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**GEOCHEMICAL CHARACTERIZATION AND WATER QUALITY
PREDICTIONS FOR THE ZORTMAN/LANDUSKY RECLAMATION PROJECT.**

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ABSTRACT

Reclamation of the Zortman and Landusky gold mines in the Little Rocky Mountains of north-central Montana is currently on-going under the direction of the Montana Department of Environmental Quality and the U.S. BLM using the funds from the established Reclamation Bond. As part of the reclamation effort, a geochemical characterization program was developed which involved an intensive field geochemical assessment and drilling program, supported by laboratory test work and 'historic' data. The objective of the characterization program was two-fold. Firstly, to identify the location, extent, current and probable future contaminant loads from the sites; secondly, to identify candidate materials for suitable cover and remediation purposes. This paper describes the material characterization program and predicted future water qualities developed for the Zortman/Landusky reclamation project.

Additional Keywords: Zortman, Landusky, reclamation, geochemistry, remediation.

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INTRODUCTION

The Zortman and Landusky mines are located in Phillips County, Montana approximately 155 miles north of Billings (Figure 1). There has been mining in the area in one form or another since the first gold panner found a nugget in 1884. The first mill was built there in 1904 and mining continued underground off and on through to the 1970's ceasing intermittently during the two World Wars. Larger scale open pit mining and heap leach operations of the lower grade ore at Zortman and Landusky began in 1979 by Pegasus Gold Corporation and continued until 1995. Gold and silver were extracted by Carbon Absorption and Stripping and Merrill-Crowe precipitation. Both mines are currently closed and being reclaimed under the direction of the Montana DEQ using the Closure Bond Funds provided for by Pegasus under Montana Bonding requirements.

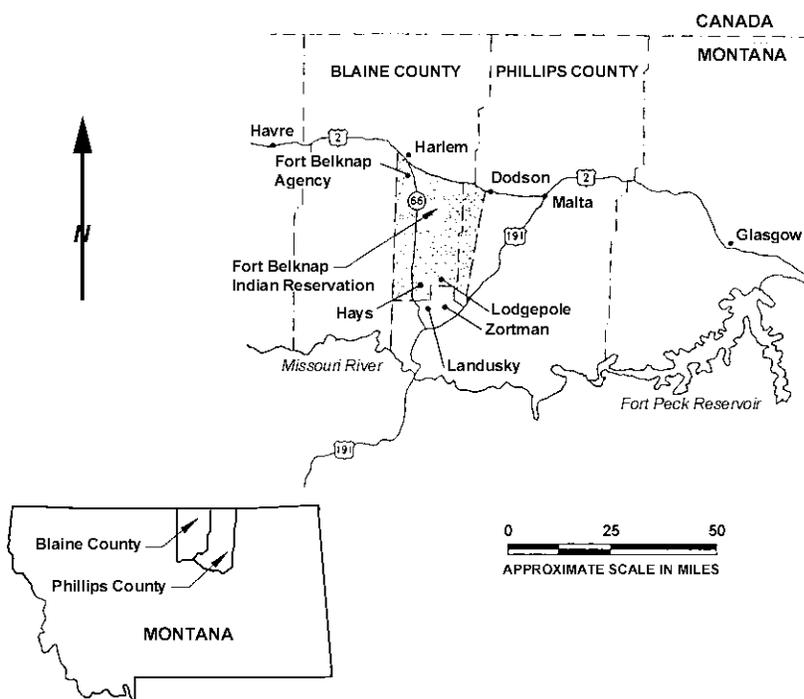


Figure 1. Location map of Zortman and Landusky Mine Sites
(after US DOI and MT DEQ, 1996)

There are at least two critical issues that the Zortman/Landusky reclamation project is faced with. There is (1) insufficient funding in the reclamation bond and (2) limited suitable construction material on site to complete the reclamation that was proposed in the Environmental Impact Statement (EIS) (US DOI and MT DEQ, 1996) and stipulated in the Record of Decision (ROD) (MT DEQ and US DOI, 1998) for the site. Therefore, an evaluation of the effectiveness of the specified measures and prioritization of reclamation areas and measures is being done. In order to complete this evaluation and prioritization a geochemical characterization program was undertaken.

The objective of the geochemical program was two-fold. Firstly, to identify the location, extent and probable current and future contaminant loads from the various facilities (leach

pads, waste dumps and open pits) on the sites and to prioritize which areas most require a high degree of reclamation and which require less or minimal reclamation. Secondly, the program was aimed at identifying candidate materials on site for cover and remediation purposes. The characterization program was comprised of an assessment of historic information, a field reconnaissance survey and surface sampling program, a drilling program focussed on collecting leach pad and dike samples from depth and extensive laboratory testing. This paper presents the results of the characterization program and some discussion as to how this information will be used to prioritize remediation areas and measures.

CHARACTERIZATION PROGRAM

Historic Data

A fair amount of geochemical and geological information is available about the site, most of which was produced after 1990. In 1992, the mining company (Pegasus) filed an application for expansion of the operations. As a result, between that time and mid 1994, a number of studies were undertaken in preparation of an Environmental Impact Statement (EIS). These studies included extensive static and kinetic tests of drillcore aimed at predicting the acid generating potential of the rock mined and exposed as a result of expansion (Miller and Hertel, 1997). The mine expansion however never went forward. Therefore, the material characterized in those studies remains unmined. The vast amount of information produced in those studies is therefore of limited usefulness to the current reclamation program.

Prior to the application for expansion in the mid-1980's an extensive water monitoring program was implemented on both the Zortman and Landusky sites. As a result, a great deal of extremely valuable information has been collected on the geochemical evolution of water interacting with the various mine facilities, such as leach piles and mine pits. Water quality trends over time have proven very helpful in assessing the current contaminant loads from the sites and likely future water qualities. They allow trends to be established indicating the evolutionary behavior of large masses of mine disturbed materials.

Another set of historic data that is often not fully exploited for geochemical characterization is the mined material itself. The pit walls, spent ore and waste rock materials that are currently exposed and have been for at least 5 to 10 years, since mining operations ceased, are essentially large, 'historic' kinetic tests. Simple, inexpensive tests such as paste pH, paste conductivity measurements and leach extraction tests on material exposed to weathering for this amount of time can provide more information than could be achieved in relatively short term, more costly laboratory tests. As a result, the field reconnaissance surveys at Zortman and Landusky were an extremely critical part of the characterization program.

Field Reconnaissance Program

The objectives of the field reconnaissance program were (1) to identify potential sources of NAG material (i.e. non-acid generating material that may be a potential source of construction and cover material) and (2) to identify and quantify potential sources of acid generating material and contaminant sources. The program consisted of paste pH and paste TDS analyses and visual identification of rock type, degree of alteration, degree of oxidation, surface precipitates and staining, presence of visible sulfides and any ‘unusual’ textures. Field logs (including photographs) were recorded and the sample locations were surveyed using a GPS system and plotted on a map.

The results of the field paste pH and paste TDS analyses are summarized in Table 1 organized by mine facility (or material type). As would be expected, samples with low pH values have higher TDS values (due to the presence of soluble minerals on the grain surfaces) and those samples with neutral pH results have low TDS values. The relationship between paste pH and paste TDS for the different material types on the Zortman and Landusky sites is shown in Figure 2. As would be expected, there is a clear trend whereby samples with pH values below approximately 5, show sharply increasing TDS concentrations. The samples that do not fall neatly within this trend are predominantly leach pad samples (designated by open circles on the figure) where the addition of lime and caustic soda in the leaching solutions account for moderate to high TDS values and still control the pH to circum-neutral values (i.e. the TDS results from alkalinity products not acidity/oxidation products).

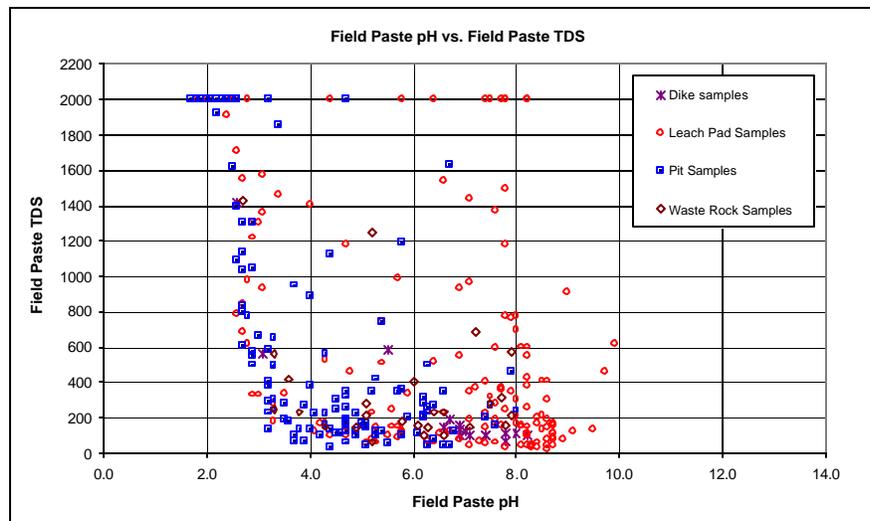


Figure 2. Paste pH versus paste TDS for Zortman and Landusky surface samples.

The color of the Zortman and Landusky mined material (again with the exception of the spent ore on the leach pads) is a relatively good indication of pH, or acid generating conditions. Visual inspection therefore can provide the first assessment of a material's acid generating potential. The unoxidized porphyry materials containing fresh sulfide minerals (in particular pyrite and, on Landusky, marcasite) are typically grey in color. These materials are acid generating with pH values commonly below 3 and very high TDS

concentrations. The partially oxidized porphyry material was often an olive-green to yellow color. This color is a reflection of the presence of secondary minerals produced when sulfide minerals oxidize, such as iron oxy-hydroxides and iron sulfates. These minerals are soluble and when dissolved produce acid, therefore they are sometimes referred to as ‘stored acid products’. The partially oxidized material is predominantly acid generating with pH values generally less than 4.5. The oxide porphyry material contains no visible residual sulfides and typically has paste pH values in the 4.5 to 6.0 range. This material is orangey-red in color and relatively easily differentiated from the other material types on this basis.

Table 1. Summary of mean, minimum, maximum and standard deviation values for paste pH and paste TDS results on surface samples, sorted by mine facility.

ZORTMAN		MEAN	MIN	MAX	STD DEV
Leach Pad Samples	pH		1.8	9.0	2.3
	TDS	597	60	>2000	641
Pit Wall and Pit Floor Samples	pH		1.7	6.7	1.4
	TDS	758	30	>2000	786
Waste Rock Samples	pH		2.7	7.1	1.4
	TDS	316	60	1430	379
Dike samples	pH		2.6	7.4	1.6
	TDS	438	100	>2000	600
Roadcut Samples	pH		3.7	6.9	1.3
	TDS	235	70	460	192
Tailings	pH		5.8	7.6	0.7
	TDS	800	70	>2000	937
Topsoil	pH		5.0	6.8	0.7
	TDS	141	50	228	64
LANDUSKY		MEAN	MIN	MAX	STD DEV
Leach Pad Samples	pH	7.1	2.5	9.9	1.8
	TDS	602	20	>2000	678
Pit Wall and Pit Floor Samples	pH	4.2	1.9	8.0	1.9
	TDS	845	40	>2000	748
Waste Rock Samples	pH	6.2	3.3	7.9	1.6
	TDS	364	140	1250	300
Stockpile Samples	pH	7.6	6.9	8.0	0.6
	TDS	130	100	170	36
Dike Samples	pH	7.2	3.7	8.2	1.7
	TDS	117	70	190	40
Topsoil	pH	7.0	3.5	8.0	1.7
	TDS	560	90	>2000	723

Although color alone is not recommended to differentiate between material types, it is a useful classification tool for the Zortman and Landusky sites. Caution should be exercised when judging leach pad material as many surface minerals precipitating from leach pad solutions have coated the surface of much of the material and the color is a less dependent

characteristic of the geochemistry. Field 'clues' including paste pH, paste TDS rock type and color description at these sites, where the material has been exposed to weathering conditions for an extended period of time, are relatively inexpensive and very valuable pieces of information. This type of survey is often not given enough credit in similar characterization programs. The outcome of the field reconnaissance survey were large maps of each site designating potentially acid generating, moderately acid generating and non-acid generating material on the sites. These maps are continually refined as new information about the sites is obtained (e.g. results of the laboratory testing program) and will be used in the reclamation decision making and prioritization of reclamation areas.

Drilling Program

The process of heap leaching gold ore with cyanide requires that the pH be maintained at approximately 10. Therefore excess alkalinity in the form of caustic soda and/or lime is added to the leaching lixiviant. During the field reconnaissance program it was determined that in certain areas, there is a significant amount of residual alkalinity from the leaching process in the leach pads at Zortman and Landusky. In other areas, it is apparent that the alkalinity has been consumed and acid generating conditions have developed. Based on the variability of the geochemistry of the surface samples collected on the leach pads and the leach pad water quality from one pad to another, it was decided that a drilling program should be undertaken to better characterize the leach pad material at depth.

A total of nine drillholes to depths ranging between 70 and 150 ft were completed. The drillholes were stopped at a depth at least 25 ft above the bottom of the pad to avoid puncturing the pad liner. Great West Drilling was contracted to complete the drilling using an AP 1000 Drill Systems Becker Hammer Drill. This type of drill was selected because it minimizes the breakup of the material being penetrated and thereby minimizes the geochemical disturbance of the material. During drilling, air is pumped downward to the cutting head through the annulus between the inner and outer casings. Drill cuttings are returned to the surface by way of the inner opening and are routed through a cyclone.

Field characterization tests were completed on site (visual description, paste pH and paste TDS measurements) on samples collected at 5 ft intervals. The depth profiles showing paste pH and paste conductivities of three drillholes representative of the range of results obtained are provided in Figures 3 to 5.

The first profile (Figure 3) shows a potential 'acid front' developing in the leach pad down to a depth of approximately 30 to 40 ft from the surface. It is expected that over time, as the residual alkalinity is consumed, the zone of depressed pH will extend deeper in the leach pad as the 'acid front' moves downwards. The second example (Figure 4) is a leach pad that was operated 3 to 5 years after the first. It shows residual neutralization to pH levels that were maintained during active leaching. It is likely that as the added alkalinity is consumed, the pH will drop but to what values it is not clear. The third example (Figure 5) is a leach pad that was operated even later than the previous two and the ore contained appreciably higher levels of sulfide. It is obvious that significant acid generation has

already developed in intervals in this leach pad and will likely continue to develop until all residual alkalinity is consumed.

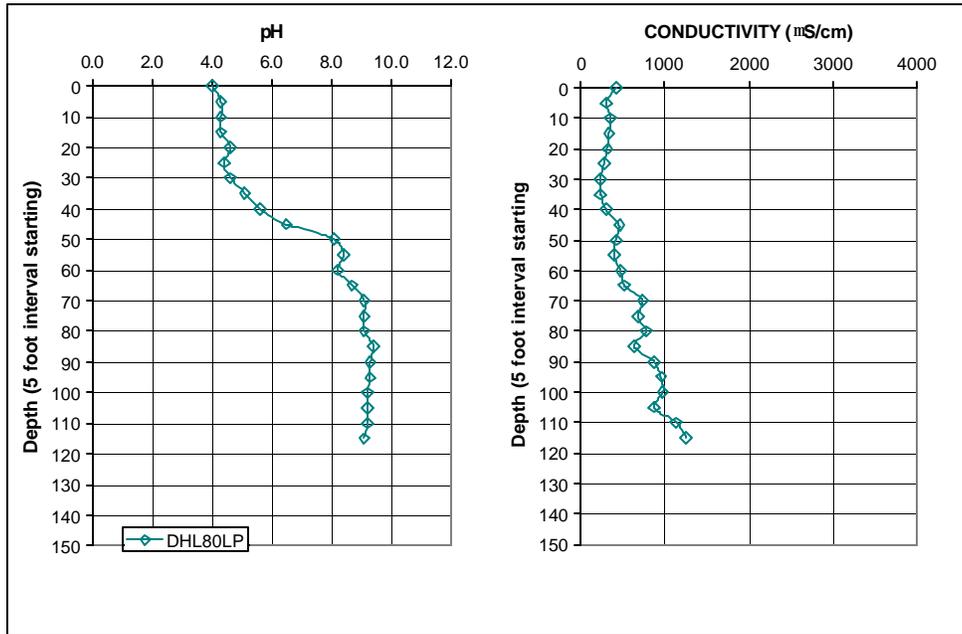


Figure 3. Paste pH and conductivity results for the leach pad drillhole DHL80LP.

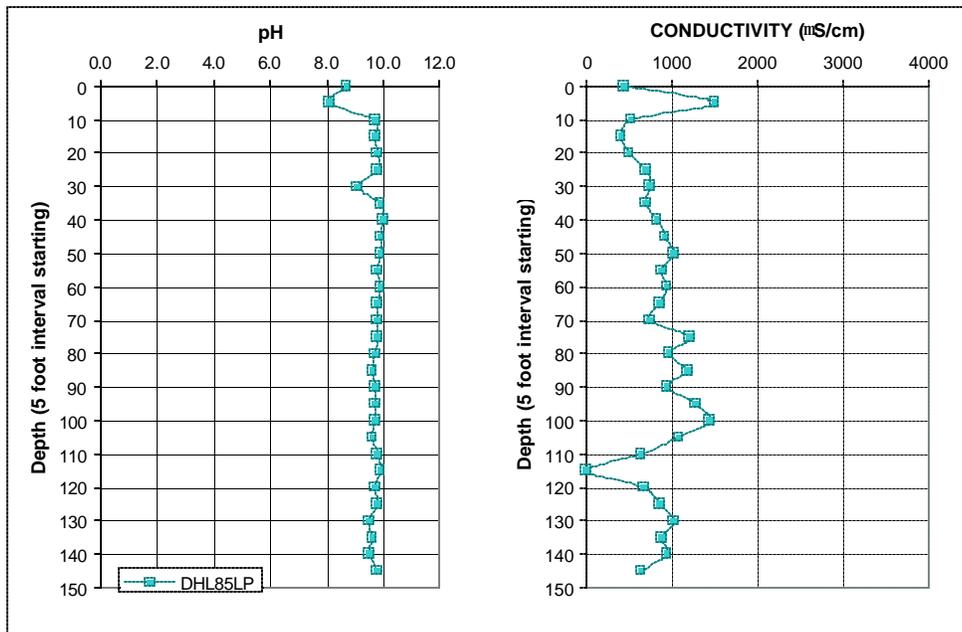


Figure 4. Paste pH and conductivity results for the leach pad drillhole DHL85LP.

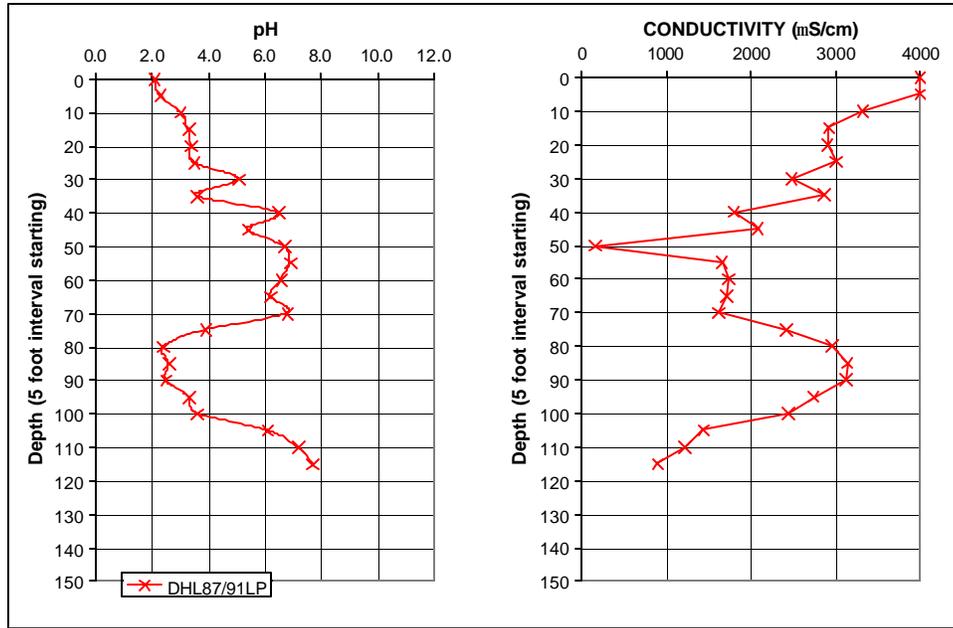


Figure 5. Paste pH and conductivity results for the leach pad drillhole DHL87/91LP.

Laboratory Testing Program

During both the reconnaissance program and the drilling program, samples were collected for confirmatory laboratory testing. Surface material sampling for lab testing concentrated on obtaining representative samples with respect to rock type and geochemical type (i.e. degree of oxidation, sulfide content etc.), as well as obtaining representative samples of each mine facility (i.e. each leach pad, pit, waste dump etc.). There was a slight bias in numbers of samples collected for lab testing towards both the potential NAG materials and the ARD/metal leaching materials. Sample selection of the drill cuttings for additional lab testing consisted of every other sample (i.e. a 5 ft interval within every 10 ft drilled). Additional samples were also taken if a sample was significantly different from both the sample immediately above and below it.

All samples collected for the laboratory testing program were submitted for paste pH and paste conductivity measurements on the as-received 'fines', modified acid base accounting (ABA) tests, inorganic carbon and leach extraction analyses. Subsets of these samples were also analyzed via forward acid titration, multi-element ICP, net acid generation (NAG) tests and sieve analyses. Some of the more critical results from these tests are discussed in the following sub-sections.

Surface Samples

Paste pH and Paste Conductivity Results

Paste pH and paste conductivity tests on the as-received 'fines' were completed for two reasons. Firstly as a quality control/quality assurance check on the paste pH and paste TDS values obtained in the field using the hand held field instruments. The paste pH and paste

conductivity measurements in the lab were taken on the as received ‘fines’ using a 1:1 solids to distilled water ratio to mimic as close to possible the methodology used in the field. Secondly, it is believed to be a more representative result than the paste pH and paste conductivity values on the same sample prepared for Acid Base Accounting (ABA) tests, i.e. the crushed samples. In effect, this crushing liberates the alkalinity from the matrix of a sample thereby effecting the paste pH. Figure 6 is provided to show the relationship between the field and lab paste pH measurements on the as-received fines (or un-crushed samples) as compared to the field and lab paste pH measurements on the crushed split sample for ABA testing. This graph clearly shows that crushing the samples liberates more alkalinity (and therefore results in higher pH values) than is available in the field. The results serve as a caution that one cannot rely on paste pH values obtained on a crushed sample as indicative of field conditions. Measurements of field paste pH should always be done on the uncrushed fines, this was an important consideration when selecting a drilling method for sample recovery in the leach piles.

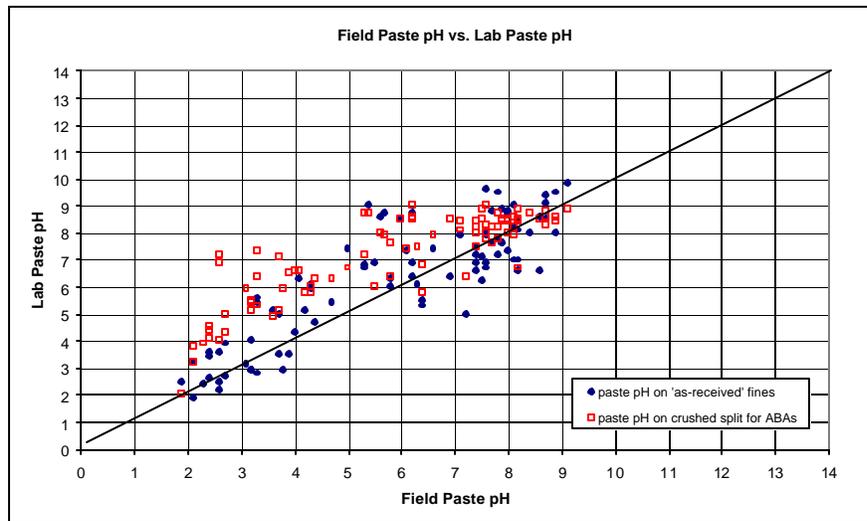


Figure 6. Field paste pH versus lab paste pH on un-crushed and crushed surface samples.

Modified Acid Base Accounting (ABA) and Inorganic Carbon Results

The modified ABA test is used to determine the balance between the acid producing (sulfides) and acid consuming components of a sample. A very definite trend can be seen in the samples (except for the leach pad material) with respect to the total percent sulfur and field paste pH (Figure 7). Almost all samples (excluding leach pad samples) with total sulfur contents greater than 0.2% have field paste pH values less than 5.0. This percentage of sulfur is far less than would be visible in the field. This suggests that there is very little neutralization or buffering capacity in the material except for that added to the leach pad material. It can be expected that once the alkalinity in the leach pad samples is exhausted that these samples will also plot within the dotted lines outlining the apparent natural trend of the other materials on site.

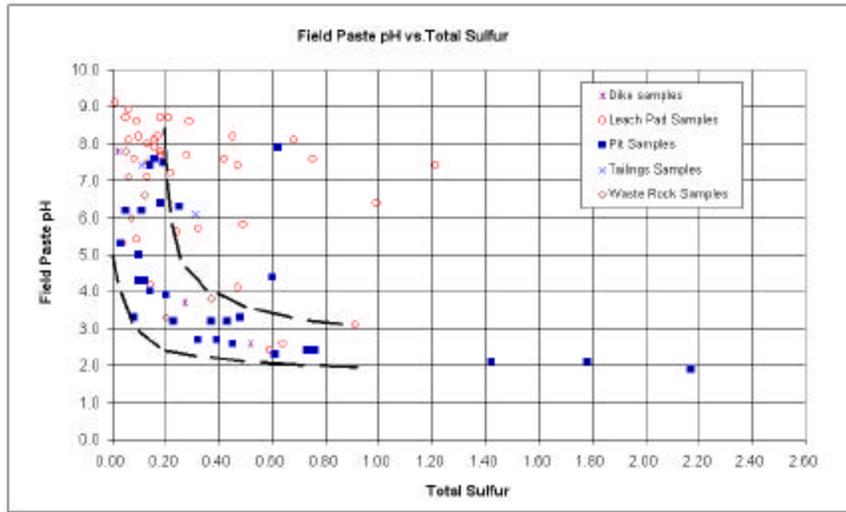


Figure 7. Field paste pH versus Percent Total Sulfur on Surface Samples.

Figure 8 is a plot of neutralization potential (NP) versus acid potential (AP) in kg CaCO_3 /tonnes equivalent. This type of graph is typically used to report results of ABA testing. In general, the samples that plot above the 1:1 line (~60%) would be considered potentially acid generating, those that plot below the 3:1 line (~28%) would be considered non-acid generating and those that fall between the two lines (~12%) would be classified as 'uncertain' with respect to acid generating potential. It takes very little sulfur content in a sample for that sample to plot below the NP/AP ratio of 1:1, this again suggests that there is very little neutralization potential in the samples to 'balance' the acid generating potential imparted by less than a quarter of a percent sulfur.

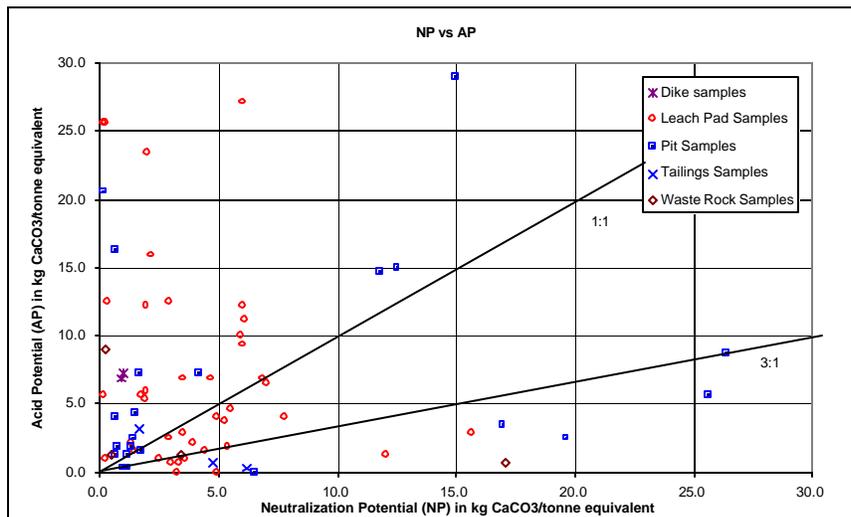


Figure 8. Neutralization Potential (NP) versus Acid Potential (AP) on Surface Samples.

Forward Acid Titration Results

The forward acid titration test is done to determine, qualitatively, the acid neutralizing capacity of a sample by adding measured amounts of acid to the sample to lower the pH.

The amount of acid required to reach each pH interval is dependent on the amount of neutralizing material available. As the pH decreases, different minerals react to neutralize (or buffer) the added acid. Within the pH range of 5.5 to 7.0 carbonate minerals in the sample dissolve and neutralize the acidity. If there are significant carbonates present a 'step' or flattening out of the curve will occur within that pH range (i.e. 5.5 to 7.0). A few of the results are shown below in Figure 9. The leach pad sample is the only sample showing any degree of flattening in this range. This is likely a result of the added alkalinity in the leach pad solutions. Between the pH range of 3.0 to 3.7, limonite (FeOOH) will buffer acid. This may be occurring to some degree in these samples. At even lower pH values (i.e. below ~3), aluminosilicate minerals such as the feldspars in the samples will dissolve and buffer added acid. This is likely the reason that these results show a long flattening tail below pH of 2.0.

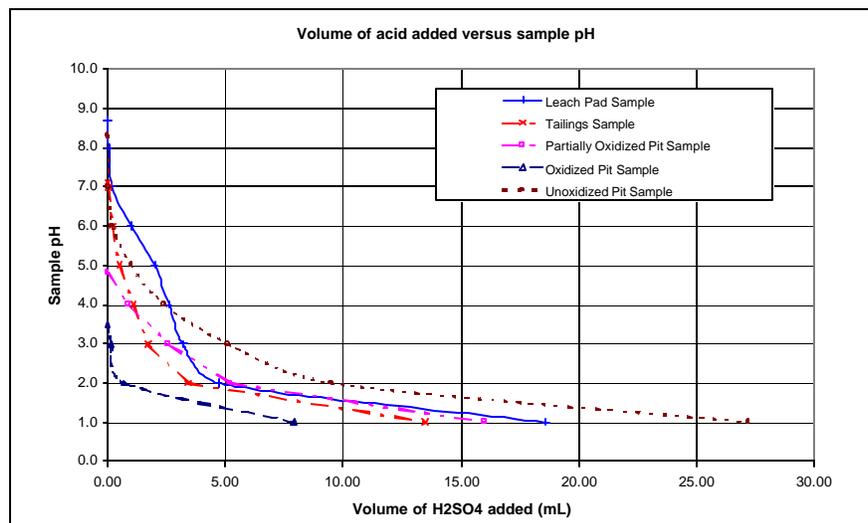


Figure 9. Forward Acid Titration Results.

Leach Extraction Tests

Leach extraction tests were completed in order to characterize and quantify the soluble contaminant content of a sample. The procedure used for these analyses was the EPA 1312 leach extraction test using a leachate reagent of de-ionized water acidified to a pH of 5.0 to 5.5 to represent rainwater. The procedure uses a solid to liquid ratio of 1:2. The leachate concentrations are representative of current ARD evolution state and the quantity of leach water compared with solid sample. Field conditions have much higher solid:liquid ratios and ARD conditions will mature with time. The resultant leachate concentrations therefore are not necessarily representative of what concentrations would be expected in the field. An assessment of the current field water qualities from material exposed on the surface was completed by accounting for the 'dilution' factor inherent in the leach extraction test and assuming a field moisture content of ~10% (as opposed to a moisture content of 200% used in the test). In other words, the leachate concentrations were multiplied by a factor of $[10/(200+10)]$. These calculated concentrations however do not yet represent field water qualities. During the leach extraction tests, the dilution of solute concentrations in the leachate can cause the dissolution of secondary mineral phases that were previously in a

solid phase (i.e. oversaturated). It was therefore necessary to “re-instate” the solubility controls on the solute concentrations by modeling the calculated leachate concentrations using the geochemical equilibrium model MINTEQA2 (Allison et al., 1991). Water quality predictions were then made for the surface water runoff from the various material types. Table 2 provides the predicted water qualities from those areas considered highly acid generating, moderately acid generating and non-acid generating for both the Zortman and Landusky sites.

Table 2. Predicted water quality of material with various degrees of acid generating potential on both Zortman and Landusky.

Parameter (mg/L)	Predicted Water Quality of:					
	Highly acid generating material		Moderately acid generating material		Non acid generating material	
	ZORTMAN	LANDUSKY	ZORTMAN	LANDUSKY	ZORTMAN	LANDUSKY
pH	< 3]	< 3]	[3 - 5]	[3 - 5]	> 5]	> 5]
Al	161	925	59	87	0	0
As	1.34	6.01	0.00	0.00	0.00	0.00
Ca	40	85	154	146	10	218
Cd	0.00	0.10	0.15	0.10	0.00	0.00
CO ₃	0	0	8	0	26	17
Cr	4.90	0.47	0.37	0.15	0.00	0.00
Cu	1.62	1.18	0.71	0.00	0.10	0.30
Fe	0.24	2.37	0.00	0.05	0.00	0.00
K	0.0	0.0	305.0	0.0	0.0	78.7
Li	22.35	27.46	10.45	0.00	0.00	0.00
Mg	55	364	689	380	14	166
Mn	2	33	40	11	0	8
Ni	0.43	1.59	1.53	0.68	0.00	0.00
Pb	0.00	0.00	0.02	0.00	0.00	0.00
Si	0.12	0.03	0.53	0.70	0.85	0.30
SO ₄	3988	3245	394	494	11	148
Zn	0.77	15.48	0.72	4.66	0.06	0.23

Leach Pad Drill Cuttings

As with the surface samples, the leach pad drill cuttings were measured for paste pH and conductivity values and submitted for modified ABA testing, multi-element ICP analyses and leach extraction testing using the same protocols as described above. At the time of paper submission, only the modified ABA results were available for discussion.

Modified Acid Base Accounting

Figure 10 is a plot of NP versus AP sorted by drillhole. Those samples that fall below the 1:1 line (i.e. those with AP>NP) are considered potentially acid generating, those samples that fall above the 1:1 line are considered uncertain with respect to acid generation or non-acid generating. A large number of the samples fall below the 1:1 line and are considered potentially acid generating. A significant number of samples also cluster in the bottom left corner with low values of both AP and NP, the acid generating potential of these samples is

uncertain. A very small number of samples would be considered non-acid generating with significantly greater NP than AP.

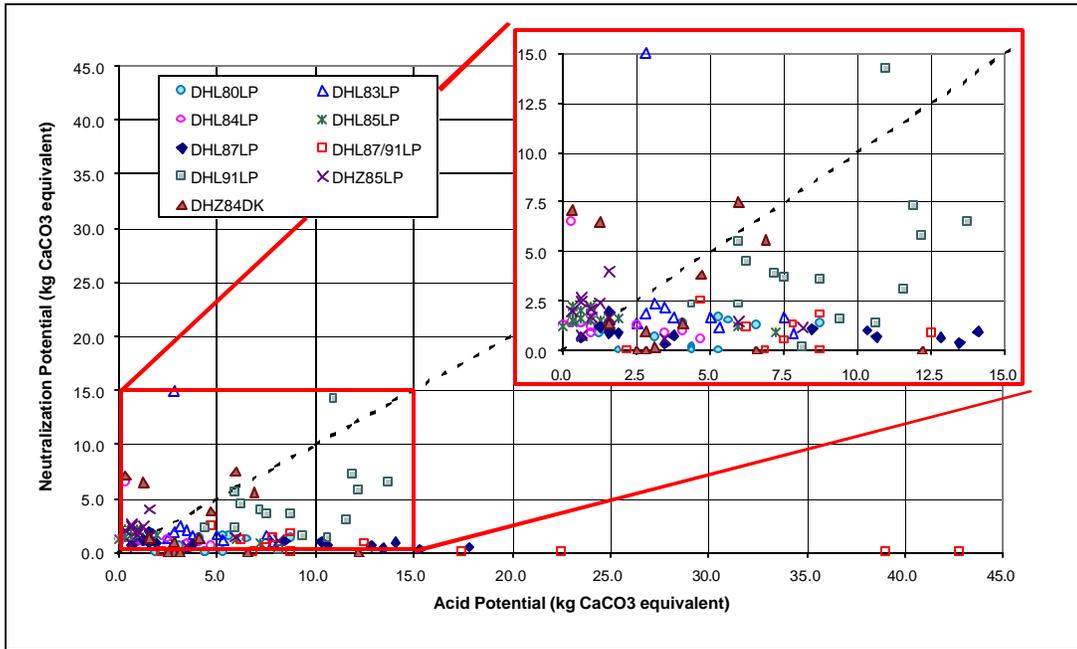


Figure 10. Neutralization Potential (NP) versus Acid Potential (AP) on Leach Pad Drill Cuttings.

Depth profiles of these results were plotted in a similar format as the pH and conductivity results presented above. The same three examples are provided in Figures 11 to 13. Figure 11 shows the top 30 to 40 feet of the Landusky 80/82 Leach Pad at the drillhole location is acidic with pH values just above 4. The neutralization potential (NP) is completely depleted in the top 30 feet of this drillhole. This suggests that the pH in this drillhole (and by association in the others) is largely controlled by the NP content and once leached, the pH can be expected to drop. The anticipation is that over time, the pH at depth in this leach pad will also decrease as the NP is depleted and an ‘acid front’ will continue to move vertically downwards.

The paste pH in the Landusky 85/86 Leach Pad is consistently higher than that in the other drillholes at values of approximately 10 (Figure 12). The leach pad water quality in this pad is also the highest on the site (between 9 and 10). This suggests that there is a significant amount of alkalinity that was added during leaching that remains in this pad. The AP is also lower in the 85/86 leach pad compared to the earlier pads. In general, the AP varies between 0 and 2 kg CaCO₃/ton equivalents with the exception of two samples that ‘spike’ to between 6 and 7. The NP is relatively constant down depth at values just below 2 kg CaCO₃/ton equivalents and is greater than the AP values in most samples. Therefore, with the lower AP values and slightly higher NP values than the other pads, these results suggest that with the exception of localized areas, there may be enough excess alkalinity in this drillhole to maintain the pH to circum-neutral values.

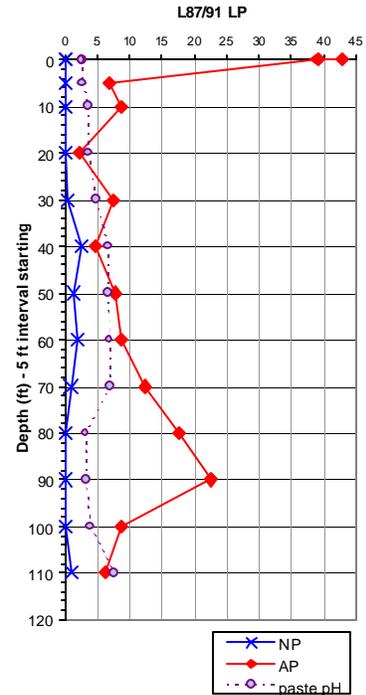
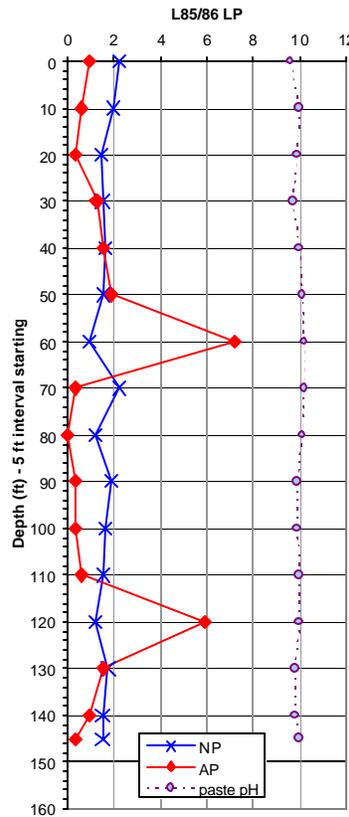
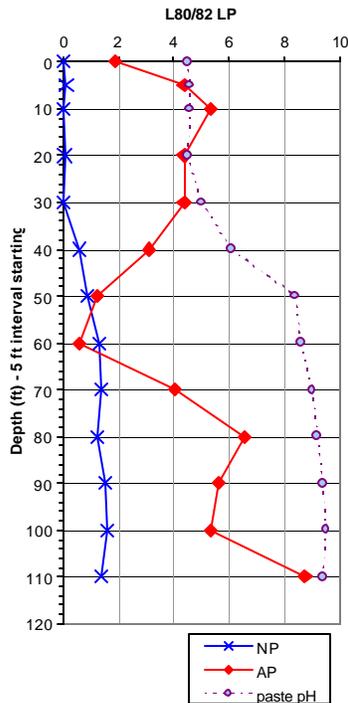


Figure 11. Landusky 80/82 LP

Figure 12. Landusky 85/86 LP

Figure 13. Landusky 87/91 LP

The sulfide content of the material The Landusky 87/91 Leach Pad (Figure 13) is higher than in other drillholes. The paste pH values range between 2 and 8 showing the effects of sulfide oxidation and acid generation. The AP values are, for the most part, much greater than in other drillholes with a surface value of approximately 40 and values at depth ranging from approximately 4 to 22 kg CaCO₃/ton equiv. The NP values range between approximately 0 and 2 kg CaCO₃/ton equiv. and every sample has an AP value greater than, and typically much greater than the NP values. This drillhole is considered highly acid generating with nearly all the available NP or alkalinity already consumed. It is likely that the pH values will continue to decrease and associated contaminant loads will likely be quite high.

SUMMARY

In summary, the combined results of the field reconnaissance, drilling and lab testing programs, together with the historic monitoring data on site, have provided the reclamation project team with the following critical information.

- The current understanding of the site geochemistry is significantly different than the understanding ~5 years ago.
- A great deal of information has been obtained using simple inexpensive field tests and by plotting routine monitoring data available on site.
- With the exception of the leach pad spent ore, there is very little neutralization potential in the mined material and therefore even small amounts of sulfur (<0.2%) can result in ARD.
- It is anticipated that significant site interaction, water collection and treatment will be required for the long term at both sites.
- The leach pad geochemistry is very different than other mine material due to the alkalinity added during leaching operations.
- The added alkalinity in the leach pads is very soluble and therefore readily 'available' to neutralize any acid produced. Once consumed however, it is anticipated that the leach pads will become acidic as some on site already have.
- The leach pad water therefore will likely need to be managed differently than today at some point in the relatively near future (i.e. be put through the water treatment plants).
- These sites should serve as examples of the long term geochemical evolution of leach pad chemistry. Rinsed leach pads that meet discharge requirements with respect to pH, cyanide, nitrates etc. may continue to evolve over time (possibly at some point after 'closure') and develop ARD problems (Figure 14).

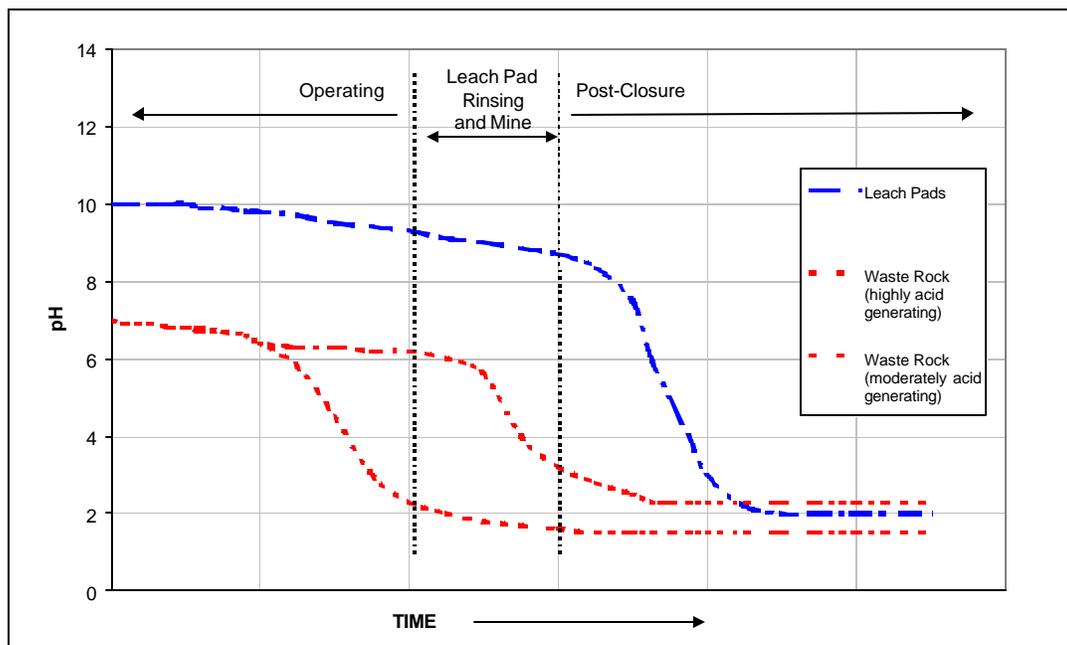


Figure 14. Hypothetical Trends in pH over Time for Leach Pad Material and Waste Rock.

The field reconnaissance results, laboratory test results, predicted surface water qualities and the data obtained from the surface and groundwater monitoring program at the sites, together with the site water balances are being used to develop current and likely future mass balance and contaminant load estimations for the sites. These estimations along with the engineering volume mass balance and material costing will be incorporated into a Multiple Accounts Analysis, or MAA, (Robertson and Shaw, 1998) decision-making tool

for the prioritization and evaluation of the likely results of certain reclamation areas and measures. The MAA evaluation of the various reclamation alternatives is currently underway as a cooperative effort between ourselves, Spectrum Engineering, the Montana Department of Environmental Quality, the U.S. Bureau of Land Management, U.S. Environmental Protection Agency and the Fort Belknap Tribal Council. Past experience with this type of decision making has proven extremely successful for multi disciplinary projects involving multiple stakeholders such as with the Zortman and Landusky Reclamation Project.

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