THE EVOLUTION OF EVAPOTRANSPIRATION COVER SYSTEMS AT BARRICK GOLDSTRIKE MINES[1]

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Abstract. Barrick Goldstrike Mines Inc. (BGMI) has developed a comprehensive closure planning, materials characterization and in-situ monitoring program for the closure of its mine waste facilities. Facility closure uses topsoil and in-pit material to construct evapotranspiration (ET) cover systems to reduce or eliminate infiltration of meteoric water. One major facility, the AA Leach Pad (AA Pad) has been closed. The Bazza Waste Rock Facility (Bazza WRF), which will hold about 1.75 billion metric tonnes (mt) of waste rock within an area of 950 ha, is undergoing concurrent closure over the next 12 years. Hydrologic performance of the AA Pad cover and the inventory, suitability and timing of in-pit materials dictated the ET cover design approach for the Bazza WRF.

The AA Pad ET cover system was constructed in 2000 using two comparative cover systems; 1.2 m of fine-grained Tertiary-aged valley fill deposits of the Carlin formation, and 1.5 m of salvaged topsoil materials. The flux of meteoric water through the AA Pad cover was measured using in-situ vadose zone monitoring. Both covers had very low deep percolation rates, especially after vegetation matured. The AA Pad monitoring results were used to optimize the Bazza cover. First, an unsaturated flow model was calibrated to the in-situ monitoring data from the AA Pad. Next, the hydraulic properties of cover materials to be used for the Bazza cover were determined in large-diameter cores to minimize scale effects. Large scale in-situ hydraulic testing was also conducted to assess material variability. Finally, in-situ monitoring systems were installed in concurrent reclamation areas at the Bazza WRF.

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Introduction

BGMI is located near Elko in north central Nevada, within the Great Basin desert. The Great Basin is the largest arid area in the United States and is composed of a series of uplifted mountain ranges and their associated intervening valleys. The climate at the site is characterized by cool winters and dry summers with an average annual temperature of 9.0 C. Average annual precipitation is about 260 mm; potential evapotranspiration (PE) is approximately 1270 mm. Most precipitation is received as snow or during summer thunderstorms. The vegetation zone at the mine site is classified as sagebrush-grass. This zone supports a diversity of shrubs, grasses, and perennial forbs.

BGMI is a large open pit and underground gold mining operation. The mine consists of the Betze Post Pit, the Bazza WRF, the AA Leach Pad, the North Block Tailings Facility, the Rodeo and Meikle Underground Mines, a Roaster and an Autoclave Facility (Figure 1).

Figure 1. Site map of BGMI.

Even though the known reserves in the Betze Post Pit provide over 10 more years of mine life, BGMI has been aggressive in developing and testing reclamation techniques during concurrent reclamation of the AA Pad and portions of the Bazza WRF. The purpose of this paper is to describe the development of the ET cover systems at BGMI.

Cover System Development

Closure planning at BGMI is a continuous process of concept development, design, construction, performance monitoring, evaluation and refinement. The concepts involved in operation and closure of the Bazza WRF are to characterize potentially acid generating (PAG) material and segregate such material within the facility, shape the pile and integrate first and second order drainage channels into a geomorphically stable form that blends with existing topography, place an ET soil cover, and rapidly establish vegetation that evolves into a permanent diverse plant community.

As of the end of 2004, approximately 1.40 billion mt of waste rock had been placed in the Bazza WRF including a mixture of about 25% classified as PAG rock and 75% classified as non-PAG waste rock. Through the end of mine life, approximately 1.75 billion mt of waste rock will be placed. The remaining 350 million mt of waste rock to be placed in Bazza are expected to be more strongly alkaline than historic waste rock, with only 16 % PAG material. All PAG material will be contained within a 230 ha cell in the central portion of the Bazza that has been placed a minimum of 15 m from the base or sideslopes of the facility.

The arid nature of the site facilitates the use of ET cover systems for mine waste closure. Based on the experience gained from the AA Pad closure and a comprehensive materials testing program, BGMI proposes to construct a 1.8 meter thick ET dual layer cover system to reduce the flux of water into the PAG waste rock. A conventional soil cover (minimum 0.3 meter thickness) is proposed for the remaining non-PAG portion of the facility.

The AA Pad Experience

The AA Leach Pad, a 170 ha and 55 million mt of run-of-mine gold heap leaching facility, was reclaimed in 2000 and 2001. The design of the AA Pad ET cover system consisted on average of 1.2 meters of fine grained soil cover derived from salvaged topsoil materials or Tertiary-aged valley fill deposits of the Carlin formation. Material characterization and unsaturated flow modeling indicated that these local borrow materials would perform as an excellent ET cover, limiting deep percolation flux. The cover system placement consisted of 1.5 m of salvaged topsoil material on the western and northern slopes, and 1.2 m of unconsolidated materials from the in-pit Carlin Formation in the eastern and southern slopes (Figure 2).

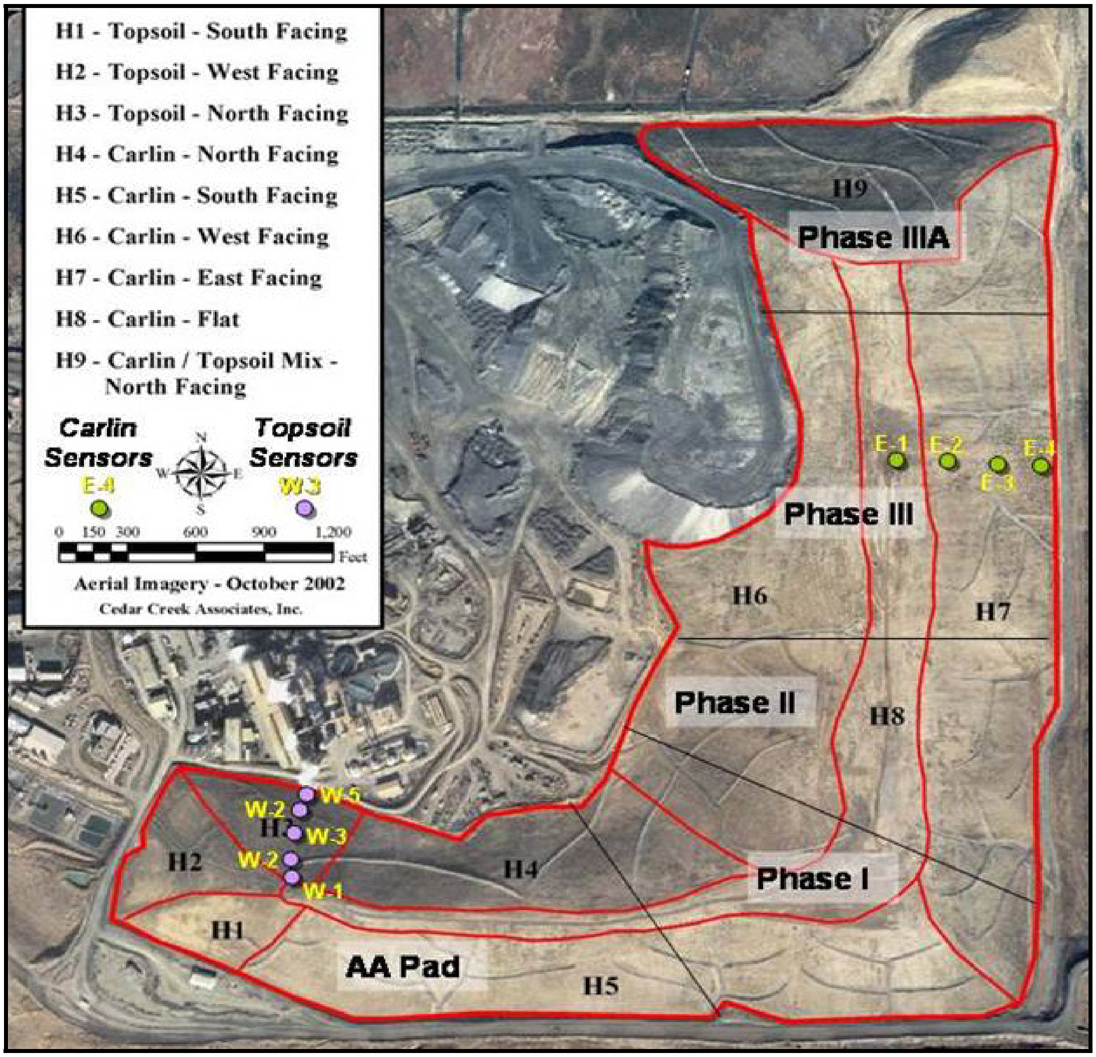


Figure 2. Closure phases, location of drainage channels
and cover performance monitoring nests at the AA Pad.

A cover performance monitoring system comprised of two transects of 4 to 5 nests of water content and water pressure potential (suction) devices was installed in 2001 (Figure 2). The west transect (W1 through W5) monitors the topsoil cover, and the east transect (E1 through E4) monitors the Carlin cover. Each monitoring nest has four water content and suction sensors at various depths within the cover and underlying heap leach material (Figure 3). These sensors measure the amount and energy of water at each sensor depth and the direction of flux between sensors on an hourly basis. In addition, heap leach drainage outflow from the AA Pad is monitored since the bottom liner of the pad serves as a giant lysimeter. The combination of monitoring determines the cover system efficiency at the surface and the overall gross performance of the closure.

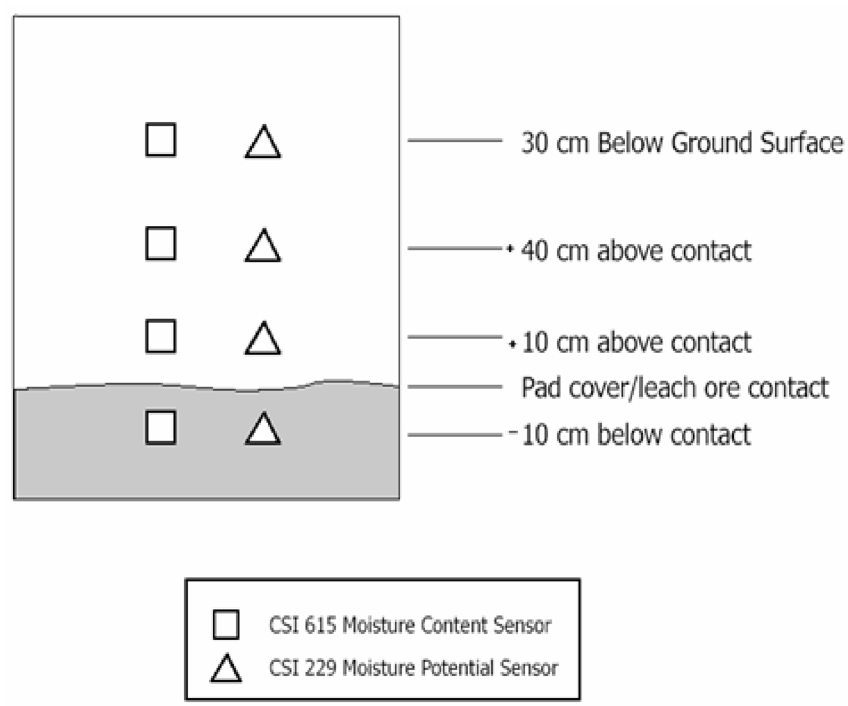


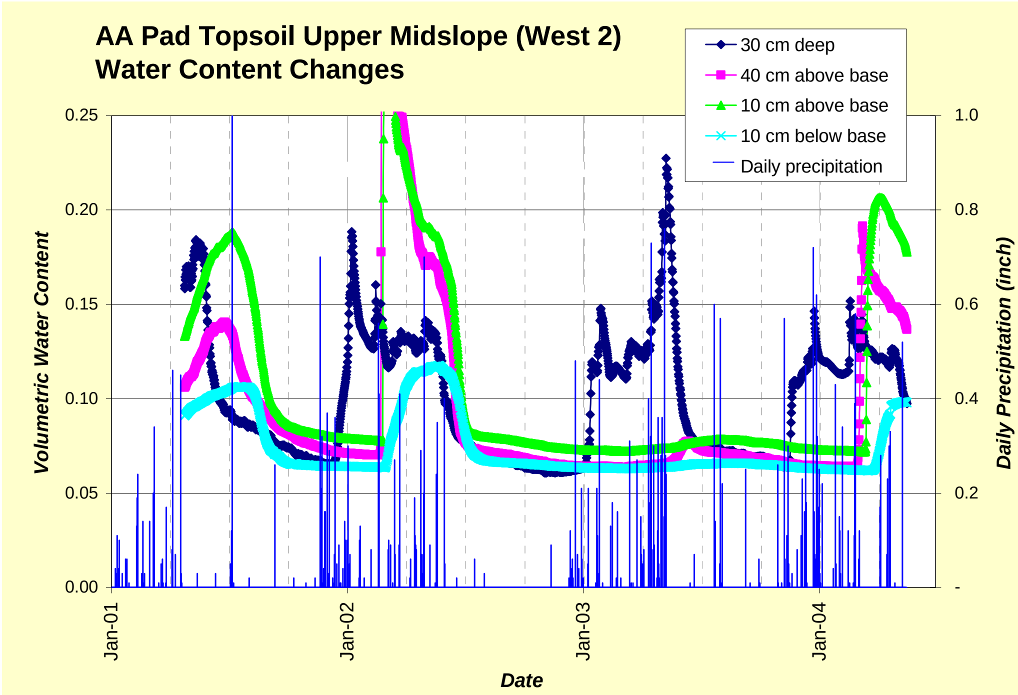
Figure 3. Installation depths for monitoring sensors.

Vegetation establishment on the cover system was vigorous: within two years over 30% cover had been achieved. Initially total cover was typically slightly less on the Carlin material than topsoil (Figure 4), with minor differences observed between different slope aspects. However, annual grasses provided a large component of cover on the topsoil, while by the fourth growing season, the Carlin had a higher cover of desirable perennial grasses and shrubs.

Figure 4. Differences in vegetative cover in 2004. Left: topsoil – north aspect; Right: Carlin - east aspect.

Water content and suction measurements over the period of 2001 to 2005 indicate that the topsoil cover system was more effective at intercepting and subsequently evaporating infiltration. Figure 5 shows soil moisture content changes at topsoil site W2. During vegetation establishment in 2001 and 2002, the wetting front from winter snowmelt reached the leach ore material, whereas in 2003 and 2004, very little water moved into the underlying leached ore material. The Carlin site E2 (Figure 5) showed greater winter snowmelt infiltration into the leached ore.

Similar trends in water content occurred at all of the monitoring locations. Peak water contents usually occurred in late April or May and stored water was rapidly removed by plants until September or October when minimum water content occurred. The plant available water capacity (AWC) can be found by comparing the minimum and maximum observed water content in the cover layer (Table 1). The Carlin monitoring sites exhibited average AWC values for the entire cover thickness of 100 to 125 mm per meter (10 to 12.5 %). The topsoil sites had higher AWC values ranging from 140 to 215 mm per meter (14.0 to 21.5%).



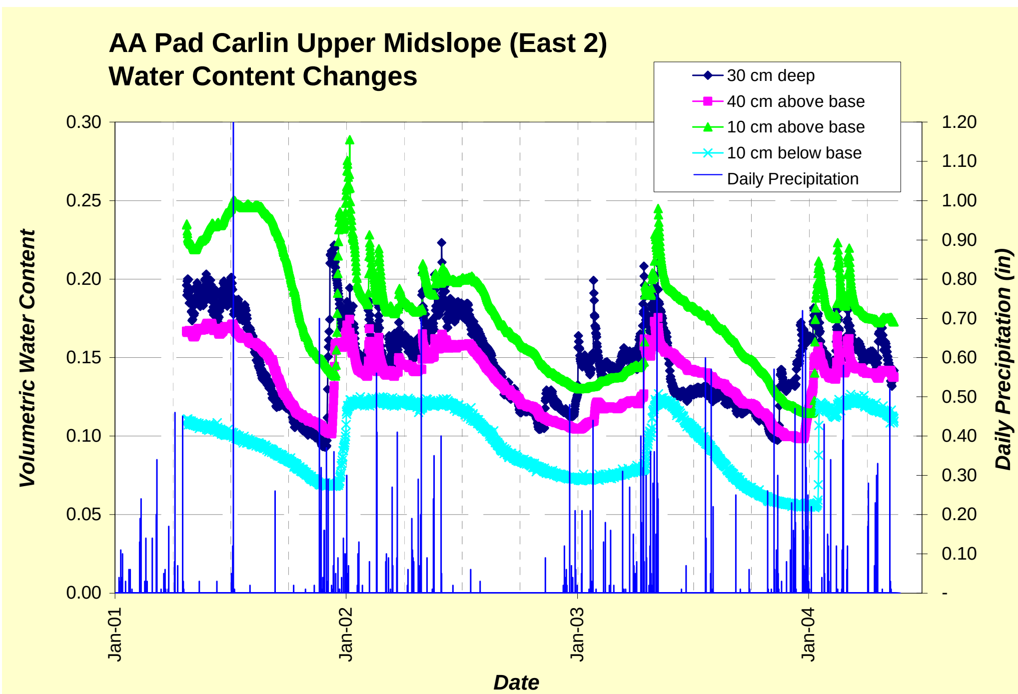


Figure 5. Soil moisture content vs. time – topsoil cover (above) and Carlin cover (below).

The higher AWC values could be from additional organic matter in the topsoil, or could be the result of a capillary break induced by the coarse leached ore underlying the topsoil. In any case, the water content monitoring results indicate that between 100 to 215 mm of infiltrated water can be seasonally stored in the cover system and then removed by vegetation.

Table 1. Effective plant available water capacities for the AA pad cover materials.

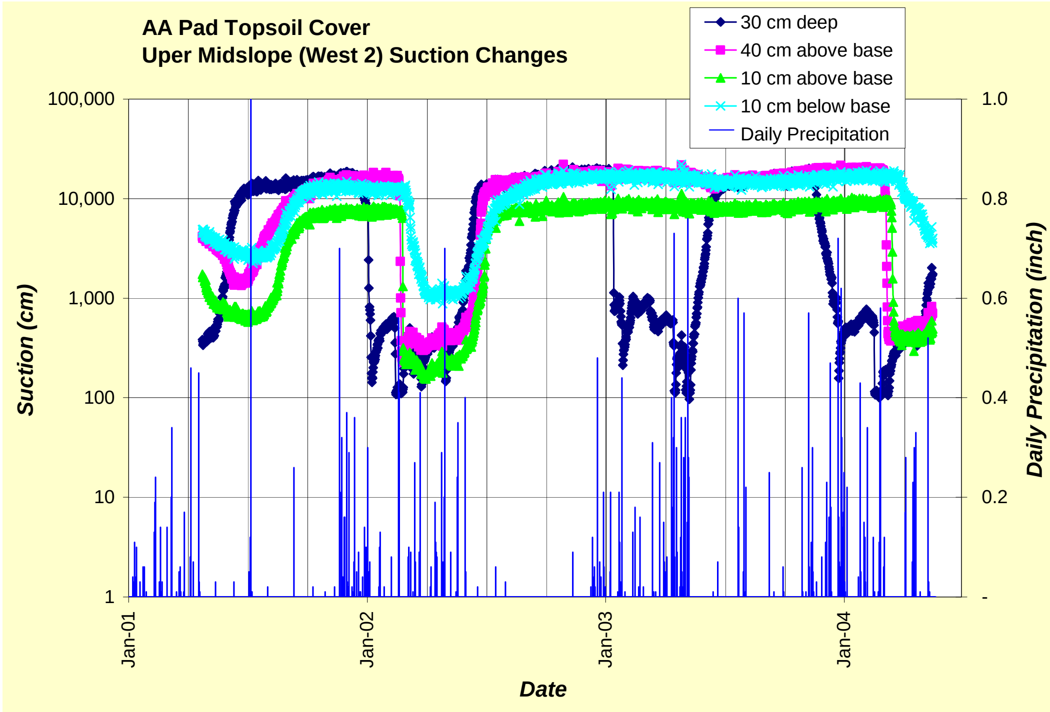
Carlin	East 1	East 2	East 3	East 4		Average
Minimum stored soil water (mm)	61	124	119	71		94
Maximum stored soil water (mm)	180	244	272	163		215
Plant available water in cover (mm)	119	119	152	91		121
Cover thickness (cm)	94	117	119	90		105
Plant available water capacity (mm/meter)	125	100	125	100		113
Topsoil	**West 1**	**West 2**	**West 3**	**West 4**	**West 5**	**Average**
Minimum stored soil water (mm)	99	86	104	119	119	106
Maximum stored soil water (mm)	378	287	315	434	434	370
Plant available water in cover (mm)	279	201	211	318	318	265
Cover thickness (cm)	130	134	150	160	160	147
Plant available water capacity (mm/meter)	217	150	142	200	200	182

Suction data also clearly show a seasonal pattern of water infiltration and downward migration in the spring followed by removal by ET and upward migration the remainder of the growing season. The root zone hydrology is fairly static in the fall and winter. In both the topsoil (Figure 6) and Carlin (Figure 6) covers, the hydraulic gradient is downward only for a short time in late winter and early spring. As vegetation begins to transpire water in April, the gradient reverses causing water to flow toward the surficial root zone. Later in the summer, plant roots obtain their water from progressively deeper zones, including the leached ore. By the end of the summer, strong upward gradient exists throughout the profile suggesting that water withdrawal occurs to depths of 2 m or more, which extends into the leached ore (e.g. and beyond the depth of the deepest sensors in the AA Pad).

The infiltration and storage of water in the leached ore material observed at most sites can be attributed to two factors. First, the hydraulic properties of the cover materials are variable and appear to have greater hydraulic conductivities than determined from the initial laboratory studies. Secondly, during 2001-2005, the winter and spring month precipitation at BGMI was 203, 220, 237 and 361 mm, respectively. These values are well above the average 62% of total precipitation (equivalent to 165 mm at BGMI) recorded in winter and spring months in the Elko area from 1888 to 2005. Nevertheless, suction data indicates that water that reaches the leached ore is mostly withdrawn by vegetation during the growing season.

The differences in suction between the bottom two sensors at each monitoring location can be used to calculate the estimated flux below the base of the soil cover at each location. The method for calculating flux uses Darcy's law and is based on measured gradient between the two sensors. To estimate flux from the gradient, the hydraulic properties of the leached ore material were used when water was moving downward, and hydraulic properties of the cover material were used when water moved upwards. When the calculated downward gradient exceeded unity (an unlikely occurrence that was more likely the result of sensor calibration), the downward gradient was assumed to be unity (e.g. 1 cm/cm).

Three sensor nests representing the crest, mid-slope and foot-slope locations at each transect were chosen to estimate the deep percolation flux during the 2003 and 2004 water years (September-August). The net deep percolation flux determined using this method averaged from 0.2 to 2.0 cm per year (Table 2). This flux range equates to a permeability of 2 to 7 x 10^{-8} cm/sec. Flux through the cover was not determined for 2001 or 2002 because the vegetation was not yet well established.



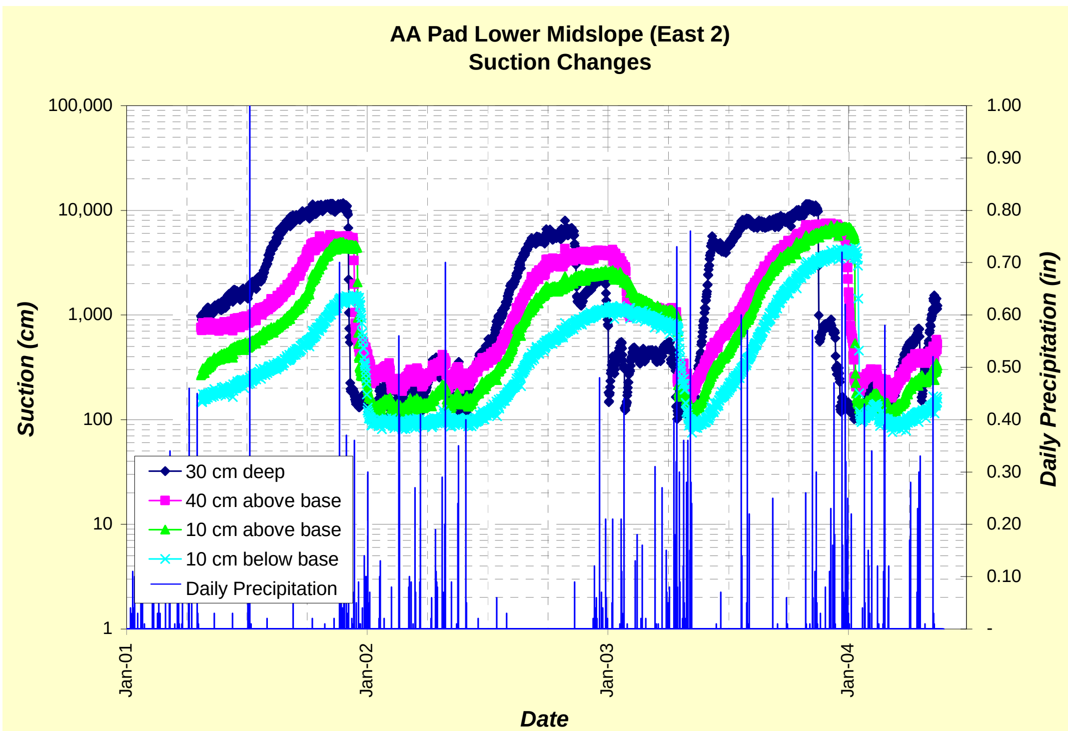


Figure 6. Changes in suction near the upper midslope on topsoil cover monitoring site West-2 (above) and the Carlin site East 2 (below).

Table 2. Calculated deep percolation flux through the Carlin and Topsoil AA Pad covers in 2003 and 2004.

Monitoring Station	Water Year 2003		Water Year 2004		Water Year 2005	
	Estim Annual Flux (cm)	Estim Flux Rate (cm/s)	Estim Annual Flux (cm)	Estim Flux Rate (cm/s)	Estim Annual Flux (cm)	Estim Flux Rate (cm/s)
Carlin Cover						
Carlin Crest (E1)	0.00	0.0E+00	0.00	0.0E+00	0.00	0.0E+00
Carlin Midslope (E3)	1.06	3.3E-08	9.35	3.0E-07	2.72	8.6E-08
Carlin Midslope (E5)	0.03	1.0E-09	1.47	4.7E-08	1.45	4.6E-08
Carlin Average	**0.36**	**1.1E-08**	**3.61**	**1.1E-07**	**1.39**	**4.4E-08**
Topsoil Cover						
Topsoil Crest (W1)	0.00	0.0E+00	0.00	0.0E+00	0.00	0.0E+00
Topsoil Midslope (W3)	0.00	4.1E-12	0.00	1.7E-11	0.82	2.6E-08
Topsoil Footslope (W5)	0.00	-5.9E-11	0.93	2.9E-08	4.79	1.5E-07
Topsoil Average	**0.00**	**-1.8E-11**	**0.31**	**9.8E-09**	**1.87**	**5.9E-08**
Average						
Average All Stations	**0.18**	**5.7E-09**	**1.96**	**6.2E-08**	**1.63**	**5.2E-08**
Annual Precipitation	**25.9**	**NA**	**31.0**	**NA**	**47.7**	**NA**
Percent of Annual Precipitation	**0.70%**		**6.32%**		**3.42%**	

Greater flux was determined through field monitoring than was predicted in the original unsaturated flow modeling performed prior to cover construction. The greater flux can be attributed to several factors including greater than average winter-spring precipitation in 2002 to 2005, the Carlin cover at the monitoring nests was slightly thinner than designed, and record precipitation occurred in 2005. It should be noted that if deeper sensors had been installed on the AA Pad, some of this apparent downward flux would have been captured by deeper roots, so actual flux should be lower than indicated in Table 2. This assertion is supported by the outflow monitoring data from the pad (Figure 7) which shows that the predicted drainage rate (modeled prior to cover construction) and actual drainage rate of leach solution from the AA Pad are very similar. The majority of flow from the AA Pad is attributed to gradual drain-down of leached ore with little or no supplemental water received due to flux through the cover. The drainage rate has gradually declined through time without any abrupt increases in flow that would suggest deep percolation of water through the cover. Consequently, the agreement in actual and modeled draindown suggests that the AA pad cover system is virtually eliminating deep percolation.

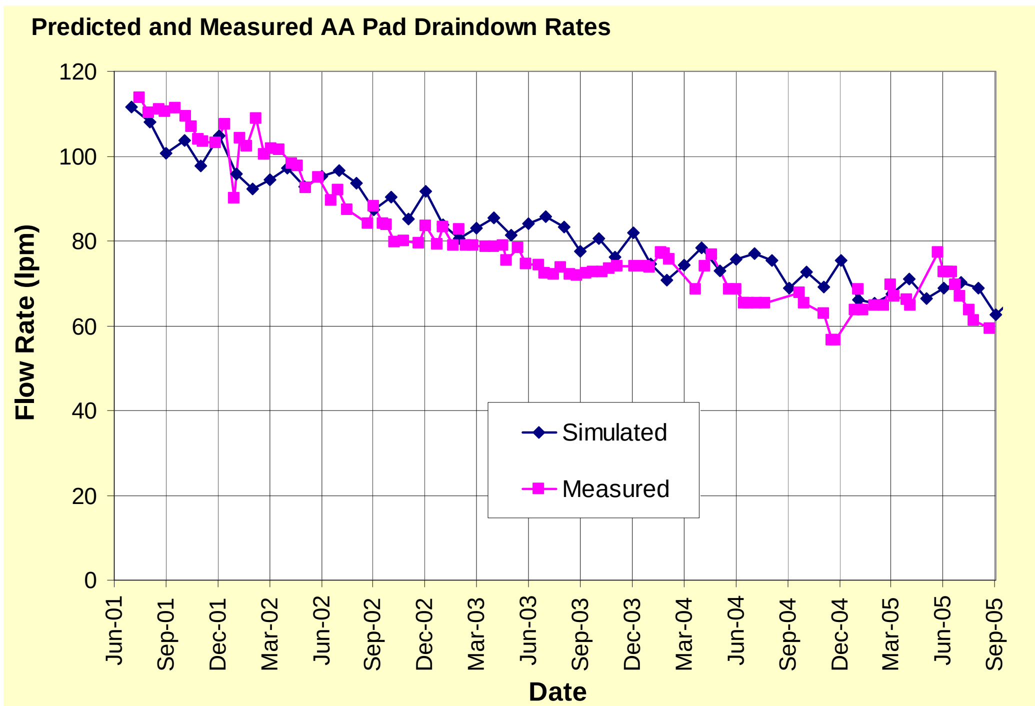


Figure 7. Predicted and measured AA Pad draindown.

<u>The Bazza WRF Design Approach</u>

Observations from the AA Pad monitoring that were used to guide the Bazza WRF design process include:

- Rooting depths will likely exceed 2 meters.
- The hydraulic properties of the topsoil and Carlin material vary and prior laboratory studies did not correspond to field-measured suction and water content.
- The thicker topsoil generally performed as a better ET cover than the in-pit Carlin material, although the differences may have been more attributable to thickness than

hydraulic properties. Also, perennial vegetation matured more slowly on the Carlin materials but generally surpassed the topsoil by the fourth growing season.

In addition, the in-pit Carlin material available for the Bazza cover will likely have higher gravel contents and lower plant AWC than the original Carlin material placed on the AA Pad. Progressing from these observations, a comprehensive laboratory and field testing, in-situ monitoring and modeling program was implemented to determine the optimum ET cover design for the Bazza WRF.

Laboratory Testing. Samples were collected from Carlin outcrops within the pit in addition to several areas on the Bazza WRF that had been previously reclaimed with 1.2 to 1.8 meters of Carlin material. Laboratory tests for particle size distribution, saturated hydraulic conductivity and water retention characteristic curves (WRCC) were performed following standard procedures (Cassel and Wilson 1986). To provide better representation of field conditions, removal of large clasts was limited to no more than 15% of the sample prior to hydraulic testing. To accommodate this practice, either 15 cm diameter or 30 cm diameter by 30 cm length cores were repacked with sample at a target bulk density determined from in-situ bulk density tests. The 15 cm diameter cores were used to test materials with up to 2 cm particle diameters, whereas the 30 cm diameter cores were used for materials with up to 4 cm particle diameter.

The WRCC (Figure 8) were determined using different methods at various suction levels. A hanging column method was used up to 100 cm of suction, followed by Tempe Cell pressure plate extraction up to 1000 cm of suction. The corresponding volumetric water content and suction data were then fit to Fredlund and Xing's equations (Fredlund and Xing, 1994) to derive the hydraulic conductivity function.

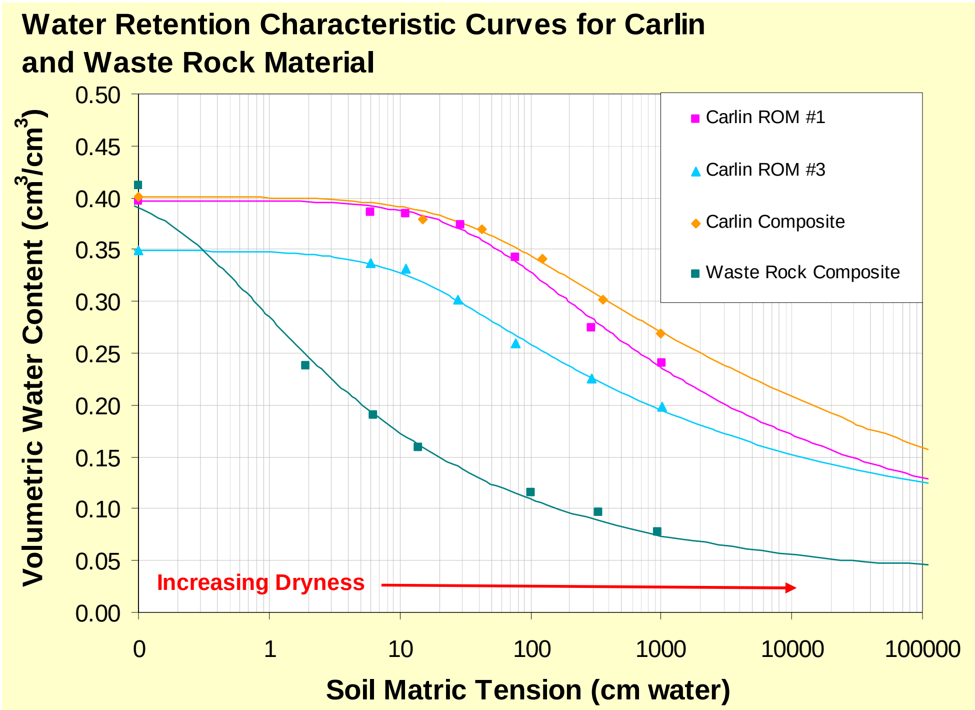


Figure 8. WRCC for Carlin and waste rock materials.

Field Testing. In-situ bulk density, AWC and effective hydraulic conductivity tests were performed on previously reclaimed areas on the north and south slope of the Bazza WRF. In-situ bulk density testing was performed using a nuclear density gage in two test pits at various depth intervals. The in-situ bulk density data were then used to specify bulk density for repacked laboratory core testing. In-situ saturated hydraulic conductivity was determined using the single ring infiltrometer method described by Bouwer et al. (1999). This is a rapid yet accurate way to determine the effective hydraulic conductivity of surface soils. Finally, available water holding capacity was determined using the method described by Cassel and Wilson (1986).

In-situ monitoring. Two in-situ monitoring stations were installed in the fall of 2003. An additional three nests were installed in July of 2005. The Bazza WRF monitoring nests are similar in design to the monitoring nests at the AA Pad, except that passive flux meters (Gee et al. 2002) were installed to measure flux directly.

Owing to the experimental status of some devices and short records, in-situ Bazza monitoring data is not presented herein.

Cover Performance Modeling. The two-dimensional finite element code, VADOSE/W (GEO-SLOPE International Ltd., 2002) was used for unsaturated flow numerical simulations of the Bazza WRF cover system. The VADOSE/W model employs daily climatic input data that includes maximum and minimum temperature, maximum and minimum relative humidity, average wind speed, and precipitation. The model estimates net radiation, which is then used to estimate potential and actual evaporation using the Penman-Wilson Equation (Wilson, 1990). Net radiation equals incoming (total) radiation, which is measured at local weather stations, minus reflected shortwave and emitted longwave radiation.

The model was first initialized using site-specific hydraulic property, climatic and vegetative demand parameters and then calibrated using measured suction data from station W-2 on the AA Pad topsoil cover.

Several modifications to the model were required to achieve adequate calibration. Owing to the north-facing slope of the AA pad where the topsoil monitoring devices were located, the energy available for evapotranspiration was less than would occur on a flat slope, which is the default model condition. Swift (1976) developed an algorithm for adjusting incoming solar radiation to account for varying slopes and aspects. Based on Swift, a 3:1 north-facing slope would have 29 % lower net radiation than a level slope and a south-facing 3:1 slope would have 24 % higher net radiation. In order to account for less evaporative energy on the north-facing slope, the albedo was increased. In addition, the transpiration demand was modified by increasing the permanent wilting point in the model to 40 bars, which is more representative of desert plant communities in the Great Basin. Similarly, the critical suction at which moisture stress begins to cause a reduction in the ET was increased from the conventionally used value of 1 bar, to 2 bars. The revised value was based on an assessment of the salinity tolerance of species in the reclaimed plant community. The cover performance was modeled for a mature stand using a leaf area index (LAI) of 2.4, which implies that when vegetation becomes fully matured, about 87% of potential solar energy will be intercepted by plants with remaining 13% intercepted by bare ground. Measured vegetation canopy cover on topsoil areas reached about 80 % by the third growing season on the AA Pad.

The VADOSE/W model provided very good agreement to the measured suction at the AA Pad sensor nest W-2. Comparing the estimated and measured suction on Figure 9 shows the model closely matched the variation in suction observed seasonally and by depth. In particular, seasonal wetting and drying was accurately predicted at 30 cm starting in December 2002 through December 2003. The calibrated VADOSE/W model also simulated the wetting front movement in February through mid March, 2004. Measured water content at nest W2 ranged from 6 to 7 % volumetric to around 17 % volumetric as the soil was wetted and dried by infiltration of meteoric water in the winter and withdrawal by plants in the summer (Figure 9). The Vadose/W model showed a similar range of predicted water content in the topsoil layer indicating the model provides good agreement of the soils water holding capacity.

Based on the calibration of the VADOSE/W model, the model was initialized (Table 3) for the Bazza cover design and several different cover depths and combinations (Figure 10) were simulated.

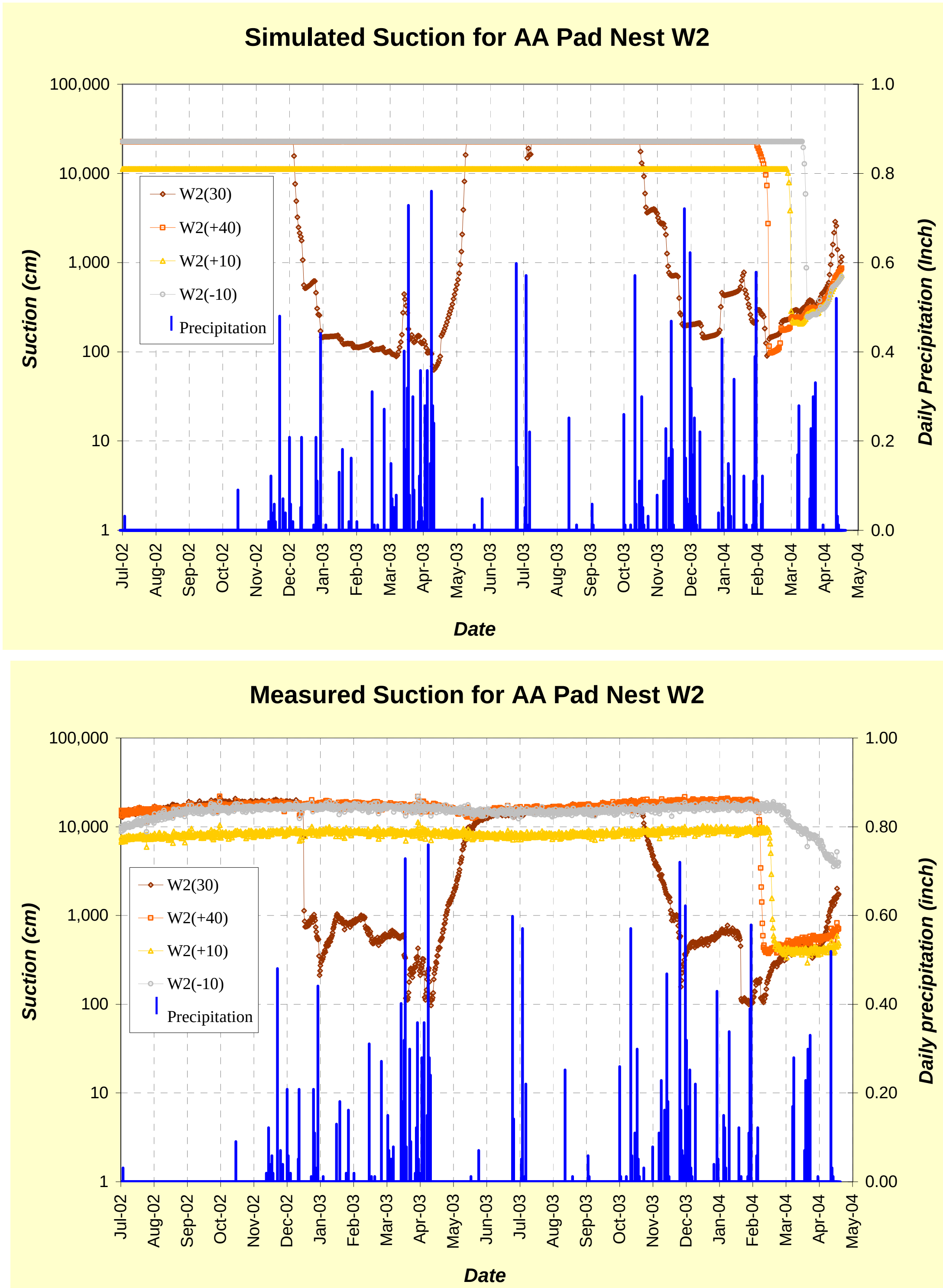


Figure 9. Simulated suction at AA Pad sensor nest W2 based on the calibrated VADOSE/W model (above) compared to measured suction for the same period (below).

Table 3. VADOSE/W input data for the Bazza soil cover simulations

Parameter	Value		
Duration of model run	34 years, based on meteorological data from January 1, 1967 through December 31, 2000		
Average annual precipitation	266 mm		
Depth of model domain	13.8 m		
Bottom boundary condition	Unit gradient		
Upper boundary condition	Atmospheric		
Growing season	April through October		
Depth of rooting	180 cm, 92 cm in April and October		
Peak Leaf Area Index	2.4		
Critical suction [1]	2 bars (200 kPa)		
Wilting point	40 bars (4,000 kPa)		
Parameter	**Material Characteristics**		
	Topsoil	**Carlin Formation**	**Waste Rock**
Thickness	variable	variable	12 m
Saturated water content (V/V)	35	39.6	47.1
Field capacity water content	25	28	26
Wilting point water content	6.5	10	9
Saturated K (0-5 cm) (5-30 cm) (30-60 cm)	$1.74 * 10^{-3}$ cm/s $1.74 * 10^{-4}$ cm/s $4.85 * 10^{-5}$ cm/s	$5.3\ 10^{-4}$ cm/s all depths	$7.4 * 10^{-3}$ cm/s all depths

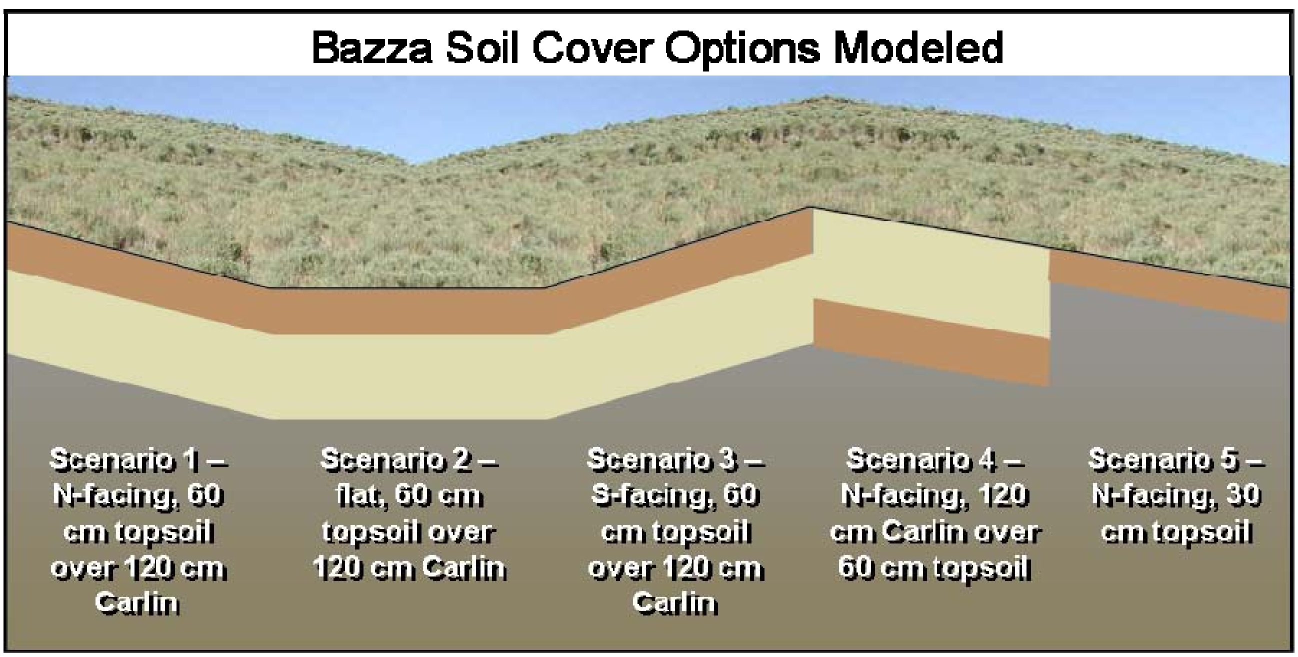


Figure 10. Cover configuration and aspects simulated using VADOSE/W for the PAG cell (scenario's 1 through 4) and for non-PAG areas.

In order to simulate the long-term performance of the cover system, a 35-year meteoric record (1966-2001) was developed. The BGMI North Block weather station only has a record from 1990 to the present. Data from 1966 to 1990 was generated by using weather data from the Carlin Newmont and Elko Airport weather stations and adjusting the data to site conditions based on correlations observed between these sites and the BGMI North Block station during overlapping periods of record. For the simulation period, 11 years were above the average annual precipitation, with a maximum daily precipitation of 59 mm. The hydraulic properties of topsoil were derived from the calibrated process using measured suction data from station W-2 on the AA Pad. The hydraulic properties of the Carlin and waste rock materials were derived from the in-situ hydraulic conductivity testing and the laboratory derived soil water characteristic curves (Figure 8 and Table 3).

Bazza Cover Modeling Results

The modeling results indicate that proposed Bazza soil cover will provide an effective barrier to movement of meteoric water into PAG waste rock (Figures 11). Overall, about 160 mm of water percolated through the cover (flat-lying slope) during the 34 year simulation. South-facing areas had less percolation (100 mm) while north aspects had more (225 mm). No percolation was predicted at all during the dry years from 1986 to 1992 (upward flux occurred in dry years) and annual flux was less than 100 mm in all years.

In scenario 2 (60 cm topsoil over 120 cm Carlin), most storage and release of water is predicted to occur within the upper 60 cm of the cover system. Most of the remaining water is then intercepted by plants before it moves through the Carlin layer. The annual water budget is listed in Table 4. The average annual flux was 4 mm or less than 2 % of the annual precipitation. Runoff accounted for about 3 % of annual precipitation. The majority of meteoric water was lost either as evaporation (97 mm/yr, 37 % of total) or transpiration (157 mm/yr, 59 % of total).

Chosen Bazza WRF Design

For PAG cell areas, the proposed cover will consist of a combination of 60 cm of topsoil and 120 cm of in-pit Carlin material. Collectively, these materials provide a thicker cover than was used on the AA pad. Simulations suggest that the Carlin is more effective when placed on the top of the soil cover. Additionally, long term perennial vegetation performance is better in the

Carlin than topsoil areas due to reduced invasion by annual grasses. Assuming that topsoil has an AWC of 18 % and 10 % for the Carlin (Table 3), the PAG cover system will provide at least 200 mm of AWC, which is about the same overall AWC as the topsoil cover used on the AA pad. The proposed PAG cell cover will be extended laterally beyond the boundaries of PAG waste rock placement to prevent lateral movement of water from adjacent non-PAG areas from contacting PAG rock.

In non-PAG areas, a thinner cover will be used, which will be comprised of topsoil or Carlin materials, alone or in combination with a minimum combined thickness of 0.3 meters. In the non-PAG areas, roots will probably extend well into the regraded waste rock layer.

The cover system proposed for the Bazza facility is expected to reduce deep percolation through the cover in the PAG cells to less than 5 mm/yr, which equates to about 22 liters per minute. Additionally, deep percolation would flow into a thick mass of waste rock that is drier than residual saturation, which would eliminate migration into unsaturated foundation materials until residual saturation is reached. If any seepage were to exit the Bazza PAG cells in the long term, the underlying aquifer materials and groundwater are strongly alkaline and would tend to neutralize the small quantity of waste rock seepage. Finally, after closure groundwater beneath the Bazza mostly flows toward the open pit where the contribution of a small amount of waste rock seepage it is not expected to have any measurable effect on long-term water quality.

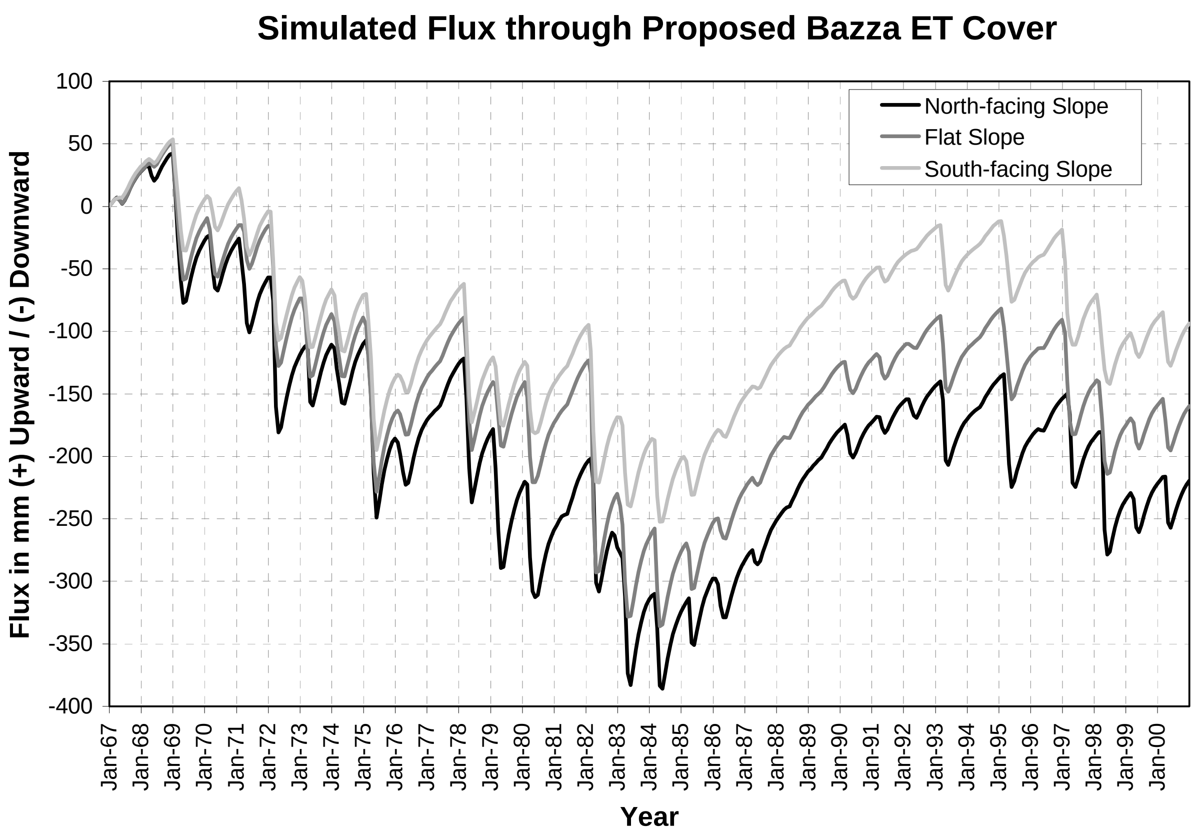


Figure 11. Simulated cumulative net flux through the proposed Bazza ET cover for flat, north and south-facing slopes.

Table 4. VADOSE/W results for the Bazza PAG and non- PAG area soil cover simulations.

Annual Water Budget	**1 - North 60T+120C+W**	**2 - Flat 60T+120C+W**	**3 - South 60T+120C+W**	**4 - North 120C + 60T + W**	**5 - North 30T + W**
			(mm/yr)		
Deep Percolation	5.65	4.08	2.39	2.36	7.72
Surface Water Runoff	7.01	7.85	6.75	5.88	8.98
ET	253.3	254.0	256.8	257.7	249.2
Evaporation	86.7	97.3	104.7	86.4	119.3
Transpiration	166.6	156.7	152.1	171.2	130.0
Precipitation	265.9	265.9	265.9	265.9	265.9
PE	1,142	1,267	1,325	1,133	1,139
Percolation/Precipitation	2.1%	1.5%	0.9%	0.9%	2.9%

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