MEMORANDUM

Date: September 14, 1997

From: A Typical Mines Student

To: Tom Boyd, Phil Romig

Subject: Gravity Bid Proposal

Introduction:

We have been asked to propose a bid for geophysical testing in an area Northwest of Golden. The client wants to know if any undocumented coal mine tunnels exist in the area she wishes to develop. We have determined that gravity testing would be the most effective and economic method to complete the task. We drew this decision because the density contrast between a tunnel and surrounding bedrock is quite significant and testing is relatively inexpensive with respect to other techniques.

The geologic units in the area are striking North-South and the dip is nearly vertical. The geologic unit of concern in the problem area is the Larimide, which consists of quartzose sandstone and claystone with lenticular coal beds in the lower 200 feet of the unit. The tunnels in the area exist exclusively in the lower 200 feet of the Larimide, and have a diameter of 3-5 meters.

The problem area is 500 feet squared and essentially flat. The client has specified that we run the testing along a line trending East-West, which bisects the entire problem area. We are to access the area within the given specifications, and complete a bid representing the best compromise, in our eyes, between cost and data quality.

We chose to implement the gravity reading strategy of alternating base station readings with a series of field readings to correct for gravity fluctuations. Many important considerations were made with respect to our survey design. A Java script was used to determine important design parameters such as gravity reading spacing and number of readings. Other technical considerations in our project include; Orientation, amplitude, and width of the gravity anomaly, frequency of base station reoccupation, and standard deviation of random noise.

Survey Plan:

We chose a gravity station interval of 7 meters because we felt it was the farthest spacing we could stretch while still being confident that a gravity anomaly associated with an underground tunnel would be recognized. Five readings will be taken at each gravity station. This sharpens the resolution of the anomaly by lowering error. Our base station location will be located in the center of our testing line. This location minimizes walking distance along the line. A base station will be reoccupied four times per day, first thing in the morning, before and after lunch, and at the end of the day. These three parameters were determined in tandem(using the Java script) to achieve a standard deviation under .01mgals, in our field data. We have proven that a tunnel should be discovered with our survey parameters to a gravity contrast of 1.5, down as low as 17 meters under the surface. This gravity contrast could detect a tunnel filled up to 25% with mud. We reasoned that this contrast would be sufficient because a higher percentage of mud in the tunnel would decrease the tunnel radius to a negligible size for our purposes.

Some limitations ultimately arise in our procedure. Many decisions were influenced by economic considerations. A compromise between cost and data quality has to be made so that we are even considered for the project. Furthermore, the use of a computer model does not always percisely simulate field situations. The earth is a chaotic system, so no simulated model is perfect; however the Java script is the best we have to work with and we feel it brought us accurate results. The necessary compromises in our survey plan were made with sound engineering judgement so that no part of the land's development will be jeopardized. We estimate the probability of success for our project is 95%, barring any unforeseen circumstances.

Survey Costs and Final Bid:

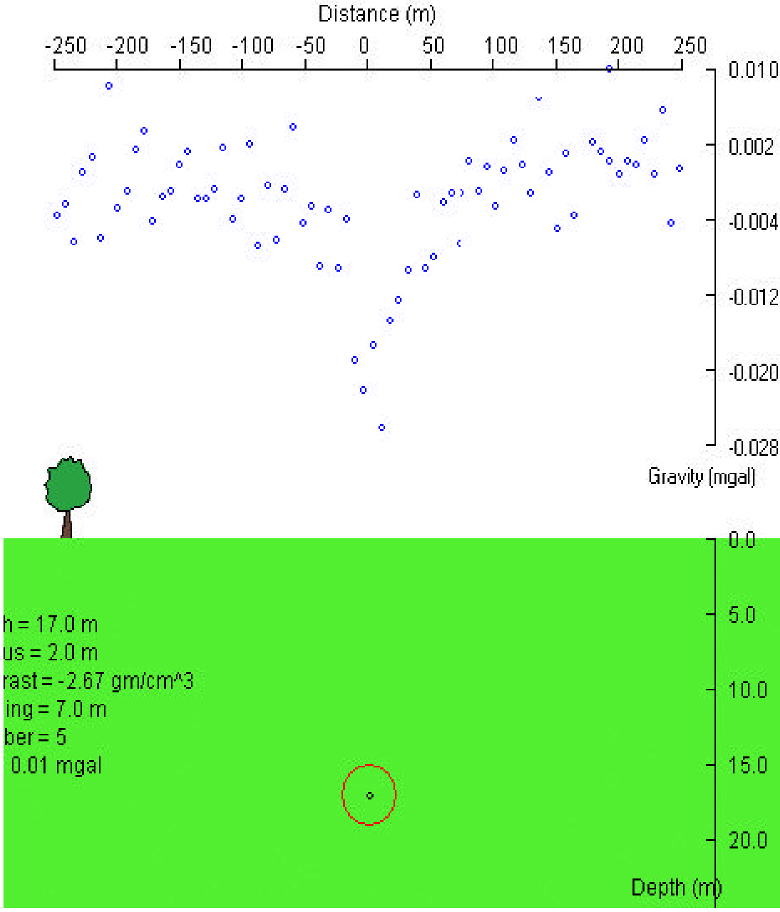
Based on the following costs and considerations:

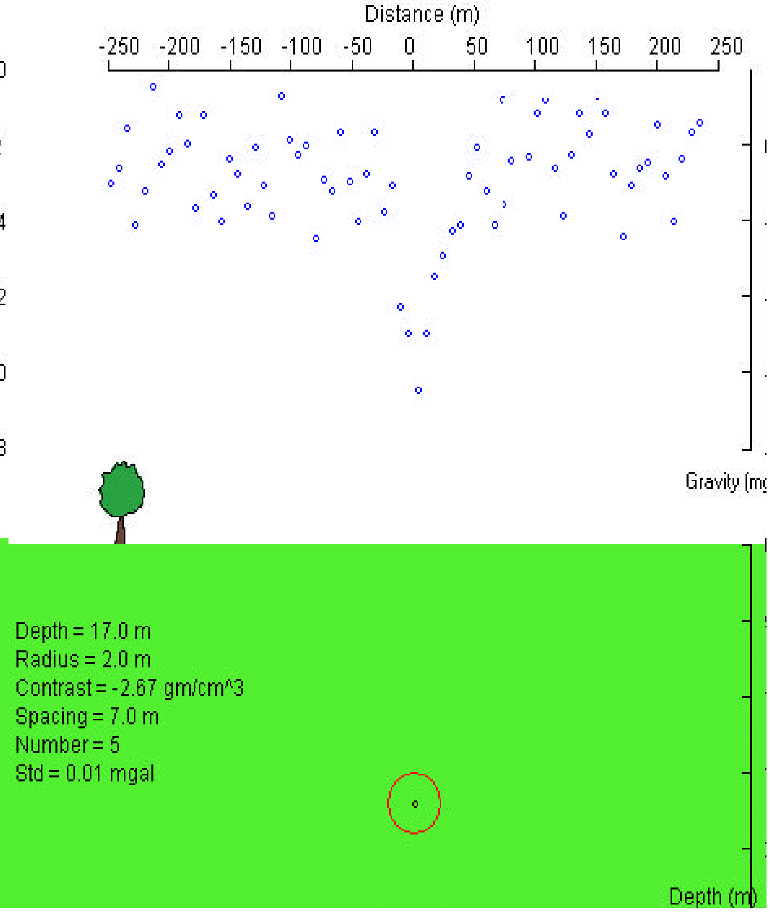
-It takes 5 minutes to take a reading
-It takes 15 minutes to return to the base station and take a reading
-Mobilization and demobilization will require 1/2 day each
-Total person-hours required for processing, interpretation and report preparation is the same as total person-hours in the field
-Field hands make $10/hour, and two are required at all times in the field
-Field hands will only work 8 hours per day.
-Processors, interpreters and report writers make $20/hour
-Subsistence and travel expenses are $100/person/8-hour day while doing the field work
-The gravity meter is depreciated at the rate of 1%/day (original cost = $20,000)
-Vehicle depreciation is $50/day
-Fringe benefits for employees are 25% of salary
-Overhead is 100% of total direct cost excluding equipment depreciation
-Profit is ---your choice---
-My consulting fee is $200/hour

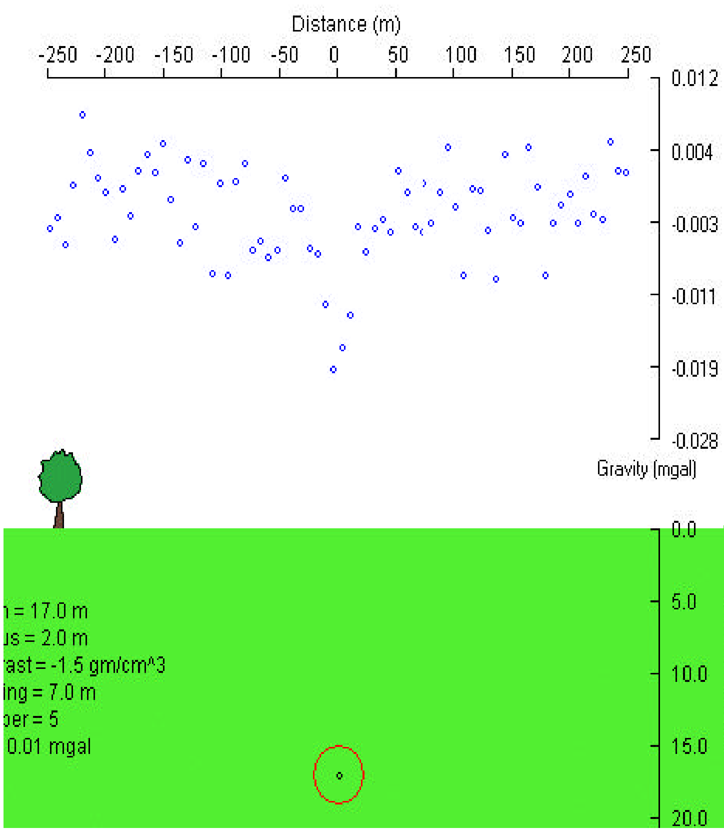
We were able to further develop our project, and finally devise a final bid. Some major cost considerations included; minimizing total days of the project and efficiently coordinating reoccupation times. We feel we could accurately perform this survey for $13,692.07 in a total of 5 days, including mobilization.(See appendix B)

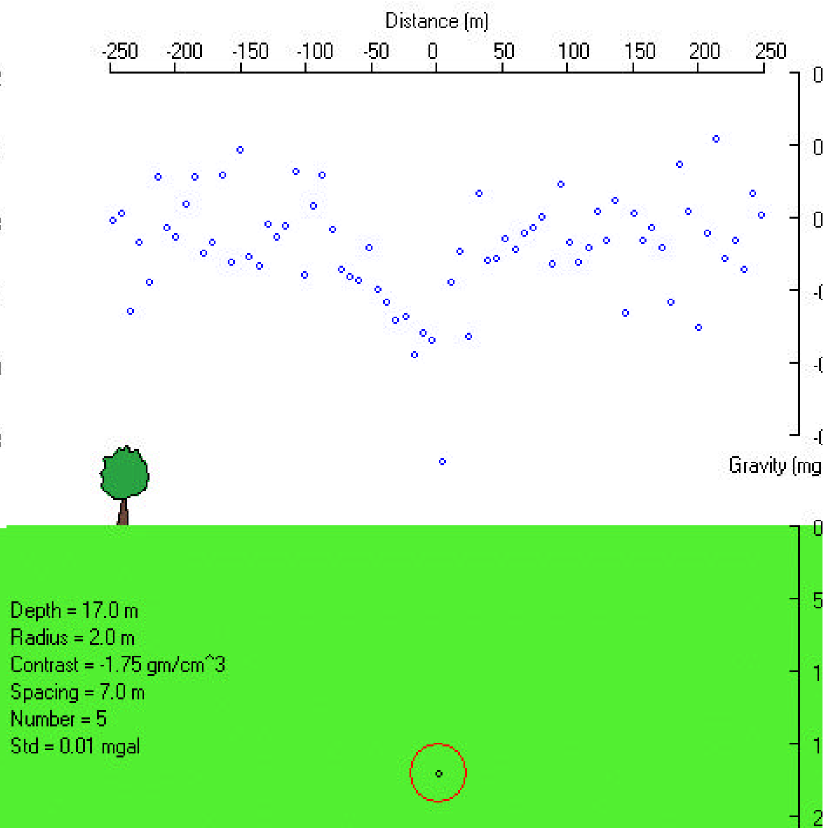
Appendix A

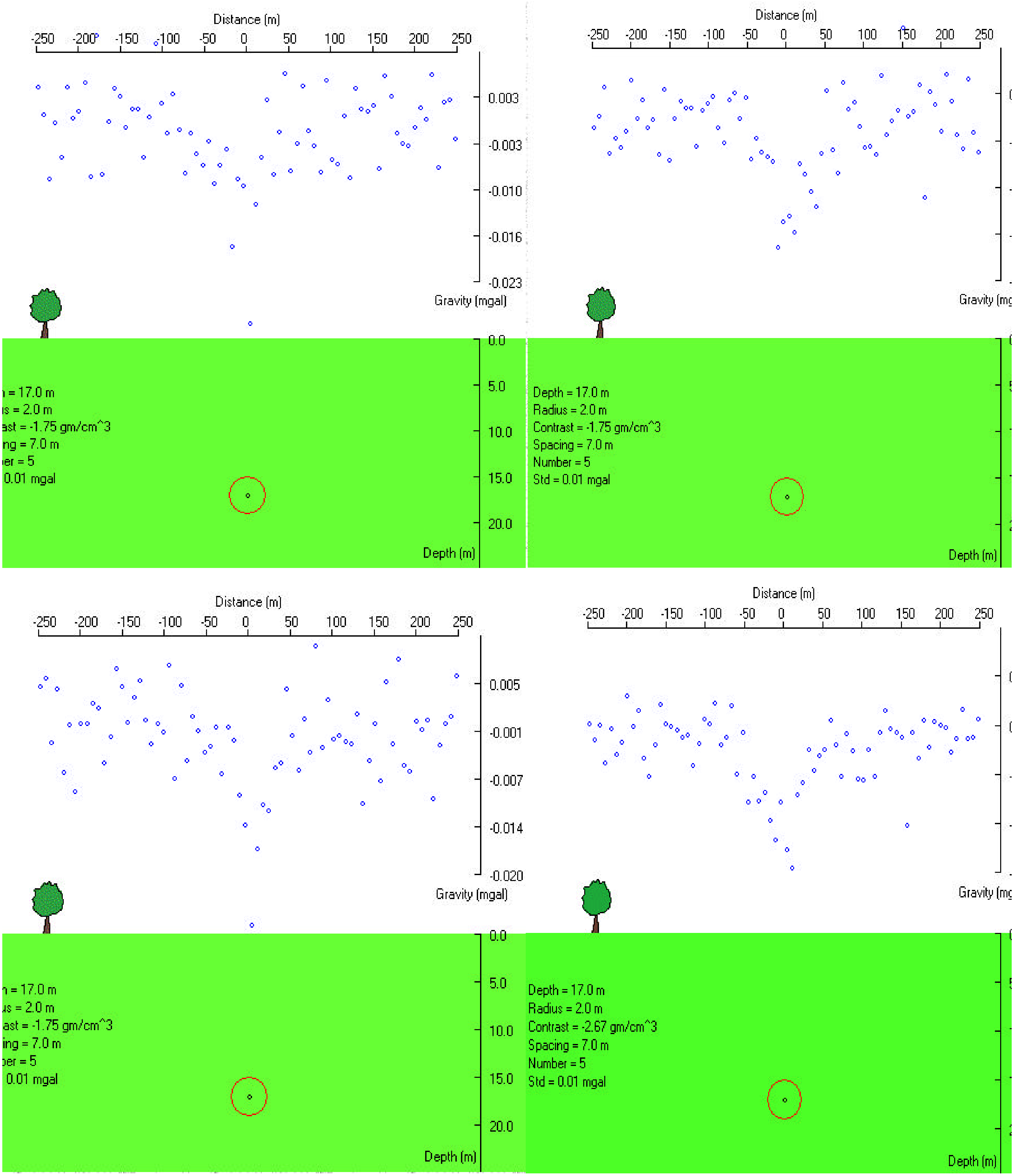
(data showing multiple readings using our defined parameters and their resulting resolution)



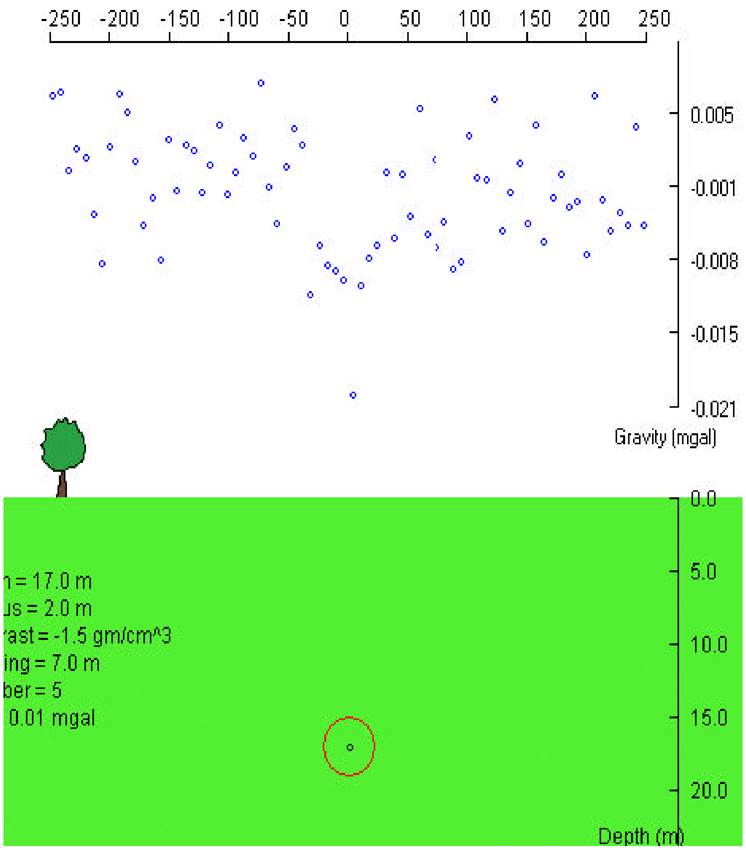








Distance (m)
-250 -200 -150 -100 -50 0 50 100 150 200 250
0.003
-0.003
-0.010
-0.016
-0.023
Gravity (mgal)
0.0
5.0
10.0
15.0
20.0
n = 17.0 m
us = 2.0 m
ast = -1.75 gm/cm^3
ng = 7.0 m
er = 5
0.01 mgal
Depth (m)
Distance (m)
-250 -200 -150 -100 -50 0 50 100 150 200 250
Gravity (mg
Depth = 17.0 m
Radius = 2.0 m
Contrast = -1.75 gm/cm^3
Spacing = 7.0 m
Number = 5
Std = 0.01 mgal
Depth (m)
Distance (m)
-250 -200 -150 -100 -50 0 50 100 150 200 250
0.005
-0.001
-0.007
-0.014
-0.020
Gravity (mgal)
0.0
5.0
10.0
15.0
20.0
n = 17.0 m
us = 2.0 m
ast = -1.75 gm/cm^3
ing = 7.0 m
ber = 5
0.01 mgal
Depth (m)
Distance (m)
-250 -200 -150 -100 -50 0 50 100 150 200 250
Gravity (mg
Depth = 17.0 m
Radius = 2.0 m
Contrast = -2.67 gm/cm^3
Spacing = 7.0 m
Number = 5
Std = 0.01 mgal
Depth (m)


-250 -200 -150 -100 -50 0 50 100 150 200 250
0.005
-0.001
-0.008
-0.015
-0.021
Gravity (mgal)
0.0
5.0
10.0
15.0
20.0
Depth (m)
h = 17.0 m
us = 2.0 m
rast = -1.5 gm/cm^3
ing = 7.0 m
ber = 5
0.01 mgal

Appendix B

(gravity survey cost analysis calculations)

COLLIER & MIXAN
GEOPHYSICS

Gravity Survey Cost Analysis

TIME:

		time(min)	time (hrs)
spacing=	7		
number=	5		
total area=	500		
total readings=	357	1786	29.76
base reocc.=	15	223	3.72
mobilization=			8
total=			41.5

COST:

field crew=	$829.64
processing=	$1,659.29
substinence=	$1,037.05
gravity meter=	$1,037.05
vehicle=	$259.26
fringe=	$497.79
overhead=	$4,023.77
fee=	$4,148.21
consulting=	$200.00
total cost=	**$13,692.07**

Appendix C

IF			THEN	
Tunnel Depth	Density Contrast	Tunnel Radius	Anomaly Strength	Anomaly Width
⇑ ⇓			⇓ ⇑	⇑ ⇓
	⇑ ⇓		⇑ ⇓	? ?
		⇑ ⇓	⇑ ⇓	? ?
⇑	⇑		?	⇑
	⇑	⇑	⇑	?
⇑		⇑	?	⇑
⇓	⇓		?	⇓
	⇓	⇓	⇓	?
⇓		⇓	?	⇓