM-05 also had two samples, collected in 2006 and 2008, exceeding the EPA drinking water standard, although all samples collected for the past 2 years have been below 2 mg/L nitrate. Cyanide, including free, total, and Weak Acid Dissociable (WAD), was below the detection limit in all baseline well samples except three. These three samples are all from MW-40 and were collected in 2007. In summary, historical impacts to groundwater from previous mining activities are minor but are evident through the temporary elevated occurrences of nitrate. Raw water-quality data and statistical analysis results for October 2006 through October 2010 are presented in Appendix 6.

The potential for water pooling in pit bottoms is discussed in Section 3.4.4. Since pooling is anticipated to be minimal, the local groundwater quality is not anticipated to be impacted.

3.3.2.1 Sulfate in Nevada Gulch

One well (SM01A), near the West Liberty Pit in Nevada Gulch, has elevated sulfates. Sulfates started to rise and exceeded the groundwater criteria in 1998 after the West Liberty Pit was backfilled. Sulfate material was placed in the West Liberty backfill and capped with a polyvinyl chloride (PVC) cap. Environmental Resources Management Consultants (ERM) completed a hydrology evaluation of the area in 2011. The report was submitted to the SD DENR in March 2011. Refer to the ERM report titled *Evaluation of Hydrogeology and Geochemistry of Sulfate-Impacted Groundwater in the West Liberty Pit Area* for a discussion on the source of elevated sulfated in SM01A. The dye testing as part of the hydrology investigation has shown that the integrity of the cap is good and the only dye migrating to monitoring wells was the dye placed at the interface of the cap and the west highwall. The final report identified that the backfill material in the West Liberty Pit under the cap was the source of the elevated sulfates in SM01A. A remediation plan will be developed to mitigate the elevated sulfate concern based on the results of the report. Mitigation will be scheduled during the mining phase of the West Liberty Highwall as described in Section 3.1.3.7 of this application.

3.3.2.2 Nitrate in the Process Area

Select monitoring wells in the Wharf Process Area exceed the groundwater criteria for nitrate. Before May 1995, the nitrate concentration in groundwater in the Process Area had slowly increased above background levels but remained below the groundwater criteria of 10 mg/L. A storm event exceeding 6 inches of precipitation occurred in October 1994 and one event exceeding 7.5 inches of precipitation occurred in May 1995. To prevent any overflow from active Process Area ponds, Wharf treated and released a 4- to 6-million-gallon mixture of rainwater, treated process water, and neutralization solution into a clay-lined Contingency Pond located west of the Process Area.

Leakage of treated process and neutralization solution from the Contingency Pond in 1995 was the likely source of the elevated nitrate concentrations in the Process Area in the late 1990s. One other known source for nitrate is the septic system leach field in the Process Area. Other potential sources of nitrate are spills and leakage from the leach pads, process ponds, piping, and ditches.

In 2007, Wharf began inoculating existing monitoring wells in the Process Area with in situ biological inoculums to treat the nitrate in the groundwater. Wharf stopped these inoculations in June 2008 and started monitoring the wells on a monthly basis. To date, monitoring has shown that the inoculated wells remain below the groundwater criteria for nitrate. However, arsenic initially increased above the groundwater standard in some of the inoculated wells. The water used to prepare the biological inoculums was high in arsenic and most likely caused the increase. Monitoring has demonstrated continual decline of arsenic in the affected wells to levels very near or below the groundwater standard.

An independent hydrology study of the Process Area groundwater was completed to (1) determine the sources of the process solution leakage from the Process Area; (2) evaluate the relative effectiveness of in situ groundwater treatment in the Process Area as opposed to a pump-and-treat method or a combination of the two methods; and (3) recommend a groundwater monitoring and treatment program for the Process Area, including the placement of additional monitoring wells and/or injection wells that may be deemed necessary [Environmental Resources Management, 2008]. The study indicated that an effective remedial strategy for the nitrate-impacted groundwater in the Process Area should include removal of all suspected or potential sources of nitrate. It also indicated that an expanded groundwater monitoring network was needed to better define the extent and depth of nitrate-impacted groundwater in the Process Area. The report further discussed pump-and-treat extraction compared to in situ treatment and indicated that in situ treatment of the nitrate-impacted water in the Process Area with denitrifying bacteria and nutrients would probably be a more effective remedial strategy.

Improvements within the process area over the last 2 years to prevent potential sources of nitrate into the groundwater in and around the process plant included the following:

- Relining the heap-leach pad dams.
- Replacing the Pad 3 effluent and influent line.
- Relining Pad 3 and Pad 2.
- Constructing a new heap-leach pad (Pad 5) with improved technology and engineering, allowing repairing and upgrading of the older pads.
- Relining and/or repairing solution ditches between pads, ponds, and the process plant and placing free-flowing solutions from the ditches into pipelines.
- Relining the Pregnant Pond, Neutralization Pond, and Overflow Pond.
- Repairing the Contingency Pond and resecuring anchor ditches resecured.
- Relining the Barren Pond, but the pond was recently damaged and will be relined the summer of 2011.
- Installing new flow meters on various solution pipes.

To help determine potential sources of nitrate into the groundwater, a fluorescent dye test was conducted in the summer of 2010 with ongoing monitoring of the leakage detection systems and selected groundwater wells. A report of the dye testing was prepared by ERM and submitted to the SD DENR in February 2011 [Environmental Resources Management, 2011]. Dye test results indicated that potential sources of process water to the groundwater were the Pad 3 leak detection collection system, leakage from the Pregnant and Barren Ponds, and leakage from Pad 4 or the Pad 4 ditch. The Pad 3 leak detection system and Pad 4 ditch were repaired in September 2010. The Pregnant Pond liners were removed and replaced in

September 2010, and the Barren Pond is scheduled for repair this coming summer. Process solutions are not being applied to Pad 4 and it is scheduled for neutralization and de-nitrification in 2011. Pad 4 will be relined after offloading before reloading. Preliminary monitoring indicates that the repairs made in September 2010 were effective in reducing nitrates in some of the new monitoring wells.

As a result of the study by Environmental Resources Management [2008] and in cooperation with ERM, six additional multilevel monitoring wells were installed in 2009 and 2010 to better define the extent and depth of the elevated nitrate to identify an effective remediation strategy. Monitoring of these wells show that elevated nitrate still exists in some areas in the Process Area. However, it also shows some areas that do not have elevated nitrate.

To begin the in situ remediation of the nitrate contaminated groundwater in the Process Area, Wharf installed eight injection wells of various depths in 2010. A remediation and monitoring plan designed to conservatively use in situ bacterial remediation was developed and submitted to the SD DENR in February 2011 for review and approval (refer to Wharf Process Area Remediation Plan). The SD DENR approved the plan on April 12, 2011, and Wharf plans to construct the facilities to begin in situ injections of bacterial inoculums in the spring of 2011.

3.3.3 Spring Survey

There are several springs around the Wharf and Golden Reward Mine areas. Since these springs are fed by groundwater sources, they are discussed under this groundwater section. A few springs may be the result of perched water zones while others may be the expression of the regional water table.

Surveys to identify the location of springs were conducted for the Golden Reward and Clinton Expansion Large-Scale Mine Permit applications [Hydrometrics 1988; Wharf Resources, 1997]. A field survey was also conducted by Wharf in November 2010 to verify the presence of springs previously identified within the proposed Expansion Area.

The majority of the area springs and seeps identified in previous investigations are typically dry with intermittent periods of low flows. Based on historic surveys presented in the Golden Reward Mining Permit application [Hydrometrics, Inc., 1988] and Wharf's Clinton application [Wharf Resources, 1997], other minor, unnamed springs in the area are located in drainages of False Bottom Creek, Deadwood Creek, Nevada Gulch, Fantail Creek, and Stewart Gulch. The majority of these springs produce only a few gallons a minute during the wet spring time of the year.

One spring is located at the head of Nevada Gulch within the proposed Expansion Area. This spring is located at the boundary of the proposed disturbance limit and will not be directly disturbed. This spring which supplies the base flow for Nevada Gulch is located north and east

of the proposed haul road. A settling basin and culvert will be placed at the location the haul road enters the Ski Area parking lot. Surface drainage flowing along the south side of the Ski Area parking lot and drainage flowing from the eastern portion of the haul road will enter the settling basin before flowing through the culvert under the haul road. The presence of springs within or near the proposed disturbance areas is not anticipated to greatly impact mining operations or regional hydrology. All other minor springs are located outside of the proposed disturbance areas. A map of springs within the proposed Expansion Area is included in Appendix 6.

Six spring localities are currently sampled as part of Wharf's ongoing water-quality monitoring program: False Bottom, Ross, Beaver, War Eagle, Annie Creek II, and Ross Valley French Drain. Measured flows at these six springs range from 1 to 150 gpm with higher flows during spring and low to no flows in later summer and fall. False Bottom Spring is located at the headwaters of False Bottom Creek, War Eagle Spring is located on Cleopatra Creek, and the other four springs are located on tributaries of Annie Creek. According to guidance from the SD DENR, only two sites are considered baseline for the Expansion Area; Beaver Spring and Ross Spring. Samples are collected quarterly at Beaver Spring and monthly at Ross Spring. Water-quality results for these two springs are provided in Appendix 6.

3.3.4 Rock and Spent Ore Disposal

Waste rock mined to remove overburden will be used to fill mined areas to create slopes that are functionally and visually compatible with the surrounding area. Nitrate levels in groundwater immediately under the waste rock is expected to rise but not exceed the groundwater standard of 10 parts per million (ppm). Historical data demonstrate that even though nitrate levels have risen in water exiting the rock facility toes and springs below the existing Squaw and Reliance rock facilities, the deeper groundwater wells below these facilities have not shown a detectable rise in nitrate levels over the past 10 years.

The final off load of the heap-leach pads consisting of approximately 10 MT will be disposed within the Portland Ridgeline within the Foley POP and/or the newly submitted American Eagle POP (if granted). Approximately one MT of spent ore will remain on the heap-leach pads for use in final reclamation of the pads. The material from the final pads will enhance the final reclamation, allowing covering more of the remaining highwalls along with discard material in the area. All material unloaded to the respected areas and POP zones will meet the required off-load criteria before off-loading.

An integral part of the application for the American Eagle Groundwater Discharge Permit will be to provide data on the effective treatment of spent ore before off-load. The reduction of nitrate levels in pore water, through bacteriological denitrification, reduces the amount of nitrate off-loaded to the facilities and the potential impact on groundwater quality. In situ

biological denitrification was used successfully on spent ore at the 33 vertical depositories and is the primary process that will be used for nitrate destruction of spent ore before off-load.

ERM performed an assessment of the current and potential future impact of ore processing and spent ore and barren rock disposal on groundwater and surface water quality at the Wharf Mine in Lead, South Dakota [Environmental Resources Management, 2010]. This evaluation was submitted to the SD DENR as a condition of the May 12, 2008, Pad 5 Technical Revision approval letter. The assessment indicates that no adverse impacts will be realized to the groundwater or surface water quality.

A analysis completed by RESPEC [2009] was prepared as part of the application for a Groundwater Discharge Permit to verify that groundwater standards will not be exceeded beyond the proposed Perimeter of Operational Pollution for the proposed American Eagle Spent Ore Facility.

3.4 SURFACE WATER

The surface water condition in the vicinity of the proposed Wharf Mine Expansion is discussed in this section. The information in this section is from a more detailed surface water report by McCutcheon [2010] and is provided in Appendix 7.

Multiple small tributaries (Deadwood Creek, Rutabaga Gulch, Nevada Gulch, Fantail Creek, Lost Camp Gulch, Annie Creek, McKinley Gulch, Calamity Gulch, Long Valley, False Bottom Creek, Whitetail Creek, Ross Valley, Stewart Gulch, and Cleopatra (Squaw) Creek) are located within or adjacent to the current Wharf and Golden Reward Mines. These tributaries eventually discharge into the Belle Fourche River. The Expansion Area drains into the multiple subbasins falling within the Spearfish Creek and Middle Belle Fourche River Watersheds. Eight of the fourteen tributaries listed above have proposed surface disturbance within their drainage basins (Deadwood Creek, Nevada Gulch, Fantail Creek, Lost Camp Gulch, Stewart Gulch, Annie Creek, Long Valley, and McKinley Gulch).

Surface disturbances within the Expansion Area will not directly overlie any streams and are not expected to greatly impact surface water flow or water quality in drainages. A large portion of precipitation within the Expansion Area will be captured by the pit area, making flow available from recharge. Flow originating outside of the Expansion Area, including flows on Nevada Gulch, will be diverted through culverts under new haul roads; a more detailed explanation of stormwater and sediment control structures are provided in Section 5.3.5. The majority of the proposed area of disturbance is located within the Nevada Gulch Watershed and, hence, any hydrological impacts would likely be focused in that drainage. Impacts are anticipated to be minor and similar to that already occurring at the mine site. Based on

impacts from current practices, possible impacts from expansion of the mine area could include minor decreases in flow and minor changes in water quality.

Both Upper Fantail Creek and Nevada Gulch Creek will not have adverse impacts because of the mining of the Expansion Project. The upper Fantail Creek where mining will take place is a dry creek and there has been no record of water flow since reclamation. Where water has been recorded for Fantail Creek within the Golden Reward property, flow is on the eastern edge immediately above and below the sand dam (near the eastern gate to Golden Reward). The flow on this section is intermittent and seasonal during large meteoric events. This section of stream will not be impacted by future mining.

The Nevada Gulch Creek will have the haul road to and from Golden Reward constructed immediately west of where the creek runs parallel to the Terry Cemetery access road. The haul road will not cross the creek at this point but will follow the current Terry Cemetery Road into Golden Reward. A culvert will be placed at the location the haul road enters the Ski Area parking lot to route surface drainage flowing along the south side of the Ski Area parking lot under the haul road. See Exhibit 29.1 for details.

3.4.1 Proposed Surface Water Monitoring Program

It is proposed to continue existing surface water monitoring programs. Currently, 23 surface water monitoring sites are being sampled at Wharf and Golden Reward, 11 of which are considered baseline sites for the Expansion Area (ARSD 74:29:02:07). Sites BMT-1 and DWD-1 are located on two branches of Deadwood Creek. Sites SS20, SS04, and SS05 are located on Nevada Gulch. Two sites are located on Fantail Gulch (SS-06 and SS-14A), and two sites are located on Stewart Gulch (SS-01 and SS-12). To the southwest of the Expansion Area, the final two baseline surface water sites include Lost Camp and Annie Creek @ USGS. The locations of baseline surface water monitoring sites are depicted in Exhibit 14 of Appendix 2 and in Appendix 7.

Typically, surface water monitoring sites are sampled four times per year. Site SS-20, which was added in December 2009, was sampled monthly from December 2009 through December 2010; it is proposed that this site be sampled four times per year, on a similar schedule as other monitoring sites at Wharf.

The current operational groundwater and surface water monitoring schedule and parameter lists are provided in Appendix 6. Wharf will review the surface water monitoring program with the SD DENR upon request and determine any changes to the sites or sample parameters that may be necessary (ARSD 74:29:02:11(7)).

3.4.2 Surface Water Quality

Baseline data for the evaluation of the surface water quality in potentially disturbed drainages before the Wharf Expansion was obtained at 11 sites—Annie Creek @ USGS, Lost Camp, BMT-1, DWD-1, SS-01, SS-04, SS-05, SS-06, SS-12, SS-14A, and SS-20. Site SS-05 was sampled historically but was removed from Golden Reward's required sampling sites, and as requested by the SD DENR, this site was added back into the sampling program. Historical data for SS-05 (2004) served as baseline data as new sampling began in October 2010. These sites will continue to be sampled on an established schedule. Any changes to the sites or sample parameters will be established in conjunction with the SD DENR.

At this time, there is no planned disturbance across the ridgeline into the Long Valley drainage. As a permit condition, a baseline sampling plan and 12 months of data will be submitted to the SD DENR for review before any disturbance occurs within the Expansion Project in the Long Valley drainage basin.

Parameters analyzed for the baseline sampling program are the same parameters as those required for the existing Wharf water-quality program and those required by SDCL 45-6B-7(9). SD DENR specified required chemical parameters as well as sampling frequency. Between 21 and 36 set chemical parameters were analyzed at each site. The required frequency of sampling events varies from site to site. The required chemical parameters, the frequency of sampling events, and the results of the chemical analysis are included in the RESPEC surface water report (Appendix 7).

3.4.3 Rock and Spent Ore Disposal

Waste rock mined to remove overburden will be used to fill mined areas to create slopes that are functionally and visually compatible with the surrounding area. There are no planned valley fill areas where waste rock is deposited on bedrock within a valley such as the Squaw or Reliance rock facilities. Typically at Wharf, only water has been seen exiting the toe of the valley fill depositories. Meteoric water flowing through waste rock or spent ore deposited in mined-out areas flows toward the bedrock groundwater. However, based on historical data from below the existing Squaw and Reliance rock facilities, nitrate levels in water exiting the toe of any valley fill would be expected to rise slowly over a period of about 6 years before beginning a gradual decline.

The leaching characteristics of the rock facility are dependent on the amount of water that infiltrates from background precipitation. Past studies indicated that after reclamation occurs and vegetation is established, the infiltration rate is reduced from approximately 9 to 4 inches per year (approximately 15 percent of the average annual precipitation at Wharf). However, because nitrate is not attenuated by soils or rock, the flushing of the limited amount of residual nitrates in a rock depository occurs fairly rapidly, before the establishment of a significant vegetative cover.

Based on the fact that Wharf has been able to improve the efficiency of its blasting practices and significantly reduce the amount of residual nitrate in blasted rock, nitrate levels in water potentially exiting the toe of any rock facility to surface water are expected to be significantly lower than the 30 ppm experienced below the toes of the existing Reliance and Squaw Creek rock facilities. The surface water standard of 50 ppm nitrate for a cold-water fishery will not be exceeded.

The final off-load of the heap-leach pads consisting of approximately ten MT will be disposed within the Portland Ridgeline within the Foley POP and/or the newly submitted American Eagle POP (if granted). Approximately one MT of spent ore will remain on the heap-leach pads for use in final reclamation of the pads. The material from the final pads will enhance the final reclamation, allowing covering more of the remaining highwalls along with discard material in area. All material unloaded to the respected areas and POP zones will meet the required off-load criteria before off-loading.

ERM performed an assessment of the current and potential future impact of ore processing, and spent ore and barren rock disposal on groundwater and surface water quality at the Wharf Mine in Lead, South Dakota [Environmental Resources Management, 2010]. This evaluation was submitted to the SD DENR as a condition of the May 12, 2008, Pad 5 Technical Revision approval letter. Pathway and fate studies were completed by RESPEC of Rapid City, South Dakota, concerning these areas. The assessments indicate that no adverse impacts will be realized to the groundwater or surface water quality. Sediment, erosion, and drainage control structures are discussed in Section 5.3.5.

3.4.4 Potential of Water Pooling in Pits

Water pooling in the final pit floors could occur for a minimal time as pits approach final mining, but because of the concurrent reclamation the time in which final pit floors are exposed is minimal and usually less than 1 month. In addition, final pit floors will not be mined to the point where large quantities of Precambrian rock are exposed for any long period (less than 1 month). All effort will be given to cover any exposed Precambrian rock immediately so that exposure to the elements (weather) is minimized to prevent ARD generation. Water pooling or drainage to pit bottoms is minimized by diversion methods (berms, water bars, drainages) so that water does not travel and accumulate at pit bottoms. This is a necessity so that it does not hamper mining at the lower levels, result in undue wear of consumables (tires and wear iron), increase the cost of transfer/pumping of water out to designated areas such as reclaimed areas, and increase the chance of exposure of Precambrian rock to generate acid. The minimal occurrences of pooled water at pit bottoms is a result of meteoric events and is of good quality, and if it does not soak into the ground, it would be pumped out immediately if necessary or required.

3.5 AIR QUALITY

3.5.1 Introduction

Operational air quality was monitored near Wharf's surface mining operation to determine localized source-generated concentrations of airborne particulates and their trends of dispersal periodically since 1985 (SDCL 45-6B-92(8)). Based on conversations with the South Dakota Air Quality and Mining Programs, no additional baseline air-quality monitoring is required for the baseline studies of the Expansion Area. Specific emission types measured at the operation are primarily rock dusts generated during the handling and transport of mined ore and rock. Off-site emissions, including dust from an adjacent county road and wood smoke from forest fires and local home heating units, also contribute airborne particulates.

In addition to monitoring air quality, meteorological data were collected and recorded at the mine from 1985 till early 2008, at which time, the station became dysfunctional and meteorology was no longer required to be monitored by the Air Quality Permit and Technical Revision to the Mine Permit. For current baseline investigations, parameters measured at nearby weather stations were analyzed. A complete analysis of meteorological conditions near the Expansion Area is provided in Appendix 8.

3.5.2 Historical Sampling Program

High volume (hivol) air samplers were used for measuring source emissions from the mine (primarily rock and road dusts) from several locations including upwind and downwind sites from 1985 until 1992. Samplers measured total suspended particulates (TSP). In 1988, a PM-10 air sampler, which measures total inhalable particulates, was incorporated into the sampling network to establish a general correlation between TSP and PM-10 particulate concentrations. In August of 1992, all hivol samplers were dismantled and the upwind site known as Preston was brought up to federal air-quality monitoring standards by installing a PM-10 air sampler. The downwind site, known as the Micro-Tower, had a PM-10 sampler in operation from 1988 through 2007. A PM-10 air sampler was installed near the Clinton Expansion Area in 1993 to record baseline emission levels. A map showing the location of the historical PM-10 air-quality samplers is provided in Exhibit 16 of Appendix 2. All PM-10 sampling was discontinued in early 2007 under the discretion of the SD DENR Air Quality Program.

3.5.3 Existing Sampling Program

Existing monitoring activities conducted by Wharf Resources personnel consisted of EPA Method 9 visible emission evaluations at the two permitted sources and the seven fugitive sources. Emissions are calculated for each permitted unit and the seven fugitive sources every month. The total emissions for each month, along with a 12-month rolling average, are reported to SD DENR each year. The most recent annual air-quality report for the year 2009 was

submitted to the SD DENR [Waterland, 2009]. No additional baseline air-quality monitoring was required by the South Dakota Air Quality and Mining Programs for the baseline studies of the Wharf/Golden Reward Expansion Area.

3.5.4 Air-Sampling Results

During 2006, the last full year of PM-10 data, the maximum 24-hour PM-10 concentration for the compliance monitors (Micro-Tower, Preston, and DN-1) was 28.7 micrograms per cubic meter ($\mu g/m^3$), which occurred at Preston. This is compared to the South Dakota 24-hour PM-10 standard of 150 $\mu g/m^3$. The maximum annual arithmetic average PM-10 concentration for the compliance monitors was 10.9 $\mu g/m^3$, which occurred at the Micro-Tower site. This is compared to the South Dakota and Federal PM-10 standard of 50 $\mu g/m^3$. Individual results of the last PM-10 suspended particulate data collected in 2006 may be found in the 2006 annual air-quality report [Wharf Resources, 2007].

During all periods of air-quality monitoring at Wharf, all particulate levels were well within both federal and South Dakota PM-10 air-quality standards. Ambient air-quality standards and a summary of 2006 PM-10 data are provided in Tables 3-3 and 3-4. Results indicate that there has been no significant deterioration of air quality because of the current operation since 1985. Annual air-quality data summary reports by Wharf Resources contain additional information.

Table 3-3. Ambient Air-Quality Standards for Total Suspended Particulates and PM-10 Suspended Particulates

Time Period	TSP	South Dakota PM-10	Federal PM-10
24-Hour	150[(a)]	150[(a)]	150[(a)]
Annual	60[(b)]	50[(c)]	50[(c)]

(a) Not to be exceeded more than once per year.
(b) Geometric average, not to be exceeded.
(c) Arithmetic average of quarterly averages, not to be exceeded.
Note: Values in micrograms per cubic meter.

3.5.5 Meteorological Stations

Meteorological data were collected and recorded at the Wharf Mine from 1985 until early 2008, at which time, the station became dysfunctional and meteorological data were no longer required to be monitored on site by the Air Quality Permit and Technical Revision to Wharf's Mine Permit. No new on-site meteorological monitoring was requested by the SD DENR for current baseline investigations; hence, analysis is based on parameters measured at two nearby weather stations and supplemented by available Wharf data.

Table 3-4. Summary of PM-10 Suspended Particulate Data for 2006

Site	Maximum	Second Highest	Annual Arithmetic Average	No. of Samples
Micro-Tower	28.3	25.2	10.9	52
Preston	28.7	27.5	9.9	56
DN-1	27.6	23.7	9.7	58

Note: Values in micrograms per cubic meter.

Meteorological data used for this baseline study were obtained from the High Plains Regional Climate Center [High Plains Regional Climate Center, 2010; Umphlett, 2010] for stations in Lead, South Dakota (2005–2009), and Spearfish, South Dakota (2009). The Lead station is approximately 3 miles from the Wharf Mine, and the Spearfish station is approximately 10 miles from the Wharf Mine. Parameters available from the Lead station include temperature, precipitation, heating degree days, and cooling degree days. Parameters available from the Spearfish station include dew point, relative humidity, wind speed, wind direction, and barometric pressure. Intermittent temperature, relative humidity, wind (2005–2008), and precipitation (2009) data were also available for the Wharf's historic meteorological station [Wharf Resources, 2006 and 2007; Waterland, 2010].

From 2005 to 2009, the Lead station had an average overall temperature of 44.5°F and an average precipitation accumulation of 2.9 inches per month. During 2009, the overall temperature and precipitation accumulation were both slightly lower (42.5°F and 2.8 inches per month, respectively). The average daily relative humidity in 2009 at the Spearfish station ranged from a low of 22.8 percent during January and a high of 98.9 percent during June. The average wind speed at Wharf in 2008 was approximately 7 miles per hour (mph). A complete analysis of meteorological data is presented in Appendix 8.

During proposed operations, meteorological data from the Lead meteorological station and on-site precipitation data will continue to be collected and summarized in annual reports to the SD DENR Air Quality Program as requested.

3.5.6 Proposed Air-Quality and Meteorological Monitoring Program

As per conversations with SD DENR mining and air-quality personnel, the current monitoring may provide adequate monitoring needs for the proposed Expansion Area. The current air-quality monitoring will continue to provide information about visible emissions. Wharf proposes that no additional monitoring will be needed to monitor ambient air-quality or meteorological data during mining operations in the Expansion Area (ARSD 74:29:02:11(8)).

3.6 VEGETATION

The objective of the baseline vegetation study was to complete surveys of critical riparian zones, mountain meadows, wetlands, and threatened or endangered species as required by SDCL 45-6B-7(3), SDCL 45-6B-92(3), and the Endangered Species Act (16 U.S.C. sections 15331–1543; 50 C.F.R. Parts 200 and 402). This was completed using aerial photographs and transect mapping. Vegetative inventories, plant cover, and density surveys were performed in 2010 by BKS Environmental Associates (Gillette, Wyoming) on approximately 573 acres of the new Expansion Area.

Four primary vegetation communities exist in the Expansion Area: ponderosa pine–common snowberry, ponderosa pine–creeping juniper, quaking aspen series, and reclaimed grassland. Each of these communities was examined as a part of the baseline vegetation study for the SD DENR Mine Permit application [BKS Environmental Associates, Inc., 2010b] and is included in Appendix 9. No wetlands were found within the proposed Expansion Area [BKS Environmental Associates, Inc., 2010b].

The ponderosa pine–common snowberry communities are dominated by ponderosa pine, common snowberry, and quaking aspen. The ponderosa pine–creeping juniper community is dominated by ponderosa pine and creeping juniper. The quaking aspen community contains quaking aspen, ponderosa pine, and grouse whortleberry (*Vaccinium scoparium*). The majority of the area is covered by the ponderosa pine-common snowberry and ponderosa pine–creeping juniper communities.

The ponderosa pine-common snowberry had the highest total vegetation cover, with the highest total cover in the quaking aspen series and the ponderosa pine–common snowberry communities. The highest and lowest shrub densities were in the ponderosa pine–common snowberry community and the reclaimed grassland community, respectively. This is logical because postdisturbance shrub recovery is time intensive. Trees were the densest in the quaking aspen series. Refer to Appendix 9 for a complete report on the vegetation within the project area [BKS Environmental Associates, Inc., 2010b].

No riparian or wetland vegetation species or communities were documented within the Expansion Project, including areas along Upper Nevada Gulch and Upper Fantail Creeks. A letter from BKS Environmental Associates stating such is provided at the end of Appendix 9.

Vegetation studies for areas within the Golden Reward Mine were conducted in 2006 as part of the reclamation release request [Environmental Resources Management, 2009]. The vegetative cover of the reclaimed lands now serves as baseline data for any new disturbance in those areas. The primary areas within Golden Reward proposed for redisturbance are located in the West Liberty Pit, East Liberty Pit, and Harmony Pit. A brief summary of the reclaimed

vegetation is provided here while the full vegetation report can be found in Environmental Resources Management [2009].

Outside of the pit highwalls, most of the Golden Reward area consists of open meadows with interspersed cover. Vegetative cover requirements include having vegetative cover capable of supporting wildlife species, an understory adequate of erosion control, a minimum 40 precent cover, five or more species, and the ability to self-regenerate. In 2009, at the time of the reclamation release request, all the released lands met the vegetative cover requirements of SDCL 45-6B-39. Specifically, the 2006 revegetative evaluation identified 72 taxa, including 21 grass or grass-like species, 28 forbs, and 23 shrubs or trees. A full list of observed plant species is in the reclamation release request [Cedar Creek Associates, 2008]. Planting and species tables from that report are included in Appendix 9. An average of 305.2 woody species was observed per acre, exceeding the 200-plant-per-acre restoration requirement. Also, average vegetative cover was 56.9 percent, exceeding the required 40 percent.

3.6.1 Species of State and Federal Interest

The state of South Dakota has only one federally listed threatened plant species, the Western Prairie Fringed Orchid (*Platanthera praeclara*). The results of the field surveys in 2010 found no individuals of the Western Prairie Fringed Orchid or any other state or federally listed threatened or endangered plant species within or adjacent to the Expansion Area. Additionally, no potential habitat for the Western Prairie Fringed Orchid was found within or adjacent to the Wharf and Golden Reward Expansion Areas.

The results of the field surveys in 2010 found two sensitive species or species of local concern within or adjacent to the Wharf Expansion Area [BKS Environmental Associates, 2010c]. Four populations of mountain huckleberry (*Vaccinium membranaceum*) and one population of white veined wintergreen (*Pyrola picta)* were located on steep rocky slopes in the southern portion of the study area. The single individual of white veined wintergreen found within the Expansion Area was located south of the red chair ski lift at Terry Peak; the species was in a vegetative state. Of the four populations of mountain huckleberry found within the Expansion Area, three are located near the red chair ski lift at Terry Peak. Each mountain huckleberry population group contained from 100 to over 300 plants. This species was in both a vegetative and fruiting state at the time of the surveys. All of these sensitive populations are outside the proposed disturbed area and are not anticipated to be impacted. Refer to Appendix 9 (Addendum J) for a more detailed report of these sensitive species; sensitive plant species locations are also shown on Exhibit 17 of Appendix 2.

3.7 WILDLIFE

3.7.1 Introduction

Bird and wildlife observations and activities within the mine site and adjacent surroundings have been monitored and recorded by the Wharf environmental staff since 1982. Annual wildlife monitoring was conducted at the Wharf and Golden Reward Mines by ICF International (formerly Jones & Stokes) since 1994. During most years from 1994 to 2002, annual monitoring included standardized wildlife surveys for game birds, breeding birds, and nesting raptors. In addition, all incidental animal species (including any federally listed species and other species of concern listed under the South Dakota Natural Heritage Program (SDNHP)) were recorded within the permit area and within approximately a 0.5-mile perimeter of the permit area during that time. Because of the cessation of mining and completion of final reclamation activities at the Golden Reward Mine, few wildlife surveys were conducted for the area between 2003 and fall 2009; however, a wildlife study was conducted in 2006 in conjunction with reclamation release at Golden Reward [Environmental Resources Management, 2009]. Annual monitoring at the Wharf Mine has been ongoing during the entire period and is current as of 2010 [ICF International, 2010].

The objective of the baseline wildlife study was to collect both quantitative and qualitative data on occurrence, abundance, diversity, seasonal trends, and general habitat affinity both in and around the Expansion Area. This included identification of habitats that could support threatened and endangered species and other high value or unusual wildlife, as well as a review of the data from previous monitoring activities, to compile a full history of wildlife use and activity in the vicinity of the proposed Expansion Area (SDCL 45-6B-92(1)). The detailed baseline wildlife report is located in Appendix 10. Exhibit 18 of Appendix 2 shows the locations of wildlife features, including owl survey points, raptor nests, and potential bat habitat structures.

3.7.2 Wildlife Inventories

Wildlife surveys in the new Expansion Area and surrounding 0.5-mile perimeter were conducted from November 2009 through July 2010. In addition to reporting all incidental sightings and generating a comprehensive species list for the area, ICF biologists conducted nocturnal surveys for breeding owls and diurnal surveys for roosting bats and other breeding raptors. Surveys for the parcel north of Wharf in Section 33 were conducted in October 2010 in a similar fashion to other surveys with the exception that no owl surveys were conducted because of the season. Standard field guides, along with the U.S. Forest Service's (USFS) Region 2 Sensitive Species list [U.S. Forest Service, 2009] and the South Dakota Natural Heritage Program [2009] list, were used to identify animals and their signs (see Appendix 10, Attachment I).

Mammals documented in the area during baseline surveys and previous years' monitoring include, but are not limited to, big game, such as antelope, deer, and elk; predators and furbearers, such as the mountain lion, coyote, raccoon, weasels, and striped skunk; and small and medium-sized mammals, such as porcupine, jackrabbits, cottontails, pocket gophers, and several smaller rodent species. A wide variety of common avian species are also present in the area either as seasonal or year-long residents or as migrants passing through the area. Avian species include, but are not limited to, various raptors, such as hawks, owls, eagles, and vultures; woodpeckers, waterfowl, and shorebirds; wild turkeys and mourning doves; and numerous songbirds.

As part of the Golden Reward reclamation release request [Environmental Resources Management, 2009], postmining wildlife studies were conducted. The wildlife sighting program was in place at Golden Reward from 1991 through 2003 with additional studies in the spring of 2006; a copy of the 2006 wildlife sightings list is found in the Reclamation Release Request [Environmental Resources Management, 2009]. The 2006 data revealed the area is being used primarily by big game (deer), game birds (wild turkey), and 21 species of songbirds; the area is also used to a lesser extent by predators, other mammals, raptors, waterfowl, reptiles, and amphibians [Environmental Resources Management, 2009].

Wildlife habitats within the survey area are common in the Black Hills region of South Dakota. No unique or unusual wildlife habitats were documented in the survey area during baseline surveys or in previous years' monitoring for the adjacent Wharf and Golden Reward Mines. The area is dominated by ponderosa pine habitats, but other scattered woodland habitats, such as white spruce and quaking aspen, are also common throughout the region. Bottomland habitats, which often support considerable wildlife diversity, are limited, as natural drainages do not maintain persistent flow. Snow runoff during the spring likely provides most of the seasonal moisture to bottomland and streamside habitats. However, because no perennial streams and only a few small ponds occur, no fisheries and only limited bottomland habitat would be affected by the project [ICF International, 2010].

3.7.3 Bats

During surveys conducted throughout the expansion survey area in the fall of 2009 and the spring and fall of 2010, wildlife biologists identified six locations (Exhibit 18 in Appendix 2) with limited potential to serve as underground roost maternity sites or hibernacula for bats. Site assessments, in cooperation with the South Dakota Game, Fish and Parks (SD GFP) and a regional bat researcher, determined that three of the sites were not suitable for roosting bats. Three nights of nocturnal surveys conducted at the three remaining sties confirmed relatively low bat use in the area (a total of 30 calls recorded) [ICF International, 2010]. Six bat species were detected with the western small-footed myotis being the most common species. None of the species identified are federally listed species; however, the SDNHP-listed silver-haired bat, northern myotis, and Townsend's big-eared bat were detected [ICF International, 2010]. The

absence of any evidence of collective roosting excludes all six sites from use as maternity roosts. As such, it is unlikely that any of these locations provide significant roosting habitat for bats [ICF International, 2010].

Regardless of the low documented use at the identified underground features within the study area, the potential for future bat use could not be eliminated unless temporary closures were implemented in advance of permanent closure. Based on consultation with Batworks, Inc., tarps positioned across or slightly within the underground entrances for a minimum of 5 days provided a suitable mitigation technique by allowing any individuals inside to crawl out along the edge of the tarp while adequately preventing additional individuals from flying in [ICF International, 2010]. Once sufficient time is allowed for escape, permanent closure or excavation of the sites can occur with little probability of inadvertent or incidental loss of bats.

Approval of the aforementioned mitigation strategy was granted by the SD GFP after survey results were determined. As such, on September 14, 2010, biologists placed tarps across the entrances to the three sites determined to have potential roosting habitat. After more than a week, Wharf Resources took measures to fill in these sites. Other known and protected underground roost sites exist beyond the expansion survey area within flight range of the bat species documented during the course of surveys. Thus the closure of these sites would not eliminate all potential bat habitat in the general area [ICF International, 2010]. The complete bat survey report and photographs of the sites are included in Appendix 10.

3.7.4 Raptors

Over the past 15 years, raptor surveys have been conducted near the Wharf and Golden Reward Mines on an annual basis. Searches for raptor nests were conducted during baseline wildlife studies within the proposed disturbance area and a 0.5-mile perimeter. The complete wildlife report, including additional details on baseline studies results and historical raptor nest territories, is provided in Appendix 10.

Numerous raptor nests sites (current and historical) are present in the general area, and all but five nests are associated with broad-winged hawks. A review of historical raptor survey data revealed that the survey area contained 20 previously identified nests and two relocation mitigation nest sites [ICF International, 2010]. In 2010, only one active broad-winged hawk territory was identified, and no other raptor species were documented nesting in the area. Although no precise nest location was identified at the active broad-winged hawk territory, defensive responses on multiple occasions indicated that the territory was active and located south of the proposed Expansion Area.

No other nest sites (current or historical) exist within the proposed disturbance area associated with the Expansion Area and, therefore, no nests will be physically disturbed by the proposed expansion. All raptor species (i.e., broad-winged hawk, Cooper's hawk, and red-tailed

hawk) documented within the Expansion Area during 2010 or in previous years are known to regularly nest elsewhere in the immediate vicinity and throughout the region. As nests have been located proximal to roads, mining, or other human disturbance, it can be concluded that the presence of human activity has not deterred nesting.

Three additional raptor species (northern harrier, sharp-shinned hawk, and red-tailed hawk) were documented within the survey area during surveys in 2009 and 2010. None of the species appeared to be associated with an active nest during the 2010 nesting season. All of the raptor species observed within the Expansion Area are common in the region.

3.7.5 Owls

Only one owl species (northern saw-whet owl) was recorded during targeted nocturnal owl surveys in 2010. This owl species is relatively common in pine and mixed-forest habitats throughout the Black Hills and was heard (although not visually detected) at three of the six listening sites within the expansion survey area. The only additional owl species recorded during wildlife baseline surveys in the fall of 2009 and spring, summer, and fall of 2010 was an incidental observation of a great-horned owl seen during the May 2010 raptor nest searches.

3.7.6 Big Game

No specific surveys were required targeting big game species; however, incidental sightings of big game are included in this section. White-tailed deer and mule deer were the only two big game species observed within the Expansion Area and 0.5-mile perimeter. Both species were observed in forested habitats and open meadows throughout the expansion survey area and during the entire baseline survey period. The only mammalian predator detected was the coyote [ICF International, 2010].

Pursuant to ARSD 74:29:07:02(6), preventative measures to minimize harmful impacts to wildlife at the Wharf Mine include active communication between the mine operators and on-site environmental personnel, a big game fence exclosure around the process area, and frequent inspections of the process ponds. Cyanide levels in process solutions are maintained at low levels (less than 50 ppm WAD Cyanide) at locations where ponds are open. These practices will continue for the expansion. In addition, Wharf personnel work closely with SD GFP personnel and wildlife consultants to address any potential harmful impacts to wildlife [Wharf Resources, 1998].

3.7.7 Game Birds

While no specific surveys targeting upland game birds were required, biologists recorded three game bird species (wild turkey, ruffed grouse, and mourning dove) during the baseline wildlife surveys. During the May surveys, six wild turkeys were observed foraging in or near pine habitats on two separate occasions. Ruffed grouse were also observed during the May and

July surveys. A "drumming" male was observed in May, and a single grouse was observed crossing a forest trail in July. Mourning doves were occasionally observed along power lines associated with residences and within nearby reclaimed grasslands [ICF International, 2010]. While the Expansion Area is used by game birds, these species do not appear to concentrate in the area in great numbers.

3.7.8 Song Birds and Small Mammals

Additional avian species recorded in the survey area, although not surveyed, included many common forest species typical of the Black Hills regions, such as the black-capped chickadee, chipping sparrow, ruby-crowned kinglet, red-naped sapsucker, red-breasted nuthatch, and darkeyed junco. Shrubs and shrub understory hosted common species such as MacGillivray's warbler, song sparrow, and Swainson's thrush. Say's phoebes and mountain bluebirds were commonly observed in open, disturbed areas [ICF International, 2010].

Red squirrels and least chipmunks were also commonly observed throughout the forested habitats within the study area and 0.5-mile perimeter, and yellow-bellied marmots were regularly seen and heard in disturbed areas [ICF International, 2010]. A complete list of avian and small mammal species was compiled within the Expansion Area as presented in Appendix 10. Species present are representative of those in similar Black Hills habitats.

3.7.9 Reptiles and Amphibians

Reptiles and amphibians were not targeted by systematic surveys. Only one amphibian species and one reptile species were encountered in the proposed Expansion Area. Boreal chorus frogs were heard on multiple occasions at small pools or along ephemeral streams throughout the survey area. This same species was also noted during historic surveys of the Clinton Expansion Area. The lone reptile species, the smooth green snake, was observed crossing a forest trail during the May 2010 surveys for bat habitats [ICF International, 2010]. Observations indicate that reptiles and amphibians are probably not numerous in the Expansion Area.

3.7.10 Species of State and Federal Interest

No state or federally listed threatened and endangered vertebrate species were documented within the survey area during wildlife baseline surveys conducted in the fall of 2009 or in the spring, summer, and fall of 2010, and no records exist within the historical accounts of the nearby Golden Reward and Wharf Mine annual monitoring programs. Likewise, no candidate, petitioned, or proposed threatened and endangered vertebrate species were recorded during recent baseline surveys or previous annual monitoring [ICF International, 2010]. The single vertebrate threatened and endangered species (whooping crane) that may be expected to occur in Lawrence County, South Dakota, is associated with low-elevation wetland or open water

habitats, which do not occur within the proposed Expansion Area and its surrounding 0.5-mile perimeter [ICF International, 2010].

Seven avian species, one reptile species, and three mammal species (bats) on the SDNHP list were observed within the proposed expansion survey area during baseline wildlife surveys completed in 2009 and 2010. Cooper's hawks, sharp-shinned hawks, broad-winged hawks, and the northern saw-whet owl were documented within or near the study area [ICF International, 2010]. A single pair of American three-toed woodpeckers was observed during the May raptor nest surveys. Brown creepers and Cassin's finches were both observed on multiple occasions throughout open pine habitats during the July raptor nest surveys. A single smooth green snake was observed crossing a forest trail during the May surveys. The silver-haired bat, the northern myotis, and Townsend's big-eared bat were detected during the surveys, but the absence of any collective roosting (observed or recorded) excludes the sites at which they were detected as maternity/nursery roosts. The only USFS-sensitive species documented within the study area during the 2009 and 2010 surveys was the aforementioned American three-toed woodpecker [ICF International, 2010].

Overall, no endangered, threatened, proposed, candidate, or petitioned vertebrate species were documented in the study area, and it is unlikely that any of those species would rely on the habitats present within the survey area [ICF International, 2010]. No designated critical or crucial habitats for any threatened or endangered species occur in the area. All of the SDNHP-listed and USFS-sensitive species documented within the survey area during the baseline study period are common in the region, either seasonally or year-round [ICF International, 2010]. Given the physical and faunal characteristics of the area, no significant impacts to wildlife or their habitats are anticipated from the proposed mining operations and reclamation of the proposed Expansion Area [ICF International, 2010].

3.8 AQUATIC RESOURCES

3.8.1 Introduction

GEI conducted aquatic species and habitat surveys for multiple years on streams that flow through or have drainages within the Expansion Areas (SDCL 45-6B-92(2)). These surveys provided recent and historical data on aquatic habitat, fish populations, benthic macro-invertebrate populations, and periphyton populations for the following streams in the vicinity of the proposed Expansion Area: Annie Creek, Ross Valley, Deadwood Creek, False Bottom Creek, McKinley Gulch, Cleopatra Creek, Nevada Gulch, Fantail Creek, Stewart Gulch, and Whitetail Creek.

Fourteen aquatic study sites are included in the baseline analysis of the Expansion Area. To the southwest of the proposed Expansion Area, there are three aquatic sites located on Annie Creek, one site on Ross Valley just above the confluence with Annie Creek, and one site on Lost

Camp Gulch, also above the confluence with Annie Creek. North of the Expansion Area, one aquatic site is located on Cleopatra Creek, one site on False Bottom Creek, and two sites on Deadwood Creek. To the east near Golden Reward, two aquatic sites are located on Nevada Gulch, one on Fantail Creek, one site on Stewart Gulch, and one site on Whitetail Creek. See Exhibit 15 in Appendix 2 for a map of aquatic sampling site locations.

The most recent data for these streams were collected in August 2010 as part of the Expansion Area baseline sampling plan. In addition, the normal scheduled annual sampling for the area was supplemented by sampling a new site on Lost Camp Gulch, sampling previously discontinued sites on Deadwood Creek and Nevada Gulch, and adding fish and habitat sampling at sites that were not scheduled to be sampled for these parameters until 2011. These supplementary sampling sites and parameters were included to better characterize the aquatic ecology of the Expansion Area for the baseline analysis.

The field studies involved collecting, identifying, counting, weighing, and measuring fish and collecting and identifying aquatic macroinvertebrates (insects) and periphyton (attached algae) that inhabit the streams. A number of stream habitat variables, including water depth and width, amount of pool and riffle, and substrate (stream bottom) composition, were measured to determine the quality of the habitat for fish, insects, and algae. The aquatic monitoring plans for Wharf and Golden Reward Mines were last updated and implemented in 2006 and 2005, respectively, to satisfy requirements of the SD DENR [Chadwick Ecological Consultants, Inc., Consultants, Inc., 2006a; 2006b]. Benthic macroinvertebrate and periphyton collection and assessment methods were modified from past data collection procedures. The detailed aquatic survey report, including a summary of historic data and detailed baseline data, are available in Appendix 11.

3.8.2 Aquatic Habitat

Sites on Ross Valley, Lost Camp Gulch, Deadwood Creek, False Bottom Creek, and Cleopatra Creek have typically been dominated by riffle habitat, with pool habitat generally present at all of these sites as well except for the Ross Valley site [GEI Consultants, Inc., 2010]. All three of the Annie Creek sites are dominated by fast-water habitat types such as riffles and runs, with smaller pools present at most sites and years. A diverse mixture of substrate sizes has been present at each site, with gravel or rubble being abundant at some sites. Fine sediment was high at the upstream Annie Creek and Deadwood Creek sites [GEI Consultants, Inc., 2010]. Banks have generally been stable at most of these sites, but eroded banks were more common at the downstream Deadwood Creek site, the downstream most Annie Creek site, and the False Bottom Creek site. Increases in eroded and exposed banks were observed at the False Bottom Creek site in some recent years, which are thought to be a result of scouring from high spring flow events; however, no exposed banks were present at this site in the past 2 years [GEI Consultants, Inc., 2010]. Some sediment deposition has been present at the two upstream sites on Annie Creek, particularly in the pool habitat [GEI Consultants, Inc., 2010].

Sites on Fantail Creek, Nevada Gulch, Stewart Gulch, and Whitetail Creek have been dominated by riffle habitat over the course of the study. Compared to aquatic sites near Wharf, pools comprised a much smaller proportion of the total length but were present at each site. Stream habitat features, such as widths, depths, and flows, varied between sites and years. Stewart Gulch and Whitetail Creek are the largest of the four study streams, while Fantail Creek and Nevada Gulch are smaller. Substrate at each site was heterogeneous, but rubble or gravel have often been the most abundant substrate size category [GEI Consultants, Inc., 2010]. Banks at these sites have generally been stable since 1998, but eroded banks have been observed in many to most years in which habitat surveys were conducted at Fantail Creek and Stewart Gulch sites [GEI Consultants, Inc., 2010].

Habitat conditions at all aquatic study sites varied considerably since monitoring began in 1986. In many cases, these variations appear to be the result of natural changes in flow conditions over the years. Water widths at some sites were greatest in 1998 and 2008, likely as a result of higher flows in late summer at the time of measurement than in most other years. In general, although habitat characteristics have been variable, few trends have been observed other than an increase in the percentage of fine substrate at the Fantail Creek site [GEI Consultants, Inc., 2010]. Habitat data are provided in greater detail in the aquatic survey report (Appendix 11).

3.8.3 Fish Sampling

No fish have been collected at the upstream Annie Creek site over the course of the study. Mountain suckers were collected in low densities from the middle Annie Creek site in most years; a single mountain sucker was observed in 2010. Currently, mountain suckers are not considered a species of concern by the state of South Dakota but do appear on the state's list of rare species. There does not appear to be any upstream sources of these fish, and movement of fish from the most downstream reach of Annie Creek is barred by Annie Creek falls. Both brook trout and brown trout maintain populations at the downstream Annie Creek site; brook trout density has increased at the site since 2001 while brown trout density has decreased. Between 1995 and 2010, only one mountain sucker was collected at the downstream Annie Creek site in June 2008 [GEI Consultants, Inc., 2010].

The streambed at the upstream Deadwood Creek site was dry from 2000 to 2008. Even while limited water was present in other years, no fish were collected, indicating that limited aquatic habitat and low, interrupted flows present in this reach are unsuitable for fish populations. The downstream Deadwood Creek site has perennial flows and appears to support a naturally reproducing brook trout population [GEI Consultants, Inc., 2010].

The site on False Bottom Creek contains a population of brook trout; the population naturally reproduces though reproduction and may be limited in some years [GEI Consultants,

Inc., 2010]. No fish have been collected from the site on Ross Valley or the current Cleopatra Creek site over the course of the study, although brook trout are common in the lower reaches of Cleopatra Creek [Chadwick Ecological Consultants, Inc., 2004; 2005; 2006c]. Lost Camp Gulch was surveyed for the first time in 2010, but no fish were present in this stream either [GEI Consultants, Inc., 2010].

A small number of brook trout were collected from the Fantail Creek and Lower Nevada Gulch sites in 1998, but no fish have been observed at either site since then. The higher than normal flows that year likely allowed fish to move upstream into these reaches [GEI Consultants, Inc., 2010]. The reaches of Stewart Gulch and Whitetail Creek both support a naturally reproducing brook trout population. Brook trout density and biomass have been variable in Stewart Gulch and Whitetail Creek, but both sites have had high trout densities and biomass in 2008 and 2010 in comparison to many earlier years of the study [GEI Consultants, Inc., 2010].

3.8.4 Macroinvertebrates

Macroinvertebrate data collected for Wharf since 1992 indicate that invertebrate populations generally have been diverse and balanced over the course of the study at sites on Annie Creek, Deadwood Creek, Cleopatra Creek, Ross Valley, and False Bottom Creek. However, the total number of mayfly (*Ephemeroptera*), stonefly (*Plecoptera*), and caddisfly (*Trichoptera*) taxa (collectively referred to as the EPT taxa) and diversity index values at the upstream Annie Creek site decreased substantially in 2002 and 2007; however, 2009 data indicate the site was beginning to recover [GEI Consultants, Inc., 2010]. The middle Annie Creek site had a significantly lower mean number of taxa and number of EPT taxa over time in comparison to the Whitetail Creek reference site, while the downstream Annie Creek site had similar or more favorable long-term values for these parameters [GEI Consultants, Inc., 2010]. While sensitive taxa have been present at the upstream Deadwood Creek site and the Cleopatra Creek site, the invertebrate assemblages at these two sites were often numerically dominated by chironomid midges, a group that is generally tolerant of disturbance [GEI Consultants, Inc., 2010]. At the downstream Deadwood Creek site, stoneflies were numerous and EPT taxa comprised 30 percent to 40 percent of the total number of taxa each year, indicating that this reach of Deadwood Creek supports many sensitive species [GEI Consultants, Inc., 2010]. The site on False Bottom Creek has been dominated by pollution tolerant taxa such as aquatic worms and true flies, although sensitive EPT taxa have also been collected during every sampling event and appear to be stable [GEI Consultants, Inc., 2010].

Invertebrate data collected for Golden Reward since 1986 with various sampling methods indicate the presence of healthy, balanced populations that include sensitive taxa at all sites on Nevada Gulch, Fantail Creek, Stewart Gulch, and Whitetail Creek. Long-term trend analyses using data from 1995 through 2010 did not detect any significant increases or decreases in the number of taxa or number of EPT taxa for any of the study sites [GEI Consultants, Inc., 2010].

However, both Nevada Gulch sites had a significantly lower mean number of EPT taxa over time than other Golden Reward aquatic sites, likely because of variations in natural conditions such as weather and flow, which apparently had a greater effect on this small stream than in the other three streams that have perennial flow [GEI Consultants, Inc., 2010]. Comparisons of recent data to data from the samples collected in 1986 and 1987 from all four streams near Golden Reward suggest that recent samples have higher relative abundance of sensitive species, especially mayflies and caddisflies [GEI Consultants, Inc., 2010]. Any changes observed in the invertebrate assemblages in these four streams appear to represent natural variation. These analyses indicate that streams near the Golden Reward Mine demonstrate no short-term or long-term impacts from mining activities.

3.8.5 Periphyton

Periphyton density from year to year has demonstrated extreme interannual variation at all sites, with many of the sites having low densities of periphyton in 2010. Algae are opportunistic and sporadic in their population levels, often exhibiting extreme variability over time and space, which may account for some of the heterogeneity in algae populations in these streams. Diatoms have dominated the periphyton assemblages at most sites since at least 2006, while the blue-green algae that were often the dominant group at sites sampled before 2002 have been detected less frequently and in lower numbers since then [GEI Consultants, Inc., 2010]. These changes in composition may have resulted at least in part from the changes in sample analysis methods. Additionally, there are limited data available for the sites on Deadwood Creek, Cleopatra Creek, and Ross Valley. The periphyton populations at most sites appear to have been healthy and diverse throughout the monitoring period [GEI Consultants, Inc., 2010].

3.9 CULTURAL RESOURCES

Cultural resources are sites or areas of use or modification by people in either prehistory or historic times. Upon their discovery, cultural resources are evaluated as to their significance as defined by criteria of the National Register of Historic Places (NRHP). To be considered NRHP eligible, an archaeological site must retain sufficient historic or physical integrity to convey its significance. Mining-related resources often lack the traditional aspects of integrity because of the passage of time, exposure to a harsh environment, abandonment, vandalism, and neglect. Although individual components appear to lack distinction, the combination of multiple components could enable the property to be labeled as a historically significant mining operation eligible to the NRHP. A property eligible to the NRHP which is threatened by mining operations will be assigned a treatment plan or mitigation plan to recover any data which makes that property significant [Wharf Resources, 1998].

Considerable cultural resources research was conducted in the vicinity of the Wharf and Golden Reward Mines in association with historic and existing mining activities. In general, the majority of historic items are related to historic mining activities, railroad transportation,

and community development. Per SDCL 45-6B-92(7), a summary of previous investigations as well as new surveys are provided below. Complete cultural resource reports for the Expansion Area are provided in Appendix 12 and were submitted to the state archaeologist's office (ARSD 74:29:02:06).

3.9.1 Previous Investigations

Cultural resources research was conducted in the vicinity of the Wharf and Golden Reward Mines in association with historic mining activities since the 1980s. A brief historic overview of the area is provided by Luoma and Lowe [2010] below.

> *The discovery of gold in the Black Hills during the 1874 reconnaissance by the Custer expedition heralded the beginning of Euroamerican settlement in the Black Hills of South Dakota—settlement based exclusively on the search for gold and the profitable commercial enterprises that supported the subsequent mining operations. The town of Portland developed a few years later in 1880 near Terry Peak in the Northern Black Hills, resulting in the Bald Mountain Mining District. The community expanded with the mining operations, and a second town, Trojan, developed approximately 0.5 mile (0.8 kilometer) south. Trojan was named for the reorganized gold mining company that played a prominent role in the area during the early twentieth century. The two towns appeared to be inexplicably linked, sharing the same school, while the working populace was employed in several nearby mines. The distinction and identity of each townsite seems to correlate to two distinct periods of mining activity; Portland, from the inception of the Portland Company and its mill, which closed in the late 1890s; and Trojan, following the creation of the Trojan Mining Company in 1911 [Lowe and Schneider, 1996]. Currently, both towns are extinct. The Bald Mountain Mining District including this project area is replete with old mining claims and mineral exploration activities.*

There are several notable historic events associated with the town of Terry (39LA358). Calamity Jane, a resident of Deadwood, often visited the town of Terry. Calamity Jane died in 1903 at Terry and is buried in Deadwood [Buechler and Scott, 1986]. In 1905, the Terry community was devastated when the Horseshoe cyanide plant at Terry burned down. At the time, the mill was reportedly the largest crusher in the world, and in the end, the Horseshoe Company could not cover their losses and was forced to sell out their interests. The year 1905 marked the climax of mining in the Bald Mountain mining district, with the economy slumping after the Golden Reward employee strike in 1910 [Buechler and Scott, 1986]. The Golden Reward Company closed in 1918 and the town folded. A detailed narrative of the Terry area is available in Buechler and Scott [1986]. Significant cultural resource studies were conducted on this site, including several artifact collections [Buechler, 1988].

The Peterson House (39LA488) was located in Nevada Gulch (NE¼ SE¼ Sec. 1, T4N, R2E). This residence was considered not eligible for nomination to the NRHP and has been removed

as part of historical mining activities near Golden Reward. The Peterson House is described in detail by Buechler [1987].

Terry Cemetery (LA00000704) is located in Section 1, T4N, R2E. The cemetery was located at the north end of the town of Terry and represents community burial practices. Today, the cemetery is solely owned by Wharf Resources (both surface and mineral rights). On January 13, 2011, the SD DENR determined the Terry Cemetery is eligible for inclusion on the state's *Preliminary List of Special, Exceptional, Critical, or Unique Lands* [South Dakota Department of Environment and Natural Resources, 2011]. On March 17, 2011, the South Dakota Board of Minerals and Environment (SD BME) conducted a hearing to determine the status of the Terry Cemetery. They heard testimony from the SD DENR, two of the three nominating petitioners, Wharf Resources, and the Terry Cemetery Association. No parties were opposed to the nomination; therefore, the SD BME voted to include the Terry Cemetery on the state's *Preliminary List of Special, Exceptional, Critical or Unique Lands*. Terry Cemetery is also eligible for inclusion on the National Register of Historic Places.

The Trojan Townsite (39LA376) once served as a residence for mine workers and their families. The area was abandoned around 1959 after the closing of the Bald Mountain Mining Company [Lowe and Schneider, 1996]. Numerous archaeological work was performed at the site since 1973, with one of the last surveys conducted by TRC Mariah Associates in 1996 with a cultural resource clearance granted by State Archaeological Research Center (SARC) that same year [Lowe and Schneider, 1996]. As a result of historic mining activities, there are no remains of the Trojan Townsite.

Previously recorded sites within proximity of the Expansion Area are listed in Buechler [2010] and are provided within Appendix 12.

3.9.2 Current Investigations

Expansion areas that were not previously surveyed, as well as those sites already identified, were included in Level III cultural resource evaluations in July, August, and October 2010. Preliminary records search at the SARC in Rapid City, South Dakota, was conducted in October 2009.

TRC Environmental (Laramie, Wyoming) completed a Level III cultural resources evaluation of the Expansion Area north of State Highway 473. Four tracts (A-D) of land previously unsurveyed, totaling 75 acres, were inventoried at Level III standards using 100-foot (30-meter) pedestrian transects [Luoma and Lowe, 2010]. Twenty-eight acres in a fifth tract (E), located in Sec. 33, T5N, R2E, were also surveyed [McClelland and Lowe, 2010]. These two cultural resources reports are provided in their entirety in Appendix 12.

Two previously recorded railroad sites (Sites 39LA2000 and 39LA2009) were noted in the project area north of State Highway 473, and both are eligible for listing on the NRHP with the South Dakota State Historic Preservation Office. Segment 1 of the abandoned Englewood to Spearfish branch of the Chicago, Burlington, & Quincy Railroad (Site 39LA2000) was recorded within the Expansion Area and recommended as noncontributing to the site's NRHP eligibility because of compromised integrity.

The other railroad site (Site 39LA2009) was recorded and recommended as contributing to the site's NRHP eligibility; this is the only site within the Expansion Area that may be considered NRHP eligible. The site is Segment 1 of the Fremont, Elkhorn, & Missouri Valley Railroad with a grade that is cut into the southwestern slope of Bald Mountain. This site has not been significantly altered other than the removal of the rails and ties and the site retains integrity of location, design, and setting [Luoma and Lowe, 2010]. Because of its potential for listing, recommendations from the state archaeologist will be followed regarding additional data collection or mitigation measures if deemed necessary.

Three other previously recorded sites were noted to occur within the project area. Site 39LA814 is unevaluated with regard to its NRHP eligibility, and this site was not found during the current inventory. Site 39LA815 is not eligible for the NRHP, and it was also not found during the current inventory. Site 39LA818 is not eligible for the NRHP; it was relocated during the current inventory and its condition was updated.

Numerous prospect pits and trenches were found during the current inventory. TRC Mariah Associates identified 15 prospect pits and 37 exploratory trenches located in Sections 1 and 2, T4N, R2E, all of which were deemed ineligible for the NRHP [Luoma and Lowe, 2010]. An additional 15 prospect pits and 13 trenches were recorded in Section 33, T5N, R2E [McClelland and Lowe, 2010].

Dakota Research Services (Rapid City, South Dakota) completed a Level III cultural resources evaluation of the Expansion Area south of State Highway 473 and immediately west of the Golden Reward Mine. Approximately 138 acres were inventoried at Level III standards using 100-foot (30-meter) pedestrian transects [Buechler, 2010].

A total of 16 previously unrecorded archaeological sites were documented along with segments of the historic Burlington Railroad and the Horseshoe-Mogul narrow gauge railroad spur. Elements of the historic railroads are considered significant in terms of NRHP-eligibility criteria; however, qualities of location, design, feeling, or association relating to the integrity of the railbed or grade within the Expansion Area were compromised by mining, mineral exploration, and/or ski activities. Therefore, Dakota Research Services recommends a determination that there are "no historic properties affected" for the proposed disturbance areas immediately west of Golden Reward. The complete cultural resources report by Dakota

Research was submitted to the State Archaeological Research Center for review [Buechler, 2010] and is included in Appendix 12.

3.10 NOISE STUDIES

3.10.1 Summary of Noise Studies

Noise impacts of the Wharf mining operation in the area were analyzed to meet permit requirements. Sound levels generated by mining activities mainly included blasting, general mine activity, backup alarms, and traffic. Two pertinent baseline noise studies were previously completed in the area, both performed by M. A. Apa, and independent audiologist [Apa, 1987; 1993]. The earlier of these two studies measured background sound at 12 locations in and around Golden Reward's proposed mine sites [Apa, 1987]. The second pertinent study was conducted by M. A. Apa for Wharf Resources' Clinton Expansion in 1992 [Apa, 1993]. Two additional sound studies were conducted that should be considered together; the first study conducted in 1987 by Dr. John Duff Erickson of South Dakota School of Mines and Technology [Erickson, 1988], and the second study conducted by Apa [1989] reviewed and further analyzed the data collected by Erickson. Apa's study validated Erickson's study and found that sound levels generated by the mine were not higher than those considered normal in the area, such as planes, motorcycles, barking dogs, residential traffic, and human activity. Sound levels coming from the mine, excluding blasts, were generally in the 35 to 50 decibel (dB) range [Erickson, 1988] with sound levels typical for rural areas.

A baseline sound study for the Expansion Area was conducted between March and August 2010 in the vicinities of current mining operations by Dr. Charles Kliche of South Dakota School of Mines and Technology (SDCL 45-6B-92(9)). A total of 11 sites were monitored on four separate occasions (see Exhibit 19 of Appendix 2). Monitoring was conducted during the early morning, early afternoon, and late afternoon for a 5- to 10-minute constant period during each site monitoring visit. Minimum readings from this study were within the range of sound level for rural area forest (25 to 30 dB), and/or living rooms (40 dB). Maximum readings were, on average, approximately 10 dB higher later in the day than early in the morning for all locations. The only difference between data from the current study and Apa's study was increased traffic noise at the intersection of Nevada Gulch/Wharf Road and Stewart Slope Road. The Last Chance Trail area, the Moose Trail area, and the Golden Reward reclaimed mine area had sound level readings in the range of background rural area forest values (25 to 30 dB) at all times. The highest values at these three sites were from wind, wildlife, or distant traffic. Only four verifiable mine activities were recorded during all sound-level monitoring sessions. These included a low boy hauling a back hoe, a Wharf water truck, a low-level backup alarm which slightly "blipped" the sound intensity charts, and traffic on Nevada Gulch Road from a shift change [Kliche, 2010]. A complete copy of Kliche [2010] is included in Appendix 13.

3.10.2 Noise Mitigation Strategies

Sound resulting from mining activities may be mitigated by leaving some natural screening such as trees and topographic features in place as long as possible without disrupting the mining sequence. As tree clearing for roads will be limited to the area necessary for construction of roads; the trees that remain will provide a screen and reduce noise from traffic.

Pursuant to SDCL 45-6B-92, baseline sound level measurements were taken by Kliche in 2010 to measure the possible noise levels from the proposed expansion. Background sound levels were recorded at multiple sites nearby and within the Expansion Area to establish a baseline for future comparison, as specified in Kiche's report. Wharf will consider monitoring noise and vibration levels on occasion at various locations.

The proposed noise mitigation plan includes:

- Monitoring noise from blasts on a quarterly basis from points outside the disturbance limit.
- Incorporating minimal disturbance of the natural topography and using existing vegetation for sound buffering.
- Blasting only during daylight hours on weekdays except during special circumstances, such as weather or unforeseen delays.

3.10.3 Blasting

Wharf will use blasting agents and techniques that are standard for the mining industry and is currently in practice at the Wharf Mine (SDCL 45-6B-6(8)). In accordance with federal regulation, blasting will only occur during daylight hours. Representative blasts within all mine areas will be monitored for noise and ground vibration at the nearest or appropriate structures. Based upon the monitoring results, blast designs (which include hole depths, hole sizes, hole spacing, stemming depths, explosive used, row orientations, timing and delay systems, and blast size) will be adjusted to prevent excessive dust, noise, and vibrations which could cause structural damage to buildings adjacent to the mine area by using industry and U.S. Bureau of Mines standards (ARSD 74:29:02:04(6)).

Sound levels and ground vibration generated during blast initiation were extensively studied at the surrounding structures from the existing Wharf Mine. Results of these studies indicate that Wharf's current blasting procedures do not generate excessive dust, noise, and vibration beyond safe standards recognized by the U.S. Bureau of Mines. Current blasts at the existing Wharf Mine are drilled on approximately 16-foot × 16-foot patterns with 6.5-inch-diameter holes drilled 23 feet deep. Each blast contains from 50,000 to 100,000 tons of rock. Typically, 2–3 holes are shot per delay. Stemming height, blasting agent, timing between delays and rows, and the initiation row are adjusted to control shot movement, hole cutoffs, air blast,

fragmentation, and vibration. Good housekeeping procedures to avoid spillage of blasting agent and misfire prevention systems are in place to minimize excess nitrates within rock facilities.

The spill plan for undetonated or spilled blasting agent is to clean by means of shovel and 5-gallon buckets in small quantities of approximately 10–15 gallons in size; larger spills will require small loader and dump trucks or vacuum trucks to clean up the material. Material will then be either used immediately back in an unshot blast to be detonated or mixed back in within the blasting agent holding tank or truck for later use. Any soil or subsoil that is contaminated by the blasting agent will be excavated and placed in the contaminated soil storage bin to be disposed of at an appropriate contaminated soil disposal site.

Wharf will use similar blast procedures within the Expansion Areas and expects similar noise and vibration levels at adjacent properties. Wharf is also committed to the trial and use of new technologies. There is potential to further reduce sound and vibration levels associated with blasting by the use of new procedures or products that may be developed in the future.

Wharf will comply with federal and industry standards for ground vibration and air noise when blasting in proximity to residential structures. Representative blasts will be monitored as near as possible to impacted structures to ensure that the maximum allowable criteria are not exceeded. The maximum accepted level for ground vibration before structural damage could occur is 2 inches per second peak particle velocity. The maximum accepted level for air blast before damage could occur is 136 dB [Siskind et al., 1980].

The Lead Fire Department has a building used for volunteer firefighting equipment that is within a 500-foot buffer zone from the proposed permit boundary. Blasting will occur approximately 500 feet from this building and will take place so that the shock of the blast is pulled away from the area of the building so as not to incur vibration or shock onto the structure. This is normal procedure, and currently and historically, Wharf has followed this procedure (which includes shot direction and lower powder factor) so that structures that fall within a close radius (usually less than 500 feet) do not sustain structural damage. One other building is located on Wharf property and is within this buffer zone; it is planned to be moved before mining within close proximity of the structure.

Typically, Wharf will blast only during daylight hours on weekdays. However, special circumstances because of weather or other unforeseen delays may require very limited weekend blasting. According to Mine Safety and Health Administration (MSHA) Regulation 30 CFR 56.6306(d), all blasts must be detonated within 72 hours of being loaded. If weather conditions (temperature inversions, cloud cover) are unfavorable to maintain a minimum air blast, the blast will be rescheduled as much as is safely or operationally feasible until more favorable conditions are present.

Fugitive dust from blasting operations at the existing Wharf Mine has not been a problem to date as evidenced by existing air-quality monitoring data. Blasts being of short duration, sufficient moisture content of the rocks (approximately 4 percent from crusher samples), and particle size generally do not generate excessive dust. Mitigation plans would include:

1. Visually monitoring blasts to determine if excessive dust is being generated.
2. Review and adjust blasting procedures to minimize fugitive dust.

3.11 VISUAL ASSESSMENT

The visual assessment of the Expansion Project was evaluated to review visual impacts of the pit designs, backfill plans, rock facility designs, and road (access and haulage) alignments. This visual assessment is provided in Appendix 14.

3.11.1 Visual Screening of Affected Lands

Visual screening of affected lands will be used to the extent possible to minimize visual impacts (ARSD 74:29:07:04 (7)). During reclamation of the pits and dumps and land shaping will occur that will enhance the reclamation so that the land ties in with the current surrounding. The land that requires reclaiming will include undulation and shaping so to break up the contour of the land to blend it with the surrounding area.

Visual screening along the northern boundary of State Highway 473 of the affected mining land will include a buffer zone of approximately 10 to 40 feet in width with existing vegetation that will include trees, shrubs, and grasses. Located between the buffer zone and the southern border of the pit will be a security berm of approximately 3–5 feet tall along with a security fence and signage, which will sit south of the berm. The security fence will be of typical size and standard that is used currently on the Wharf Mine access road, approximately 6 feet in height and being either chain-link type or game-fence type with approximately 4-inch-square wire spacing.

Screening along the Portland Ridgeline, which includes the area from the beginning of the current Stewart Road where it leaves State Highway 473 straight west to the end of the new disturbance boundary, will be similar. From the proposed disturbance boundary, a buffer zone of a minimum of 500 feet of undisturbed land will separate the mining area. This buffer zone will include existing vegetation that consists of trees, shrubs, and grasses. In addition, along this section, the mining does not encroach on the ridgeline. Here, the ridgeline acts as a visual screening aid when viewing from the Stewart Lodge Road, Terry Peak Ski area, and the Lost Camp Subdevelopment. Screening between the disturbance boundary and the pit limits will also include similar security berm, fence, and signage as stated above.

Pursuant to ARSD 74:29:07:02(3), the main areas of concern regarding visibility of the Expansion Area are from the paved portion of State Highway 473, the road to the Stewart Lodge, and the Terry Peak Ski area. The ridgeline along the Portland Ridge Expansion Area provides a topographical and vegetative screen that effectively minimizes the visibility concerns from the main public access areas. The view from portions of State Highway 473 (northern final 1 mile), the first half mile of Stewart Road to the Terry Peak Stewart Lodge, and parts of Terry Peak Ski Area will be in view of the mining operation on Bald Mountain and Green Mountain intermittently throughout the mining phases (anticipated to be during the years 2013–2017). During this period, mining will be intermittently screened by the natural landscape above State Highway 473 with the buffer zone. In addition, once the mining progresses below the buffer zone, the mining will be screened because of being below an elevation that is no longer visible from these locations.

Viewing of the Golden Reward mining activity will be visible from the top of the Terry Peak Ski Area from both the Empress Lift (Red Chair) and the Kussy Express Lift. Since mining will only take place during the off-season of skiing (April–November), the visual impact will be minimal. Along the Liberty Highwall and Harmony Highwall pushback, there will be a buffer zone of a minimum of 100 feet between the Ski Area and the mining. Natural vegetation (trees, shrubs, and grasses) will be used in the buffer zone and visual screening mainly on the Liberty Highwall side. Along the length of the pushback from the Harmony Highwall and Liberty Highwall will be a security fence of typical size and standard that is used currently on the Wharf Mine access road—approximately 6 feet in height and being either chain-link type or game-fence type with approximately 4-inch-square wire spacing. The fence will be adequately signed to warn the public of the hazards and will tie into existing Golden Reward perimeter fencing on both the north and south perimeter. In addition, a security berm will run the length of the pit outline on the eastern edge of the two highwall pushbacks located between the highwalls and fence.

The current visual assessment images and video are found in Appendix 14. A total of nine vantage points and four aerial viewpoints view areas of the Expansion Project, including both Wharf Resources and Golden Reward. The images show the current visual and what is planned once mining is complete with reclamation finalized. The vantage points can also be viewed in more detail within the Visual Assessment Video before and after provided on DVD in Appendix 14.

3.12 INFORMATION ON CRITICAL RESOURCES

3.12.1 Soils—Soils With High Erosion and Low Revegetation Potential

There are no soils at the Expansion Project that have a high erosion potential or low revegetation potential. Based on the soil mapping conducted by BKS, the hazard for soil erosion based on soil type varies from negligible to moderate, with soils more susceptible to erosion from

water than wind [BKS Environmental Associates, 2010a]. To minimize soil erosion, soil stockpiles may be revegetated if they are to remain undisturbed for more than 2 years (Section 6.3). Also, reclaimed slopes will be graded and shaped at 3H:1V. Additional erosion control measures are described in Section 5.3.5. Area soils are also suitable as a plant grown medium with revegetation potential affected mostly by rock fragments; fertilizer is not recommended as native species typically grow without amendments in soils around the Wharf mine.

3.12.2 Water—Direct or Indirect Sources of Drinking Water

There are no drinking water wells within the Expansion Project, although a few private wells are located in the vicinity of the area. These wells are available in Appendix H of the *Groundwater Characterization Study of the Wharf Expansion Project Area* (Appendix 12).

It is not predicted that proposed mining will have an overall influence on groundwater flow or quality outside the Expansion Project [Hocking, 2010]. Impacts to groundwater quality resulting from waste rock disposal may be similar to the groundwater impacts in nearby areas that have previously been mined and backfilled with waste rock. Examples of these impacts include increased nitrate concentrations in shallow wells immediately adjacent to backfilled areas within the Wharf permit boundary. Given these experiences, it is possible that an increase in nitrate may occur below the proposed expansion pits. The increase in nitrate from blasting and disposal of waste rock is not expected to exceed the groundwater standard of 10 ppm outside the proposed expansion permit area. Additionally, the geochemical characterization of the ore and overburden material (Section 3.1.3) does not indicate a risk of developing acid rock drainage, and no spent ore will be deposited in the expansion pits (Section 5.4).

3.12.3 Air Quality—Impacts to Terry Peak, Barefoot Condominium, and Lost Camp Areas

As described in Section 3.5, there has been no significant deterioration of air quality in the area because of mining operations at Wharf or Golden Reward. Therefore, air-quality impacts from the Expansion Project to Terry Peak, Barefoot Condominium, Lost Camp Subdivision, or the other surrounding areas are not anticipated. However, Wharf has and will continue to monitor visible emissions and work with the state air-quality personnel to ensure adequate monitoring needs are met.

3.12.4 Vegetation—Wetland and Riparian Vegetation

Vegetation studies, as described in Section 3.6 and Appendix 9 of this application, were conducted by BKS Environmental Associates. Although there are moist areas present within the various vegetation communities, there are no wetland or riparian species or communities

observed within the Expansion Project (see letter from BKS Environmental Associates in Appendix 9).

3.12.5 Wildlife—Species on the South Dakota National Heritage Program List (Including Raptors) and Critical Deer Winter Range

Pursuant to ARSD 74:29:07:02(6), preventative measures to minimize harmful impacts to wildlife at the Wharf Mine include active communication between the mine operators and on site environmental personnel, a big game fence exclosure around the process area, and frequent inspections of the process ponds. Cyanide levels in process solutions are maintained at low levels (less than 50 ppm WAD cyanide) at locations where ponds are open. These practices will continue for the expansion. In addition, Wharf personnel work closely with SD GFP personnel and wildlife consultants to address any potential harmful impacts to wildlife [Wharf Resources, 1998].

Species of federal and state concern, including those listed on the SDNHP list, are discussed in Section 3.7.10. Although seven avian species, including raptors, were observed within the proposed Expansion Project, no active raptor nest sites were documented within the proposed permit area. These avian species have and continue to use the area around Wharf and Golden Reward where historic and current mining have occurred. Wharf does not propose any mitigation measures for these avian species but will continue to work with the SD GFP to address any necessary mitigation measures.

Within the Expansion Project and 0.5-mile perimeter, there were several incidental sightings of mule and white-tailed deer. Both species were observed in forested habitats and open meadows including reclaimed grassland areas of Golden Reward. Although this area serves as important winter range for deer, there is abundant habitat on surrounding lands and no additional mitigation measures are necessary at this time.

3.12.6 Aquatic Resources—Cold-Water Fish Life Propagation Water

The majority of the Expansion Project is located within the Nevada Gulch drainage, with some surface mining disturbance in Fantail Creek and Lost Camp Gulch drainages. According to ARSD 74:51:03:01, all streams in South Dakota are listed as having the beneficial use as fish wildlife propagation, and as such must maintain water-quality standards for such use. The surface water standard of 50 ppm nitrate for a cold-water fishery will not be exceeded within any drainage as a result of mining operations at the Expansion Project (Section 3.4.3). Nitrate levels in water potentially exiting the toe of any rock facility to surface water are expected to be significantly lower than the 30 ppm experienced below the toes of the existing Reliance and Squaw Creek rock facilities as Wharf has been able to improve its blasting practices and thereby reduce residual nitrate in blasted rock. Efforts to mitigate effects on surface water quality and aquatic resources include sedimentation, erosion, and drainage control structures (described in detail in Section 5.3.5).

3.12.7 Cultural Resources—Summary of Sites Eligible for National Register of Historic Places

Adjacent to the proposed Expansion Project, Terry Cemetery has been included on the state's Preliminary List of Special, Exceptional, Critical or Unique Lands and is also eligible for inclusion on the National Register of Historic Places (NRHP). Within the Expansion Project, cultural resource surveys have been conducted (see Section 3.9 and Appendix 12). Two railroad sites within the project area are eligible for listing on the NRHP. As described in Section 3.9.2, Site 39LA2000 is part of the Chicago, Burlington, and Quincy Railroad though the segment within the Expansion Project is recommended as noncontributing to the site's NRHP eligibility because of comprised integrity. The other railroad site (Site 39LA2009) is Segment 1 of the Fremont, Elkhorn, and Missouri Valley Railroad grade. This segment has been described as noncontributing [Buechler, 1990] and more recently as contributing [Luoma and Lowe, 2010] to the sites NRHP eligibility. The state archaeologist's office has recommended that no mitigation is necessary for any site within the proposed Expansion Project (see letter from Mr. Mike Fosha in Appendix 12).

3.12.8 Noise—Impacts to Terry Peak, Barefoot Condominium, and Lost Camp Areas

A recent baseline study was conducted to determine the current background sound levels at several areas around Wharf's current operation and the proposed Expansion Project (Section 3.10 and Appendix 13). Sound measuring points included the Terry Peak Ski Lodge, Barefoot Condominiums, and two points along the Last Chance Trail near the Lost Camp Subdivision. Background sound measurements from most sites were typical of rural forest areas. It should be noted that current Wharf operations were conducted during this study and noise impacts were minimal. Operations at the expansion areas are not anticipated to greatly increase noise levels. The greatest impacts to these areas of concern will likely be during blasting events. Wharf's noise mitigation plan, as described in Section 3.10.2, includes quarterly monitoring of noise from blasts, incorporating topography and vegetation for natural sound buffering, and blasting only during daylight hours on weekdays. Overall, noise impacts directly related to the Expansion Project are expected to be negligible to low.

3.12.9 Visual Resources—Visual Impacts to Barefoot Condominium and Lost Camp Areas

Visual assessment and screening of affected lands are described in Section 3.11. The Barefoot Condominium area and the Lost Camp Subdevelopment are located near the western part of the proposed Expansion Project area adjacent to the existing mine. Visual impacts from these areas will be minimal since mining will only occur north of the Portland Ridgeline along this western section of the expansion. Here the ridgeline acts as a visual screening aid when viewing the operation from the Barefoot Condominium and Lost Camp Subdevelopment. Visual impacts to these areas will also be minimized by the use of a 500-foot vegetation buffer zone screen.

4.0 SOCIOECONOMIC ASSESSMENT

Wharf's proposed expansion qualifies as a large-scale mine under Lawrence County's Zoning Ordinance and the South Dakota Codified Laws. Under these statutes, applicants seeking to develop a large-scale mine are required to file a socioeconomic assessment. The statutes identify the basic subjects to be addressed in such an assessment, which generally include demographic factors (population impacts), economic issues (employment and income/ expenditures), social considerations (education, public safety, and utility services), and quality of life issues (health, parks, and recreation). This assessment outlines the economic, fiscal, and social impacts likely to be associated with the Wharf expansion (SDCL 45-6B-33.1).

Socioeconomic studies are different when a given permit is associated with an entirely new operation than when a permit only extends the life of a project. In this case, the proposed mining permit is simply extending the life of the mining operation with the total number of employees and spending is not projected to significantly change from levels experienced over the past 10 or 15 years. In fact, adverse socioeconomic impacts would be more likely to occur if the proposed expansion was not permitted.

The following sections summarize the socioeconomic findings of the study conducted to assess the impacts of the proposed expansion. The complete socioeconomic assessment, completed by Dr. Michael Madden, is located in Appendix 15.

4.1 KEY PROJECT PARAMETERS

The proposed expansion permit would extend the life of the mine approximately 7 years. Approximately 2 years of mine life currently remain; thus, the approval of the proposed expansion would extend the life of the mine to 2019 or 2020. Also, the expansion would maintain the current number of employees at about 155 people.

4.2 FISCAL TRENDS AFFECTING LAWRENCE COUNTY

A comparison of Wharf Resources to Lawrence County was made for employment, income, and directly and indirectly traceable expenditures to estimate the economic influence Wharf Resources has on the local economy. The complete socioeconomic analysis is available in Appendix 15.

Historically, per capita income in Lawrence County was approximately 95 percent of the state average. Even though mining and its relatively high wage rates was a boost to overall per capita earnings in the county, a large component of the work force has been involved in lower paying service sectors. When mining employment dropped in the mid to late 1990s, per capita

earnings in the county fell to near 80 percent of the state average. With growth in other sectors of the economy, per capita wages relative to the state have rebounded to their historic level of 95 percent of the state average. The sectors that have contributed to the improvement in earnings relative to the entire state over this decade include wholesale trade, finance, insurance, real estate, and some service sectors [Madden, 2010].

Income has been growing in Lawrence County over long periods of time. In 1989, total income from all sources was about $290 million. By 2007, the last year for which data are available, it had grown to $793 million. The change in income was significant subsequent to the enactment of legal gaming in 1989. A leveling off of the growth rate happened in the late 1990s because of the reduction of mining activity and the loss of relatively high-paying jobs. In the 2000 decade, income increased again at a quite rapid rate. The rate of growth for Lawrence County is quite comparable to that which occurred in the entire state of Wyoming. Over this span of time, statewide income grew by 277 percent while Lawrence County income grew by 274 percent. The importance of the contribution of mining sector earnings is quite apparent when isolating wage and salary income from total county income. Wage and salary income reached a peak at the time in 1996 and then dropped off significantly in following years because of the reduction in gold mining activity. This loss in income spilled over into other sectors as the multiplier impact in sectors supported by the mining industry took effect. Wage and salary income did not recover to 1996 levels until 5 years later in 2001. From 2001 to 2008, income arising from wages and salaries rose significantly each year [Madden, 2010].

There are a number of significant changes that have allowed the local economy to thrive during the reduction in mining jobs in the county, with three developments that stand out most. One impact concerns the development and continued growth of gaming and the associated growth of the vacation travel industry. Major inroads are also expected to occur in business and convention business with the recent development of expanded facilities tailored to that purpose. A second impact involves the transformation of the city of Spearfish into a major shopping and service location in the Northern Black Hills region. This region extends well into Wyoming and perhaps into some sparsely populated areas of southeast Montana. A third development in the early stages of producing economic benefit to the area is the conversion of part of the underground Homestake Mine to a scientific laboratory. This development has the potential to increase employment opportunities in the skilled and higher salaried job positions [Madden, 2010]. It has been shown that mining jobs will continue to serve as an important source of income for families in the Northern Black Hills that are likely to be very much needed in the region as other new economic opportunities continue to develop [Madden, 2010].

4.3 WHARF'S CONTRIBUTIONS TO THE LOCAL AND REGIONAL ECONOMIES

Wharf Resources began mining in Lawrence County in 1974 and is considered a major Lawrence County employer since 1982.

All of Wharf's employees live in the Black Hills. Almost one-half (45 percent) live in the Lead-Deadwood area, followed by Spearfish (24 percent), Sturgis (15 percent), Butte County (6 percent), Pennington County (7 percent), or elsewhere in Lawrence and Meade Counties (5 percent).

In 2008, Wharf's 134 employees earned an average of $46,600 per worker for a total of $6,245,790. Additionally, employee fringe benefits and payroll expenses added an additional 40 percent of net payroll [Madden, 2010].

A positive impact of the local, state, and regional economy occurs because of ongoing purchases of goods and services for mine operation, as these operational costs averaged $11,457,000 per year over the last 4 years of available data [Madden, 2010]. Approximately 6 percent of these expenses went to Lawrence County businesses, 24 percent to the Rapid City area, 26 percent to other South Dakota businesses, and 44 percent to businesses outside South Dakota [Madden, 2010]. Therefore, Lawrence County businesses will likely sell $4,812,000 in goods and services to Wharf Resources over the 7-year extension. The Rapid City area would likely generate an additional $19,248,000 in sales, and the rest of South Dakota would likely generate sales $20,851,000 from Wharf throughout the 7-year extension [Madden, 2010].

Overall, the economic impacts would be substantial to employees, businesses, local governments, and the state of South Dakota, and the prospect of an additional 7 years of mining will maintain jobs that are important to the local economy [Madden, 2010].

4.4 TAX PAYMENTS

4.4.1 Sales Tax

Between 1998 and 2008, sales tax paid directly by Wharf Resources to the state varied between $521,000 and upward of $900,000 in 2007 [Madden, 2010]. An 8 percent drop in taxable sales occurred in 1998 (and did not recover to 1997 levels until 2000) because of the contraction of the mining industry, again pointing to the importance of employment in that sector to the overall economy of the county. Given estimated projections of local expenditures in the South Dakota economy, the estimated future sales tax paid by Wharf to the state would range somewhere between $670,000 to $902,000, averaging about $820,000 per year [Madden, 2010]. Workers, in the process of spending their earnings, will add at least another $300,000 in sales tax benefits to the state annually [Madden, 2010].

4.4.2 Property Taxes

Property taxes directly arising from mine property accrue to school districts and to Lawrence County government. The average property tax paid by Wharf from 2005 through 2008 was

about $277,000. In past years when gold reserves were near their high levels, Wharf's property taxes reached a maximum amount of $540,000 with about 74 percent of this total amount paid to the Lead-Deadwood School District [Madden, 2010]. Although property taxes are difficult to forecast, with the high value of gold at a level of $1,200 per ounce, it is safe to estimate that property taxes during much of the 7-year mine life extension could reach $900,000 annually.

4.4.3 Severance Tax

The state tax on gold is comprised of two components. The first component consists of a basic $4 per ounce severance tax on gold; however, when the price of gold is above $800 per ounce, the severance tax becomes $8 per ounce. In addition, a net income tax is charged to gold companies and is equal to a flat 10 percent of net company profits. Together, these two taxes will generate substantial revenue if the price of gold maintains near today's present value of $1,200 per ounce. In 2009, Wharf paid almost $3.2 million in state severance taxes, largely because of the increase in the market price of gold [Madden, 2010]. Any estimate of this revenue far into the future is subject to significant error; however, broad estimates suggest that it could amount to between $1.5 and $2.5 million annually during the 7 years of production [Madden, 2010]. The $1,000,000 cap on the amount of severance taxes paid to the county was reached in 1993 so all tax payments will accrue to the state.

4.5 EFFECT ON NEARBY RESIDENTIAL DEVELOPMENT AND PROPERTY VALUES

The Barefoot Condominium area and the Lost Camp area are located near the western part of the permit area adjacent to the existing mine. Lost Camp was originally planned for recreational, seasonal-use cabins and cottages. However, over time, more high-quality structures that could be occupied all year were built, and these structures are now occupied during the summer tourism period and the winter ski season. Also, most of the buildable lots are currently developed. Presently, approximately 11 homes in Lost Camp are occupied year-round; no occupancy data are available for the Barefoot Condominiums. Because residences in Lost Camp are generally viewed as seasonal or second homes, turnover in the area is fairly high. Also, some of the properties are used as investments which are rented out during the summer tourist season and the winter ski season [Madden, 2010].

Fluctuations in the housing market in this area are significantly impacted by local and national economic conditions because of the discretionary nature of the second-home market. Personnel at the County Assessor's office indicate that over long periods of time, the housing market near Terry Peak mirrors the overall housing market of the county. Currently, the local real estate market is somewhat weakened from a combination of the closing of the Homestake Mine to the national recession [Madden, 2010].

Realtor's with work experience spanning the entire span of Wharf mining activity believe that the critical factor in determining the ultimate impact on these housing areas is the degree to which environmental impacts are screened from the area in a manner similar to what has been experienced in the past. Historically, mining by Wharf has had no measurable effect on property values, and if Wharf maintains their past record of being sensitive to adjacent land use, the impact resulting from the additional mine life will remain much as it has over the last quarter century [Madden, 2010].

Also, it is important to point out that the long-term impact to the area has the potential to greatly enhance the recreational and commercial attributes of the area if certain reclamation efforts associated with the new permit are accepted. Past reclamation land use plans were focused primarily on wildlife habitat and grazing. The present permit involves a Reclamation Plan that redirects reclamation efforts much more to recreational, residential, and commercial land uses. Should the permit application be approved, the opportunity for enhanced reuse of mined land will be highly compatible with present adjacent land use in the immediate vicinity of Terry Peak [Madden, 2010].

4.6 EFFECT ON RECREATION AND SKIING

Outdoor recreation opportunities near the Wharf Mine and proposed expansion include hiking and biking trails, hunting, all-terrain vehicle use, snowmobiling, skiing, camping, and a myriad of other activities. Such activities, however, are not permitted on the property within the currently permitted mining boundary and would not be allowed on land considered under this expansion. Land area that is presently accessible to the public that is also included under this expansion permit is quite limited. Nearby major recreation areas include Black Hills National Forest, Spearfish Canyon, and Terry Peak.

Commercial recreation in the vicinity of the Expansion Area is limited primarily to Terry Peak Ski Area, which is immediately adjacent to the proposed Expansion Area. Terry Peak is unique to the area in that it is one of two local ski areas and plays a role in winter recreation opportunities and the region's economy. For this reason, the potential for adverse impacts arose as a concern in the past. An investigation into the impact of mining activity on skiing was prepared during the 1997 Clinton Expansion permit application [Hammer, Siler, George Associates, 1996]. This analysis provided considerable statistical evidence that days of skiing rise when snow conditions are better and fall when snow conditions are poor. Although there is not enough data available to support a systematic assessment of effects, trends in winter recreational use have continued to increase. During the decade of 1986 to 1996, when skiing improvements were taking place and mining was visible, visitor volume improved from the 50,000 skier visits per year to 80,000 skier visits toward the end of this 11-year period [Hammer, Siler, George Associates, 1996].

Wharf Resources is one of the partners in the Black Hills Chairlift Company (Terry Peak). The ownership interest of the company by Wharf has been mutually beneficial to all parties. Wharf, as a company, has gained insight on the sensitivity of the ski business to what occurs on properties that are proximate to their mining operation. The ski company benefits by being aware of what resources Wharf is capable of providing to make the ski area more functional. In 2002, Terry Peak acquired three wells and three holding ponds as part of the Reclamation Plan and partnership of the Golden Reward Mine. Through the years, Wharf Resources also provided material for parking lots and assisted with investments in artificial snow making equipment. The latter was instrumental in reducing the ski downtime in the early part of the season when precipitation is often not dependable [Madden, 2010].

The proposed expansion will likely have minor short-term impacts to winter recreation activities during mining and reclamation activities. The visual impacts of mining will become greater as mining occurs near the ridgeline and at the eastern edge of Terry Peak. The proposed Expansion Area also lies adjacent to existing ski runs on the eastern side of Terry Peak; the actual disturbance area will likely not cause disturbances to recreational use. Mining in this area may be limited to the east of the runs and will be seasonal with plans to mine small sections at a time and reclaim those areas before the winter ski season to keep the impact to a minimum. The disturbance is believed to have a negligible impact on the number of skiers, as the amount of snowfall will likely have a greater impact.

In summary, the last 20 or so years have confirmed that ski recreation can coexist in relative harmony to nearby gold mining operations and even grow in popularity when investments are targeted to improving the skier experience on the slope. It also has shown that the visual impacts of mining activity as skiers recreate do not interfere with their participation in the sport. Both Wharf and earlier, Golden Reward, played some part in enabling and encouraging many of the improvements of the ski facility. It would appear this past pattern can be continued with the appropriate seasonal timing of the mining of those newly permitted mining areas that would interfere with ski activities. This means that the former Golden Reward permit areas would probably need to take place during seasons of the year other than when skiing is taking place [Madden, 2010].

Postmining land use plans for this area will likely result in increased recreational opportunities. At Terry Peak, removal of the Liberty and Harmony Highwall will allow the southeastern ski runs to be extended approximately 40 percent (see Appendix 14). The old red chair lift is planned to be replaced with a new high-speed lift. Trails adjacent to Terry Peak Ski Area will be open for snowmobiling, snowshoeing, biking, and hiking. These postmining improvements in recreational opportunities will result in an increased use of the area, an increased need for additional commercial businesses and home sites, and other interrelated economic growth.

4.7 FUTURE TRENDS IN MINING EMPLOYMENT

In 1989, mining employment accounted for about 1,900 jobs out of 9,200 total private employment, or about 20 percent. Beginning in 1996, substantial drops in private employment occurred primarily because of the scaling back of underground mining. In 2001, mining accounted for only 484 jobs and by 2008, only 181 mining-related jobs remained in the county [Madden, 2010]. The reduction in mining employment is significant since this span of years coincided with the closing of the Homestake Mine. In 2008, mining accounted for 3 percent of total private earnings.

In the case of Wharf, the proposed mining permit simply extends the life of a mining operation. The pending permit application will involve the development of new ore reserves owned by the company and will consequently extend the life of the mine by approximately 7 years. Since there are about 2 years of mine life remaining under the current permitting, the approval of the proposed permit would extend the life of the mine to the range of 2019 to 2020. The expansion is expected to increase mining employment in the county by about 21 employees. Other than Wharf's proposed expansion, there are no announced plans to initiate any other new large-scale mining projects in the area.

The extended mine life of Wharf Resources will continue the employment of approximately 155–165 employees during the active mining life. The jobs are high-paying jobs with full benefits that help to sustain and support communities in the region through tax dollars, payroll spending, education, and community involvement.

5.0 MINE PLAN

5.1 CONSTRUCTION PHASE

The approximate timeline for the construction and mining phases of the Expansion Area will be based on time forward from the approval of the Large-Scale Mine Permit and is anticipated to be in the fourth quarter of 2011. The proposed schedule of construction and mining phases are interchangeable and may occur at different sequences dependent upon the mine needs at any time. The proposed phase schedule is as follows:

- **Phase 1 (Year 2011–2012):** Green Mountain/Bald Mountain site preparation, tree clearing, soil salvage. State Highway 473 reroute construction begins.
- **Phase 2 (Year 2013–2014):** State Highway 473 reroute complete, mining begins on Green Mountain/Bald Mountain, haul road to Golden Reward is constructed.
- **Phase 3 (Year 2014–2017):** Mining at Golden Reward begins and ends, mining continues at Green Mountain/Bald Mountain.
- **Phase 4 (Year 2017–2023):** Mining completes at Green Mountain/Bald Mountain, Wharf Access Road is rerouted, mining begins and ends at Portland Ridgeline along with final reclamation.

Mining of the Expansion Area, which includes Green Mountain, Bald Mountain, Portland Ridgeline, and Golden Reward, will involve relocation of approximately the last 1 mile of State Highway 473, abandonment of the first approximately ½ mile of Stewart Slope Road (county highway), the Wharf Mine access road, the Black Hills Power (BHP) power line along Bald Mountain, the Terry/Trojan Water District delivery lines, the natural gas line, and the Trojan telephone line. The following sections serve to detail the sequence of pit development and system relocation.

5.1.1 State Highway 473 Road Movement Plans

Mining activity in the Expansion Area will involve permanent relocation of the final northern end 1-mile portion of State Highway 473 and an addition of a tunnel/bridge for use of mine traffic traveling to and from Golden Reward during the mining at Golden Reward (see Exhibit 29 of Appendix 2). The highway and tunnel/bridge will be built to SD DOT standards and with SD DOT approval. The design phase and construction management of the road and tunnel/bridge (mine traffic traveling below the state highway) will be completed by an independent engineering firm (FMG Engineering) with the necessary qualifications. The majority of the construction of the highway will be completed by independent contractors managed by the design engineering firm. Minor dirt work may be completed by Wharf Resources, which could include but not be limited to, topsoil salvage, rough road layout construction, and hauling of fill and waste material.

The construction of the highway will follow all DOT standards and regulations that are applicable to highway construction and disturbance of the surrounding area. The highway relocation construction is anticipated to start during Phase 1; this will include rough dirt work, grubbing, and topsoil removal and will follow the engineering details specified within the plans developed by FMG Engineering and be completed by construction contractors managed by FMG Engineering.

The highway construction will be completed during Phase 2 of the Mine Plan along with the tunnel/bridge option for mine traffic. During the entire construction of the highway and tunnel/bridge, the current highway will be kept in place and be used for public access. The new section of the road will not be opened until completed; at which time, the old highway section will be closed to public traffic and will be later mined out during the mining phase of Green Mountain/Bald Mountain.

The tunnel/bridge located on the new section of State Highway 473 will be designed to SD DOT specifications and approval. The size of the tunnel/bridge will be large enough so that mine equipment can travel through safely and will ensure that all required safety concerns are met to provide safety for public and mine personnel.

Mining at this time will continue within the American Eagle Pit and will begin on Green Mountain/Bald Mountain with site preparation and prestripping. During times of blasting within close proximity of the current highway and the new highway, tight blasting and mining constraints will be enforced as local traffic and haul traffic will be in close proximity during this time frame. During times of blasting within 1,000 feet of public travel will result in stoppage of traffic and removal of all personnel from the blast radius to ensure a safety buffer.

As shown on Exhibits 22 and 29 in Appendix 2, the new state highway section will intersect Stewart Road to Terry Peak approximately ½ mile south of its current location. This section of Stewart Road back to the mine access road will be kept in service and will be used for public access to the north (LAC Minerals) and to the Wharf Mine.

With the movement of the state highway, a power line (owned and operated by BHP) currently located in the valley between Green Mountain and Bald Mountain running south toward Terry Peak will be rerouted. This section of power line will be extended on Bald Mountain to run south and then will run west on the south side of the newly rerouted State Highway 473 and will connect back into the current line at the base of the valley between Green Mountain and Bald Mountain (see Exhibit 22 of Appendix 2). The line will be moved by a qualified company specializing in this area, such as BHP.

The new highway section and the tunnel/bridge will remain in place and are not planned for any future movement in the future.

5.1.2 Traffic Flow Patterns During Construction and Mining

Phase 1 of the Expansion Area will not require any traffic flow changes on State Highway 473 or with use of the mine access road to Wharf Resources or north on the Perkins Road.

During the Phase 2 mining sequence, State Highway 473 will be rerouted (approximately the last 1 mile of roadway) south of the current roadway lower on the hillside of Green Mountain (see Exhibit 22 in Appendix 2). During the construction of the reroute section of State Highway 473 and the tunnel/bridge, public traffic will continue to use the current highway section through the full construction period. Once the new section has been completed in full and tied in to the current highway section at both ends, the old section will be terminated for use. It is not anticipated that any traffic flow during construction of the new section of road will require travel off of a paved road. During construction of the road, it may require temporary halting of traffic if blasting is required that is within the 1,000-foot blast radius. If this occurs, the usual stoppage time is approximately 10–15 minutes and all care and courtesy will be given to the public.

The haulage road construction from Wharf Resources to Golden Reward for use of transporting ore or waste will be constructed during Phase 2. The haul road will intersect State Highway 473 at the location of the new tunnel/bridge point where mine traffic will flow through the tunnel/bridge and public traffic above. The haul road will be constructed by Wharf Resources on both sides of the tunnel/bridge and constructed by contractors managed by FMG Engineering at the location of the tunnel/bridge area. The haul road will be constructed so that minimal impact will take place concerning the drainage in this area; suitable sediment and erosional control structures will be put in place to ensure this (see Exhibit 28 in Appendix 2). Gravel, water, road oil, and/or chemical binders will be used to reduce road dust.

The haul road will be constructed and maintained in the same manner and standards that are currently being practiced at Wharf Resources. The haul road will be designed to have sufficient drainage along with the proper and adequate drainage and sediment control along the road required by state regulations.

The haul road to and from Golden Reward and Wharf Resources will include fencing on both sides of the haul road along with proper signage to inform and to prevent the public onto the haul road. The fencing will be of typical size and standard that is used currently on the Wharf Mine access road, approximately 6 feet in height and being either chain-link type or game fence type with approximately 4-inch-square wire spacing. Beginning on the south side of the tunnel/bridge, the fencing will begin and tie into the tunnel/bridge structure on each side of the haul road and will run the distance of the haul road to Golden Reward. At the intersection of the haul road and the entrance road to the Terry Peak Ski Area Kussy Express Lift parking lot, a gate will be located on each side of the haul road. The gate will be constructed of the same

height and materials as the fence but will have ridged framing for greater support. The gate will be kept closed and locked during the mining season at Golden Reward, and only predetermined personnel will have authority and right to open the gate for special circumstances. The haul road fencing on the north side of the tunnel/bridge will tie in to the pit perimeter fencing along Green Mountain and Bald Mountain and will also be constructed of the same standards and fence type (6 feet in height and being either chain-link type or game-fence type with approximately 4-inch-square wire spacing). The fencing along the northern side of the new rerouted section of State Highway 473 will have a security fence along with signage at the same specifications stated above that will run from the tunnel/bridge along the new disturbance boundary and tie in at the Wharf Access Road security fence. On the east side of the tunnel/bridge, the fence will run along the north side of the tunnel/bridge along the new disturbance boundary up the west side of Bald Mountain and tie into the current perimeter fence on the east side of Trojan.

The fencing along the haul road on the south side of the tunnel/bridge during the off-season of mining at Golden Reward (approximately November to April) will be dismantled on the west side of the haul road so that additional area can be used within the parking lot for patrons at the Terry Peak Ski Area, at which time, the gates at the entrance of the parking lot will be opened. During this period, the haul road will be completely closed down and gated off so that no mine traffic can enter this area. Once the ski season ends and mining resumes at Golden Reward, the fence and signage will be put back into place and the safety berm on the north side of the tunnel/bridge will be removed.

On each side of the tunnel/bridge, gates will be placed of the same type and construction which will be located at the entrance of the Terry Peak Kussy Express parking lot road and intersection of the haul road. These gates will be closed and locked during the off-season of mining at Golden Reward. In addition, on the north side of the tunnel/bridge, a haul-truck size berm will be constructed immediately on the north side of the fence and gate for added security and prevention of mine equipment entrance to this area during the off-season of mining at Golden Reward. The haul road will tie into the current road to the Terry Cemetery and will be widened to accommodate haul traffic. The haul road will turn south at the first reclaimed northern knob at Golden Reward and will enter the property at that point.

During the mining phases at Golden Reward, traffic to the Terry Cemetery will either be rerouted through the Fantail Gulch entryway (which will be enhanced along with necessary fencing and road maintenance, if required) or the current road to the cemetery will be kept in service but will be partioned off from mine traffic with berm and fencing to inhibit comingling and safety to the public.

The Wharf Mine access road will be rerouted during Phase 4 for mining along the Portland Ridgeline. The access road traffic will be rerouted to the east (see Exhibit 22 of Appendix 2) while mining progresses along the Portland Ridgeline. Traffic will not be rerouted off the

current access road until the new section is fully complete for travel and safety. The road will be built to the required standards and all normal state requirements will be followed such as signage, fencing, and drainage. The reroute of the access road will not affect the current location of the mine crossing gates and will be left in-place with the road tying in approximately 150 feet south of the gate on the current road. The access road will include fencing on both sides of the road along with proper signage to inform and to prevent the public onto the haul road. The fencing will be of typical size and standard that is used currently on the Wharf Mine access road, approximately 6 feet in height and being either chain-link type or game-fence type with approximately 4-inch-square wire spacing. Gravel, water, road oil, and/or chemical binders will be used to reduce road dust.

5.1.3 Utilities—Electric, Gas, Water, Telephone

The proposed expansion will require relocation of the existing water, telephone, and gas and power lines. To maintain service of these utilities to the various affected communities, the service lines will be rerouted as shown on Exhibit 22 of Appendix 2.

The proposed utility reroute will involve the following changes:

- **Water:** Approximately 3,000 feet of new line in the rerouted access road. The pipe will be compatible in size and quality to the existing line and installed by qualified personnel and/or contractors to maintain the level of service that presently exists. The new line will connect to the existing underground line in the locations shown in Exhibit 22. The reroute will take place during Phase 4 of the mine sequence.
- **Telephone:** Approximately 3,000 feet of new line in the rerouted access road. The line will be compatible in size and quality to the existing line and installed by qualified personnel and/or contractors to maintain the level of service that presently exists. The new line will connect to the existing lines as shown in Exhibit 22 of Appendix 2. The telephone line reroute will take place during Phase 4 of the mine sequence.
- **Gas:** Approximately 3,000 feet of new line in the rerouted access road. The line will be compatible in size and quality to the existing line and installed by qualified personnel and/or contractors to maintain the level of service that presently exists. The new line will connect to the existing lines as shown in Exhibit 22 of Appendix 2. The gas line reroute will take place during Phase 4 of the mine sequence.
- **Power:** Approximately 2,000 feet of new power line will be rerouted along the south side of Bald Mountain and the valley of Green Mountain, as shown in Exhibit 22 of Appendix 2. This will allow the existing lines within the disturbance area to be abandoned. The line will be compatible in size and quality to the existing line and installed by qualified personnel and/or contractors to maintain the level of service that presently exists. The power line reroute will take place during Phases 1 and 2 of the mine sequence.

All attempts will be made to have these utilities constructed before tying into the existing lines. This will allow for minimal or no interruption of service.

5.2 GENERAL MINE PLANNING AND DESIGN

Mining of the Expansion Area will coincide with mining in the current permitted areas during Phases 1 and 2, and then during Phases 3 and 4 of mining will coincide in all areas of the new Expansion Area only. During the majority of the mine life, ore and rock will be extracted from a variety of mine areas, based on the quality of ore in each pit, to produce a uniform ore grade for processing.

Orebodies are a function of nature, and hence, irregular by deposition. Because of the diversity of the deposit and the need to maintain a reasonably constant grade and level of rock production, the size of a given area to be worked at any given time will vary. Generally, each individual mine working area will be from 20 to 40 acres. However, it can be expected that the total area of mining, backfilling, dumping, and reclaiming will approach the disturbance limit at certain times (SDCL 45-6B-6(9)).

Also inherent to the mining industry is the natural tendency to minimize the amount of unmineralized rock and spoil produced (ARSD 74:29:07:02 (8)). Before permitting a pit, the projected production costs are incorporated into a computer mining model that also contains the exploration drilling data. This model will run iterations of mine development until it is optimized into a final pit configuration. This final configuration represents a pit that maximizes the profitability, thus minimizes the overall costs. Unmineralized rock represents no economic viability; therefore, the unmineralized rock will be minimized through the modeling and pit design process.

Based upon experience in the Foley, Trojan, Harmony, Liberty, and American Eagle Pits and data from exploration drilling, the highwalls in the Expansion Area will be constructed in a similar manner (SDCL 45-6B-42). The highwalls within the competent rock units (typically the Deadwood Formation and the main porphyry sills) will be constructed at a maximum angle of 60 degrees with 40–60-foot walls and 20–30-foot catch benches. The highwalls within less competent units, such as the phonolite and Winnipeg Shale, will be constructed at a maximum angle of 45 degrees with 20-foot walls and 20-foot catch benches. Areas that will be mined within dumps, rehandle, or spent ore depository will be constructed at a maximum angle of 35 degrees. As the pits are being developed, significant fracture systems will be mapped and monitored and highwalls adjusted accordingly to provide long-term stability.

Select areas within the pits will leave the highwalls in place at closure. This will be primarily realized along parts of the Portland Ridgeline Pit area, since it is the final phase to be mined out; thus, there will be no available material to backfill the pit area. The Portland

Ridgeline highwall exposure will be reduced to two sections, one of 400 feet in length by 30 feet in height, and 500 feet in length by 20 feet in height. The need to leave partial highwall exposed in these areas is because of the lack of material to cover the remaining section, and it is impractical and uneconomical to blast additional land that is undisturbed to reduce the highwall exposure. It will be impracticable to blast this down as the additional disturbance required would negate the positives of reducing the highwall. However, all means will be taken to maximize highwall coverage during backfill sequencing. The remaining highwall in the Portland Ridgeline area will be of minimal height of 20–30 feet and will not pose any significant hazard. A security fence and signage will be constructed along the two highwall sections to warn and prevent access to the area.

The Portland Ridgeline Highwalls orientation and rock types will be the same as the current walls found along this section of Portland but will be pushed back upward to 100 feet to the south. These areas are initially identified from past mining of this area in Portland and previous and historic exploration drilling program and then incorporated into the pit designs. As the mine areas are developed, detailed mapping of altered zones and fractures are incorporated into the pit designs and adjustments made to maintain a stable highwall configuration.

The top levels (approximately 10 to 40 feet) of the Portland Ridgeline will consist of strongly fractured to altered phonolite porphyry. Based upon experience in the current Portland reclaimed highwalls in this rock type, the overall highwall angle must be maintained at less than 45 degrees to be stable in the fractured portions. In the areas where the phonolite is strongly altered, highwall angles of less than 35 degrees are required. These highwall angles are achieved with 20-foot highwalls and 20–30-foot catch benches. The area below the phonolite will be located within the upper to middle Deadwood Formation and porphyry sills. Generally, the highwalls within the Deadwood Formation and porphry in this area are constructed from 45 to 60 degrees with 40–60-foot highwalls and 20–30-foot catch benches. The predominant fracture systems are near vertical and trend north to northeast within these rock types. The regional dip within this area is approximately 5 degrees to the south which enhances the stability to the predominantly northeast-trending highwall (ARSD 74:29:02:04(5)).

The Deadwood Formation within the Portland Ridgeline area was mined sporadically by underground methods in the past by room-and-pillar type stopes, which parallel the northeast-trending fractures systems. During normal mine practices, these stopes are collapsed to provide safe mine access. Highwall and catch bench configurations are adjusted based upon the exact position of these workings to maintain a stable configuration within the collapsed zones. The similar fracture, stope and highwall orientations within the Trojan, Foley, or American Eagle Pit, have not caused significant stability problems to date.

The rock types and fracture systems within the Green Mountain and Bald Mountain Pit areas are also similar to the adjacent Trojan and American Eagle mine area and similar

highwall design criteria was used. The major highwalls are orientated northeast and northwest but will be backfilled within 60–80 feet of the top and will be comprised of both the Deadwood Formation and porphyry sill. The highwalls will be backfilled in a similar fashion as realized in the Trojan and American Eagle Pits.

Within the Deadwood Formation, most highwalls are designed at 45 degrees; within the phonolite, the highwalls are designed from 35 to 45 degrees, depending on the degree of alteration; and within the typically more massive monzonite porphyry sills, the highwalls are designed from 45–60 degrees. The designs are based upon exploration drilling data current and historical practices, and field observations, and they incorporate 20–40-foot highwalls and 20–40-foot catch benches, depending on the rock types encountered. The regional dip of approximately 5 degrees to the south will also enhance the stability of this configuration. Detailed mapping of fracture and alteration zones as mined areas are developed will provide additional information to make adjustments to the highwall configuration for maintaining a stable slope.

Most of the underground workings within the Green Mountain and Bald Mountain area were mined by room-and-pillar stopes. These stopes will be collapsed to provide safe access to those mine workings and catch bench adjustments made to maintain stable slopes within the collapsed zones.

The primary mine areas at Golden Reward site are also a pushback of previous mined areas and are of the same rock type as what is seen at the Wharf Expansion Area. The Harmony Highwall pushback consists mainly of Deadwood Formation, and the Liberty pushback is a combination of Deadwood Formation and Monzonite Formation identical to that seen in the north-facing Trojan Highwall and what will be realized in Green Mountain and Bald Mountain. The design and mining of these areas will be the same specifications of that in Green Mountain and Bald Mountain. The pushback of both these highwalls will be mined and reclaimed so that there is no highwall left exposed.

The geotechnical analysis of the Trojan Pit Highwalls, which the Green Mountain and Bald Mountain mine areas are a pushback of, was completed by Professors Kliche and Zbigniew of the South Dakota School of Mines and Technology. Copies of this report can be referenced within the Clinton Permit and the American Eagle Permit Amendment. The Golden Reward Pit design is identical to that of what is realized on the Wharf property, and additional information concerning Pit Slope Design can be referenced in Volume 1 of the Golden Reward Mining Company Application for Permit, Section 5.11.6 Pit Slope Design (ARSD 74:29:07:14).

The highwall west of the Terry Cemetery and at the north end of the East Liberty Pit at Golden Reward has had several stability analysis conducted by RESPEC of Rapid City, South Dakota. Following a period of instability in 1994, analyses were conducted to determine the extent of the problem and provide a solution so that no damage would occur in the cemetery

[Blankenship, 1994. It was determined that the wall would be buttressed with backfill material. The backfill was placed to the top edge of the Terry Cemetery Highwall along the length of the highwall with 180-foot base width and 20-foot crest width. Since the backfill material was emplaced, no additional stability issues have been noted and displacement data indicate the highwall has stabilized [Nelson and Osnes, 2008].

Review of the proposed mine plan indicates that little to no backfill material that is supporting the Terry Cemetery Highwall will be moved as part of nearby expansion mining and no adverse effects are expected at the cemetery. If modifications to the mining and engineering plan are made, additional highwall stability analysis will be completed and submitted to the SD DENR as required. Any changes in stability will be verified through stability analysis so that mining can proceed and not adversely impact the Terry Cemetery.

There has been no impact on stability issues with the current spent ore and waste rock disposal areas at the mine, and the amount of material disposed within the disposal area is insignificant to cause any stability issues (ARSD 74:29:07:14). Stability of rock disposal areas will be ensured by maintaining slopes of 3H:1V.

The portion of the Expansion Area in Section 33, T5N, R2E is located just north of the current process area (Exhibit 2 of Appendix 2). Although the final plan for this area is not yet determined, it is proposed that this area may be used for a roadway and utility corridors or parking lot space. Plans for this area do not currently include an additional pad or pad expansion; if future uses lend the need for an additional pad, additional studies and a technical revision will be submitted to the SD DENR for approval. No additional millsites, process ponds, or buildings will be constructed in conjunction with the Expansion Project (ARSD 74:29:05).

The list of proposed technical revisions from the Clinton Permit is submitted as requested technical revision categories Wharf would like to have considered for the Expansion Project. The list is included in Appendix 16.

5.3 MINE DEVELOPMENT

5.3.1 Site Preparation

The boundaries of all areas of disturbance (i.e., pits, rock depository, haul roads, and topsoil stockpiles) will be surveyed and physically marked before the onset of construction. Initial site preparation will begin with the harvesting of merchantable timber and other usable wood products. The topsoil and any other suitable growth medium will be salvaged and stockpiled for use in the final reclamation of the property. The pit disturbance limits will be adequately fenced to limit access and provide primary security and safety.

To maintain control of access to the Expansion Area pits and haul roads, a fence will be constructed that will surround all the affected acres (ARSD 74:29:07:02(5)). Gates will be maintained for service access only. Signs warning of pit areas, active mine traffic, and blasting activity will be posted intermittently along the fence. The fence and warning signs will be constructed in a manner to prevent inadvertent entry.

Gates will be placed at various locations where the perimeter fence will cross existing roads and trails to provide emergency and other required access either through the mine permit area or to adjoining lands (see Exhibit 21 of Appendix 2).

5.3.2 Tree Clearing

Pursuant to ARSD 74:29:07:02(2), construction of mine facilities will be completed in phases so that the affected lands are cleared in small sections or increments to match the needs of mine production. The Green Mountain and Bald Mountain areas will be developed in two phases (Phases 1 and 2), and Golden Reward and Portland Ridgeline will be developed in Phases 3 and 4, respectively. Table 6-4 in Chapter 6.0 details the timing of the various activities and the corresponding acreages to be disturbed or reclaimed. Once an area is marked out, the timber will be removed. If feasible, the marketable timber will be logged and sold. Any trees or large slash remaining will be grubbed and either piled and burned or disposed of in an existing rock depository. Slash disposed in the rock depository will be piled without creating "nests" to reduce the potential of subsidence problems. While it is quite difficult to remove all debris, the vast majority of native debris-type material will be hauled to a separate site for controlled burning or systematic burial.

5.3.3 Soil Salvage Handling Plan

All salvageable soil within the clearing areas will be stripped using mine equipment and stockpiled at designated topsoil stockpile locations (SDCL 45-6B-7(11)). When possible, Wharf Resources will directly haul topsoil to a targeted reclamation site. If surplus topsoil is available after these measures have been implemented, topsoil will be stockpiled on designated areas (SDCL 45-6B-40). Location of topsoil piles are in areas to aid in the final reclamation of land for ease of moving and applying to the recontoured land that require short hauls or immediate application across slopes (ARSD 74:29:07:02(7)). Spoil topsoil or unconsolidated material will not be placed within 10 feet of any perennial or intermittent streams.

The general location of the soil stockpiles is shown on Exhibit 21 of Appendix 2. Stockpiles will be built at a stable grade, usually 2.5:1 or shallower, bermed, and labeled as per ARSD 74:29:07:07(4). Any debris which would hinder redistribution of the topsoil will be removed and disposed of in an existing rock facility or in the one proposed within this permit. Topsoil stockpiles which are to remain undisturbed for more than 2 years will be regraded to a stable configuration, bermed, and seeded.

The topsoil stockpile along the Portland Ridgeline will not need to be moved for the mining of the Portland Ridgeline Pit and will be used for the reclamation of this pit. The Portland topsoil stockpile will be used for reclamation purposes before the Portland Ridgeline Pit is mined so it will not need to be moved; if plans change or there is excess topsoil, it will be moved to one of the active topsoil piles.

Achieving 4 inches of cover over the 298 disturbed acres of pit, road, and dumps within the Expansion Area will require approximately 155,418 yd^3 (ARSD 74:29:07:07(5)). It is determined that approximately 215,947 yd^3 can be salvaged from the disturbed areas of the Expansion Area during topsoil salvaging, which leaves approximately 60,529 yd^3 surplus. The topsoil on reclaimed areas to be disturbed at the Golden Reward and Wharf Mines is included in the topsoil salvage estimates (SDCL 45-6B-40). The current mine area will require approximately 281,650 yd^3 of soil (including both topsoil and subsoil) for reclamation for a 4-inch coverage, and currently there is 344,365 yd^3 topsoil stockpiled plus 31,191 yd^3 that can be salvaged from the Portland Pit, leaving a surplus of 93,906 yd^3. The total soil surplus from both Wharf and the new Expansion Project is approximately 154,436 yd^3. This anticipated surplus ensures that all areas will have adequate topsoil coverage after final reclamation, with surplus soil used to increase coverage depth as available. All efforts will be made to salvage as much topsoil in all areas; in addition, subsoil may be salvaged or mixed during the process in areas (ARSD 74:29:07:07). All efforts will be made to segregate the topsoil from rocks, trees, and subsoil; however, because of the mountainous terrain, segregation has not been very successful in the past.

Wharf has shown successful reclamation in overburden on areas such as the Trojan, Portland, Reliance, and Foley Pits as well as Golden Reward. Methods of determining vegetative success throughout the mine life is described in Section 6.9.1. Pursuant to SDCL 45-6B-40 and ARSD 74:29:07:07, topsoil and subsoil stockpile areas are shown on Exhibit 21 of Appendix 2.

As stated in the Clinton Permit, the success of revegetation in subsoil is evident in the Bald Mountain Historic Tailings Revegetation Survey [BarrXX Environmental Service, 1995]. The historic tailings were covered in 1993 with rock overburden from two borrow areas. Little to no subsoil was used to cover the tailings as it was not available in the borrow area. Soil tests were completed after the tailings were covered with the rock overburden. The texture analysis indicated a gravely loam with an average of 74 percent gravel greater than 2 millimeters. Phosphorus values were considered low to medium, potassium values were medium, and organic matter and available nitrogen were considered low.

As indicated by BarXX Environmental Service [1995], the frequency of seeded species was especially good at all locations surveyed after 2 years of growth. Results also indicate that the establishment of plants was variable, as evidenced by the cover values. Since the 1995 vegetative survey, one more fertilizer application was applied in the fall of 1995. Select areas of

limited vegetative establishment were also reseeded in 1995. Vegetative growth on the tailings was visually inspected in 1996. Vegetation appears healthy and self-sustaining as some of the reclaimed grasses are producing viable seed. No other soil amendments and vegetative treatments are recommended at this time. Some noxious weeds (Canada thistle and tansy) have been identified in small communities on the upper and lower tailings. Wharf has and will continue to conduct an herbicide program at this site.

5.3.4 Pit Development and Sequencing

The Expansion Area is proposed to be developed in four phases, all of which are interchangeable in sequence timing dependent upon the mine needs. The first phase will concentrate on the southern side of Green Mountain, immediately adjacent to the last 1-mile section of State Highway 473. The second phase will be the north portion of Green Mountain and the Bald Mountain area. The Green Mountain and Bald Mountain area is a pushback of the Trojan Pit to the south and will have a higher profile since it will temporarily interrupt existing roads. It is critical that development begin on Green Mountain area to facilitate State Highway 473 reroute and the haul road to Golden Reward, as well as rock stripping to provide a continual flow of quality ore to sustain mining. Phase 3 will continue mining on the Green Mountain and Bald Mountain area and Golden Reward. In the final phase, mining will finish on Green Mountain and will primarily focus on the Portland Ridgeline. The depth and direction of mining is shown on representative cross sections on Exhibits 23 through 26 of Appendix 2 (ARSD 74:29:02:04(3)).

Phase 1 mining will begin on the southwest side of Green Mountain beginning late 2011 through 2012. The southwest side of Green Mountain adjacent to State Highway 473 will begin to be mined in 2011 concentrating on clearing, grubbing, topsoil removal, and prestripping and will continue through 2012. The reroute of State Highway 473 will begin during this period and will concentrate on roughing in the main route of the new highway section. This will also provide for the continual feed of quality ore to the process area and timely reconstruction of State Highway 473 that will be completed in Phase 2. Most of the unmineralized rock from the Green Mountain Phase 1 mining will go to the American Eagle Pit for backfill and final contouring; all ore mined during Phase 1 will be processed. This part of Green Mountain will be mined down to approximately final elevation of 6,100 feet.

During Phase 2, mining will begin approximately in 2013 and continue through 2014, concentrating on Green Mountain and moving north adjacent into the current Trojan Pit. In addition, Bald Mountain will begin being mined and will also be completed during this phase. The reroute of State Highway 473 along with the tunnel or bridge will be completed and the haul road to Golden Reward will be constructed. Mining Green Mountain will continue to approximately the 6,180-foot elevation and Bald Mountain will be mined to completion to approximately the 6,100-foot elevation on the west flank and 6,160 feet on the north side of the mountain. On completion of mining, the south side of Green Mountain adjacent to the newly

rerouted State Highway 473 and Bald Mountain, will serve as a backfill site for material mined primarily from the remaining Green Mountain area. Refer to Exhibits 23 through 26 of Appendix 2 for final reclamation of these areas.

Phase 3 mining will begin in late 2014 and go through 2016 with mining at Golden Reward and on Green Mountain. Mining at Golden Reward will take place during the off-season of winter ski activity at Terry Peak Ski Area, anticipated to be from early April through mid to late November. The first year (projected 2014) of mining at Golden Reward is anticipated to begin with the Harmony Highwall area because of its low ore to waste ratio and is planned to be mined to completion during the first year of mining at Golden Reward. The highwall once mined down will be sloped to near final reclamation with remaining discard material and partial strip material from the beginning of mining of the Liberty Highwall pushback. This will result in minimizing any hazard for skiers or the public around this area and greatly reducing the current highwall hazard. The second year (2015) of mining at the Golden Reward area will begin with the Liberty Pit Highwall pushback and will be mined to completion. Concurrently, the small pit east of the Harmony and Liberty Highwalls will also be mined to completion the second year of mining at Golden Reward. Reclamation of both the Liberty Highwall and eastern pit will be completed concurrently as areas from both mining sites come to final. Final reclamation of Golden Reward will take place during the third year (2016) with the spreading of topsoil and seeding of the area.

Mining will continue on Green Mountain but at a slower pace except during the winter periods of November–April when mining is not active at Golden Reward. The mining at Green Mountain will be near completion during this phase (being mined to a final depth of 5,940 feet elevation on the north end) and will also concentrate on continued backfill of the area for final reclamation. The primary ore source during this phase will be from Golden Reward; waste mined at Golden Reward will be used for reclamation at that site. It is anticipated that the mining at Golden Reward will take approximately three seasons to complete. Mining in this area will go to a depth of 5,720 feet at the deepest point, with most areas being mined to a depth of approximately 5,900 feet. Both the Liberty and Harmony east-facing highwalls at the base of Terry Peak will be mined in conjunction so that proper staging of waste handling can be completed. The Harmony Highwall will be mined back to the base of the Terry Peak Red Chair within 100 feet of the base lift station. Reclamation of the Harmony Highwall will be contoured out at approximately 15 to 8 percent grade (down slope) beginning at the base of the ski area and to the east, eliminating any highwalls. The Liberty Highwall will be laid back and reclaimed and contoured so that it will remove all of the current highwall. The final reclamation of two highwalls (Harmony and Liberty) will create the opportunity to lengthen the current ski runs of Terry Peak on the Red Chair side and add ski runs between the Red and Blue Chair where the Liberty Highwall will be mined and reclaimed. Two small pits will also be mined east of the Harmony and Liberty Highwalls that will supply supplemental ore from the Golden Reward site and will be reclaimed to near-current reclamation contours.

Once mining is completed at Golden Reward, the haul road into Golden Reward beginning from the Terry Peak Kussy Express entrance to the Golden Reward Mine will be left in place for future use for Terry Peak Ski area. All fencing will remain, along with gated entrances for security purposes.

Phase 4 mine sequence will concentrate on mining the Portland Ridgeline west of Green Mountain that runs approximately 5,000 feet to the southwest and approximately a 100-foot pushback to the south along the old Portland mining area that has been reclaimed to date. The final reclamation of the Green Mountain area will also be completed. Mining will begin in this area in approximately 2017 and continue through 2019. Mining is planned to start on the far southwest end and will concentrate on near-surface ore while prestripping is initiated along the remainder of the ridgeline area. The majority of the prestrip waste will be hauled to the Green Mountain area for backfill material during the first year of production in this area and backfilling the far west end of the Portland Ridgeline for final reclamation.

During the next 2 years, the pit will be mined in a sequence to balance ore production to the process plant and maintain the waste for backfill. Mining along the Portland Ridgeline will encounter previously deposited spent ore which will be required to be rehandled, some of which will be backfilled within the ridgeline and within the current POP Zone in which it was deposited. During the mining of the Portland Ridgeline, the Foley/Polo/Portland Denitrification liners will not be disturbed and will be left in place. Any area which requires mining into spent ore or rehandled material that will be left in place within expansion pits (Portland Ridgeline, Green Mountain, Bald Mountain, and Golden Reward) will be laid back at approximately 33 percent to ensure ample stabilization and safety. As one area along the ridgeline comes to mining completion, final waste from an adjacent area will be used to backfill that area for final reclamation. The pit on the far southwest end will be mined to approximately the 6,300-foot elevation and to about the 6,000-foot elevation everywhere else along the Portland Ridgeline. Included in the final backfill of the Portland Ridgeline will be approximately ten MT of spent ore originating from the final heap-leach pads. The final heap-leach pads (1–5) are anticipated to be unloaded or reclaimed in place in 2023 once final recovery is met and the pads have completed neutralization and denitrification (in-place) and have met the required unload standards. Final reclamation of the ridgeline will have a section of highwall exposed approximately 400 feet in length by 30 feet in height and one section 500 feet in length by 20 feet in height (all facing north) (see Exhibits 24 through 26 of Appendix 2).

Wherever economically and operationally feasible, highwall areas will be backfilled and sloped to 3H:1V or shallower. All of the Green Mountain and Bald Mountain Highwalls will be backfilled; the Portland Ridgeline will have been majority backfilled except for two sections of exposed highwall (one 400 feet long by 30 feet in height and one 500 feet long by 20 feet in height). Highwalls not backfilled will be reclaimed in place or slope reduction via land shaping. Conceptual configurations of Postmine Land Use of the affected pits are shown in Exhibits 23 through 26 of Appendix 2.

Mining of the Expansion Area will include approximately 26 MT of ore that will be processed for gold. It is planned that the material will be neutralized and denitrified on the heap-leach liners and then unloaded to the American Eagle Pit under a new planned Groundwater Discharge Permit (being submitted in mid-2011). The spent ore will meet the required pad off-load criteria set within the Groundwater Discharge Permit.

The Expansion Project gives the opportunity to enhance the final reclamation at both Wharf Resources and Golden Reward so that less highwalls will be exposed under the current mine plan (SDCL 45-6B-7(7)). At Wharf Resources, the north-facing Trojan Pit Highwall will no longer be exposed and will be reclaimed with no highwalls exposed.

At the Golden Reward property, the Harmony Highwall currently exposed will be laid back and reclaimed so there is no exposed highwall, which will give the opportunity to lengthen the south side ski runs on Terry Peak approximately 40 percent. The current exposed Liberty Highwall will also be laid back during the mining phase and reclaimed so that no highwalls will be exposed. The Liberty Highwall pushback will also give the opportunity to lengthen ski runs and add new ski runs. The mining at Golden Reward will not only enhance the visual and aesthetic view of the site but will also enhance the ski area and recreational use in the area.

Beginning in the Year 2011, approximately 34 MT of ore remain within the current permitted area and the Expansion Area. Of this, 8 MT are within the current permitted area of American Eagle, and approximately 26 MT are within the new Expansion Area. This 34 MT plus the approximate 10 MT of ore on the heap-leach pads currently will be unloaded in the following areas: Portland Denitrification Pad, American Eagle POP (planned new Groundwater Discharge Permit area), Reliance Spent Ore depository (if needed), and Portland Ridgeline. The spent ore unload and deposit schedule can be viewed in Table 5-1.

5.3.5 Water Management and Erosion Control During Mining

There are no planned diversions of perennial or intermittent streams or channel and flood plain diversions that will affect these streams (ARSD 74:29:07:10). Upper Fantail Gulch within the proposed mine area does not contain any intermittent or perennial streams. Fantail Creek starts below the filtered sand dam outside the current permitted area of Golden Reward. The drainage structure constructed within the Liberty/Harmony Highwall backfill area within the proposed mine area is built on top of a backfill area and does not carry any water throughout the year. Any meteoric events that occur in this area drains into the ground (backfill material) and does not have any flow path. When this area is mined and if any distinguishable water flow is encountered, mitigation plans will be developed to ensure proper drainage and flow direction. Once mining is completed and reclamation is being conducted, the dry unused drainage pathway will be reconstructed where necessary. Refer to Exhibit 28 for proposed sediment and erosion control. The reconstruction of the drainage within the Liberty/Harmony Pit area is

shown in Exhibit 28. There is no stream diversion with Fantail Creek or Nevada Gulch Creek since neither are in the area of disturbance.

Table 5-1. Spent Ore Unload Schedule

Year	Tonnage (MT)	Pad Unload	Unload Area
2011	4.2	Pads 5 and 4	Portland Denit Liner
2012	3	Pads 3 and 2	American Eagle
2013	3.5	Pads 2 and 1	American Eagle
2014	3.5	Pads 1 and 5	American Eagle
2015	3.5	Pads 5 and 4	American Eagle
2016	3.5	Pads 4 and 3	American Eagle
2017	3.5	Pads 3 and 2	American Eagle
2018	3.5	Pads 2 and 1	American Eagle
2019	3.5	Pads 1 and 5	American Eagle
2020	2.3	Pad 5	American Eagle
2023	10	Final Pads (All)	Portland Ridgeline
Total	**44**		

During the period of mine operation, erosion control practices will be employed to preclude soil loss and control sedimentation downgradient (ARSD 74:29:02:11(9)). Ditches will control runoff along haulage roads, and culverts or filter rock structures will be used in areas where roads or trails cross drainage areas (see Exhibit 28 and 29 of Appendix 2). All water diversion structures are designed to carry a minimum of a 2-year, 6-hour precipitation event. Erosion will be controlled with rock riprap at culvert outlets or as needed along any diversion ditches. Straw bale or silt fence sediment traps will be constructed downgradient of disturbed grounds where sediment runoff is possible. Sediment control devices such as these are highly effective during the early stages of site disturbance, as has been demonstrated before vegetation reestablishment at the active Wharf Mine.

Following ground disturbance, areas conducive to planting will be prepared and seeded with an appropriate seed mixture (see Section 6.5) to accelerate rehabilitation of the land and further reduce the potential for soil erosion. Exhibit 28 illustrates the sedimentation control patterns that will be used during construction through reclamation (ARSD 74:29:07:08). Conceptual ditch designs, culvert locations, and sizes are shown as insets. The proposed haul roads have been designed to minimize drainage disturbance. Location of culverts and sediment control structures are shown on Exhibits 21, 28, and 29, pursuant to ARSD 74:29:07:12(6). Pursuant to

ARSD 74:29:07:12(7), the haul road disturbance will be limited to the width needed for haul road construction and maintenance.

The haul road that will be used for mine traffic between the Golden Reward and Wharf Resources will include erosional control measures as stated above and can be viewed in detail on Exhibit 29. As shown on Exhibit 29, the haul road will have numerous sediment traps and drainage control structures on both sides of the haul road to ensure that runoff is minimized and controlled. The haul road will use the Terry Peak Ski Area Dark Horse parking lot and the roadway to the Terry Cemetery. At the point where the Terry Cemetery road crosses above the Nevada Gulch drainage, sediment control measures will be put into place, such as silt fences, sediment traps, and check dams, to control runoff into the drainage where sediment runoff is possible (refer to Exhibit 29) (ARSD 74:29:07:12). In addition, if deemed necessary, a culvert will be sized to help in water management and erosional control.

Sedimentation, erosion, and drainage control structures will be constructed before disturbance and will be similar to those of existing structures. Surface runoff diversions constructed in soils or unconsolidated materials will be seeded as soon as practical and be constructed with sides that do not exceed two horizontal to one vertical. If constructed in rock, they will be stable. Riprap, geosynthetic filter media, and other methods will be used to prevent erosion in diversions. They will be constructed to minimize hazards to humans and wildlife and will not discharge to topsoil storage areas, spoil, or other unconsolidated areas such as newly reclaimed lands. Culverts or bridges will be installed to cross surface water streams and diversions as indicated on Exhibit 22, 29, 29.1, and 32.

All sedimentation, erosion, and drainage control structures will be left in place until vegetation is adequately established to prevent sedimentation in downstream waters. The structures will continue to be inspected on a quarterly basis and cleaned or upgraded as required during the postclosure period. After a selfsustaining vegetation is established and there is no longer the threat of sedimentation during rain event or runoff periods, the structures will be removed (see Exhibit 28 in Appendix 2 for details and location of sediment control).

5.3.6 Rubble Site Conditions

Wharf Resources proposes to place mining-related rubble/construction and demolition debris, as defined by ARSD 74:27:07:01, in the permitted rock disposal areas of the Wharf Mine. Rubble/construction, demolition debris, and other waste-building materials resulting from construction, remodeling, repair, and demolition operations on pavements, houses, commercial buildings, and other structures, as well as slash from tree-clearing activities and ash from slash burned under the regulation of Forest Service Burn Permits, would be acceptable materials for disposal. Wharf Resources will continue to use their current rubble permit for disposal of rubble. There has been no impact on stability issues with the current rubble permit at the site of disposal, and the amount of material disposed within the disposal area is insignificant to cause any stability issues.

Unacceptable material would consist of regulated asbestos-containing material as defined in the National Emissions Standards for Hazardous Air Pollutants (NESHAP) 40 CFR part 61, petroleum-contaminated soils, herbicide/pesticide containers, car batteries, tires, putrescible waste, yard wastes, and hazardous or special wastes, as defined by ARSD 74:27:07:01.

Self-imposed restrictions regarding the disposal of the above-listed acceptable materials are:

1. No rubble/construction and demolition debris shall be accepted from an outside source. Only the above-listed acceptable materials generated at the Wharf Mine will be placed in the rock depositories.
2. All slash and burned material disposed of in the rock depositories would be pushed so as not to create a "pocket" of rubble.
3. All rubble/construction and demolition material will be covered by the rock disposed of in the site.
4. The disposal sites will not be located within 300 feet of surface water as defined by ARSD 74:27:07:01.
5. The disposal site will not be located within 1,000 feet of any occupied dwellings.
6. The active disposal area will not be located within 200 feet of the mine permit boundaries without written approval of the adjacent property owner/owners.
7. The disposal sites will not be within 500 feet of any private or public well which supplies drinking water for human consumption.
8. The disposal sites will not be located in a 100-year flood plain.
9. The disposal site will not be located in a wetland as defined by ARSD 74:27:07:01.
10. The site will be not be located within the incorporated limits of any municipality.
11. The site will not be located where the depth to an aquifer (as defined by ARSD 74:03:16:01(1) is less than 10 feet.

Records shall be maintained and shall include, at a minimum:

1. A copy of the permit approval letter from the SD DENR.
2. The date on which the disposal of rubble/construction and demolition debris commenced.
3. Names, dates, and nature of any complaints received concerning the disposal of rubble/construction and demolition debris.
4. Dates when open burning occurs.
5. A description of the debris, the estimated tonnage, and the sources.

All refuse not defined in this section will be disposed of in an approved landfill that complies with the South Dakota solid waste regulations. Any potential acid-forming material mined from the pit areas will be disposed of according to Section 3.1.2.7 (Mitigation Plan for AGP Rock). All other hazardous wastes will be handled in accordance with South Dakota hazardous waste regulations.

5.4 PIT BACKFILLING—ROCK AND SPENT ORE

Wharf Resources owns or controls all surface and mineral rights within all proposed spent ore disposal areas. Wharf's legal right to dispose of spent ore is further evidenced by State Mine Permits 356, 434, and 435. Spent ore is scheduled to be deposited within the current American Eagle Pit with the approval of a new Groundwater Discharge Permit to be submitted in early 2011. The use of denitrification pads will also be used for the treatment and disposal of spent ore. In situ treatment of nitrates within the leach pads before unload of pads will be implemented to reduce or deplete nitrates in the spent ore before unloading (ARSD 74:29:05:05, ARSD 74:29:07:11, SDCL 45-6B-91). This will help in the disposal of spent ore and the protection of the groundwater.

The rock production throughout the mine life will be prioritized as pit backfill whenever operationally feasible. The present rock schedule associated with the Expansion Area calls for the American Eagle, Green Mountain, Bald Mountain, Portland Ridgeline, and Golden Reward areas to be backfilled either partially or completely.

The backfill of pits with discard rock and spent ore help aid reclamation through the means of concurrent reclamation. As areas of pits are mined to completion, dump areas are begun in the finalized pit area to meet the reclamation plan. This minimizes the amount of area at any time being unreclaimed and ensures continued backfill and reclamation of the land. With this practice, the environmental impact is reduced by returning the land to an atheistically pleasing design that fits in with the surrounding undisturbed land.

All the aforementioned pits will be backfilled with pit rock and rehandle material since all of the proposed areas have rehandled material associated with them. American Eagle Pit will be backfilled with pit rock and spent ore. A Groundwater Discharge Permit will be obtained for spent ore disposal in the American Eagle Pit.

The Wharf Mine is currently permitted to place spent ore from the leach pads in Ross Valley, the Juno Cut, Reliance Depository, and the Foley Pit as part of current mine permits and Groundwater Discharge Permits. These permits address such information as: (1) the treatment method proposed; (2) the reasons for selection of the proposed treatment method; (3) the plans and specifications for the existing facilities used to treat the spent ore; (4) the plan of operation for the treatment of spent ore; (5) sampling and chemical characterization of effluent before

initiation of treatment (neutralization) (ARSD 74:29:05:06); (6) sampling and chemical characterization during treatment (neutralization) to meet off-load standards, including solids and effluent sampling; (7) the standards (groundwater and/or surface water) to be met before off-load; (8) locations for spent ore disposal; and (9) Reclamation Plans for all areas scheduled for spent ore disposal. Storage of the treatment reagents at the Wharf Mine is addressed in Wharf's Spill Prevention Control and Countermeasure Plan (provided in Appendix 17) (ARSD 74:29:02:11(10)). The Groundwater Discharge Permit that will be obtained for spent ore disposal in the American Eagle Pit will address the same information as listed above.

The disposal of spent ore within the Portland Ridgeline Pit will meet off-load criteria. Currently Wharf Resources holds two GWDs, one within the Portland Ridgeline that allows off-load of spent ore and the Foley GWDP. In addition, another GWDP has been submitted which includes the eastern end of the Portland Ridgeline and the American Eagle Pit. If the permit is approved, the new permit will be used to off-load spent ore contingent upon making groundwater discharge requirements. Please refer to Exhibits 2, 2.1, and 21.1 for current and proposed POP zones for off-load of spent ore.

For final off-load of the heap leach pads, it is estimated that approximately 10 MT will be off-loaded from the heaps to a POP zone within a GWDP. It is anticipated that it will be unloaded within the current permit boundary at Wharf Resources within the Portland Ridgeline. View Exhibit 2.1 and 21.1 for spent ore placement. Pads unloaded will meet the necessary off-load criteria set within each GWDP. It is estimated that approximately 1.5 MT will be left on the heap-leach pads for use in final reclamation of the pads and ponds within the process area. This material left in-place on the heaps will meet the necessary groundwater discharge or surface water discharge requirements for final reclamation.

Concerning ARSD 74:29:05:05 through 12, all spent ore that is planned to be off-loaded to an unlined area will meet the necessary off-load criteria and will be unloaded within a designated POP boundary. All spent ore subject to the above will be treated by in situ treatment through bio-denitrification within the heap-leach pad system before unload. Treatment of the spent ore will take place during the neutralization cycle of the pad before off-load. Treatment by this process (insitu) has been successful on current denitrification pads and the operation is set up for this type of process and is most feasible. All treatment reagents for this process are currently stored and used on site; the storage facilities for the reagents pass all applicable storage laws. Once the pad has been determined neutralized/denitrified, the effluent solution from the treated pads will undergo off-load sampling protocol to ensure that the solution passes groundwater discharge standards. Once the spent ore has been cleared for off-load, the material will be suitable for use in backfill of pits for reclamation. The final pads to be off-loaded will be used to help cover the remaining highwalls within the Portland Ridgeline area along with waste material in the backfill.

Before initiation of treatment (neutralization/denitrification) the pad will undergo the required effluent sampling of pore water for the required parameters and will be monitored throughout the

treatment process. Off-load of each pad in treatment will be determined by the final off-load sampling protocol set and approved by the SD DENR. If any pad(s) cannot meet treatment standards, the pad(s) will need to be evaluated on how to prepare for final reclamation and a plan set and agreed upon with the SD DENR so that the material will not negatively affect the environment.

5.5 GOLD PROCESSING PHASE

Processing of gold will not change at the Wharf Mine process plant as a result of the Expansion Project. Ore from both the Wharf site and Golden Reward site will still be crushed at the Wharf crushing plant and gold will be heap leached on each of the five existing process pads. No additional surface disturbance from facilities will occur (ARSD 74:29:07:02:1). The impact to the process end of the gold recovery circuit will not be affected by the rate of mining in the Expansion Area or the specific geology of the ores; both of which are nearly identical to the current mining operation.

5.6 PROCESS SOLUTIONS

The leaching of gold and silver uses a number of different chemicals in the overall process flow sheet (see Exhibit 27 of Appendix 2). A general chemical description of the process solution includes high alkalinity (pH = 10.0), a relatively high level of dissolved solids, a generally even distribution of anions and cations, and a number of metals. The majority are below drinking water standards.

Lime is added to the ore during the crushing stage to buffer the process solution and maintain a basic pH of approximately 10. Liquid sodium cyanide is added to the process solution before being applied to the leach pads. Typical cyanide values range from 50–60 ppm in the solution. The pH of 10 in the process solutions prevents the formation of hydrogen cyanide (HCN) gas.

The process solution is percolated through the leach pad to dissolve gold and silver. The gold- and silver-laden process solution is then routed through and adsorbed onto activated carbon. The carbon is then removed and put through a high-pressure stripping process. This stripping process removes the gold and silver from the carbon and then electroplates the gold and silver onto steel wool cathodes. Liquid sodium cyanide and sodium hydroxide (caustic) are used in stripping process solutions.

Before the carbon is put back into the main process stream, the carbon is thermally reactivated. Antiscalent is also used in the process solutions to reduce the amount of carbonate and scale growth.

To off-load spent ore from the heaps, the material must be neutralized to meet a number of groundwater parameters. This is accomplished by adding hydrogen peroxide to the neutralization pond which oxidizes the cyanide. The solution then is streamed through a series of carbon columns which removes particular metals to the required levels for discharge.

Nitrate is removed from the neutralization solution by a biodenitrification plant or through batch treatment within a pond using denitrifying bacteria. The bacteria lower the nitrate level within the solution to meet the groundwater standard so that it may be discharged. Spent ore may also be placed onto a denitrification liner where denitrifying bacteria in solution is applied to the spent ore to lower the nitrate levels.

Spent ore may also be unloaded into pits for backfill if the material meets the necessary off-load requirements or within an designated POP boundary with specified criteria for groundwater discharge and the appropriate Groundwater Discharge Permits. Before initiation of treatment (neutralization/denitrification), the pad will undergo the required effluent sampling of pore water for the required parameters and will be monitored throughout the treatment process. Off-load of each pad in treatment will be determined by the final off-load sampling protocol set and approved by the SD DENR. If any pad(s) cannot meet treatment standards, the pad(s) will need to be evaluated on how to prepare for final reclamation and a plan set and agreed upon with the SD DENR so that the material will not negatively affect the environment.

Per ARSD 74:29:02:11(12), average concentrations or consumption rates for the major chemicals used in the processing of ore are shown in Table 5-2. Other parameters monitored in the process solution include: sulfates, chlorides, nitrogen species, and a number of required metals. A copy of the current spill contingency plan for Wharf Mine and the Expansion Project is provided in Appendix 17.

5.7 PROJECT WATER REQUIREMENTS

Water requirements related to the open pit heap-leaching process are limited to a few basic areas. Water is needed in the leaching process to leach fresh ore on the pads. A majority of this water requirement is achieved through natural precipitation. Approximately 60,000,000 gallons per year are required for leaching new ore. Of this amount, roughly 50 to 55 million gallons are provided by precipitation. Other makeup water is available from pad draindown. During the hotter summer months, makeup water is required for dust control. Although a chemical treatment (magnesium chloride) is used during these months, an average of 60,000 gallons per day of water is required to maintain acceptable dust levels. Up to 100,000 gallons per day can be used during the hotest portions of the month.

Table 5-2. Average Chemical Concentration or Consumption Rates

Chemical	Consumption Rate
Cyanide	~50–60 ppm
Lime	0.9–1.5 pounds per ton (lbs/ton) ore
Caustic	20 lbs/ton strip solution
Antiscalent	2–4 ppm
Hydrochloric Acid	25,000 gallons per year
Ammonia	0.4 lbs./ton solution
Copper Sulfate	4 ppm as copper
Hydrogen Peroxide	15 ppm
pH of Leach Solution	9.5–10.5

The normal road watering season runs from May through October. Water is also needed throughout the mine site for general purpose needs, such as personnel hygiene, plant operations, equipment washing, crusher dust control, and building cleanup and maintenance.

Per ARSD 74:29:02:11(11), a summary of the approximate average annual water requirements is shown below in Table 5-3 along with the location of the water source. At times throughout the year, this rate can range from 0 to much higher than the average.

Table 5-3. Water Requirements

Requirement	Consumption (gpm)	Location
Process Make-up Water	25	PW-1 Well
Process Treatment Water	150	PW-2 Well
Road Water	30	Ross Valley Bio Plant
Road Water	375	Bonanza Well at Golden Reward
Fresh Ore	95	Precipitation and Pad Draindown
General Use	4	HDH-8A

6.0 RECLAMATION PLAN

6.1 INTRODUCTION

The reclamation plan was developed by Wharf personnel including Mr. Ron Waterland, Mr. Ken Nelson, Mr. Garth Evers, and Mr. Tony Auld (résumés provided in Appendix 16). These individuals are competent and have experience managing and planning for reclamation at Wharf's current mining operations (ARSD 74:29:07:18). Portions of land at Wharf and Golden Reward Mines, under the management of these individuals, have successfully been reclaimed to rangeland (woodland grazing).

The initial and most critical goal of mined land reclamation is to stabilize the primary disturbance to reduce off-site impacts. The overall long-term objective of reclamation at the proposed project area is to return future as well as past areas of disturbance to a beneficial land use after mining activities have ceased. During the period of active mining, interim management of disturbed lands through revegetation techniques, sediment control, dust and noise suppression, and management of noxious weeds will be conducted to minimize impacts to land, water, air, wildlife, and humans. As mining is completed within various portions of the permit area, long-term reclamation treatments will be implemented to ensure the creation of a stable and environmentally sound postmining land base. Further detail on the Reclamation Plan can be found in Appendix 16.

Wharf will not be responsible for reclamation of underground mining that occurred before July 1, 1980 (per SDCL 45-6B-9). Underground workings displayed on Exhibit 30 are all included in this category. Portions of Golden Reward that will be reworked do not apply to this statute and thus will be reclaimed in accordance with the proposed Reclamation Plan of this chapter.

6.2 POSTMINING LAND USE PLAN

The formal land use selected as the objective of this Reclamation Plan after completion of the project is a number of options, including: rangeland (ARSD 74:29:07:20), recreation (ARSD 74:29:07:23), industrial (ARSD 74:29:07:24), and home sites (ARSD 74:29:07:25). This multiple-use Reclamation Plan is in keeping with the land use objective for the adjacent properties and will provide a significant beneficial use of the property at closure. These reclamation types were chosen in conference with the SD DENR and the property owners of the affected area in a meeting held on December 16, 2010 (reference letters are included in Appendix 16) (SDCL 45-6B-44). These specific types of reclamation were chosen because they will support the existing commercial, recreational, and home site uses of the surrounding area (SDCL 45-6B-7(1)).

Wharf Resources' postmine land use is based upon the speculation and growth needs for the area especially within the Terry Peak Ski Area, and this is substantiated by the long-term growth plan of Terry Peak Ski area (BHCLC). The current market for postmine land use plans (Recreation, Industrial, Residential, and Rangeland) and what is expected in the future, especially a decade or more from now is speculative, but growth of any region is dependent upon it. This locale (Terry Peak Ski Area) is a recreational region and destination; growth is anticipated and planned to enhance this area's economic future. Traffic control plans are dependent and determined on a development plan that will be based on the needs in the future with the developer at that time. Wharf Resources does not plan to develop this area but sell the land so that it can be used in the specific postmine land use.

With the postmine land use of recreation, industrial, residential development and rangeland, all the land is reclaimed as rangeland until development of the areas proceeds forward. The rangeland reclamation is suitable for all postmine land use in that it ensures the area is stabilized and in accordance with all pertinent SDCLs. This reclamation will allow the future postmine land use to develop and/or expand these areas for future needs as best realized at the time and speculated during the current time.

The conceptual proposed postmine land use and estimated acreage for various areas are outlined on Exhibit 23 In Appendix 2. These maps are conceptual at this time and will be subject to change as the mine plan progresses or opportunities to enhance the plan present themselves in the future. The postmine topography and revegetation plan shown in Exhibit 23, Postmine Land Use Map, and Exhibits 24, 25, and 26, Postmine Land Use Cross Sections, will produce structural as well as biological diversity within what is currently a rolling mountainous and forested landscape. The creation of multiple land uses as suggested in ARSD 74:29:07:18 will not only be beneficial for supporting the land use objective of woodland grazing, but will also enhance the recreational and residential value of the area for local residents and provide a benefit to the all-season tourist industry that the Northern Black Hills is noted for.

6.2.1 General Reclamation Type Requirements

Pursuant to ARSD 74:29:06:02, general requirements for determination of reclamation type, and ARSD 74:29:07, Wharf submits the following Reclamation Plan information.

The affected land has the capability of meeting reclamation criteria as stated in ARSD 74:29:07. Reclamation success at the Wharf Mine is demonstrated by the fact that SD DENR already approved the reclamation of significant acreages at both Golden Reward and Wharf. The proposed reclamation types of rangeland (ARSD 74:29:07:20), recreation (ARSD 74:29:07:23), industrial (ARSD 74:29:07:24), and home sites (ARSD 74:29:07:25) are achievable for the areas affected by mining as outlined in the details of this Reclamation Plan (per ARSD 74:29:07:01). Concurrent, interim, and final reclamation were done at Golden Reward and are

being done at Wharf and will continue as described in Sections 6.5 and 6.7 of this Reclamation Plan.

In accordance with ARSD 74:29:07:02, the impacts of mining to the environment will be minimized as surface disturbance will be phased. Visual screening, construction of mine facilities, location of waste dumps, spoil piles, and topsoil stockpiles will be considered to the extent possible when developing the Mine Plan. Access to active mining areas will be controlled via fencing (SDCL 45-6B-42). As with the existing wildlife program at Wharf, raptor nest site monitoring will be continued with an emphasis to reduce or mitigate impacts to these sites during breeding season. Facilities will be located so they are compatible with the surrounding land uses and mine operations will be integrated with the Reclamation Plan.

Grading and backfilling will be done to achieve visually and functionally compatible contours with the surrounding area and enhance public safety and welfare when it is technically and economically feasible (SDCL 45-6B-37 and ARSD 74:29:07:03). Grading will be done to minimize surface runoff and reduce pollution potential. Additionally, grading will be done so that final topography is appropriate to the final land use.

The land will be reclaimed to rangeland to ensure stabilization of the area until areas are released for final postmine land use. In accordance with SDCL 45-6B-42 and ARSD 74:29:07:04, all reclaimed slopes will be visually and functionally compatible to the surrounding area. Slope combinations will be reclaimed to be suitable for the primary postmining land use of rangeland and be structurally stable. Fill slopes will not exceed the angle of repose. Topographic reconstruction will control erosion and sedimentation, protect areas outside the affected land from slides or other damage, and minimize the need for long-term maintenance. Along the perimeter of mining areas a retaining berm is constructed for safety and to inhibit erosion and runoff that could take place in the active mining area (ARSD 74:29:07:04(2)). The berms minimum size is built to half the height of the largest equipment on site, which results in a berm of 5 feet tall by 8 feet wide. This size of berm has shown to be adequate in current and past practices at the site. Erosion control measures will be implemented during all phases of construction, operation, reclamation, and closure. Refer to Exhibits 28 and 29 of Appendix 2 for details on erosion control measures. Backfilling and recontouring will be done concurrently with mining or as soon as practical as specified in the mining schedule described in Section 6.8. Highwalls will be reduced to the extent practical, but where it is impractical to do so, they will be stabilized and constructed to minimize negative visual impacts (ARSD 74:29:07:04(6)).

All refuse from the mining operation, including garbage and rubbish, will be disposed of in an approved landfill according to SDCL 45-6B-38 and ARSD 74:29:07:05. Only the allowable rubble and construction demolition debris will be disposed of at the permitted facility on site. Petroleum-contaminated soils will be disposed of at a facility permitted for such disposal such as the permitted petroleum remediation site at the Belle Fourche landfill. If materials or soils are contaminated with process solutions containing cyanide, they will be neutralized and placed

onto one of the existing heap-leach pads. Acid-forming materials that have been mined will be handled and disposed of in a manner consistent with the Wharf Acid Management Plan in place at the Wharf Mine. All hazardous wastes must be handled in accordance with South Dakota hazardous waste regulations in ARSD 74:28.

Initial revegetation will focus on meeting the needs for the rangeland postmine land use. Vegetation species, seed mixtures, and seeding rates are described in Section 6.5 of this plan and follow guidance of SDCL 45-6B-39 and ARSD 74:29:07:06. This seed mix has been slightly modified from the mix presently used on the Wharf Mine site and it has been developed in consultation with the local conservation district. As with the existing Wharf and Golden Reward Mine sites, an active noxious weed control plan will continue to be implemented. Section 6.6 of this plan describes the Weed Control Program in place at the Wharf Mine (ARSD 74:29:07:15). Topsoil management and seed bed preparation are described in Section 6.4 of this Reclamation Plan (SDCL 45-6B-40 and ARSD 74:29:07:07).

All water rights and water-quality laws will be adhered to during and after mining (SDCL 45-6B-41 and ARSD 74:29:07:08). If 401 or 404 Federal Clean Water Act permits are required for any areas affected by dredge or fill activities, proper application will be filed with the U.S. Army Corps of Engineers and conditions will be complied with. Temporary sedimentation, erosion control, and drainage control structures will be removed when no longer needed. Permanent diversion structures will be designed to handle precipitation without eroding. Unchannelized surface water will be diverted away from the operation to the extent possible.

Surface runoff diversions constructed in soils or unconsolidated materials will be seeded as soon as practicle and be constructed with sides that do not exceed 2H:1V (ARSD 74:29:07:09). If constructed in rock, they will be stable. Riprap, geosynthetic filter media, and other methods will be used to prevent erosion in diversions. They will be constructed to minimize hazards to humans and wildlife and will not discharge to topsoil storage areas, spoil, or other unconsolidated areas such as newly reclaimed lands. Culverts or bridges will be installed to cross surface water streams and diversions as indicated on the utilities and road map, Exhibit 22 of Appendix 2. There are no planned diversions of perennial or intermittent streams or channel and flood plain diversions that will affect these streams (ARSD 74:29:07:10). Spoil topsoil or unconsolidated material will not be pushed or placed within 10 feet of any perennial or intermittent streams. Additionally, there are no planned permanent surface impoundments or water depressions within the Expansion Project (ARSD 74:29:07:04(4) and 74:29:07:11).

The haul road constructed in Nevada Gulch will be constructed so that negative impacts to the stream are minimized (ARSD 74:29:07:12). Although Nevada Gulch is not a permanent fishery, all culverts will be installed and maintained to avoid plugging, collapsing, or erosion at inlets and outlets. Trees and vegetation will be cleared only to the width necessary to maintain slope stability and to serve traffic needs. Access and haul road drainage structures will be

routinely maintained to control degradation of water quality and quantity. The relocated State Highway 473 will be turned over to the South Dakota DOT with easements upon completion. The DOT will assume maintenance of the new State Highway 473 as indicated in their letter dated February 10, 2011 (see Appendix 1) (ARSD 74:29:07:12:10).

Per ARSD 74:29:07:13, any buildings and structures constructed specifically for the mining operation will be dismantled at completion of the mining.

Waste rock will not be placed in areas that block perennial drainages (SDCL 45-6B-43 and ARSD 74:29:07:14). Permanent waste rock depositories will be constructed to be stable and the existing Wharf Acid Mitigation Plan will be used to ensure that they are not a potential source of water pollution. (The ARD Management Plan was submitted to the SD DENR in November 2001 with Amendment Technical Revision to Mine Permit #464 conditionally approved September 30, 2002.) Noxious weeds infestations shall be controlled during all phases of the mining operation and reclamation.

Subsidence is not anticipated, but if it occurs, measures will be taken to minimize damage to and loss of value of property and to minimize hazards to livestock, wildlife, and humans (SDCL 45-6B-42 and ARSD 74:29:07:16). All underground mine openings and workings or previously existing underground mine workings intercepted by surface mining activities will be sealed during reclamation as per ARSD 74:29:07:17.

Final reclamation will commence as mining, rock deposition, and pit backfilling are progressively completed (see Section 6.7). Please reference the reclamation timetable (Table 6-4) in Section 6.8 of the permit application. This type of reclamation scheduling allows for concurrent reclamation costs, therefore, reducing the majority of reclamation costs subsequent to the completion of mining. In addition, as discussed in Section 6.10, the affected land areas to include the Wharf Mine (Permit Numbers 356, 434, 435, 450) will be bonded. The Goldcorp Inc. annual report indicates the financial status of Wharf Resources South Dakota operations. (Copies are available upon request.)

As per ARSD 74:29:07:20, reclamation will be completed when the affected land has the capability to support a livestock-carrying capacity that is equivalent to that of the surrounding area. Final reclamation will be complete when it is determined to be capable of withstanding proper stocking rates for 2 consecutive years. As per ARSD 74:29:07:23, reclamation will be complete when the affected land has been vegetated to control erosion and the proposed recreation facilities for the identified property have been constructed such as ski runs, snowmobile trails, and/or bike trails. As per ARSD 74:29:07:24 and 74:29:07:25, reclamation will be complete when the affected land has been vegetated to control erosion if construction of facilities is not scheduled within 1 year and the proposed development is on schedule to be completed or underway within 3 years. If the proposed development is not scheduled to be completed or underway within 3 years, then the alternate postmine land use of rangeland will

be used and final reclamation will be complete when it is determined to be capable of withstanding proper stocking rates for 2 consecutive years.

Within the Black Hills, there is an expected need and market for additional recreational, residential, and associated commercial tourist facilities. During 2010, South Dakota's tourism industry brought in more than $1 billion in revenue. Over $130 million was spent in Lawrence County in 2010—an increase of 14.7 percent over 2009 [South Dakota Office of Tourism, 2011]. The Office of Tourism expects continued revenue and is partnering with the Deadwood Chamber and Visitors Bureau to promote additional participation in outdoor winter activities. The planned postmining expansion of recreational offerings at Terry Peak would fill the market need for additional winter recreation opportunities. Commercial or industrial facilities planned for postmining reclamation would primarily revolve around outdoor recreation activities (skiing, snowmobiling, and snowshoeing), and in conjunction with increased recreation, would feed the need for increased local housing and rental opportunities.

Land within the project area is zoned Park Forest District (PF), Park Forest Residential (PFR), Highway Service Commercial (HSC), and Suburban-Residential (SRD). Extractive industries are allowed in all zoning districts by Lawrence County, subject to the acquisition of a Conditional Use Permit. The postreclamation land use of rangeland, recreation, industrial, and home site development will be reviewed by the county in the permitting process. All of the uses proposed in the postmine land use are options identified as minimum reclamation standards pursuant to ARSD 74:29:07. All of the proposed uses will benefit the local area, the state of South Dakota, and the region in general. These uses have the potential to improve property value and potentially increase the tax base by adding additional property and sales tax for the area.

Commitments from public agencies for the approval of the permit application will be forwarded when received or are included in Appendix 16. Landowners, including the BLM and Black Hills Chairlift Company, were consulted during the development stage of the Reclamation Plan and will be consulted during reclamation implementation. Per SDCL 45-6B-44, Wharf has consulted with Natural Resources Conservation Service (NRCS) on seed mix and will consult with NRCS again when grazing is proposed.

6.2.2 Specific Postmining Land Use Types

Surrounding land uses include mining, woodland grazing, residential development, tourist industry, recreational skiing, and snowmobiling. This permit proposes a multiple-use Reclamation Plan for the areas proposed to be mined with this permit application (ARSD 74:29:07:18, SDCL 45-6B-7(1)). The specific types of reclamation proposed are: rangeland (ARSD 74:29:07:20), recreation (ARSD 74:29:07:23), industrial (ARSD 74:29:07:24), and home sites (ARSD 74:29:07:25). Development of these various reclamation plans will be accomplished in consultation with individuals competent in the management and planning of

each of the specific types of reclamation. The following describes how each specific type of reclamation will be managed.

The postmine land use of rangeland or woodland grazing is also currently approved for the adjoining Wharf Mine. The recreation postmine land use is compatible with the existing ski and snowmobile use of the surrounding land. The industrial postmine land use would specifically target the development of commercial properties to enhance the tourist industry that exists in the area. The home site postmine land use is compatible with the surrounding properties that are presently being developed for residential home sites.

6.2.2.1 Rangeland

Rangeland reclamation will follow guidelines established in ARSD 74:29:07:20. The specific reclamation type in place now at Wharf is rangeland, and Wharf has developed reclamation practices to ensure that the requirements for reclaiming the land to rangeland are accomplished through consultation with Cedar Creek Consultants and the Lawrence County Conservation District. Monitoring as per the recommendations outlined in Wharf Resources' Reclamation Performance Criteria document [Cedar Creek Associates, 2008] (provided in Appendix 16) will determine reclamation success to ensure that the land has the capability to support a livestock-carrying capacity that is equivalent to that of the surrounding area. Reclamation for this land use type will be considered complete when the reclaimed range is capable of withstanding proper stocking rates for 2 consecutive years before bond release. Slopes will not exceed three to one unless the board approves steeper slopes for areas to be used as rangeland. Newly seeded areas will be fenced if it is necessary to preclude livestock or wildlife from impairing establishment of the required vegetation.

6.2.2.2 Recreation

Recreation reclamation will follow guidelines established in ARSD 74:29:07:23. The types of recreation proposed for the area will provide summer and winter outdoor recreation opportunities. These recreation opportunities will include adventure-type activities such as skiing, sledding, tubing, snowmobiling, biking, hiking, horseback riding, motorized trail riding, and many other outdoor activities similar to those conducted in the adjacent area. The enhancements to the Terry Peak Ski Area with this reclamation will provide recreational opportunities that can make the area more of a destination location for the multistate region. One merely needs to look to our neighbors (Terry Peak, Mystic Miner Resort, Black Hills National Forest, and the Black Hills Snowmobile Trails System) to see that the affected land will support these activities.

Estimates of the number or individuals partaking in recreational activities in the Black Hills, including snowmobiling, skiing, and hiking, are not readily available (ARSD 74:29:07:23b). However, management at Terry Peak indicates that there is a continued demand for outdoor winter recreational opportunities [Madden, 2010]. In the past, improved

facilities and snow-making facilities have resulted in increased use [Madden, 2010]. The final reclamation at Golden Reward would allow for the extension of ski runs and additional facilities anticipated to increase attendance. The number of snowmobile licenses sold in Lawrence County has slowly increased from about 300 in the 1990s to 820 in 2010, indicating an increasing number of snowmobilers are using the area [South Dakota Department of Revenue and Regulation, 2011]. Recreational use on the nearby Mickelson Trail has steadily increased over the past decade. Pass counts (including daily and yearly passes) totaled approximately 19,000 in 2010, up from about 16,000 in 2009 [Garry, 2011]. Trail usage is also predicted to be several times greater than the number of passes sold as the purchaser may have used the trail multiple times and some trail users may not have paid for passes.

Specific plans for extended ski runs, possible sledding tubing runs, hiking, biking, and horse trails may be developed as the Mine Plan is developed and will be determined as best fit applications to be combined with areas of other reclamation types.

6.2.2.3 Industrial Use

Reclamation to industrial use will follow guidelines established in ARSD 74:29:07:24 unless specified otherwise. The type of industrial use proposed for the area is development of commercial property. These properties will include lodges, condominiums, and commercial facilities relating to the outdoor recreational activities proposed for the area. There is and will be a market for these types of facilities as the recreational areas are developed. Electricity, water, telephone services, sewage and waste disposal, and other support services are available and can be developed as the area is developed. Access to the sites proposed for commercial development is available or can be developed during the development phase of the reclamation. The sites proposed for commercial development will have geotechnical studies performed to ensure that the proposed facilities are feasible. The area is zoned for Park Forest which allows for these types of activities. Lawrence County approval will be obtained through the conditional use or request for zoning change process for any proposed commercial development.

The proposed alternate postmine land use for these areas will be rangeland. If the proposed development is not scheduled to be completed or underway within 3 years, then the alternate postmine land use of rangeland will be used and final reclamation will be complete when it is determined to be capable of withstanding proper stocking rates for 2 consecutive years. The concurrent reclamation will reclaim the areas proposed for commercial development to rangeland specifications outlined in this document in Section 6.5. This will ensure that the vegetative cover will be sufficient to control erosion before establishing the commercial development.

6.2.2.4 Home Sites

Home site reclamation will follow guidelines established in ARSD 74:29:07:25. There is and will be a market for home sites as the recreational areas are developed. Electricity, water,

telephone services, sewage and waste disposal, and other support services are available and can be developed as the area is developed. Final reclamation will ensure the area is suitable for residences. Access to the sites proposed for home site development is available or can be developed during the development phase of the reclamation. The sites proposed for home site development will have geotechnical studies performed to ensure that the proposed facilities are feasible. The area is zoned for Park Forest which allows for these types of activities. Lawrence County approval will be obtained through the conditional use process or request for zoning change for any proposed home site development. Areas formerly used for disposal of tailings, hazardous or toxic wastes, sewage, rubbish, or other potentially harmful materials will not be developed for home sites.

The proposed alternate postmine land use for these areas will be rangeland. If the proposed development is not scheduled to be completed or underway within 3 years, then the alternate postmine land use of rangeland will be used and final reclamation will be complete when it is determined to be capable of withstanding proper stocking rates for 2 consecutive years. The concurrent reclamation will reclaim the areas proposed for commercial development to rangeland specifications outlined in this document in Section 6.5. This will ensure that the vegetative cover will be sufficient to control erosion before establishing the commercial development.

6.3 INTERIM REVEGETATION

Interim revegetation is the process of temporarily stabilizing grounds which are scheduled to be redisturbed before the completion of mining. Portions of the project area which will receive interim revegetation treatments include topsoil stockpiles and all suitable peripheral areas (pit perimeters, fence, and power corridors) of disturbance. Since little auxiliary disturbance is being proposed under this mine permit, other than topsoil and roads, a minimal amount of interim revegetation work is anticipated. Because of the limited availability of suitable and salvageable soil material, interim reclamation methods will entail direct seeding areas. This method of revegetation has been proven to be effective at the Wharf Mine. Straw mulch may be applied at the time of seeding to further improve and accelerate planting success; however, such applications will be site specific. Topsoil stockpiles which are to remain undisturbed for more than 2 years will be regraded to a stable configuration, bermed, and seeded (ARSD 74:29:08:02). Interim seeding will be done with the same seed mixture as the final seeding mixture shown in Table 6-2 (Section 6.5.2) to ensure that all interim reclamation is compatible with final reclamation when it occurs.

6.4 SOIL REPLACEMENT AND SEEDBED CONSTRUCTION

6.4.1 Soil Replacement

Topsoil is a critical component to successful revegetation. Wharf has always endeavored to salvage as much native soil as possible. As soil is being salvaged, operators trained to recognize soil and suitable subsoils sort the soil materials as much as possible from the unwanted rock and debris. Because of the small quantity of quality topsoil available in the project area, it is anticipated that there will be some reclaimed areas where the cover soil will be mine rock that was actually a subsoil material before disturbance. The initial key physical component is the amount of fines present in the material.

As mentioned in the Section 3.2.2 (Soils), an estimated 270 acre-feet of salvageable topsoil will be available to be recovered from the project area. This amount should cover the 298 acres of mine disturbance at a depth of 4 inches as described in Section 5.3.3.

6.4.2 Seedbed Construction

Critical to the establishment of an adequate vegetative cover is the initial condition of the seedbed. Through experience, Wharf has found that revegetation is enhanced by creating a firm but irregular seedbed. This is accomplished during the cover soil application by the action of a dozer working on a slope. A typical farmland seedbed is not possible to construct in these situations because of the steepness of the terrain, quality of available cover soil, and the amount of natural debris present in the material (small brush and rocks). Wharf has found that after cover soil has been placed on the reclaimed area, the rough seedbed accelerates initial vegetative establishment, reduces runoff, and promotes the establishment of unique microclimates at the soil surface. The specialized microclimates provide different niches for the variety of plant species seeded into the cover soil. Ultimately, these niches provide for the establishment of a diverse plant cover. The use of fertilizer encourages weeds and has negative effect on diversity. Therefore, Wharf does not plan to use fertilizer during reclamation activities as recommended by their vegetation consultant Cedar Creek Associates, Inc. (refer to letter from Cedar Creek April 6, 2011, provided in Appendix 16 of the revised application).

6.5 SEEDING

Seeding can commence once an area is prepared. Seed will be sewn via the broadcast method or hydroseeding as soon as possible after the seedbed becomes available. A nurse crop seed mix will be used before or in combination with the final seed mix to attain a quick initial cover. The reclamation seed mixture was approved by the NRCS as it is believed to provide adequate cover (SDCL 45-6B-39). Seeding will be done in the spring, summer, or late fall when the soil can be prepared into a suitable seedbed and there is a chance that germinated seeds will mature enough to withstand the winter, or late enough in the fall that germination will not occur until

the following spring. In consultation with Cedar Creek Associates, fertilizer is not recommended for revegetation at the Expansion Project as native vegetation has the competitive advantage when fertilizer is not used (see letter in Appendix 16).

In accordance with SDCL-45-6B-46, all reclamation plantings will be complete within five years, with the exception that no revegetation will be required on land being used or proposed for future mining under the existing permit, or within depressed haulage roads or final cuts while such roads or final cuts are being used or made, or where permanent pools or lakes have been formed. Areas of affected land that are toxic; deficient in plant nutrients; or composed of sand, gravel, shale, or stone to such an extent as to seriously inhibit plant growth will not be planted if such conditions cannot feasibly be remedied by chemical treatment, fertilization, replacement of overburden, or like measures (SDCL 45-6B-46).

6.5.1 Nurse Crop Seed Mix

The primary purpose of the nurse crop seed mix is to give the disturbed area a rapid initial vegetative cover that does not need to persist. Therefore, annual grasses are usually preferred to most other species. These plants provide a quick initial cover and rapid growth during the first year, which is imperative to controlling the rate of erosion on newly regraded slopes. Since the plants are annuals, they do not persist in the revegetated landscape beyond the first year. However, the soil-anchoring characteristic will provide a benefit for a few years to come. The nurse crop seeding will be done in combination with or followed with a more permanent seeding.

It is also critical to inventory the seed to assess its purity. Generally, the agricultural seed species are very closely regulated for the amount of weed seed present in any particular seed lot. Table 6-1 outlines the nurse crop seed mix used at the Wharf Mine.

Table 6-1. Nurse Crop Seed Mixture

Species	Pounds (pls/acre)[(a)]
Spring Wheat	40
Siberian Millet	7
Annual Ryegrass	4
Total	**51**

(a) pls/acre = pure live seed per acre.

6.5.2 Final Seed Mix

The seed mixture chosen for the final vegetative landscape must be capable of meeting the criteria for the designated postmining land use (ARSD 74:29:07:06). In this case, the final use will merge with that of the adjacent reclaimed landscape at the Wharf Mine and fit into the rangeland/woodland grazing scenario. Therefore, the seed mix for this project will be very similar to that of the existing approved Wharf final reclamation seed mix, as shown in Table 6-2. At the recommendation of the SD DENR, the amount of hard fescue has been reduced and crown vetch has been removed.

Table 6-2. Final Reclamation Seed Mix

Species	Pounds (pls/acre)
Alfalfa	0.5
White Dutch Clover	0.5
Slender Wheatgrass	7.0
Thickspike Wheatgrass	7.0
Hard Fescue	1.5
Timothy	1.0
Western Wheatgrass	8.0
Russian Wildrye	3.0
Canada Bluegrass	0.5
Pubescent Wheatgrass	2.5
Blanket Flower	0.3
Black-eyed Susan	0.1
Rocky Mt. Penstemon	0.1
Total	**32.0**

This seed mixture was selected to provide the revegetated area with a variety of species, either native, adapted, or introduced. The goal in designing the seed mixture was to provide a mixture of species that would give the revegetated stand a genetic, phenotypic, and structural diversity. Some species like Russian wildrye and timothy are tall erect species, while clover and hard fescue are low-growing plants. Diversity such as this provides a tiered approach to the vegetation and allows variable animal utilization while protecting the soil from water or wind erosion. Because of the elevation and climate, all species that appear in the mix are cool season plants that will “green up” early and grow rapidly early in the season. This is critical since the growing season is generally less than 90 days.

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6.5.3 Woody Species Revegetation

Although postmining land use for the Wharf Mine and the proposed area does not require woody species revegetation (see ARSD 74:29:07:20), Wharf is planning to include a woody species component to the vegetative community. The purpose of the eventual establishment of woody species in the final landscape is to provide visual diversity and hiding and consumptive cover diversity for domestic and wildlife grazing. Woody species in the postmining environment will be planted in clumps and interspersed in groups of species rather than evenly spaced throughout the landscape. Some reclaimed acres will have tree and shrub clumps while other reclaimed acres will have no tree and shrub clumps. This technique allows the use of large expanses of forage-based areas while still providing the breaks in the landscape provided by shrubs and trees. Landscaping with domestic trees and shrubs may be included as areas are developed for recreational, commercial, and home site development.

Trees and shrubs that have done well in the Northern Black Hills will be planted in the best location suited for their survival. Specific tree and shrub areas will be identified during the mine planning and reclamation development process. The trees and shrubs listed in Table 6-3 may be used in these areas. In addition, clumps of existing native vegetation will be transplanted during the concurrent mining and reclamation process if practical.

Table 6-3. Reclamation Woody Species

Common Name	Species Name
Black Hills Spruce	*Picea glauca* (Moench)
Ponderosa Pine	*Pinus ponderosas*
Bur Oak	*Quercus macrocarpa*
Chokecherry	*Prunus virginiana*
Woods Rose	*Rosa woodsii*
Current	*Ribus rubrum*
Quaking Aspen	*Populus tremuloides*

6.6 WEED CONTROL AND REFUSE MANAGEMENT

Wharf maintains an active weed control program to control noxious weeds occurring on the property (ARSD 74:29:07:15 and SDCL 45-6B-43). Objectives of the program are:

- Conduct a yearly property inspection.
- Identify locations of weed growth.
- Treat weeds annually through chemical control.

Weed control and refuse management is part of a much larger program of "housekeeping." It has always been Wharf Resources' goal to maintain the area disturbed by mining operations in an as organized condition as possible. Wharf consulted with the Lawrence County Conservation Board and the Lawrence County Invasive Species Management Department during previous mine permitting efforts, and the new Expansion Project makes no changes to these practices (see Appendix 1). Along with the weed control program, Wharf manages refuse according to state and federal requirements (ARSD 74:29:07:05). Wharf is not proposing to use any of the land in the Expansion Project area for deposit or disposal of refuse.

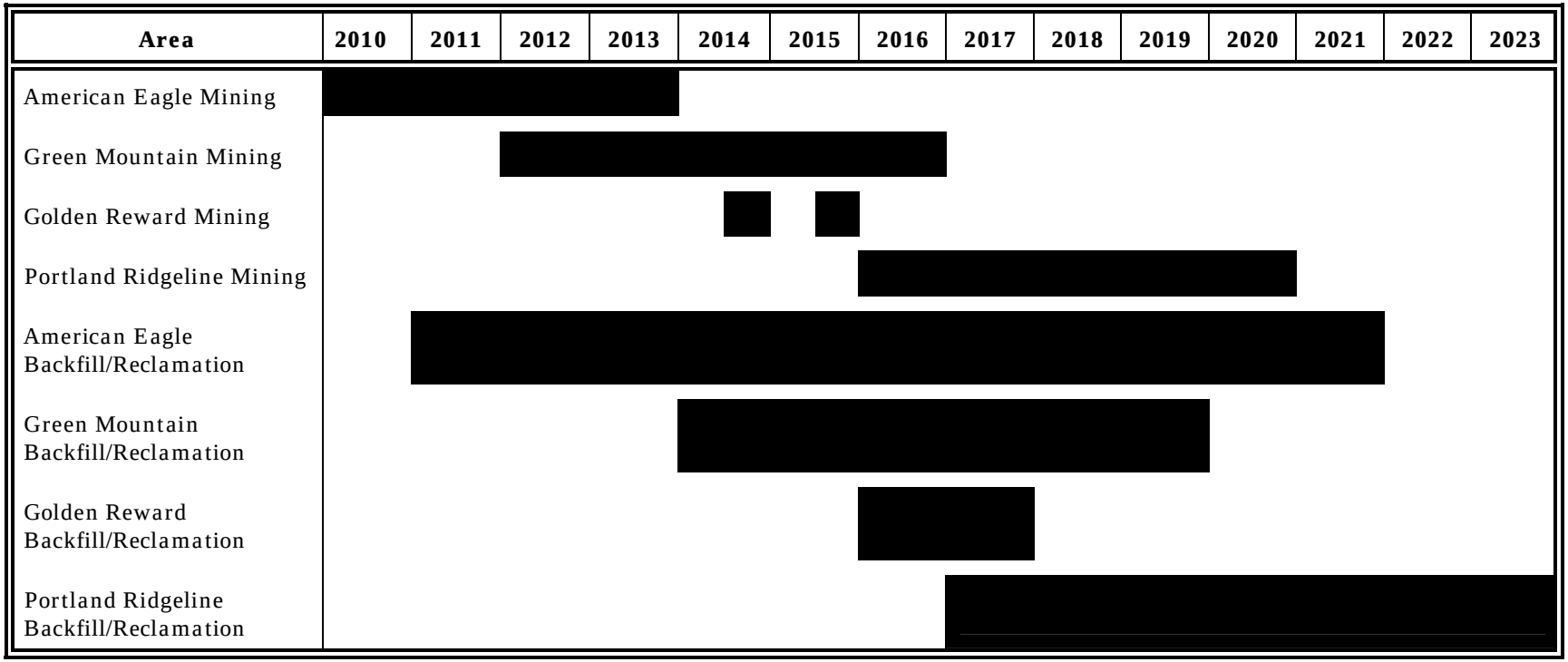
6.7 FINAL RECLAMATION METHODS

The areas to be mined and reclaimed will be surrounded by a naturally hilly topography. Most of the hills surrounding the reclaimed pits and rock facilities are steeper than the reclaimed 3H:1V slopes proposed in this permit. However, past reclamation at the existing Wharf Mine has used similar criteria and has proven to be both visually and functionally compatible with the surrounding area. All slopes are designed at 3H:1V or shallower and will be seeded with the approved seed mix described in Section 6.5.

Erosion and sediment control on backfilled and sloped areas will be conducted as described in Sections 5.3.5 and 5.4. Concurrent reclamation and intermittent sediment control structures will be the primary means of controlling erosion and sedimentation during mining. Vegetation along with the 3H:1V slopes has proven successful in stabilizing the rock faces, along with controlling sedimentation for the long-range reclamation. See Exhibit 28 of Appendix 2 for sediment control structure locations. After vegetation is established and the need for the interim sediment control structures is eliminated, the silt fences and other synthetic structures will be removed. However, hay bales will be left in place.

Final reclamation will commence as mining, rock deposition, and pit backfilling are progressively completed (ARSD 74:29:07:02(10)). Table 6-4 shows a conceptual projected mining and reclamation schedule for features located within the project area as well as those remaining within the Wharf Mine property. Modifications to this plan would result from the development of improved reclamation or mining method strategies, mitigation of unseen

Table 6-4. Wharf Expansion Project Mine and Reclamation Schedule



geologic landform situations, redesigning of the mine plan, identification of new reserves, or other unforeseen factors. Major modifications to the Reclamation Plan would be presented to the SD DENR for their approval before implementation.

6.7.1 Pit Bench and Backfill Reclamation

As shown in Exhibit 23 of Appendix 2, the mine areas proposed as part of this application will all be partially backfilled and recontoured to provide for a stable and functional postmining land form compatible with surrounding land uses (ARSD 74:29:07:02(9)). Final reclamation of select pit benches will entail the reapplication of cover soil and seeding with the final reclamation seed mix shown in Table 6-2. Stability of the select pit benches will be ensured through the initial design and construction of the pits, previously described in Sections 5.2 and 5.3.4.

Grading and backfilling will be conducted according to criteria set forth in ARSD 74:29:07:04. Portions of the pits that are planned for large-scale backfilling will be regraded to a stable configuration. Final backfill slope angles will not exceed 3H:1V unless the stability of a steeper land form can be established or is conducive to the surrounding topography. Experience at the Wharf Mine has shown that fill material slopes steeper than 3H:1V can be successfully reclaimed and do, in fact, create contour diversity within the postmining landscape similar to that which is found naturally in the Black Hills.

Areas within the pits which are not suitable for bench reclamation and cannot be backfilled because of inaccessibility or lack of materials may be sculpted or otherwise secured through the creation of features such as talus slopes. The creation of the various reclaimed land forms proposed in this plan will provide stable and functional diversity to the ecosystem which currently surrounds the proposed mine Expansion Area.

The broad flattened or gently rolling nature of the pit bottoms and planned backfilled configuration will serve as excellent grazing and loafing areas for livestock, ungulate wildlife, and recreational purposes (ARSD 74:29:07:04(1b)).

Select areas within the Expansion Area will leave highwalls in place at closure. Areas with highwalls remaining are the result of being final phases to be mined out; thus, there will not be material available to backfill the pit area. For parts of highwalls that remain after closure, it is impracticable to blast them down as the additional disturbance required would negate the positives of reducing the highwall.

A portion of the Portland Ridgeline will remain as a highwall upon completion of mining and reclamation. Pursuant to ARSD 74:29:07:04(6), a reduction of this highwall will be impractical and aesthetically undesirable. As this area is developed at the end of the mine life, backfill is unavailable for full highwall coverage.

6.7.2 Reclamation of Roads

Following mining, all nonfunctional roads leading from the Expansion Area to public access roads will be reclaimed to blend with the existing topography. Compacted road surfaces will be ripped, soil will be reapplied, and the area will be seeded with the final reclamation seed mix. Trees and shrubs will be transplanted where appropriate. The public access roads will be reclaimed as required by ARSD 74:29:07:12, unless a local, state, or federal agency requests that the public rights-of-way remain unreclaimed and agrees to be responsible for future maintenance (ARSD 74:29:07:12(10)).

6.7.3 Buildings and Structures

All buildings and structures to be used are existing, and reclamation of such are covered in previous permits (see Permit Nos. 356, 434, and 435). All equipment used will also be removed (ARSD 74:29:05:04).

6.8 RECLAMATION TIMETABLE

Table 6-4 shows a conceptual projected mining and reclamation schedule for features located within the Expansion Project area as well as those remaining within the Wharf Mine. The sequence of reclamation within these various areas is dependent upon mining progress and may actually vary somewhat. Final reclaimed areas will be submitted each year to the SD DENR in the Wharf Annual Report.

All reclamation will be carried to completion with all reasonable diligence, and each phase of reclamation shall be completed within 5 years, unless such period is extended by the Board of Minerals and Environment upon a finding that additional time is necessary for the completion of the terms of the reclamation plan (SDCL 45-6B-46).

Wharf is not proposing to use any of the land in the Expansion Project for deposit or disposal of refuse. Planting will not be done on any affected land proposed for future mining under the existing permit, or within depressed haulage roads or final cuts while such roads or final cuts are being used or made, or where permanent pools or lakes have been formed (SDCL 45-6B-46).

6.9 RECLAMATION MONITORING

Monitoring is essential to the determination of reclamation success and eventual bond release. Specific concerns relative to the postmine landscape are addressed below.

6.9.1 Vegetation

Seeded areas will be qualitatively monitored to determine changes in plant species composition and production and to determine vegetative trends. Results of early vegetative

trend analyses will be used to determine both revegetation success and changes in species composition. These studies will be incorporated into reclamation seed mixes to ultimately determine the species best suited to the reclaimed environment. The relative absence of similar physiography within an acceptable ecological region makes the use of reference areas unfeasible. As per ARSD 74:29:07:20, reclamation will be complete when the reclaimed range is capable of withstanding proper stocking rates for 2 consecutive years before bond release. Stocking rates will be determined as per NRCS guidelines.

Wharf Resources worked with Cedar Creek Associates to establish monitoring criteria for the vegetation within Wharf's existing permitted areas. The monitoring methods and criteria are described in the Wharf Resources' *Reclamation Performance Criteria Document* and specifically referenced in Section II, Part 4 Revegetation Evaluation Procedures in the Cedar Creek Report found in Appendix B of the Wharf Resources' *Reclamation Performance Criteria Document* (provided in Appendix 16). The following monitoring criteria are consistent with the existing Wharf permit area and will be used to monitor vegetation for this reclamation project.

Representative monitoring transects will be established in the reclaimed area using the point intercept method to determine percent cover. Vegetative monitoring and casual pedestrian surveys will be conducted to identify the species composition in the reclaimed area to document seed or rhizome production. The mean current annual forage production (excluding noxious weeds) will be compared against the appropriate standard depending on whether the sampling year is determined to be a dry year, normal year, or wet year with regard to incident precipitation. The comparison will be made on an "Air-Dry Basis" (ADB) to one of the following standards:

- Dry Year – 190 pounds of production (ADB)
- Normal Year – 275 pounds of production (ADB)
- Wet Year – 330 pounds of production (ADB).

The determination of average versus above average versus below average will be made based on the recorded precipitation over the past 59 years (1948–2007) from the National Oceanic and Atmospheric Administration (NOAA) station in Lead, South Dakota. In addition, to the above proposed monitoring, the revegetated areas will be surveyed to ensure that they are overall 40 percent live and self-sustaining vegetative cover.

6.9.2 Mine Benches and Rock Facility Slopes

Critical to the assessment of reclamation success on the nonbackfilled areas of the reclaimed landscape is slope stability. Through the use of selective land shaping, potentially unstable areas will be manipulated to yield a safe and functional land form.

6.9.3 Final Reclamation Review

The overall appearance of the reclaimed area is paramount to evaluating reclamation success. An important component to establishing this goal is the blending of contours. Much of the final blending will be site specific and conducted using selective blasting or localized backfill in mine pits. Many of these sites are not possible to delineate on a map; however, the general concept is presented in Exhibits 24 through 26 of Appendix 2 (also see Appendix 14).

Final review criteria will incorporate results from the previously mentioned topics over time. At the time bond release is requested, the overall reclamation product will be presented to the SD DENR for review.

6.10 BONDING

6.10.1 Estimated Bond Calculations

Table 6-5 shows the estimated reclamation costs for each component of the proposed affected lands for the Expansion Area (ARSD 74:29:02:08, SDCL 45-6B-7(12)). The final cost estimate was derived by first developing a Mine Plan that exhausted the reserve base established January 1, 2011. After establishing the material characterization quantities within the mine plan, the material destination was determined by means of economics, as well as maximizing reclamation areas available.

Upon establishing a final land configuration, costs were developed by assuming dumped material would be dozed to the final slopes shown on Exhibit 23, the heaps would be neutralized and land shaped, and the pond liners will be folded and covered with material from the heaps or other pit source. These areas would be topsoiled and seeded as described in Section 6.5. Costs for all activities were developed using the Wharf Mine equipment costs and total equipment hours necessary to complete the tasks were computer generated using Caterpillar™ (registered trade mark) Equipment Fleet Analysis computer model.

The information found on the following pages provides a breakdown of costs for full reclamation of the Expansion Area and Wharf Mine. Calculations for each component, as well as for the operation being performed, are summarized on the bond calculation summary table for the Expansion Area.

All general assumptions for the bond calculations were taken from the 2010 Wharf Resources annual bond update and are included in Table 6-5A. Though current reclamation plans do not include the use of fertilizer, the cost of fertilizer and application are included in the bond calculation in the event that it becomes necessary to use to help reestablish vegetation.

Table 6-5 Wharf Resources 2011 Bond Update Summary (Page 1 of 4)

Earthmoving and Revegetation	
NFL Denitrification Areas	$474,797
American Eagle Expansion	$495,504
Portland Pit	$315,566
Green Mountain	$782,573
Golden Reward	
Liberty Pit	$270,587
Harmony Pit	$123,043
Satellite Pit	$50,532
GR Pad Area	$32,547
GR Flats	$50,371
Process Ponds	$69,011
Leach Pads	$208,762
Ross Valley Spent Ore Facility	$321,594
Reliance	$27,400
Land Application / Juno	$27,133
Building Demolition (2.5% Adjustment for Inflation)	$366,057
Foley Access and Haul Corridors	$54,258
Minimum Impact (Reclaimed Areas)	$70,652
Landshaping	$22,600
Other Earthmoving	
Other Payroll	
Earthwork Superintendent	$210,000
Demolition Superintendent	$75,000
Mechanic	$151,250
Security/Safety	$100,800
Road Maintenance	$289,000

Table 6-5. Wharf Resources 2011 Bond Update Summary (Page 2 of 4)

Air Quality Monitoring	$24,000
Sediment Basin Maintenance	$9,600
Weed Control	$24,000
Shipping lead wastes	$1,600
Shop wash water disposal	$2,400
Petroleum contaminated soil disposal	$15,000
Boneyard Cleanup	$2,000
Site Survey	$200,000
Subtotal Earthmoving	**$4,813,380**
Mobilization (5%)	$240,669
Performance Bond (1%)	$48,134
Contractor Overhead (8%)	$385,070
State Excise Tax (2%)	$96,268
Contractor Profit (10%)	$481,338
Contingency (4%)	$192,535
Insp., Adm., and Maint. (10%)	$481,338
Engineering & Consulting (3%)	$144,401
Total Earthmoving and Revegetation	**$6,883,133**
Add: 2.5% Adjustment to "Other Earthmoving" for Inflation	$27,616
Adjusted Total Earthmoving and Revegetation	**$6,910,749**
Water Treatment	
Pad Neutralization and Water Treatment	
Pad Drain Down Pumping	$19,382
Cyanide Destruction	$193,820
Pad Denitrification	$1,407,784
Polo Denitrification	$179,663
North Foley Denitrification	$473,406
Ross Valley and Reliance Valley Water Treatment Plant	
Nutrient	$1,650,000
Electricity	$1,050,000
Plant Operators	$3,150,000

Table 6-5. Wharf Resources 2011 Bond Update Summary (Page 3 of 4)

Gas and Diesel for Pickups and Misc. Equipment	$180,000
Equipment & Vehicle Maintenance	$300,000
Pickup Truck	$100,000
Water Sampling & Analysis	$1,320,000
Biological Monitoring	$600,000
Replacement Pumps	$120,000
Analytical Testing	$1,800,000
Ross Valley and Process Area Groundwater Remediation	
Pumping costs	$6,000
Nutrient	$50,000
Monitoring	$525,000
Analytical Testing	$900,000
Subtotal Water Treatment	**$14,025,055**
Engineering & Consulting (3%)	$420,752
Total Water Treatment	**$14,445,807**
Add: 2.5% Inflation Adjustment	$361,145
Adjusted Total Water Treatment	**$14,806,952**
Miscellaneous	
Gas and Diesel for Pickups and Misc. Equipment	$19,500
Equipment and Vehicle Maintenance	$36,000
Office Supplies	$6,300
Insurance	$90,000
Pickup Truck	$25,000
Computers	$7,500
Utilities	
Electricity	$991,524
Garbage Disposal	$12,600
Telephone and Internet	$24,600
Propane	$24,000
Subtotal Utilities and Miscellaneous	**$1,237,024**

Table 6-5. Wharf Resources 2011 Bond Update Summary (Page 3 of 4)

Contingency (10%)	$123,702
Insp., Adm., and Maint. (1%)	$12,370
Total Utilities and Miscellaneous	**$1,373,096**
Add: 2.5% Inflation Adjustment	$34,327
Adjusted Total Utilities and Misc Treatment	**$1,407,423**
Total Earthmoving, Water Treatment, Misc, and Utilities	**$23,125,124**

Note: Construction Cost Index (CCI) for February 2002= 6461.81
Formula for Computing Future Construction Cost
Future costs = (Future CCI/Original CCI) × Original Construction Costs.

6.10.2 Postclosure Plan

6.10.2.1 Introduction to the Postclosure Plan

Once the mining process is completed and reclamation is in the final stages of vegetation establishment, the Wharf Mine operation will inspect and maintain activities to ensure compliance and reduction of potential environmental impacts (SDCL 45-6B-91). It is not anticipated that any new environmental impacts will be identified after mining has been completed.

All depositories are constructed to a 3:1 final slope, which has proven to be stable. All highwalls are described in Section 5.2 and have also proven to be stable.

Possibly of more critical interest is the proper evaluation of the success of reclamation in relation to the chemical environment. The long-term impacts to surface and groundwater sources will be well known before the request for bond release in all known affected areas. The primary areas of interest with this project are in the Fantail and Nevada Gulch drainages. The elevated groundwater levels of sulfate near the West Liberty Pit will require monitoring long term to identify how mining and/or any mitigating activities have affected groundwater sulfate.

Wharf Resources currently has a Surface Water Discharge (SWD) permit that is scheduled to expire in June 2011 for all of the drainages associated with the Wharf Mine. Wharf submitted an application to renew the existing SWD permit. The renewal application includes the drainages associated with this project and details long-term monitoring conditions for these drainages. The monitoring program will provide definition of specific surface water concerns, germane to the issue of long-term monitoring. The postclosure surface water program will dove-tail with the SWD permit.

Table 6-5A. Bond Calculation Assumptions

Bond Calculation Assumptions

Equipment	Model	Use
Motor Grader	16m	Spread topsoil on flat areas.
Dozer	D9T	Re-contour slopes, spread topsoil on slopes, ripping prior to topsoil.
Loader	993k	Load topsoil
Trucks	777F	Haul topsoil

Assumed all slopes re-contoured from a slope of 1.5:1 to a final slope of 3:1.
The equipment costs were generated by estimating the required number of hours for each piece of equipment to reclaim each area.
Equipment hours were estimated using productivity rates obtained from the "Caterpillar Performance Handbook 39 Ed."
Hourly rates were obtained from **Wyoming Machinery Company** wyomingcat.com

Equipment	**Rental $/Hr**	**Operator $/hr.**	**Gal/Hr**	**Diesel $**
16m	$96.59	$ 26.50	5	$ 3.00
D9T	$133.52	$ 26.50	12	$ 3.00
993k	$298.29	$ 26.50	30	$ 3.00
777F	$171.02	$ 26.50	17	$ 3.00

	Denit. Pads	Portland	Am. Eagle	Green Mtn.	Liberty	Harmony	GR South	GR Pads	GR Flats	Ross Valley	Pad/Plant	Land App.	Reliance	Ponds
Volume to re-contour to 3:1 (yd^3)	550,000	470,000	570,000	1,302,639	335,000	190,000	90,000	70,000	0	400,000	110,000	0	0	75,000
Average distance to push (Ft.)	212	160	178	234	330	250	180	150	0	230	110	0	0	200
Total Acres to Reclaim	123	87	174	110	19	23	12	10	29	78	102	13	15	18
Volume of topsoil (yd^3)	66,147	46,787	93,573	59,156	10,218	12,369	6,453	5,378	15,596	41,947	54,853	6,991	8,067	9,680
Average haul distance. (ft.)	3,750	5,500	3,000	3,500	4,500	4,000	3,500	3,500	3,500	2,500	2,500	500	2,000	1,500

SEED COSTS (MIXTURE #1)

SEED TYPE	APPL. RATE	
Alfalfa	0.50	lbs/acre
White Dutch Clover	0.50	lbs/acre
Slender Wheatgrass	7.00	lbs/acre
Thickspike Wheatgrass	7.00	lbs/acre
Hard Fescue	1.50	lbs/acre
Timothy	1.00	lbs/acre
Western Wheatgrass	8.00	lbs/acre
Russian Wildrye	3.00	lbs/acre
Canada Bluegrass	0.50	lbs/acre
Pubescent Wheatgrass	2.50	lbs/acre
Blanket Flower	0.30	lbs/acre
Black-Eyed Susan	0.10	lbs/acre
Rocky Mt. Pestemon	0.10	lbs/acre
Total	**32.00**	**lbs/acre**

$ 136.00 /acre

SEEDING COSTS
Cost ($/acre): $ 500.00

HYDROMULCH (WOOD FIBER)
Cost ($/acre): $ 400.00

FERTILIZER

N Appl. Rate (lbs/acre):	18
P Appl. Rate (lbs/acre):	46
K Appl. Rate (lbs/acre):	0
N Cost ($/lb):	$ 0.22
P Cost ($/lb):	$ 0.30
K Cost ($/lb):	$ 0.15

$/Acre $ 17.76 /acre

SEED COSTS (MIXTURE #2, NURSE CROP)

SEED TYPE	APPL. RATE		COST
Spring Wheat (nurse crop)	40.00	lbs/acre	
Siberian Millet (nurse crop)	7.00	lbs/acre	
Annual Ryegrass (nurse crop)	4.00	lbs/acre	
Total	**51.00**	**lbs/acre**	**$ 30.60 /acre**

Monitoring of groundwater after the mining and processing operations are complete is regulated by state statutes that control the impacts to groundwater. Wharf currently has three Groundwater Discharge (GWD) permits for disposal of spent ore at Wharf. There is also one GWD permit in place at the Golden Reward Mine site. A GWD permit application will be submitted for the American Eagle area before the issuance of this mining permit. Wharf developed a groundwater monitoring program associated with the existing GWD permits, the existing Wharf Mining permit, and the existing golden Reward Postclosure Mining permit. Additional wells have been added and will continue to be added with the baseline monitoring for this mine permit application and the baseline monitoring for the proposed GWD permit. Wharf will develop a long-term monitoring plan in conjunction with the SD DENR for the areas included in existing and subsequent Groundwater Discharge Permits as well as those areas associated with the process facility.

The following is a detailed description of the proposed postmining Monitoring Plan. If the affected area is found to be stable, free of hazards, has established and self-regenerated vegetation as specified in the Reclamation Plan, has minimal hydrologic impacts, has minimal air-quality impacts, or is maintenance free to the extent practicable, the operator may submit an application to reduce the monitoring requirements or to shorten the Postclosure Plan period to the Board.

6.10.2.2 Water Quality Monitoring

Postclosure water-quality monitoring will be performed at the surface water and groundwater monitoring sites described in Table 6-6. The sites include areas permitted under Permit Nos. 356, 434, 435, 450 and proposed with this project. The samples will be collected and analyzed for the parameters listed and schedule provided in Appendix 6.

6.10.2.3 Air Quality Monitoring

No postclosure air-quality monitoring is currently required for the Expansion Area mining activities.

6.10.2.4 Vegetation Monitoring

Reclaimed land will be inspected on an annual basis, coinciding with the growing season, to ensure compliance with the final Reclamation Plan and postmining land use. If the vegetation is not achieving the goals of the final Reclamation Plan and postmining land use, as discussed in Section 6.9.1, steps will be taken to correct or mitigate the situation. If a change in the seed mixture as described in Section 6.5 is necessary to ensure vegetative success, these changes will be submitted to the pertinent agencies for approval.

Table 6-6. Water Monitoring Sites (Page 1 of 6)

Site	Purpose	Location/Description
Annie Creek @ USGS	Wharf Surface Water Quality	Annie Creek
Annie Creek II	Wharf Surface Water Quality	Annie Creek
Beaver Springs	Wharf Surface Water Quality	Reliance
BMT-1	Wharf Surface Water Quality	Deadwood
DM01	Golden Reward Groundwater Quality	Well just south of Stewart Gulch
DM14A	Golden Reward Groundwater Quality	Located in the central portion of Golden Reward between Fantail and Stewart Gulch
DM16	Golden Reward Groundwater Quality	On eastern Golden Reward boundary between Fantail and Stewart Gulch
DWD-1	Wharf Surface Water Quality	Deadwood
FB Spring	Wharf Surface Water Quality	False Bottom
FB-1	Wharf Surface Water Quality	False Bottom
FB-2	Wharf Surface Water Quality	False Bottom
Foley Shaft	Expansion Groundwater Quality	Foley Mine Shaft
GWAC6	Wharf Groundwater Quality	Reliance
HDH-10A	Wharf Groundwater Quality	McKinley Gulch
HDH-11	Wharf Groundwater Quality	McKinley Gulch
HDH-12	Wharf Groundwater Quality	Downgradient of the Process Facility
HDH-12	Wharf Groundwater Quality	McKinley Gulch
HDH-8A	Wharf Groundwater Quality	Ross Valley
Horse Shoe MW	Expansion Groundwater Quality	Well located in Nevada Gulch parking lot
Joseph Well	Wharf Groundwater Quality	Well near headwaters of Cleopatra Creek
Lost Camp	Wharf Surface Water Quality	Lost Camp
McKinley Gulch	Wharf Surface Water Quality	McKinley Gulch
MM03	Golden Reward Groundwater Quality	Along Stewart Gulch
MM04A	Golden Reward Groundwater Quality	Well located east of Terry Peak inside Golden Reward
MW-1	Wharf Groundwater Quality	Ross Valley
MW-10	Wharf Groundwater Quality	McKinley Gulch

Table 6-6. Water Monitoring Sites (Page 2 of 6)

Site	Purpose	Location/Description
MW-10A	Wharf Groundwater Quality	McKinley Gulch
MW-13	Wharf Groundwater Quality	Ross Valley
MW-13A	Wharf Groundwater Quality	Ross Valley
MW-14	Wharf Groundwater Quality	Ross Valley
MW-15	Wharf Groundwater Quality	Upgradient of the Process Facility
MW-17	Wharf Groundwater Quality	Reliance
MW-18	Wharf Groundwater Quality	Reliance
MW-19	Wharf Groundwater Quality	Well in Annie Creek drainage downgradient of Reliance
MW-1A	Wharf Groundwater Quality	Ross Valley
MW-1B	Wharf Groundwater Level	
MW-1C	Wharf Groundwater Level	
MW-2	Wharf Groundwater Quality/ GWD Permit	Deep groundwater below the toe of the Ross Valley rock facility
MW-2A	Wharf Groundwater Quality / GWD Permit	Shallow groundwater below the toe of the Ross Valley rock facility
MW-2B	Wharf Groundwater Level	
MW-31	Wharf Groundwater Quality	Ross Valley
MW-33	Wharf Groundwater Quality/GWD Permit	Below the toe of the Reliance rock facility
MW-37	Wharf Groundwater Quality	Cleopatra Creek
MW-40	Wharf Groundwater Quality	Well located just east of Trojan Pit
MW-41	Wharf Groundwater Quality/Proposed for GWD Permit	Below the toe of the Squaw Creek rock facility and downgradient of the proposed Foley rock facility and the northern portion of the Reliance rock facility
MW-42	Wharf Groundwater Quality	Below the north toe of the Trojan rock facility; headwaters of False Bottom Creek
MW-43	Wharf Groundwater Quality	Below the north toe of the Trojan rock facility; headwaters of False Bottom Creek
MW-44	Wharf Groundwater Quality	McKinley Gulch
MW-45	Wharf Groundwater Quality	Ross Valley

Table 6-6. Water Monitoring Sites (Page 3 of 6)

Site	Purpose	Location/Description
MW-47	Wharf Groundwater Quality	McKinley Gulch
MW-48	Wharf Groundwater Quality	McKinley Gulch
MW-49	Wharf Groundwater Quality	McKinley Gulch
MW-50	Wharf Groundwater Quality	McKinley Gulch
MW-51	Wharf Groundwater Quality	McKinley Gulch
MW-52	Wharf Groundwater Quality	Reliance
MW-53	Wharf Groundwater Quality	McKinley Gulch
MW-54	Wharf Groundwater Quality	McKinley Gulch
MW-55	Wharf Groundwater Quality	McKinley Gulch
MW-56	Wharf Groundwater Quality	McKinley Gulch
MW-57	Wharf Groundwater Quality	McKinley Gulch
MW-58	Wharf Groundwater Quality	McKinley Gulch
MW-59	Expansion Groundwater Quality	Dry well located near head of Deadwood Creek at Bald Mountain
MW-60	Wharf Groundwater Quality/ Proposed for GWD Permit	Deep groundwater north and west of the proposed American Eagle/Portland spent ore disposal facility
MW-61	Wharf Groundwater Quality/ Proposed for GWD Permit	Deep groundwater north and west of the proposed American Eagle/Portland spent ore disposal facility
MW-62	Wharf Groundwater Quality/ Proposed for GWD Permit	Deep groundwater north and east of the proposed American Eagle/Portland spent ore disposal facility
MW-63	Wharf Groundwater Quality/ Proposed for GWD Permit	Deep groundwater north and east of the proposed American Eagle/Portland spent ore disposal facility
MW-9	Wharf Groundwater Quality	McKinley Gulch
MW-9A	Wharf Groundwater Quality	McKinley Gulch
Nevada Gulch MW	Expansion Groundwater Quality	Terry Peak water well at the Nevada Gulch Lodge; at Dark Horse
OM05	Golden Reward Groundwater Quality	Well located in Stewart Gulch

Table 6-6. Water Monitoring Sites (Page 4 of 6)

Site	Purpose	Location/Description
PW02	Golden Reward Groundwater Quality	Along Stewart Gulch at the eastern Golden Reward boundary
PW04	Golden Reward Groundwater Quality	Along Stewart Gulch upstream of the mine boundary
PW-2	Expansion Groundwater Quality	Well located north of Pad No. 4
Railroad MW	Expansion Groundwater Quality	Well located on the railroad grade (Liberty)
Ross Springs	Wharf Surface Water Quality	Ross Valley
RV French Drain	Wharf Surface Water Quality	Ross Valley
RVLC Pond	Wharf Surface Water Quality	Ross Valley
RVSO Discharge	Wharf Surface Water Quality	Ross Valley
Site 001	SWD Permit	Below the toe of Reliance rock facility; headwaters of Annie Creek
Site 002	SWD Permit	Below the toe of the Ross Valley rock facility; Ross Creek above the Confluence with Annie Creek
Site 003	SWD Permit	Downgradient of the Process Facility; McKinley Gulch (dry drainage)
Site 004	SWD Permit	Below the toe of Squaw Creek rock facility; headwaters of Cleopatra (Squaw) Creek
Site 005 (In-stream Monitoring Site)	SWD Permit	Below the confluence of Ross Creek and Lost Camp drainages; at the stream classification change in Annie Creek
Site 006	SWD Permit	Discharge of treated water from either biological treatment facility or the carbon treatment facility to either Ross Valley or Annie Creek
Site 007	Proposed SWD Permit	Below the toe of the Trojan rock facility in False Bottom Creek; site to be determined in conjunction with the SWD Program
Site 008	Proposed SWD Permit	Below the toe of any rock facilities in Deadwood Creek; site to be determined in conjunction with the SWD Program

Table 6-6. Water Monitoring Sites (Page 5 of 6)

Site	Purpose	Location/Description
Site 009	Proposed SWD Permit	(Formerly Golden Reward's NPDES 001) Discharge of precipitation and infiltration from rock and spent ore areas in Stewart drainage
Site 010	Proposed SWD Permit	(Formerly Golden Reward's National Pollutant Discharge Elimination System (NPDES) 003) Discharge of precipitation and infiltration from rock and spent ore areas in Fantail drainage
Site 011	Golden Reward Surface Water Quality / Proposed SWD Permit	(Golden Reward's Surface site SS05) Discharge of precipitation and infiltration from rock and spent ore areas in Nevada Gulch drainage
SM01A	Golden Reward Groundwater Quality	Near Nevada Gulch south of Bald Mountain
SM02A	Golden Reward Groundwater Quality	Near Fantail Creek
SM03A	Golden Reward Groundwater Quality	At eastern Golden Reward boundary near Fantail Creek
SM06	Golden Reward Groundwater Quality	At Golden Reward boundary near Stewart Gulch
SM09	Golden Reward Groundwater Quality	Near Nevada Gulch south of Bald Mountain
SM10	Golden Reward Groundwater Quality	Near Nevada Gulch southeast of Bald Mountain
Spearfish Falls	Wharf Surface Water Quality	Little Spearfish
Squaw War Eagle	Wharf Surface Water Quality	Cleopatra
SS-01	Golden Reward Surface Water Quality	Stewart Gulch
SS-04	Golden Reward Surface Water Quality	Nevada Gulch
SS-06	Golden Reward Surface Water Quality	Fantail Gulch
SS-12	Golden Reward Surface Water Quality	Stewart Gulch
SS-14A	Golden Reward Surface Water Quality	Fantail Gulch
SS-17	Golden Reward Surface Water Quality	No Name Gulch

Table 6-6. Water Monitoring Sites (Page 6 of 6)

Site	Purpose	Location/Description
SS-20	Wharf Surface Water Quality	Nevada Gulch
Terry Peak Water Well	Expansion Groundwater Quality	Located ¾ of the way up Terry Peak; completed in the Ben Hur mine

6.10.2.5 Spent Ore Treatment

Monitoring of water quality for the proposed spent ore facility will be discussed in the American Eagle Groundwater Discharge Permit. All spent ore related to the Expansion Area will be deposited in the American Eagle Pit, Upper Reliance Depository, and/or denitrification pads. Tailings will be treated to ensure continued neutralization and immobilization of parameters of concern (SDCL 45-6B-91).

During operations, spent ore from the heap-leach pads will be neutralized and denitrified in place and then unloaded to areas permitted with existing or proposed Groundwater Discharge Permits. The final heap-leach pads (1–5) are anticipated to be unloaded once final recovery is met and the pads have completed neutralization and denitrification (in-place) and have met the required off-load standards. The use of denitrification pads will also be used for the treatment and disposal of spent ore. In situ treatment of nitrates within the leach pads and denitrification pads before unload of pads will be implemented to reduce or deplete nitrates in the spent ore before unloading or reclaiming in place (ARSD 74:29:05:05, SDCL 45-6B-91).

Biological reduction of nitrates under anaerobic conditions will occur in the presence of an organic source. Denitrifying bacteria require a low oxygen environment (anaerobic), a carbon source, nutrients, adequate pH and temperature. After neutralization the pads will be treated with pulses of water containing bacteria, nutrients and a carbon source. Suitable carbon sources would be methanol, ethanol, acetate or a sugar compound such as molasses. Monitoring the drain down will be conducted to ensure that some level of denitrification has taken place. Initiating this process will ensure that denitrifying bacteria are in place before unloading the spent ore to the disposal area and will enhance the protection of the groundwater.

To ensure protection of the groundwater resources, Wharf will monitor groundwater within the existing and proposed POP zones and at the existing and proposed Points of Compliance. These wells will serve as an early-warning system and will enable Wharf to respond if an increasing nitrate trend establishes itself in the POC wells. If noticeable increases are detected, Wharf personnel will have sufficient time to respond to the problem before these effects impact groundwater.

If the POC wells reach one-half of the standard for nitrate during operations or postclosure, the facility will develop a mitigation/response plan that potentially may include in situ treatment for nitrates. Any long-term response action will be negotiated with the SD DENR. Similarly, if monitoring indicates a potential problem during the postclosure care period, a study will be conducted to determine the potential significance and the need for action. The air- and vegetative-quality monitoring for the tailings area is discussed in Sections 6.10.3.3 and 6.10.3.4.

All slopes in spent ore deposited will be dozed down to 3H:1V and will be stable. The spent ore will not extend beyond the designed limits. Any portion of the spent ore facility that is not sloped will abut against highwalls, as shown in Exhibit 23 Appendix 2. The angle of the slopes, along with the support of the highwalls, will ensure stability of the spent ore.

6.10.2.6 Sediment and Erosion Control Structures

Sediment and erosion control structures will be inspected on a quarterly basis to ensure compliance with all applicable reclamation, design, and operating criteria. Maintenance and repair work needed to keep the structures in proper operating order will be performed as necessary. This work will include the removal and proper disposal of sediment captured by the structures and repair or replacement of old straw bale barriers and silt fences, culverts, rock filters, and sediment dams, for example. If during the term of the postclosure period erosion and sedimentation becomes a problem in any area, new structures will be installed to adequately address any problems. Conversely, if the need for sediment and erosion controls in an area becomes unnecessary, the synthetics will be removed for aesthetic purposes.

6.10.2.7 Miscellaneous Maintenance and Care

All fence lines and warning signs to restrict access to the open pit will be inspected on a semiannual basis. Maintenance work needed to keep the fence line and warning signs in good repair will be performed as necessary.

6.10.2.8 Postclosure Surety

After release of the reclamation bond by the state, a portion of the reclamation surety will be dedicated to the postclosure bond. Before the release of the reclamation bond, a detailed bond calculation for postclosure activities will be submitted to the state of South Dakota for approval.

6.10.2.9 Cyanide Bond

The heap-leach mining industry was reviewed in 1992 for the issue of bonding for large and potentially catastrophic cyanide spills. In conjunction with the SD DENR, various scenarios were developed in attempt to address costs associated with each scenario. As a result, each mine was assessed a cost for abatement and mitigation of cyanide spills that affected both

surface water and groundwater. Wharf is currently assessed a value of $438,917.27, which pursuant to state statute, was assessed against the net value of the company, and is updated annually for inflation.

The Expansion Area will not increase the relative amount of cyanide used annually since the rate of ore processed will not significantly differ from current levels. Therefore, it does not appear that there will be any need to reassess a cyanide bond.

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