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CDS -- Client Communication

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Water Balance Study for the King II Mine In Response to Neighborhood Comments In Conjunction with a Permit Expansion of GCC Energy, LLC King II Coal Mine

For
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May 8, 2014
Executive Summary added July 20, 2015

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Executive Summary

This is report summarizes a research/analytical project completed in response to adjacent landowner comments received at a Neighborhood Meeting held December 19, 2013. This meeting is part of the technical review of a Class II Land Use Permit and Lease Modification for the King II Mine, located at 6473 County Road 120, Hesperus, Colorado 81326 and operated by GCC Energy LLC (GCC).

GCC contracted with CDS Environmental Services LLC, of Durango, Colorado [CDS], to address the specific concern about water balance within the active mine. To complete this study CDS utilized input from Southwest Land Services, Inc. and Resource Hydrogeogic Services Inc. [RHS], both from Durango, CO.

The general concern posed, at the Neighborhood Meeting, was possible local groundwater contamination. The specific questions addressed in this report are ***1] how much water remains in the mine and 2] could that residual water enter local groundwater?*** To answer these questions a study to acquire specific data on water usage within the King II Mine began February 10, 2014 and ended February 23, 2014. This two week study is representative of ongoing mining operations and does reflect the mine's ongoing operational water balance.

The study was able to determine two major water uses within the mine:

1. Dust suppression at the continuous miner during actual mining operations
2. Dust suppression of roadways within the mine [includes small amounts of water used for washing dust off of equipment within the mine]

The study determined there are three terminal dispositions for water in the mine:

1. Wet coal leaving the mine [water sprayed onto the coal during mining]
2. Water leaving the mine as increased humidity due to sprayed water during operation of the mining machine and from evaporation from moving coal on the conveyor system and from evaporation from roadway spraying
3. Water that remains in the mine

The following data was used in this study:

1. Gallons of water entering the mine each 24 hour day for 14 consecutive days and it's split between the roadway and the mining machine
2. Tons of coal mined each 24 hour day for 14 consecutive days
3. Moisture content of unmined coal derived from core analysis
4. Moisture content of coal arriving at its final destination for four months

5. Average relative humidity as reported by the National Weather Service for the same 14 day consecutive period
6. Relative humidity measurements of air leaving the mine
7. Amount of air pumped into the mine from fans for the same 14 day consecutive period

The water balance summary for the 14 consecutive days in February 2014 is:

1. **Total water entering mine over the 14 day period** **348,500 gallons**
   or an average of 24,893 gallons per day
2. **Total water leaving the mine as wet coal** **203,282 gallons**
   or an average of 14,520 gallons per day
3. **Total water leaving the mine by evaporation** **140,312 gallons**
   or an average of 10,022 gallons per day
4. **Total water left in mine over 14 days** **4,906 gallons**
   or an average of 350 gallons per day

Looking at the same data as a percentage is:

1. **Total water entering mine over the 14 day period** **100%**
2. **Total water leaving the mine as wet coal** **58.33%**
3. **Total water leaving the mine by evaporation** **40.26%**
4. **Total water staying in the mine** **1.41%**

Looking at the same data after statistical analysis of raw data is:

1. Median gallons of water entering the mine per day 24,893 gallons
2. Median gallons of water leaving the mine on coal 14,411 gallons
3. Median gallons of water lost to daily evaporation 10,022 gallons
4. Median daily gallons water left in the mine **122 gallons** ± 218 gallons

In summary, the median amount of water left in the mine per day is 122 gallons. The statistical variability of ± 218 gallons suggests that the measurable water left in the mine is very low – a median percentage of 0.49 % remaining in the mine or between 340 and zero gallons per day. The median maximal amount of water remaining in the mine is 1.36%.

Final Report of Project

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Water Balance Study for the King II Mine In Response to Neighborhood Comments In Conjunction with a Permit Expansion of GCC Energy, LLC King II Coal Mine

For

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May 8, 2014

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Water balance study: King II Mine

This report is a summary of a research/analytical project completed in response to adjacent landowner [ALO] comments received at a Neighborhood Meeting held December 19, 2013. This meeting is part of the technical review of a Class II Land Use Permit and Lease Modification for the coal mine known as the King II Mine, located at 6473 County Road 120, Hesperus, Colorado 81326 and operated by GCC Energy LLC (GCC).

In a good faith response to a concern voiced at this meeting, GCC contracted with CDS Environmental Services LLC, of Durango, Colorado [CDS] , to work in conjunction with Southwest Land Services, Inc., of Durango, Colorado, and Resource Hydrogeogic Services, Inc. also of Durango, Colorado [RHS] to address this neighborhood concern.

This report deals with a specific question posed at the Neighborhood Meeting. In general, the question asked was ***how much water remains in the mine and can that water enter local groundwater?*** To answer this question CDS along with RHS setup a study to acquire specific data on water usage within the King II Mine between February 10, 2014 and February 23, 2014. The specific data sets sequestered for this study are:

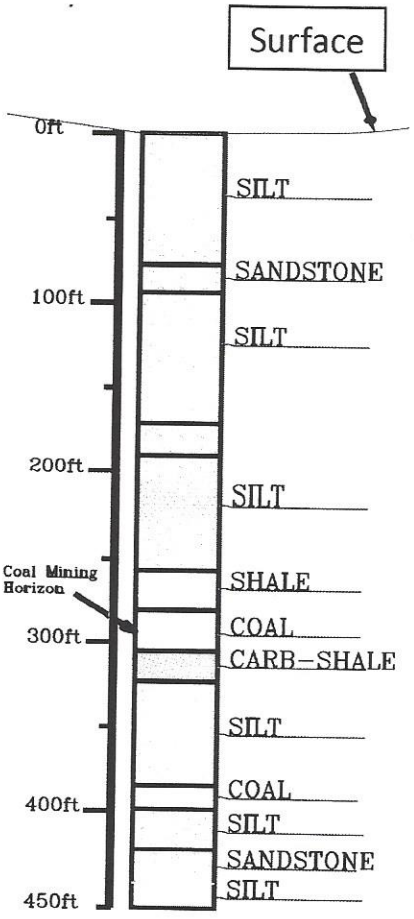
- How much water enters the mine each day
- How much water leaves the mine each day from:
  a) Mined coal
  b) Water used for dust control carried on mined coal
  c) Loss by evaporation carried out by ventilation air
  d) Other factors
- How is the water entering the mine used
- How much coal is mined and leaves the mine each day
- How much air enters and leaves the mine each day
- What is the intrinsic moisture of the coal in situ
- What is the moisture of the mined coal as is leaves the mine
- Factors effecting the water vapor entering and leaving the mine
  a) Temperature
  b) Relative humidity
  c) Elevation of the mine
  d) Barometric pressure
  e) Other factors
- What is the underlying geology of the floor of the mine

As can be seen, from the list of various types of data, which enters into the water balance calculation, this is a complex process. Since the solution of this complex process over a long time, such as a year, is both expensive and time consuming, CDS chose to use a well-defined two week period where most of the factors effecting water balance could be assimilated at a reasonable cost. The period chosen to carry out the water balance calculations for the King II Mine was February 10 to February 23, 2014.

This report is composed of five specific items:

1. A listing of collected data
2. A collection of calculation factors needed to complete the math
3. A report discussing the calculated water balance
4. Summary and conclusion
5. An appendix of a Technical Report, raw data, assumptions and calculations

1.0 Geological data



GCC operates the King II mine with mechanical miners, which require spray nozzles to control dust during continuous mining. In addition water is used to control dust on the roadways within the mine proper. Each of these require a variable amount of water depending on how fast a particular miner unit is moving, and in particular the rate of coal generation to the outside. Some of this water is carried from the mine portal as wet coal, while the movement of air carries the balance. Figure 1, to the left demonstrates the layers [strata] from the surface down to 450 feet below surface. Figure 1 indicates several impervious layers [strata] below the mined coal seam. These include carbonaceous shale and silt (stone).

Figure 1 Typical cross section of area currently mined at the King II Mine

The determination of a true water balance over a long period is difficult to obtain since conditions within the mine change constantly. For example, the rate of mining is not constant so the amount of water needed for dust suppression varies from day to day. In addition, the amount of water vapor carried into and out of the mine by the ventilation system also varies continuously. For example, temperature, relative humidity and barometric pressure, which affect the amount of water carried by the air moving into and out of the mine can vary during any 24 hour cycle. To incorporate these variables into a water balance calculation is at best a difficult and expensive task. To achieve a reasonable water balance calculation CDS chose a fourteen day period to illustrate a reasonable water balance estimate. To achieve this two-week data set GCC personnel obtained temperature and relative readings, amount of coal mined and its water content, air throughput and water entering the mine between February 10, 2014 and February 23, 2014. In addition several calculation values were obtained from larger data sets encompassing several months, for example air throughput was obtained over the four month interval just prior to the two week period used for calculations. Data for barometric pressure were obtained from weather service data for the Durango-La Plata County Airport.

The following is extracted from a technical report provided by Landon Beck of RHS. The complete report is found in the appendix.

2.0 Dust suppression

The only purpose for direct water use underground at the King II Mine is dust suppression. Dust suppression is required for two primary reasons. First, coal dust suppression in confined spaces such as underground mine workings is critical to minimizing the potential for an explosive atmosphere. Second, to minimize respirable coal dust by miners. The United States Mine Safety and Health Administration (MSHA) established permissible standards for coal dust as required by the Federal Mine Safety and Health Act of 1977. The King II mine is in compliance.

Ultimately, the need for this study is based on the high value of water in this region due to limited supplies of potable quality. GCC Energy holds ditch water rights in Hay Gulch to meet the King II mine water supply needs. Water use and management can add substantial costs to mining operations, and GCC Energy is not immune to these costs. This is particularly true given the coal currently mined at King II is not groundwater saturated [dry coal] so any water addition potentially devalues the product due to the negative effect of moisture on its heating value. As such, water conservation measures are practiced to minimize any waste. These conservation measures include use of low-flow misting nozzles on the continuous mining equipment. Misting nozzles keep water use low while removing airborne coal particles from suspension in the atmosphere. See **PHOTO 1** for a picture of one of GCC Energy's continuous miner

machines actively misting dust suppression water. This misting system on the continuous mining machines is used in conjunction with an onboard ventilation system to ensure dust is directed away from the machine operator. This equipment is the primary means for distributing dust suppression water as it is applied while coal is actively being cut. The equipment is operated in a manner so that the water is only used as needed.

Additionally, roadway dust is suppressed by spraying water directly to the underground mine roads. The fraction of water used for road watering of the total amount used for underground dust suppression ranges from 11% to 21% daily during the period of investigation. This water is applied in a manner so that puddling is minimized, thereby reducing any potential for infiltration into the mine roads

3.0 Water Balance Summary

The resulting water final balance for the King II mine is calculated by subtracting the total water output from the total water input. Table 1, in the attached Technical Report, shows the daily calculated values and summary statistics for the fourteen day period of investigation. The results indicate the fourteen day median water balance is 122 gallons per day, ± 218 gallons. This equates to 99.51% accountability of the water entering the mine and leaving the mine through mined coal and evaporation. The calculated statistical error range of ± 218 gallons demonstrates the water balance may be in equilibrium or in deficit. A water balance deficit could occur if more water is removed from the mine by evaporation and mining than is pumped in from the surface. A water balance surplus could occur if more water is pumped into the mine than is removed by evaporation and mining.

4.0 Summary

A water balance study was conducted with available data for a fourteen day period of investigation from February 10, 2014 through February 23, 2014. The purpose of the study was to identify and quantify the water input and output at the King II mine. It was found that the active sources of water input to the mine are either liquid water piped in for required dust suppression efforts or as relative humidity in the form of water vapor drawn into the mine by the ventilation system. GCC Energy practices water conservation in dust suppression efforts by use of low-flow misting nozzles on the continuous miner machines and by application procedures to prevent puddling during mine road watering. These practices minimizes the potential for any water to be available for infiltration into the subsurface.

The water output from the mine was found to be either through mining of the coal or through evaporation. Water applied for dust suppression to the mine face is immediately reclaimed by collection and transport of that mined coal to surface via the belt portal. Documentation of mined coal moisture and inherent, or in-place coal

moisture by laboratory tests allow a calculation of water volume added to coal during dust suppression. Based on the fourteen day average for the period of investigation approximately 58% of the water used in dust suppression is reclaimed in mined coal. The mine ventilation system draws substantial air flow throughout the mine, including the areas subject to active dust suppression. The removal of water vapor by evaporation from the mine is greater than two times the amount of water vapor that enters the mine in ambient surface intake air. Nearly the balance of the dust suppression water, 41.5%, was calculated to be removed by evaporation through the mine ventilation system.

The results of the water balance study show 122 gallons per day, ± 218 gallons input to the mine that are potentially not recovered by coal extraction or evaporation. However, given a statistical error of ± 218 gallons, the system could be in equilibrium or even deficit with more water removed from the mine than introduced to the mine.

5.0 Conclusion

Based on the dust suppression water use practices at the King II mine and the water balance prepared for this fourteen-day period of investigation, it appears unlikely there is a potential water source for subsurface infiltration.

6.0 Appendix

Technical Report by RHS, Inc.

Underground Mine Water Consumption

Temperatures and Relative Humidity Data

Analyzed Moisture in Coal, as Received

Underground Mine Surface Area Exposed

Water Loss from Evaporation Calculations

Main Mine Fan Output

Mine Coal Production in Tons per Day

Water in air conversion chart [temperature v relative humidity]

Assumptions and data used for calculations

Map showing airflow within the King II Mine

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TECHNICAL MEMORANDUM

To	Trent Peterson, GCC Energy LLC	**Ref #**	5-1-TM-FINAL
CC	Joe Bowden, CDS Environmental, LLC	**Date**	May 8, 2014
From	Landon Beck		
Subject	King II Coal Mine Water Balance		

This technical memorandum presents documentation of water use in operations of the GCC Energy, LLC King II Coal Mine. This study was conducted in response to adjacent land owner (ALO) questions raised at a neighborhood compatibility meeting held December 19, 2013. A water balance was prepared to quantify water input and output at the mine to assess the potential for water infiltration and migration offsite.

KING II WATER USE

DUST SUPPRESSION

The only purpose for direct water use underground at the King II Mine is dust suppression. Dust suppression is required for two primary reasons. First, coal dust suppression in confined spaces such as underground mine workings is critical to minimizing the potential for an explosive atmosphere. Second, to minimize respirable coal dust by miners. The United States Mine Safety and Health Administration (MSHA) established permissible standards for coal dust as required by the Federal Mine Safety and Health Act of 1977.

Ultimately the need for this study is based on the high value of water in this region due to limited supply of potable quality. GCC Energy holds ditch water rights in Hay Gulch to meet the King II mine water supply needs. Water use and management can add substantial costs to mining operations, and GCC Energy is not immune to these costs. This is particularly true given the coal resource at King II is not groundwater saturated so any water addition potentially devalues the product due to the negative effect of moisture on its heating value. As such, water conservation measures are practiced to minimize any waste. These conservation measures include use of low-flow misting nozzles on the continuous mining

equipment. Misting nozzles keep water use low while removing airborne coal particles from suspension in the atmosphere. See **PHOTO 1** for a picture of one of GCC Energy's continuous miner machines actively misting dust suppression water. This misting system on the continuous mining machines is used in conjunction with an onboard ventilation system to ensure dust is directed away from the machine operator. This equipment is the primary means for distributing dust suppression water and it is only applied at the face while coal is actively being cut. The equipment is operated in a manner so that the water is only used as needed.

Additionally, roadway dust is suppressed by spraying water directly to the underground mine roads. The fraction of water used for road watering of the total amount used for underground dust suppression ranges from 11% to 21% daily during the period of investigation. This water is applied in a manner so that puddling is minimized thereby reducing any potential for infiltration into the mine roads.

WATER BALANCE

A water balance is simply a means to document the flow of water into a given system and the flow of water out from that system. In a natural system there are numerous potential pathways for water to travel in and out of the system which can be quite complicated to assess and quantify. The pathways can also be influenced by the physical state of the water being solid, liquid or gaseous. However, in the case of the King II Mine, the water input sources are limited given that this particular underground mine does not intersect any groundwater.

A water balance was prepared using GCC Energy data for the King II Mine over a fourteen day period of record from February 10, 2014 to February 23, 2014. This period is representative of routine mining operations with coal production within the normal daily range. The water balance is presented as the following **TABLE 1**. Input and output values are displayed as daily figures and then used to compute fourteen day summary statistics. The final balance is given in gallons of water so unit conversions have been calculated as necessary.

Water Input

As discussed in the previous section, surface ditch water is collected and piped into the mine for dust suppression and distributed either by the continuous miner machines or by a water truck. The quantity of water piped into the mine is metered so an accurate daily volume record of use is maintained by GCC Energy. These volumes are recorded in gallons in **TABLE 1** under the column heading "Water Piped into Mine". The fourteen day average is 24,893 gallons of water piped into the mine per day.

The other source of water introduced into the mine is through the air ventilation system. Mine ventilation air flow is documented as follows:

Air Flow	ft3/minute	ft3/hour	ft3/day
Air Flow into Mine by Fan	342,720	20,563,200	493,516,800

342,720 ft3/minute is the average air flow from Nov. 2013-March 2014

Fresh air drawn at the mine ventilation fan includes natural water vapor which can be quantified with the ambient relative humidity, temperature, barometric pressure and elevation data. These values during this period of investigation were taken from local National Weather Service average data collected at the Durango-La Plata County Airport (DRO) and are expected to be representative of conditions at the surface of the King II Mine due to relative proximity. The elevation used for the calculation is the elevation at the King II surface facility. The calculated densities of both dry air and water are given in the following table.

Measurements Taken	Air Intake
Ambient Air Temperature (°F)	38.0
Relative Humidity (%)	46%
Barometric Pressure (inches Hg)	30.2
Elevation (ft msl)	7,320
Constant	
Density of Water - lbs./ gallon	8.345404
Result	
Density of Dry Air (lbs./ft3)	0.06010
Density of Water in air (lbs. water/lbs. air)	0.00254

The water vapor contained in the ventilation air flow into the mine was then calculated to be 9,027 gallons per day.

Water Vapor Flow into Mine by Fan per Day	Result
Air Entering Mine (lbs)	29,660,360
Water Vapor Entering Mine (lbs)	75,337
Water Vapor Entering Mine (gallons)	**9,027**

Moisture is contained within the in-place coal and is referred to as the inherent coal moisture. This value was derived from laboratory testing of crushed coal core samples collected during exploratory drilling by GCC Energy for resource evaluation and mine planning. The inherent (in-situ) coal moisture is 4.40% and is considered a constant for the area of the King II Mine. It is important to note that this moisture in place is not due to current saturation by groundwater of

the coal seam. If that were the case, the coal would contain free-flowing groundwater within fracture networks, which it does not. The inherent moisture value is critical to calculate the volume of water added to the coal as discussed in the next section.

Water Output

Greater than 50% of the water output from the King II Mine is through the physical removal of the coal. As most water distribution is by the continuous miner machines, the daily water use is directly correlated to coal production. The water misted directly onto the mine face during cutting is generally absorbed and held by the coal. The mined coal holds the moisture while being transported from underground to the surface. For the period of February 14, 2014 through February 20, 2014 the average laboratory tested mined coal moisture was 6.46%. From the inherent coal moisture stated previously of 4.40%, it is inferred that the difference in value (6.46% - 4.40% = 1.86%) is a direct result of dust suppression water introduced during the mining operation. **TABLE 1** shows the calculation of water added to the coal by dust suppression, in gallons, by the multiplication of coal produced by 1.86% moisture with unit conversions. The fourteen day average for the period of investigation is 14,520 gallons of water removed per day by mining coal.

The water that is misted but remains in the mine air space either falls as liquid to freshly cut coal to be removed to surface or is drawn into a gaseous state by evaporation as water vapor. The water vapor is then subject to removal from the mine by the ventilation system. The ventilation system outlets at two locations, the return portal and the belt portal. Air flow from these two locations is recorded weekly and results in the following splits.

Air Splits	% of Total	ft3/day
% Air Out By - Portal	83.7%	413,073,562
% Air Out by - Belt	16.3%	80,443,238

Water vapor in the mine output air is calculated in the same fashion as the water vapor input air as discussed in the previous section. However, air temperature and relative humidity data are regularly collected at the return and belt portals so site data was available for the period of investigation. This data was averaged for the fourteen day period of investigation. Again, barometric pressure was obtained from National Weather Service data at DRO and the elevation used is for the surface facility at the King II mine. The following table shows the measurement values and resulting calculated densities and volumes of water removed by the mine ventilation system for each portal.

Measurements Taken	Return Portal	Belt Portal
Ambient Air Temperature (°F)	52.0	49.0
Relative Humidity (%)	60%	90%
Barometric Pressure (inches Hg)	30.2	30.2
Elevation (ft msl)	7,320	7,320
Constant		
Density of Water (lbs./ gallon)	8.345404	8.345404
Result	**Return Portal**	**Belt Portal**
Density of Water (lbs. water/lbs. air)	0.00506	0.00690
Air Out (ft3/day)	413,073,562	80,443,238
Air Out (Lbs.)	24,825,721	4,834,639
Water Out (Lbs.)	125,618	33,359
Water Out (Gallons)	15,052	3,997

The resulting sum of the water removed by the mine ventilation system (Water Out) through the return and belt portals by evaporation is 19,050 gallons per day. The total water removed by evaporation from the mine is based on the difference of the water vapor entering the mine subtracted from the water vapor exiting the mine.

Total Water Loss Due to Evaporation Per Day	
Total Water Out - Portal and Belt (gallons)	19,050
Total Water In - Mine Fan (gallons)	9,027
Total Water Loss Due to Evaporation (gallons)	**10,022**

The total loss of water due to evaporation is assumed to be constant for the fourteen day period of investigation given the input data for that calculation are daily averages.

Water Balance Summary

The resulting final water balance for the King II mine is calculated by subtracting the total water output from the water input. **TABLE 1** shows the daily calculated values and summary statistics for the fourteen day period of investigation. The results indicate that the fourteen day median

water balance is 122 gallons per day, ± 218 gallons unaccounted. This equates to 99.51% accountability of the water entering the mine and leaving the mine through mined coal or evaporation. The calculated range of ± 218 gallons statistical error demonstrates that the water balance may or may not be in equilibrium on any given day. A daily water balance deficit could occur if more water is removed from the mine by evaporation than is input by the combination of dust suppression water and water vapor in the ventilation system supply air from surface.

CONCLUSION

A water balance study was conducted with available data for a fourteen day period of investigation from February 10, 2014 through February 23, 2014. The purpose of the study was to identify and quantify the water input and output at the King II mine. It was found that the active sources of water input to the mine are either liquid water piped in for required dust suppression efforts or as relative humidity in the form of water vapor drawn into the mine by the ventilation system. GCC Energy practices water conservation in dust suppression efforts by use of low-flow misting nozzles on the continuous miner machines and by application procedures to prevent puddling during mine road watering. These practices minimizes the potential for any water to be available for infiltration into the subsurface.

The water output from the mine was found to be either through mining of the coal or through evaporation. Water applied for dust suppression to the mine face is immediately reclaimed by collection and transport of that mined coal to surface via the belt portal. Documentation of mined coal moisture and inherent, or in-situ coal moisture by laboratory tests allow a calculation of water volume added to coal during dust suppression. Based on the fourteen day average for the period of investigation approximately 58% of the water used in dust suppression is reclaimed in mined coal. The mine ventilation system draws substantial air flow throughout the mine, including the areas subject to active dust suppression. The removal of water vapor by evaporation from the mine is greater than two times the amount of water vapor that enters the mine in ambient surface intake air. Nearly the balance of the dust suppression water, 41.5%, was calculated to be removed by evaporation through the mine ventilation system.

The results of the water balance show 122 gallons per day, ± 218 gallons input to the mine that are potentially not recovered by coal extraction or evaporation. However, given a statistical error of ± 218 gallons, the system could be in equilibrium or even deficit with more water removed from the mine than introduced to the mine.

Based on the dust suppression water use practices at the King II mine and the water balance prepared for this fourteen day period of investigation, it appears unlikely water piped into the mine is a potential water source for subsurface infiltration.

Appendix:

Table 1

Photo 1

Date	Water Piped into Mine (Gallons)	Coal Produced (Tons)	Water Added To Coal from Dust Suppression* (%)	Water Added To Produced Coal (Tons)	Water Added to Produced Coal (Lbs)	Water Added to Produced Coal from Dust Suppression (Gallons)	Water Balance (Gallons)	Water Lost from Evaporation** (Gallons)	Final Water Balance (Gallons)
2/10/2014	21,700	2,629	1.86	48.899	97,799	11,718.88	9,981	10,022	-41
2/11/2014	24,600	3,166	1.86	58.888	117,775	14,112.58	10,487	10,022	465
2/12/2014	28,600	3,497	1.86	65.044	130,088	15,588.03	13,012	10,022	2,990
2/13/2014	26,000	4,279	1.86	79.589	159,179	19,073.83	6,926	10,022	-3,096
2/14/2014	22,900	3,581	1.86	66.607	133,213	15,962.46	6,938	10,022	-3,085
2/15/2014	16,900	2,694	1.86	50.108	100,217	12,008.62	4,891	10,022	-5,131
2/16/2014	20,100	2,873	1.86	53.438	106,876	12,806.52	7,293	10,022	-2,729
2/17/2014	28,400	3,122	1.86	58.069	116,138	13,916.45	14,484	10,022	4,461
2/18/2014	22,000	2,623	1.86	48.788	97,576	11,692.14	10,308	10,022	286
2/19/2014	31,400	3,300	1.86	61.380	122,760	14,709.89	16,690	10,022	6,668
2/20/2014	29,900	3,301	1.86	61.399	122,797	14,714.35	15,186	10,022	5,163
2/21/2014	24,000	3,497	1.86	65.044	130,088	15,588.03	8,412	10,022	-1,610
2/22/2014	25,300	4,146	1.86	77.116	154,231	18,480.97	6,819	10,022	-3,203
2/23/2014	26,700	2,896	1.86	53.866	107,731	12,909.05	13,791	10,022	3,769
Totals	348,500	**45,604**		**848.234**	**1,696,469**	**203,282**	**145,218**	**140,312**	**4,906**
14 day Average	24,893	3,257		60.59	121,176	14,520	10,373	10,022	350
14 day Median	24,950	3,233		60.13	120,268	14,411	10,144	10,022	122
Standard deviation-P ±	**3,858**	**498**		**9.27**	**18,537**	**2,221**	**3,570**	**0**	**3,570**
Standard deviation-S ±	**4,004**	**517**		**9.62**	**19,237**	**2,305**	**3,705**	**0**	**3,705**
Average dev from the mean	3150	400		7.44	14875	1782	3059		3059
14 day Median water balance	**122**	**± 218 Gallons per day unaccounted for by current measurements*** **							

Daily Water Use Accounted for 99.51 Percent of water entering King II accounted for from coal dust suppression and water vapor loss

**Average coal moisture as shipped 2/14/14 to 2/20/14 = 6.26% less coal moisture in situ [4.40%] = 1.86% for dust suppression*

*** Temperature/Relative Humidity readings for incoming air are based on National Weather Service average data for 2/10/14 to 2/23/2014*

Temperature/Relative Humidity readings for outgoing air based on a 7 day average at mine air exits, which tend to be constant

**** Calculated from the 14 day median ÷ average deviation from the mean ÷ 14 days = average deviation from the mean [3059 ÷14 = ± 218 gallons]*

Table of Constants and Conversations

Table of Constants	
Inherent coal moisture	4.40%
Density of water, (Lbs./gallon)	8.345404
Pounds per Ton	2,000

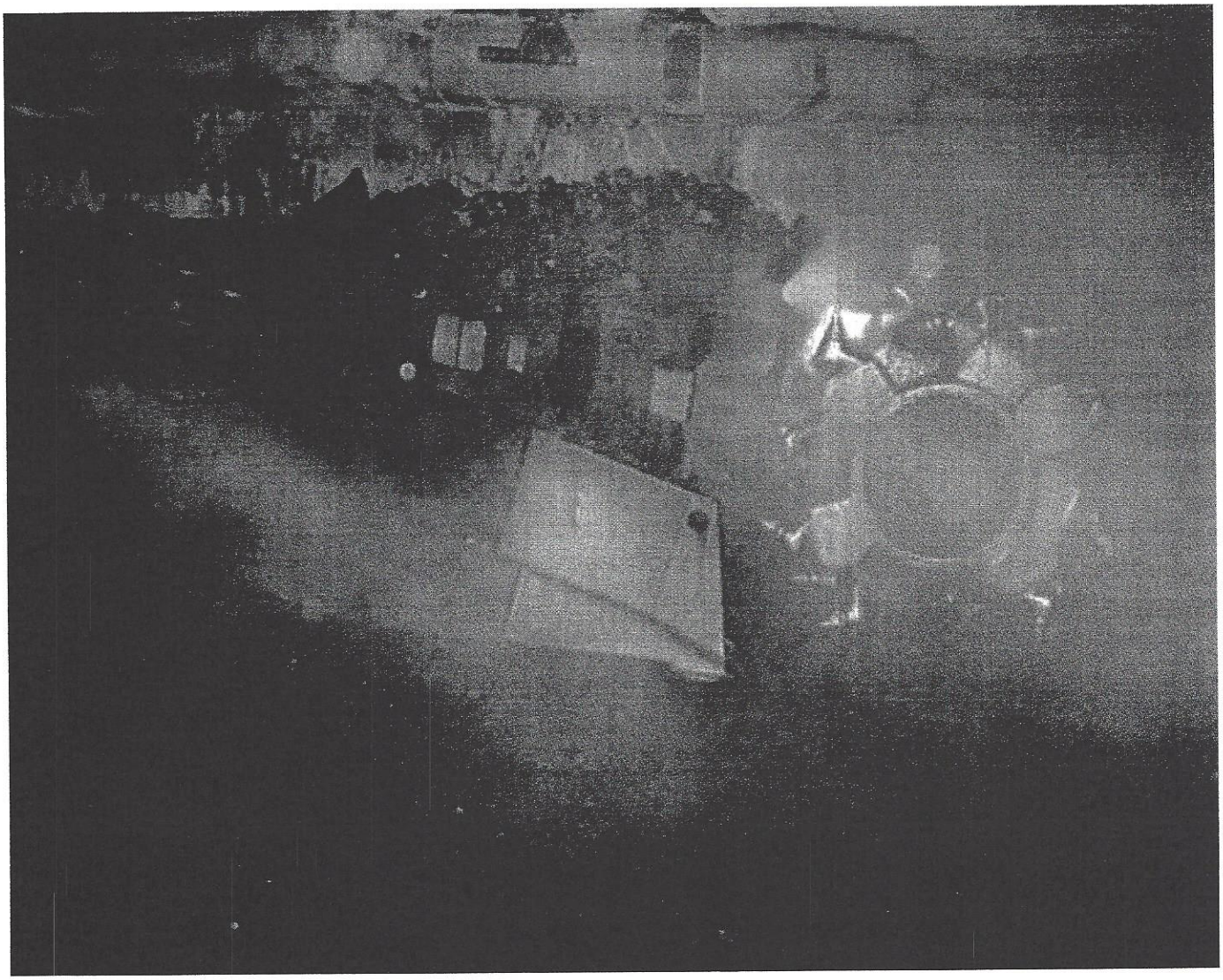

Photo 1. GCC Energy King II Continuous Miner Machine with Water Misting Spray

GCC King II Mine

Underground Mine Water Consumption

Date	Water pumped Underground (Gallons)	Coal Produced (Tons)
2/10/2014	21,700	2,629
2/11/2014	24,600	3,166
2/12/2014	28,600	3,497
2/13/2014	26,000	4,279
2/14/2014	22,900	3,581
2/15/2014	16,900	2,694
2/16/2014	20,100	2,873
2/17/2014	28,400	3,122
2/18/2014	22,000	2,623
2/19/2014	31,400	3,300
2/20/2014	29,900	3,301
2/21/2014	24,000	3,497
2/22/2014	25,300	4,146
2/23/2014	26,700	2,896
Totals	**348,500**	**45,604**
Avg./Day	24,893	3,045

This table was edited from the original report to remove extraneous information and to present the essential data in a clearer format.

GCC King II Mine

Temperatures and Relative Humidities

Surface					
Date	**Time**	**Air Temp (°F)**	**Relative Humidity (%)**	**Wet Bulb (°F)**	**Dew Point (°F)**
2/14/2014	3:00PM	56	38	43	30
2/15/2014	9:00AM	55	22	41	20
2/16/2014	9:30AM	54	24	41	21
2/17/2014	10:00AM	53	21	40	18
2/18/2014	2:00PM	58	25	42	22
2/19/2014	9:00AM	59	22	42	20
2/20/2014	10:30AM	32	24	30	8
	Average =	52	25	40	20
	Max. Value =	59	38	43	30
	Min. Value =	32	21	30	8

Return Portal (292,000 cfm)					
Date	**Time**	**Air Temp (°F)**	**Relative Humidity (%)**	**Wet Bulb (°F)**	**Dew Point (°F)**
2/14/2014	3:00PM	52	62	46	40
2/15/2014	9:00AM	52	60	46	40
2/16/2014	9:30AM	52	60	45	39
2/17/2014	10:00AM	52	58	45	38
2/18/2014	2:00PM	52	59	45	38
2/19/2014	9:00AM	51	62	45	38
2/20/2014	10:30AM	51	59	44	37
	Average =	52	60	45	39
	Max. Value =	52	62	46	40
	Min. Value =	51	58	44	37

Belt Portal (57,000 cfm)					
Date	**Time**	**Air Temp (°F)**	**Relative Humidity (%)**	**Wet Bulb (°F)**	**Dew Point (°F)**
2/14/2014	3:00PM	49	94	47	46
2/15/2014	9:00AM	48	93	47	46
2/16/2014	9:30AM	49	90	46	45
2/17/2014	10:00AM	49	87	46	45
2/18/2014	2:00PM	51	81	48	49
2/19/2014	9:00AM	48	92	45	44
2/20/2014	10:30AM	46	94	46	44
	Average =	49	90	46	46
	Max. Value =	51	94	48	49
	Min. Value =	46	81	45	44

		Moisture in coal, as received		As Received	
	Date	Description	Sample #	Moisture	
	1/2/14	Release 2289 Oro Grande	1152198	6.55	
	1/7/14	Release 2290 Lonestar	1152483	6.12	
	1/10/14	Release 2291 Lonestar	1152821	4.82	
	1/10/14	Release 2092 Pondercel	1152822	7.07	
	1/10/14	Release 2293 Samalayuca	1152819	7.23	
	1/10/14	Release 2294 Chihuahua	1152820	7.25	
	1/15/14	Release 2295 TXI Texas	1153095	6.12	
	1/23/14	Release 2296 Lonestar	1153391	5.69	
	1/21/14	Release 2297 Drake	1153392	5.58	
	1/24/14	Release 2289 Oro Grande 77 Cars	1153801	4.48	
	1/24/14	Release 2289 Oro Grande 15 Higher Ash Cars	1153800	4.39	
	1/30/14	Release 2299 Drake	1154227	4.88	
	1/30/14	Release 2300 Lonestar	1154228	4.77	
	2/4/14	Release 2303 Drake	1154399	6.29	
	2/4/14	Release 2304 Phoenix	1154397	6.37	
	2/7/14	Release 2305 TXI Texas	1154804	6.68	
	2/12/14	Release 2305 TXI Texas-GCCE Sample	1155239	5.68	
	2/12/14	Release 2303 Drake	1155229	7.36	

	2/12/14	Release 2308 Phoenix	1155228	7.21	
	2/13/14	Release 2309 TXI Texas	1155335	7.09	
	2/24/14	Release 2309 Phoenix	1156104	7.23	
	2/24/14	Release 2310 Drake	1156102	7.00	
	2/24/14	Release 2311 Lonestar	1156103	7.45	
	2/24/14	Release 2315 Lonestar	1156191	7.52	
	2/24/14	Release 2316 Drake	1156192	6.82	
	2/24/14	Release 2317 Phoenix	1156190	6.73	
	2/27/14	Release 2318 TXI Texas	1156509	6.27	
	3/4/14	Release 2319 Phoenix	1156857	6.74	
	3/4/14	Release 2320 Lonestar	1156856	6.83	
	3/7/14	Release 2321 Oro Grande	1157140	6.73	
	3/7/14	Release 2322 Lonestar	1157142	6.63	
	3/7/14	Release 2323 Phoenix	1157141	6.77	
	3/12/14	Release 2324 TXI Texas	1157506	6.49	
	3/13/14	Release 2325 Oro Grande	1157702	6.84	
	3/21/14	Release 2326 Samalayuca	1158299	6.07	
	3/21/14	Release 2327 Chihuahua	1158300	5.75	
	3/21/14	Release 2329 Lonestar	1158298	6.14	
	3/24/14	Release 2330 Phoenix	1158418	7.17	
	3/24/14	Release 2331 Lonestar	1158419	7.31	
	3/27/14	Release 2332 TXI Texas	1158812	6.53	
	3/28/14	Release 2334 Phoenix	1158926	6.79	
	3/28/14	Release 2335 Lonestar	1158927	6.25	
	4/8/14	Release 2336 TXI Texas	1159050	7.04	
	4/7/14	Release 2337 Oro Grande	1159413	7.37	
	4/7/14	Release 2338 Lonestar	1159573	6.60	
	4/7/14	Release 2339 Phoenix	1159572	6.61	
			Avg. =	6.46	

Underground Mine Surface Area Exposed

Date	Section						Total Linear Ft.	Total Surface Area (ft^2)
	3NE (feet)		4NE Pillar Tons		4 NE (Eq. Ft)			
	Days	Swings	Days	Swings	Days	Swings		
2/10/2014	289	179	0	0	0	0	468	24,804
2/11/2014	250	165	1,029	0	200	0	615	32,616
2/12/2014	318	111	1,421	0	277	0	706	37,403
2/13/2014	310	214	1,656	0	322	0	846	44,864
2/14/2014	292	187	1,146	0	223	0	702	37,215
2/15/2014	296	230	0	0	0	0	526	27,878
2/16/2014	320	235	0	0	0	0	555	29,415
2/17/2014	231	50	1,563	326	304	63	649	34,390
2/18/2014	310	173	0	0	0	0	483	25,599
2/19/2014	270	239	621	0	121	0	630	33,386
2/20/2014	252	160	1,103	0	215	0	627	33,220
2/21/2014	260	235	855	0	167	0	662	35,060
2/22/2014	350	235	1,174	0	229	0	814	43,122
2/23/2014	230	80	1,200	0	234	0	544	28,815
							Total ft^2 =	**467,788**

Avg. Entry Dimensions

Ht (ft) =	8.5
Width (ft) =	18.0
Perimeter (ft) =	53.0

Avg. Tons/ft = 5.1

Notes:

- 3 NorthEast footage is from Daily Shift Reports

- 4 NorthEast Pillars footage is calculated using average ft. of advance from 3 NE based on tons per ft.

Water Loss from Evaporation Calculations

Air Flow	ft3/minute	ft3/hour	ft3/day
Air Flow into Mine by Fan	342,720	20,563,200	493,516,800

342,720 ft3/minute is the average air flow from Nov. 2013-March 2014

Water Vapor Flow into Mine by Fan *	
Lbs of Air Entering Mine	29,660,360
Lbs of Water Entering Mine	75,337
Gallons of Water Entering Mine	9,027

Air Splits	% of Total	ft3/day
% Air Out By - Portal	83.7%	413,073,562
% Air Out by - Belt	16.3%	80,443,238

Air split % is from February 2014 weekly examination air readings

Water Vapor Loss from Return Portal **	
ft3/day Air Out By - Return Portal	413,073,562
Lbs. of Air Out - Portal	24,825,721
Lbs of Water Out - Portal	125,618
Gallons of Water Out - Portal	15,052

Water Vapor Loss from Belt Portal ***	
ft3/day Air Out By - Belt Portal	80,443,238
Lbs. of Air Out - Belt	4,834,639
Lbs of Water Out - Belt	33,359
Gallons of Water Out - Belt	3,997

Total Water Loss Due to Evaporation	
Total Gallons of Water Out - Portal and Belt	**19,050**
Total Gallons of Water In - Mine Fan	**9,027**
Total Gallons of Water loss due to Evaporation	**10,022**

Table of Constants	
Density of water - Lbs./ gallon	8.345404

Measurements Taken	Location	Result
Density of Dry Air (lbs./ft3)	Fan Entry	0.06010
*Density of water (lbs. water/lbs. air)	Fan Entry	0.00254
**Density of water (lbs. water/lbs. air)	Return Portal	0.00506
***Density of water (lbs. water/lbs. air)	Belt Portal	0.00690

Data from National Weather Service - Durango, CO

**Intake 14 day [2/10/2014 to 2/23/2014]average T = 38 deg F - RH = 46%*

***Return Portal 7 day average T = 52 deg F -RH = 60%*

****Belt Portal 7 day average T = 49 deg F - RH = 90 %*

Main Mine Fan
Quantities taken from Weekly Examinations

Date	Fan (cfm)
11/2/2013	348,212
11/9/2013	354,540
11/16/2013	346,416
11/23/2013	372,400
11/30/2013	365,550
12/7/2013	355,240
12/14/2013	375,400
12/21/2013	354,160
12/28/2013	376,782
1/4/2014	385,360
1/11/2014	342,608
1/18/2014	344,200
1/25/2014	346,728
2/1/2014	349,440
2/8/2014	352,610
2/15/2014	364,640
2/22/2014	342,720
3/1/2014	345,600
3/8/2014	336,160
3/15/2014	332,860
3/22/2014	337,488
3/29/2014	357,656
4/5/2014	362,544
Average =	**354,318**

Mine Production Tons/day

Nov-13		Dec-13		Jan-14		Feb-14		Mar-14	
Date	Tons	Date	Tons	Date	Tons	Date	Tons	Date	Tons
1-Nov	1,778	1-Dec	1,047	1-Jan	0	1-Feb	2,576	1-Mar	4,069
2-Nov	1,148	2-Dec	2,697	2-Jan	3,334	2-Feb	2,411	2-Mar	1,805
3-Nov	1,011	3-Dec	2,858	3-Jan	1,288	3-Feb	3,396	3-Mar	0
4-Nov	2,668	4-Dec	2,010	4-Jan	1,034	4-Feb	3,205	4-Mar	2,902
5-Nov	3,246	5-Dec	2,668	5-Jan	927	5-Feb	3,371	5-Mar	4,712
6-Nov	3,268	6-Dec	692	6-Jan	3,776	6-Feb	3,219	6-Mar	2,203
7-Nov	3,506	7-Dec	0	7-Jan	1,894	7-Feb	2,675	7-Mar	2,520
8-Nov	1,285	8-Dec	0	8-Jan	2,300	8-Feb	4,636	8-Mar	2,258
9-Nov	1,355	9-Dec	0	9-Jan	2,181	9-Feb	1,305	9-Mar	2,515
10-Nov	1,188	10-Dec	0	10-Jan	3,744	10-Feb	2,629	10-Mar	3,587
11-Nov	3,272	11-Dec	1,830	11-Jan	1,060	11-Feb	3,166	11-Mar	2,309
12-Nov	2,720	12-Dec	2,173	12-Jan	1,899	12-Feb	3,497	12-Mar	4,144
13-Nov	2,691	13-Dec	1,663	13-Jan	2,226	13-Feb	4,279	13-Mar	854
14-Nov	2,752	14-Dec	1,086	14-Jan	1,583	14-Feb	3,581	14-Mar	3,245
15-Nov	1,910	15-Dec	1,500	15-Jan	2,690	15-Feb	2,694	15-Mar	1,912
16-Nov	1,084	16-Dec	3,232	16-Jan	3,297	16-Feb	2,873	16-Mar	983
17-Nov	1,145	17-Dec	4,237	17-Jan	2,539	17-Feb	3,122	17-Mar	2,368
18-Nov	2,576	18-Dec	3,796	18-Jan	1,969	18-Feb	2,623	18-Mar	995
19-Nov	2,953	19-Dec	4,067	19-Jan	2,468	19-Feb	3,300	19-Mar	1,016
20-Nov	2,491	20-Dec	1,900	20-Jan	3,813	20-Feb	3,301	20-Mar	1,713
21-Nov	3,408	21-Dec	2,157	21-Jan	2,368	21-Feb	3,497	21-Mar	0
22-Nov	2,385	22-Dec	1,341	22-Jan	2,483	22-Feb	4,146	22-Mar	2,216
23-Nov	1,071	23-Dec	3,576	23-Jan	3,149	23-Feb	2,896	23-Mar	2,933
24-Nov	2,368	24-Dec	0	24-Jan	2,182	24-Feb	0	24-Mar	2,456
25-Nov	2,810	25-Dec	0	25-Jan	3,687	25-Feb	4,004	25-Mar	2,756
26-Nov	2,851	26-Dec	3,920	26-Jan	4,572	26-Feb	2,490	26-Mar	2,636
27-Nov	3,208	27-Dec	2,113	27-Jan	3,086	27-Feb	2,859	27-Mar	1,760
28-Nov	0	28-Dec	1,034	28-Jan	3,025	28-Feb	2,882	28-Mar	1,951
29-Nov	0	29-Dec	1,175	29-Jan	3,576	**Total =**	**84,633**	29-Mar	1,164
30-Nov	983	30-Dec	3,921	30-Jan	3,436			30-Mar	1,602
Total =	**63,131**	31-Dec	3,591	31-Jan	4,712			31-Mar	2,757
		Total =	**60,284**	**Total =**	**80,298**			**Total =**	**68,341**

Water Vapor - Weight in Air

water vapor in *"pounds water vapor per pound dry air"*.

Water Vapor in Air (*pounds water vapor per pound dry air*)

Relative Humidity (%)	Temperature °C							
	-1	4	10	18	22	27	32	38
	°F							
	30	40	50	60	70	80	90	100
10	0.0004	0.0006	0.0009	0.0011	0.0016	0.0023	0.0030	0.0041
20	0.0007	0.0010	0.0014	0.0023	0.0030	0.0043	0.0060	0.0083
30	0.0010	0.0016	0.0020	0.0031	0.0049	0.0066	0.0093	0.0124
40	0.0013	0.0020	0.0029	0.0043	0.0063	0.0089	0.0122	0.0166
50	0.0017	0.0026	0.0037	0.0056	0.0079	0.0112	0.0154	0.0210
60	0.0020	0.0031	0.0046	0.0069	0.0094	0.0132	0.0183	0.0252
70	0.0024	0.0037	0.0054	0.0077	0.0112	0.0154	0.0217	0.0297
80	0.0027	0.0041	0.0060	0.0089	0.0126	0.0179	0.0247	-
90	0.0030	0.0047	0.0069	0.0100	0.0143	0.0200	0.0272	-

1 cuft dry air @ 60°F = 0.0807 #

Related Topics

- Air Psychrometrics - The study of moist and humid air - air condition - psychrometric charts, Mollier diagrams, air temperature, absolute and relative humidity, moisture content and more

Related Documents

- Specific Volume of Moist Air - Specific volume is defined as the total volume of humid air per mass unit of dry air
- Density of Dry Air, Water Vapor and Moist Humid Air - Calculate the density of dry air, water vapor or the mixture of air and water vapor - moist or humid air
- Water Vapor - Specific Heat - Specific heat of Water Vapor - H_2O - at temperatures ranging *175 - 6000 K*

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- editor.engineeringtoolbox@gmail.com

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Assumptions and data used in the 14-day water balance study for King II Mine

Various water vapor conversion factors for temperature and relative humidity are from www.engineeringtoolbox.com, and www.denysschen.com

Durango-La Plata County Airport weather information from www.wunderground.com

Air into the mine – see attached four month summary

Air out of mine by portal – [83.7% of inflow]

Air out of mine by belt system – [16.3% of inflow]

Average temperature/humidity data from weather data Durango-La Plata Airport

Average temperature/humidity of air leaving portal – data from GCC measurements

Average temperature/humidity of air leaving belt system - data from GCC measurements

Density of air entering at T/RH = calculated from chart in appendix

Density of air leaving portal at T/RH = calculated from chart in appendix

Density of air leaving belt at T/RH = calculated from chart in appendix

Water vapor content of air entering mine see calculations in the Technical Memorandum

Water vapor content of air leaving portal see calculations in the Technical Memorandum

Water vapor content of air leaving belt see calculations in the Technical Memorandum

Pounds of dry air entering mine see calculations in the Technical Memorandum

Pounds of dry air leaving mine see calculations in the Technical Memorandum

Pounds of dry air leaving mine see calculations in the Technical Memorandum

Pounds of water in air entering mine see calculations in the Technical Memorandum

Pounds of water leaving mine via portal see calculations in the Technical Memorandum

Pounds of water leaving mine via belt see calculations in the Technical Memorandum

Gallons of water entering mine via intake fan see calculations in the Technical Memorandum

Gallons of water exiting mine via portal see calculations in the Technical Memorandum

Gallons of water exiting mine via belt system see calculations in the Technical Memorandum

Total gal of water leaving mine via air = [out return + belt – in by fan]

Total gal of water leaving mine as wet coal = [see chart in Appendix for long term average]

Total gal leaving mine = [total by air + total by coal]

Total water entering mine by pipeline [data from GCC use records]

Total water remaining in mine = water balance of 122 gal/day ± 218 gal/day

RESOURCE HYDROGEOLOGIC SERVICES, INC.

LANDON BECK
PRINCIPAL HYDROGEOLOGIST

EDUCATION

MS Hydrology, 2001, University of Idaho

BS Geology, 1999, Kansas State University

ASSOCIATIONS

National Ground Water Association (NGWA)

International Ground Source Heat Pump Association (IGSHPA)

CURRENT LICENSES & CERTIFICATIONS

MSHA Part 48 Training (Form 5000-23)

H2S Alive Training

Petroleum Safety Training

OSSA Regional Orientation

40-hour Hazardous Waste Site Health and Safety OSHA Training

8-Hour Hazardous Waste Site Supervisor OSHA Training

Confined Space Safety OSHA Training

Schlumberger Westbay Instruments Operator Training

First Aid/CPR

Master Drive (USA) & AMA (CAN) Winter Driving Clinics Completion

IGSHPA Accredited Geothermal Installer

PROFESSIONAL HIGHLIGHTS

Mr. Beck is a principal hydrogeologist with fifteen years of diversified experience. The focus of his expertise is well hydraulics and includes test design, equipment specification, acquisition, field implementation and project management. He has experience in projects for the coal, coal bed methane (CBM), oil shale, underground coal gasification (UCG), oil sands, potash mining, in-situ uranium recovery, and geothermal energy and water resources industries. His experience also includes all phases of environmental site assessments, including groundwater, surface water, process water and soil sampling and testing, monitoring and water well installation and well logging, health and safety supervision and compliance. He has successfully implemented and managed complex field studies and testing programs to determine hydrogeologic conditions in a wide variety of situations and locations in North America and worldwide.

PROFESSIONAL EXPERIENCE

Mr. Beck has extensive experience as project manager, field program manager, and field hydrogeologist mainly for confidential clients in the coal, CBM and oil shale/sand industry. Project activities have included:

- Injection fall-off test (IFOT) design, implementation and data interpretation with and without downhole wellbore isolation and flow rate, pressure and temperature monitoring.
- Drill and direct-push rig oversight, well design, installation, core/sample logging and interpretation.
- Multiple and single-well production test design, implementation and analysis including numerous well isolation/pump/instrumentation schemes.
- Discrete interval aquifer slug testing with instrumentation monitoring up to six isolated intervals for pressure and temperature.
- Water level monitoring network operation and maintenance utilizing standard and specialized instrumentation, telemetry and satellite data upload as well as by conventional manual methods.
- Schlumberger Westbay multi-level well installation, pressure profiling, groundwater sampling and pumping port operation for various testing and sampling scenarios utilizing standard wire line equipment and techniques.
- Complete multi-level well, aquifer test tooling and groundwater sampling equipment design, specification, acquisition, delivery and client training, for international and domestic project sites.
- Groundwater, surface water, process water and soil sampling program design, implementation and management.
- Bioremediation system design, fabrication, implementation and maintenance.
- Data management, evaluation, interpretation and report preparation.

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PROJECT EXPERIENCE

Mr. Beck has extensive experience in a managerial and technical role for a number of clients and projects. Relevant projects include:

ENEFIT AMERICAN OIL, UINTA BASIN, BONANZA, UT
Environmental monitoring well design and installation oversight, aquifer testing and water quality. As field project manager Mr. Beck was tasked with supervision of an air-rotary drill rig, processing and documenting cuttings samples from depths of 10 feet to 1000 feet depth, and designing, installing and developing (12) 2" and 4" PVC well completions in alluvium, shale and sandstone for the purpose of baseline hydrogeologic characterization of a proposed oil shale mine. Concurrent with well installation activities, Mr. Beck designed and implemented a slug testing and pumping test program to evaluate the oil shale and confining unit aquifer parameters. Mr. Beck supervised program data compilation, figure preparation and aquifer testing interpretation for the final report.

CONFIDENTIAL CLIENT, MUWAQQAR CHALK-MARL FORMATION, JORDAN
Design, specification, procurement and implementation of equipment and methodology for a single-well, multiple-interval geomechanical micro-frac well testing program for an oil shale exploration project for depths to 600 meters. As project manager Mr. Beck was responsible for budget, staffing, sourcing and delivery of all equipment to Amman, Jordan. Mr. Beck was also responsible for training Jordanian field crews and client engineers in the use of the equipment onsite during initiation of the field program. The custom-designed fluid injection equipment, down hole isolation assembly and monitoring systems was used to generate data to determine in-situ formation injectivity pressures.

BHP BILLITON NEW MEXICO COAL, SAN JUAN BASIN, FARMINGTON, NM
Environmental monitoring well design and installation oversight and aquifer testing. As field project manager Mr. Beck was tasked with supervision of a track-mounted sonic-rotary drill rig, processing and documenting core samples, and designing (10) 2" and 4" PVC well completions in surface operations at three mines, two operating and one reclaimed. Following well installation activities, Mr. Beck designed and implemented a slug testing and pumping test program on a subset of new and existing monitoring wells to evaluate the subsurface hydrology. Mr. Beck completed all relevant reports documenting these activities and data interpretation.

COLORADO OIL & GAS CONSERVATION COMMISSION, SAN JUAN BASIN, DURANGO, CO
Maintains a 17-monitoring well network for pressure and temperature data collection via remote telemetry as part of the 4M Project gathering information on CBM and water production in the Fruitland Formation of the Northern San Juan Basin. As project manager, Mr. Beck is responsible for budget, annual well inspections, data compilation, interpretation and report preparation.

CONFIDENTIAL CLIENT, MUWAQQAR CHALK-MARL FORMATION, JORDAN
Design, specification, procurement and implementation of equipment and methodology for a single-well, multiple-interval well testing program for an oil shale exploration project for depths to 900 meters. As project manager Mr. Beck was responsible for budget, staffing, sourcing and delivery of all equipment to Amman, Jordan. Mr. Beck was also responsible for training Jordanian field crews and client engineers in the use of the equipment onsite during initiation of the field program. The custom-designed equipment was used to generate data to determine horizontal and vertical permeability and storage parameters to characterize and evaluate low-permeability "seal" intervals identified for fluid and gas containment during proposed in-situ oil shale production. This was accomplished with a robust program of pneumatic slug test, pumping test and injection-fall-off test methods using a three-packer downhole assembly. Pumping tests were also used to collect baseline organic

and inorganic water quality data. Additionally, air-injection permeability testing and analysis was conducted within the vadose zone intervals of these open-hole well completions. Mr. Beck analyzed and interpreted data onsite while also training the Jordanian client team in well test analysis. Upon successful initiation this project was expanded greatly beyond the originally planned program, allowing characterization of assets throughout Jordan.

CONFIDENTIAL CLIENT, MUWAQQAR CHALK-MARL FORMATION, JORDAN
Design and specification of monitoring wells for an in-situ oil shale pilot project including wellheads, groundwater sampling systems (+300 m depth), vapour sampling systems and groundwater and vapour pressure monitoring with telemetry.

CAMECO RESOURCES, SOUTHERN POWDER RIVER BASIN, WYOMING
Design, implementation and management of numerous multi-well, (up to 75 observation wells) interference pumping test programs at multiple mine units for in-situ uranium recovery hydrogeologic characterization to support permitting requirements. As project manager Mr. Beck was responsible for the budget, test prognosis, crew training and scheduling, data management, data analysis, interpretation and reporting. Project support also included groundwater modeling and geochemical analysis oversight.

CONFIDENTIAL CLIENT, PICEANCE BASIN, COLORADO
Provided technical design and operational input for straddle packer micro-frac and injection fall-off tests (IFOT) at a proposed oil shale pilot site. Mr. Beck provided project development, design and equipment delivery, followed by the implementation of field operations supervising the field crew for downhole tool installation and operating the IFOT trailer for all tests.

CONFIDENTIAL CLIENT, PICEANCE BASIN, COLORADO
Design, implementation and management of a four-well, three-interval pneumatic slug test program for permeable fracture identification in oil shale. Two of the four holes were open to pyrolyzed hole shale, resulting from a previous pilot study. The test design was based on a complete testing of the entire open interval of each hole, discrete to ten foot intervals. Real-time data were observed in four packer-isolated intervals by direct-read pressure transducers with temperature logging capability. The resulting data was interpreted by Mr. Beck and others with a team-designed quantitative analytical solution package to generate the first-known in-situ permeability data for pyrolyzed oil shale.

CONFIDENTIAL CLIENT, PICEANCE BASIN, COLORADO
Design, implementation and management of three multi-well, multi-interval interference tests programs for oil shale hydrogeologic characterization. As field project manager Mr. Beck was responsible for all phases of pumping test design, equipment specification and acquisition, budget management, contractor scheduling and oversight, data collection, management and interpretation while living on location in man camp accommodations.

CONFIDENTIAL CLIENT, PICEANCE BASIN, COLORADO
Supported subsurface characterization and engineering efforts for two freeze wall pilot projects to depths greater than 1500 feet. There projects each successfully created a long-term, groundwater container to prevent any flow or transport outside of the wall. Mr. Beck was involved in all aspects of pre-freeze phase hydrogeologic characterization, construction phase well and freeze plant installation, well pressure and temperature monitoring for wall closure and reclamation phase groundwater monitoring and well abandonment.

CONFIDENTIAL CLIENT, HANNA BASIN, WYOMING
Supported drilling and completion operations for installation of 5" stainless steel coal seam groundwater monitoring wells to 1200' depths. Mr. Beck then conducted numerous single-well pumping tests at these wells with automated pressure data collection for hydrogeologic characterization of a coal seam gas/liquefaction research project. Mr. Beck incorporated barometric efficiency and analyzed pumping test data for standard aquifer parameters utilizing AQTESOLV for groundwater modeling input.

CONFIDENTIAL CLIENT, PICEANCE BASIN, COLORADO
Design, implementation and management of a three-well, four-interval interference pneumatic slug test program for permeable fracture identification in oil shale. Test design utilized brine resistivity, OBI, gamma/resistivity, calliper and video logging to target expected permeable open hole intervals. Mr. Beck designed an integrated inflatable four-packer system that allowed for discrete interval pressure measurement at the four intervals. He delivered first-ever real-time modbus communication of a total of twelve independent memory gauges from one test and two monitoring holes at depths to 1200 feet all logging to a single system allowing for industry-best accuracy and resolution. The multi-well test allowed for quantitative characterization of horizontal and vertical permeability to within a range of one vertical foot when analytical and numerical methods were applied through rigorous modeling efforts with MODFLOW and FEFLOW.

CONFIDENTIAL CLIENT, PICEANCE BASIN, COLORADO
Design, implementation and management of a multi-well, three-interval pneumatic slug test program for permeability characterization in oil shale. Dozens of holes were tested over several years of nearly continuous testing for over 1000 successful tests with no recorded HSE incidents. Real-time data was observed in four packer-isolated intervals by direct-read pressure transducers with temperature logging capability. Data were interpreted by Mr. Beck and others with a team-developed quantitative analytical solution package to for use in several regional geologic and groundwater models. Data were also used to drive exploration and monitoring well drilling and completion programs.

INDEPENDENT RESOURCES, TUSCANY, ITALY
Conducted single-well pumping test and injection fall-off test (IFOT) for a CBM exploration project. Objectives were to obtain a fluid sample, determine reservoir pressure and calculate the coal seam permeability. Mr Beck accomplished this task on time, under budget and without incident with very limited English/Italian translation and a completely inexperienced IFOT rig crew.

SHELL CANADA, BRITISH COLUMBIA, CANADA
Conducted numerous straddle packer injection fall-off tests (IFOT) for a CBM exploration project on remote site. Mr. Beck operated a project team-designed IFOT trailer, a self-contained intrinsically safe test unit with onboard fresh water tankage and fully redundant high pressure triplex pumps, turbine and positive displacement meters, pressure transducers and data collection systems. This system was designed to Shell specifications by the project team specifically for CBM testing. Mr. Beck was responsible for all data collection and data management as well as equipment maintenance.

MEDCO, ILLINOIS BASIN, ILLINOIS
Conducted straddle packer injection fall-off tests (IFOT) in six coal seams for a CBM exploration project. Mr. Beck trained and managed a crew operating an IFOT trailer for CBM testing as well as coordinated all pipe-running activities with the drilling contractor. Mr. Beck was responsible for all specification, acquisition and maintenance of surface and downhole equipment including packers, pressure

transducers, temperature loggers, data collection systems and site HSE. Mr Beck was responsible for onsite test interval picks from geophysical logs in order to determine proper down hole packer placement.

SABER ENERGY, BOTSWANA
Design testing program, specify test equipment and train testing crew for a multi-well, multi-zone CBM exploration project. Test method was pneumatic slug falling head tests utilizing a triple packer system with direct, real-time downhole data collection system.

SHELL CANADA, ALBERTA, CANADA
Provided technical design and operational input for numerous straddle packer injection fall-off tests (IFOT) for two CBM exploration projects. Mr. Beck provided initial project development assistance and then supported field crews operating the IFOT trailer.

CONFIDENTIAL CLIENT, PICEANCE BASIN, COLORADO
Management of basin-wide baseline groundwater quality monitoring program and pilot site compliance sampling in pyrolyzed and non-pyrolyzed fractured oil shale aquifers, fractured sandstone aquifers and unconsolidated alluvial aquifers resulting in over 10,000 water quality samples collected and submitted for laboratory analysis with tens of thousands of man-hours worked incident-free. Mr. Beck maintained a regional groundwater level monitoring network. This program also included quarterly surface water quality and quantity data collections. Mr. Beck managed the multiple streams of data to coordinated project team efforts for multiple GIS-integrated databases.

WESTERN RESOURCE COUNCIL, POWDER RIVER BASIN, WYOMING
Monitoring well drilling program for shallow hydrogeologic characterization in the vicinity of CBM discharge water reservoirs. Continuous core was collected, logged and interpreted onsite by Mr. Beck for immediate design and installation of the 2" PVC monitoring wells. The project also included surface water weir and stage instrumentation installation at four sites for monitoring of CBM outfall discharge flow.

CONFIDENTIAL CLIENT, PICEANCE BASIN, COLORADO
Design and implementation of an anaerobic bioreactor pilot test for treatment of pyrolyzation-impacted produced oil shale water. Mr. Beck designed, fabricated, installed and monitored the three-column system for reduction of BTEX through a side-stream of the process water train. Data collected included field parameters and fluid samples submitted for analytical testing and was used for design criteria of a full scale anaerobic bioreactor at an adjacent pilot site to be operated by the same client.

SHELL CANADA, ALBERTA, CANADA
Design, implementation and acquisition of equipment to conduct one multi-well, multi-interval interference test and approximately ten single-well, multi-interval well testing programs for a bitumen exploration project, including one horizontal well. As equipment design and logistics manager Mr. Beck was responsible for sourcing and delivery of all equipment for several field seasons in remote northern Alberta. Mr. Beck was responsible for training all crews and client engineers in the use of the equipment both onsite and in shop facilities. The hybrid water well testing equipment was successfully used in this application at a project savings of an order of magnitude better than the previous exclusive use of oil field well testing equipment. Permeability data generated from the well tests allowed for accurate reservoir simulation and recognition of the significant groundwater concerns.

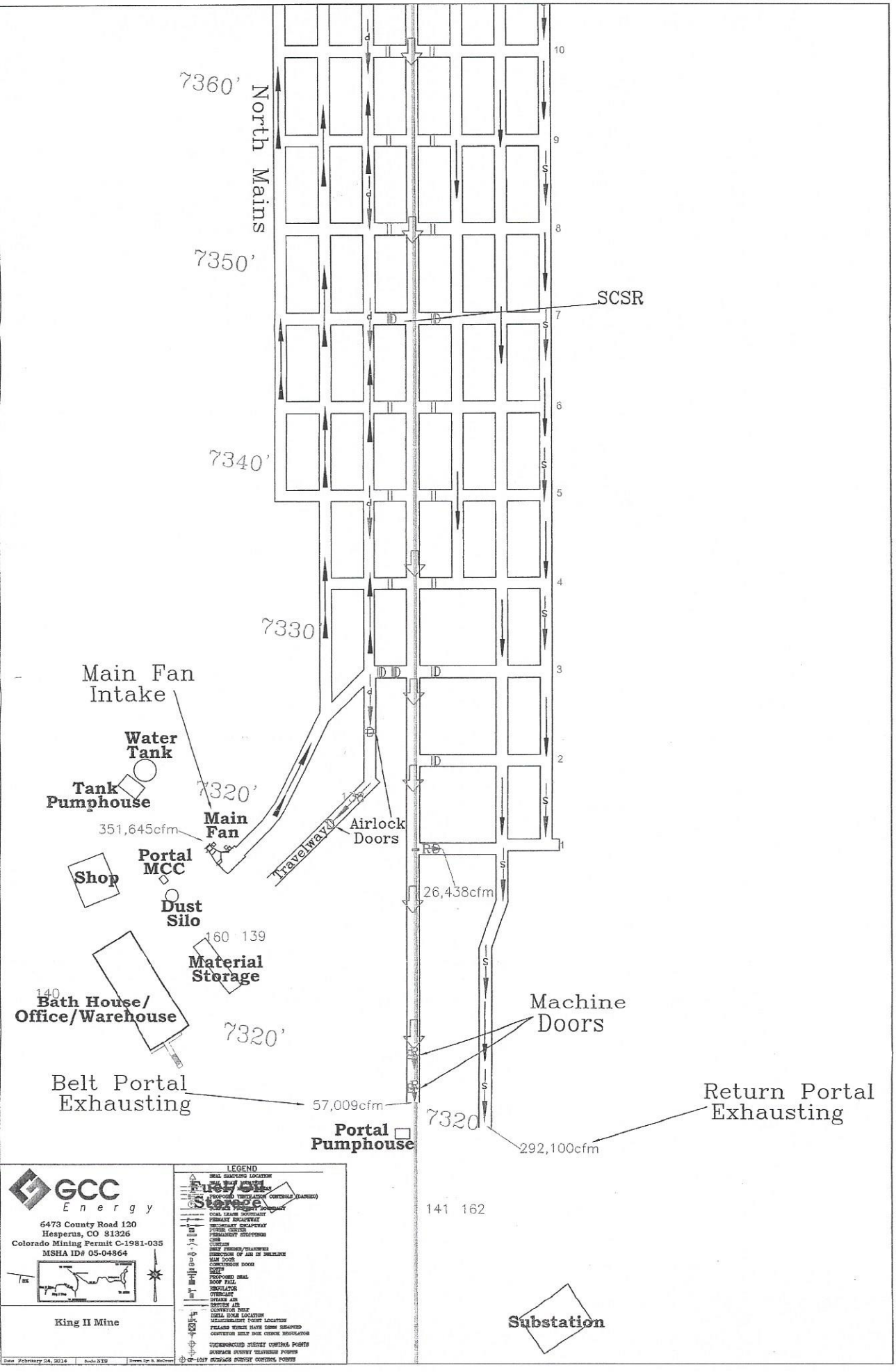
CONFIDENTIAL CLIENT, PICEANCE BASIN, COLORADO
Design, implementation and management of over 300 single-well pumping tests for oil shale hydrogeologic characterization. Each test also consisted of monitoring up to five overlying and underlying aquifers for potential pumping influence. Pumping rates ranged from 1-100 gpm and hole depths were to 2000 feet.

CONFIDENTIAL CLIENT, PICEANCE BASIN, COLORADO
Operator of a pump-and-treat anaerobic bioreactor pilot test for remediation of steam-impacted produced oil shale water with BTEX contamination. Mr. Beck collected process and groundwater monitoring well field parameters and fluid samples submitted for analytical testing using the real-time field parameters to adjust the anaerobe food supply. Water production methods included steam condensate collection, electric submersible pump, gas displacement and bailer. A carbon treatment skid was also utilized to further reduce the BTEX concentration to environmental compliant levels and close the site.

CONFIDENTIAL CLIENT, PICEANCE BASIN, COLORADO
Completed Schlumberger Westbay operator training program including MOSDAX temperature/pressure direct-read memory tool installation and repair for the Westbay multi-level monitoring well systems MP55 stainless steel and PVC models. Mr. Beck has provided oversight to the installation, sampled groundwater, utilized pumping ports and operated and trouble-shooted data logging systems for Westbay wells installed in oil shale aquifers.

IDARADO MINING COMPANY, TELLURIDE, COLORADO
Conducted three single-well pumping tests in unconsolidated fluvial/colluvial aquifers with automated pressure data collection for a water supply well field development project. Mr. Beck analyzed all field data onsite for standard aquifer parameters utilizing AQTESOLV.

ARAPAHOE AVENUE DEFENDANTS, BOULDER, COLORADO
Monitoring well drilling and sampling program for delineation of shallow aquifer MTBE contamination. Continuous core was collected by use of a GeoProbe direct-push rig, logged and interpreted onsite by Mr. Beck for immediate design and installation of the 2" PVC monitoring wells. Low-flow water quality sampling was conducted by Mr. Beck with bailer and peristaltic pump to meet EPA standards for submittal of water samples to the analytical lab.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7350'
SCSR
7340'
7330'
Main Fan Intake
Water Tank
Tank Pumphouse
7320'
Main Fan
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Airlock Doors
Travelway
Portal MCC
Shop
Dust Silo
26,438cfm
160 139
Material Storage
140
Bath House/ Office/Warehouse
Machine Doors
7320'
Belt Portal Exhausting
57,009cfm
Return Portal Exhausting
7320
Portal Pumphouse
292,100cfm
141 162
Substation
Fuel Oil Storage
GCC Energy
6473 County Road 120
Hesperus, CO 81326
Colorado Mining Permit C-1981-035
MSHA ID# 05-04864
King II Mine
LEGEND