REVIEW OF COST AND EXCAVATION TIME OF THE VERY LARGE (100-KILOTON) WATER CERENKOV DETECTOR CHAMBER AT THE HOMESTAKE UNDERGROUND LABORATORY

Topical Report RSI-1919

by

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1.0 INTRODUCTION

On January 11, 2007, Dr. Ken Lande of the Department of Physics and Astronomy at the University of Pennsylvania asked RESPEC to submit a proposal to conduct a detailed design and cost estimate for the Very Large (100-Kiloton) Water Cerenkov Detector Chamber at the Homestake Underground Laboratory in Lead, South Dakota. On January 26, 2007, after establishing the work scope requirements, RESPEC submitted its proposal to conduct the work for $195,000 over seven months.

On February 5, 2007, Dr. Lande asked RESPEC to undertake a study much reduced in scope, i.e., to review a previous estimate of cost and duration prepared by Homestake Mine in 2002, to determine whether that estimate is reasonable. This study was to be completed by the end of February 2007.

On February 8, 2007, RESPEC submitted a revised proposal for the reduced scope for $15,000. A copy of this proposal was sent to Dr. Milind Diwan of Brookhaven National Laboratory on February 9, 2007. The detailed study mentioned above is to be performed at a later date.

2.0 SCOPE OF WORK

The reduced work scope for the present study was requested by Dr. Lande in his letter of January 30, 2007, to RESPEC (see Item 5 and closing paragraph of Appendix A). In further discussions between Angus Robb and Dr. Lande, Mr. Robb suggested that with the limited time and funds available, the best check on whether the Homestake estimate falls within a reasonable range would be to compare it with estimates or actual costs of other underground construction projects completed recently. This principle was conveyed in RESPEC's revised proposal to Dr. Lande on February 8, 2007 (see Appendix B).

3.0 SPECIFICATIONS

In 2002, Mark Laurenti, Homestake Mine's Chief Engineer at the time, designed a chamber that was located between the 6,950-ft level and the 7,100-ft level. This chamber was to be 164 ft in diameter (inside a concrete liner) and to have vertical cylindrical walls of 164 ft in length and a domed top and bottom, both 41 ft high. The chamber was close to the excavated rock disposal point. Homestake Mine's 2002 cost and schedule estimate was based on these specifications.

Since the mine shutdown, the water level in the workings has risen; therefore, per Dr. Lande's letter of January 30 (Appendix A), the chamber will now be positioned with its top at the 4,850-ft level and will be 53 meters (approximately 174 ft) in diameter inside the concrete liner and 53 meters in height. As previously designed, the cylindrical chamber will have a domed top and bottom.

However, RESPEC's present undertaking is to evaluate Homestake Mine's cost estimate as escalated to 2007 dollars, along with a schedule estimate, both based on the original location and dimensions. Detailed design, with cost and scheduling activities based on the new location and dimensions, will be a separate task, to be conducted at a future date.

4.0 BASIS OF COST COMPARISON

Accurate cost and schedule calculations are based on detailed design, cycle times, production rate estimates, rock reinforcement requirements, material quantities, and schedule logic considerations such as which activities can be performed concurrently and which activities must be performed sequentially. The present preliminary study is based on a cost/schedule comparison of the Homestake Mine project (hereafter referred to as the Homestake Project) and two recently completed projects in New Mexico, one near Socorro (hereafter referred to as the Socorro Project) and the other near Carlsbad (hereafter referred to as the Carlsbad Project). Because cost bases and conditions of the three projects differ, RESPEC has made conversions to enable comparison.

Homestake Mine's 2002 cost and schedule estimate, reviewed by RESPEC, consisted of a one-page cost summary and included statements of assumptions and exclusions (see Appendix C). In general, the estimate included only direct operating costs and excluded indirect and overhead costs. The schedule estimate was based on the necessity of conducting excavations in a producing mine with shared facilities. This restriction is further discussed in Section 7.0 of this report.

The Carlsbad Project's cost basis was similar to Homestake's in that it was an excavation conducted by mine personnel in a producing facility and allowed for only direct costs. The Socorro Project, on the other hand, was carried out by a contractor, and the cost estimate included all costs attributed to the project, including indirect and overhead costs. Thus, the two projects used for comparison to the Homestake calculation did not have the same cost basis.

To reduce the three projects to a common basis, RESPEC has compared only their direct costs, although contractors' indirect costs are significant and include supervision, a share of home office costs, profit, etc. All cost comparisons are calculated on the basis of 2007 dollars.

Similarities and differences in conditions of the three projects are discussed in the sections that follow.

5.0 COMPARISON OF CONDITIONS

As mentioned above, making a valid comparison of cost estimates requires reducing them to a common basis. The validity of any comparison also depends on commonalities or at least close similarities in mining method, rock type, production rates, etc. These similarities, along with the differences, are shown in the subsections below.

5.1 SOCORRO PROJECT

5.1.1 Similarities

1. COST BASIS: Indirect and overhead categories were eliminated from the Socorro estimate to make it comparable to the Homestake estimate.
2. ROCK TYPE: The excavations at Homestake will be done in metamorphic rock of similar hardness and density to those of the rock in the Socorro Project.
3. ROCK REINFORCEMENT: There will be extensive use of rock bolts and shotcrete in the Homestake Project, as there was in the Socorro Project.
4. REMOTENESS: Because of the remoteness of both sites, the costs of delivered materials are likely to be similar.
5. MINING METHOD: As in the Socorro Project, the method in the Homestake Project will be drill and blast, with some top heading and bench.
6. MINING EQUIPMENT: Equipment similar to that of the Socorro Project, including jumbos, load-haul-dump vehicles (LHDs), bolters, etc., will be used in the Homestake Project.
7. TRAMMING: Distances to dump points for muck are short.
8. PRODUCTION RATES: The projects have similar daily production rates.

5.1.2 Differences

1. OPERATOR: The Socorro Project was executed by contractors. The Homestake Project was planned to be executed by mine personnel.
2. MINE: The Socorro Project was not connected to an operating mine.

3. SCALE: The scale (total volume of rock excavated) of the Homestake Project is larger than the scale of the Socorro Project.

5.2 CARLSBAD PROJECT

5.2.1 Similarities

1. COST BASIS: As with the proposed Homestake Project, the cost for the Carlsbad Project was limited to direct costs.
2. MINE: Like the Carlsbad Project, the proposed Homestake Project will be conducted in an operating mine.
3. TRAMMING: Both the method of tramming (LHDs) and the short tramming distance are similar in the Homestake and the Carlsbad Projects.

5.2.2 Differences

1. ROCK TYPE: The Carlsbad Project was conducted in salt rock, which has a different hardness and density than the metamorphic rock of the Homestake project.
2. MINING METHOD: The Carlsbad Project was carried out by continuous miners, whereas the method at the Homestake site will be drill and blast.
3. PRODUCTION RATES: The Carlsbad Project has higher production rates because of the mining method and softer medium.

6.0 COST ESTIMATES

Comparing total costs of the three projects with differing conditions and scale would not be meaningful. On the other hand, comparing unit rates, e.g., costs per cubic yard or ton of excavated material, is quite useful, although of necessity rough because of project differences. This type of comparison can be used in determining whether or not unit costs fall within a reasonable range when compared with other current project unit costs.

6.1 HOMESTAKE ESTIMATE

Homestake Mine's 2002 cost and schedule estimate by Mark Laurenti is based on known mine operating costs, with the qualifications that follow in this subsection.

1. These costs are not included in the estimate:
    a. Equipment purchase or lease
    b. Cost of waste handling
    c. General operation of the mine
    d. Engineering and geological services
    e. Power and water consumption
2. The cost estimate assumes the following:
    a. A waste handling system is in place and is capable of handling up to 540 tons per shift (8,000 tons per week) before the start of excavation work on the chamber.
    b. Ventilation is sufficient for more than one activity at a time in the chamber.
    c. Labor is multitasked to operate and construct all aspects of the chamber.
    d. After construction, shop areas and other miscellaneous excavations will be used for permanently installed equipment, such as electronics, cooling equipment, etc.

According to Dr. Lande (see Item 4 of his letter in Appendix A), Homestake's cost estimate, escalated to the present-day dollar value, is $30 million, or about $26 million without the concrete liner. The concrete liner is a significant cost item not applicable to the Socorro or the Carlsbad Project, and hence the reduction of $4 million in the Homestake estimate for purposes of comparison. The cost of the concrete liner would, of course, have to remain part of the total cost.

Item 2 of Dr. Lande's letter of January 30 (Appendix A) gives the estimate of 440,000 tons of waste rock per chamber. The unit excavation cost is therefore $26 million divided by 440,000 tons, or $59 per ton, or using a density of approximately 2.45 tons per cubic yard (solid), about $145 per cubic yard.

6.2 SOCORRO ESTIMATE

The project consisted of four tunnels, a large chamber, and a vertical shaft. The direct operating cost of the Socorro Project was compiled by RESPEC and escalated to current dollars. The resultant costs were $69 per ton or approximately $169 per cubic yard (as mentioned earlier, the rock types in the Socorro and Homestake Projects have similar hardness and density).

6.3 CARLSBAD ACTUAL COST

The Carlsbad Project consisted of 2,600 ft of tunnel in an existing underground facility. As calculated by mine staff, the actual direct operating cost for the Carlsbad Project was $43 per ton in current dollars. Given that the density of salt is 1.84 tons per cubic yard, the cost per cubic yard is slightly more than $79.

6.4 RELEVANCE OF RESULTS

Of the three projects considered here, it is to be expected that the direct operating cost of the Carlsbad Project would be the least per unit, i.e., cubic yard or ton of rock excavated. The salt rock mined in the Carlsbad Project is softer than the igneous/metamorphic rock mined in the other two projects. The faster production rate resulting from the mining method and relative rock hardness leads to cheaper unit cost. It is also to be expected that the Socorro Project, because of economies of scale (smaller overall volume), would be the most expensive per unit. The direct unit cost at Homestake was based on actual mine cost statistics, and it falls between the direct costs of the other two projects (see the comparison in Table 1 below).

Table 1. Comparison of Cost Per Unit

Cost Per Ton ($)	Project	Cost Per Cubic Yard ($)
69	Socorro	169
59	**Homestake**	**145**
43	Carlsbad	79

7.0 SCHEDULE

Homestake Mine's 2002 estimated schedule for the excavation of one chamber allowed a duration of 4 years. At that rate, 110,000 tons of waste rock per year or 440 tons of waste rock per day would be mined, assuming that there are 250 workdays in a year (5 workdays per week). That estimate seems unduly conservative.

However, without further information regarding Homestake's schedule logic, RESPEC cannot give a definitive opinion on that estimated schedule. The seemingly long duration may be due to the fact that in a producing mine, hoisting services must be shared, with priority

always given to mineral production. Without this restriction, the production rate could reach or surpass 800 tons per day. At this rate, with the 6-day week normally worked by contractors, the duration of the Homestake Project could be reduced to 2 years (of 300 workdays).

8.0 DETAILED DESIGN AND COST/SCHEDULE ESTIMATE

RESPEC has already submitted a proposal for the detailed phase of the work that will follow the decision to proceed with the project. During that phase, all aspects of the project will be addressed as shown in Table 2 (see page 8), derived from the Gantt chart submitted with the proposal. That Gantt chart shows which tasks are concurrent and which are sequential.

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Table 2. Activities and Schedule for the Homestake Project

Activity	Duration (Months)
PRELIMINARY INVESTIGATIONS	**1.0**
INSPECT SITE	1.0
Inspect surface facilities	**0.6**
Hoists	0.3
Loading arrangements	0.3
Waste rock disposal	0.1
Meet state regulators	**0.2**
REVIEW RELEVANT DESIGN AND COST REPORTS	1.0
WASTE ROCK HANDLING REQUIREMENTS	**1.0**
DETERMINE SURFACE ROCK HANDLINGREQUIREMENTS	1.0
DETERMINE UNDERGROUND ROCK HANDLING REQUIREMENTS	1.0
CHAMBER DESIGN REQUIREMENTS	**1.5**
EVALUATE ALTERNATIVE DESIGN CONCEPTS	1.0
DETERMINE Q SYSTEM VALIDITY/ROCK REINFORCEMENT	1.0
DETERMINE VENTILATION/COOLING REQUIREMENTS	1.0
DETERMINE CONSTRUCTION METHODS	1.0
SELECT BEST DESIGN	0.5
SCHEDULING	**0.5**
DETERMINE PRODUCTION RATES FOR ALL CONSTRUCTION ACTIVITIES	0.5
COMPILE CONSTRUCTION SCHEDULE WITH LOGIC FOR CONCURRENT AND CONSECUTIVE ACTIVITIES. COMPLETE RESOURCE LOADING.	0.5
PRICING	**1.5**
MOBILIZATION	1.0
SURFACE FACILITIES	1.0
UNDERGROUND FACILITIES	1.0
EXPLORATORY DRILLING	0.5
CONSTRUCTION	1.5
Time-related costs	**1.0**
Material costs	**1.0**
Overhead costs	**1.0**
Other costs	**0.5**
DEMOBILIZATION	0.5
REPORTS	**1.5**
PRODUCE FINAL DESIGN REPORT AND DRAWINGS	1.5
PROJECT COSTS--PRODUCE FINAL COST REPORT	1.5
Miscellaneous Support Labor (Secretarial/Drafting)	7.0
Total Estimated Duration	**7.0**

9.0 CONCLUSIONS

RESPEC concludes that Homestake Mine's 2002 cost estimate, escalated to 2007 dollars, is in the range of what can be considered reasonable. Its unit costs are between those of the Carlsbad Project and the Socorro Project, two recently completed excavation projects. The overall cost of the excavation of the Homestake detector chamber can be assumed to be on the order of $30 million. This estimate includes $4 million for the concrete liner and $26 million for excavation, in 2007 dollars. In RESPEC's opinion, Homestake's cost estimate would fall into the Department of Energy (DOE) class of Title I, Preliminary Design, which has an accuracy of ± 20 percent (Title II and Title III estimates are increasingly more accurate). Therefore, the range of cost for the Homestake Project, expressed in 2007 dollars, would be $24 to $36 million.

This cost estimate is based on certain exclusions and assumptions that should be reiterated here. The estimate is for direct costs only and therefore does not include indirect or overhead costs. Specifically, it does not include the costs of equipment purchase or lease, waste handling, general operation of the mine, engineering and geological services, or power and water consumption. The cost estimate assumes that a waste handling system capable of handling up to 8,000 tons per week is in place, that ventilation is sufficient for more than one activity at a time in the chamber, that labor is optimally multitasked, and that shop areas and other miscellaneous excavations will be used for permanently installed equipment after construction.

Homestake Mine's 2002 schedule and cost estimate was appropriate for the conditions prevailing at the time of its compilation, in particular because it was based on established mine operating costs. However, those conditions, including the necessity of sharing facilities with a producing mine, will presumably not prevail in any future construction at the Homestake Underground Laboratory; thus, there should be increased productivity, reduced duration, and potential cost savings. Furthermore, the construction of the chamber at a shallower level may lead to additional savings in ventilation and cooling costs.

If the project is to be undertaken by more than one contractor, it will be important to ascertain their relative cost responsibilities, particularly regarding indirect and overhead items. This determination will ensure accuracy in calculating the total project cost.

Because of the limited time and information available for this review, RESPEC's evaluation of Homestake Mine's 2002 cost and schedule estimate should be regarded as preliminary. A more conclusive cost/schedule estimate can be determined only by conducting a detailed study as outlined in Section 8.0 of this report.

APPENDIX A

DR. KEN LANDE'S LETTER OF JANUARY 30, 2007

UNIVERSITY of PENNSYLVANIA

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David Rittenhouse Laboratory
209 South 33rd Street
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Professor Kenneth Lande
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January 30, 2007

Mr. Angus Robb
Respec Engineering

Dear Angus,

Thank you very much for the detailed Cost Estimate (P-2373) for the planning for our large chamber excavations at the Underground Laboratory at Homestake. The scope of work in your estimate is greater than I had envisaged for now. That is, we are in the proposal budget estimating phase, and not yet in the pre-construction phase. I do understand that you are interested in a larger and more encompassing role in this project and reflected that in your cost estimate.

I would like to make some specific comments on some of the items in your proposal.

1) **Site Inspection** – The SDSTA (South Dakota Science and Technology Authority) is engaged in an inspection of all hoisting and related equipment. A contractor has been engaged to carry out this work. Thus, we do not have to do this work and are not responsible for this effort.
2) **Waste Rock Disposal** – I have assumed that our responsibility for the waste rock ends at the 4850 ore dump and that the SDSTA will co-mingle our waste rock with that from other projects at this point. SDSTA has given us a planning figure of $4.55 per ton for waste rock disposal. Using this figure and a rough estimate of 440,000 tons of waste rock per chamber gives a disposal cost of $2 million per chamber. I assume that this figure will be revised before we submit a final proposal or any excavation work begins.
3) **Chamber Design Requirements** - This is clearly the central issue in our proposal, the design of a safe and reliable excavation and chamber. You mentioned an alternative to the Mark Laurenti excavation plan, one that might be faster and less expensive. As I recall, you suggested treating the excavation as a very large diameter shaft. I think it is very useful to explore alternate design concepts and then select the best one for construction.
4) **Construction Costs and Schedules** - These are critical issues in our plans. A final proposal will require a detailed set of costs and schedules. However, we will, most likely, need preliminary and thus cruder cost and schedule estimates. These preliminary estimates are necessary to get preliminary design funding. So far, we have used the costs generated by Mark Laurenti in 2002 and have adjusted them by inflation. The result is roughly doubling the 2002 figures to about $30 million per chamber. This is where we really need some help right now. If this figure is reasonable, it would be useful to have confirmation of that. If this figure is not reasonable, then it would be useful to have a correct figure to use in request for preliminary design funds.

5) **Timetable** – Several review meetings will occur in March. These will involve both total underground laboratory reviews and specific experimental proposal reviews. We plan to submit an update in the second half of February to our proposal of last fall. An improvement to our excavation estimate would be most useful in this update. We have a small amount of money available at Brookhaven National Laboratory to use for the proposal update. We have to decide by the end of this week how best to do this. Would you be able to do a rough excavation cost update with some modest funds?
6) **Bill Pariseau and Doug Tesarik** – I think I mentioned to you on the phone that both Bill Pariseau from the University of Utah and Doug Tesarik from NIOSH-Spokane are collaborating with us in the chamber construction process and have plans to monitor the excavation stability after construction is completed. Given the critical nature of the stability of the excavation, I personally would find it most reassuring if there were two completely independent excavation stability evaluations. I mention this because you list "Q System Validity" as one of your tasks.

I hope we can talk later this week about the above and see how to get Respec involved in the preliminary, rough budget and timetable estimate process.

Best regards,

Ken

APPENDIX B

WORK STATEMENT
FOR THE REVIEW OF
COST AND EXCAVATION TIME

RESPEC
CONSULTING & SERVICES

RSI(ALO)-996/2-07/03

February 8, 2007

Dr. Ken Lande
Department of Physics & Astronomy
University of Pennsylvania
209 South 33rd Street
Philadelphia, PA 19104-6396

Dear Dr. Lande:

Re: Work Statement for the Review of Cost and Excavation Time of the Very Large (100-Kiloton) Water Cerenkov Detector Chamber at the Homestake Underground Laboratory

RESPEC proposes to examine the costs estimated by Mark Laurenti in 2002 to excavate a very large chamber in the underground laboratory at the Homestake Mine, Lead, South Dakota. This chamber is a vertical cylinder 50 meters high and has an interior diameter of about 50 meters. The chamber will have a domed top and bottom.

In particular, RESPEC proposes to:

1. Determine whether the unit rate (cost/unit mined) used by Mark Laurenti falls within a reasonable price range as compared with other recent projects of similar type.
2. Review the estimate of the time required to carry out the proposed excavation and compare it with standard contractor estimates for such work. In addition, RESPEC will offer suggestions for alternative designs and other potential cost-saving measures to be considered when the detailed design and costing is performed.
3. Deliver a written report on Items 1 and 2 above.

It is anticipated that this work will be finished by the end of February and will cost approximately $15,000. The hourly rates of the two RESPEC employees involved, Angus Robb and Phillip Scott, are $140/hr and $45/hr, respectively. Their résumés are attached to this letter.

RESPEC has previous experience with the Homestake Mine, the proposed Underground Laboratory, and the proposed 100-kiloton water Cerenkov detector excavation. In 2002, RESPEC did a two-dimensional stress analysis and excavation stability study for the proposed 100-kiloton detector excavation (Rock Mechanics Analyses of Preliminary Designs of the Megaton Modular Multi-purpose (3M) Neutrino Detector in the Homestake NUSL). In

addition, RESPEC has considerable experience with other nonmining underground excavations, such as the Waste Isolation Pilot Plant (WIPP) site near Carlsbad, NM; various DoD underground facilities; and major chamber excavations in China.

Sincerely,

Angus Robb
Manager, Geoengineering

AR:pas

Enclosures

cc: Dr. John D. Osnes, RESPEC
Dr. Gary D. Callahan, RESPEC
Mr. Thomas J. Zeller, RESPEC
Project Central File 996 — Category B

APPENDIX C

HOMESTAKE MINE'S
2002 COST AND SCHEDULE ESTIMATE

Total Estimated Costs for the Construction of One 100 Kiloton Module

Sub Total Labor & Benefits	$ 5,506,656
Sub Total Equipment Operation	$ 1,297,210
Sub Total Supplies	$ 7,760,490
Sub Total Contractors	$ 123,000
15.% Contingency	$ 2,203,103
GRAND TOTAL	**$ 16,890,460**

Labor

Description	Units	Hr Rate	Salary Rate	Yearly Rate	Years	TOTAL $
Salary Labor	3		$ 55,000	$ 165,000	4	$ 660,000
Salary Benefits	40%			$ 66,000	4	$ 264,000
Hourly Labor	24	$ 17.00		$ 848,640	4	$ 3,394,560
Hourly Benefits	35%			$ 297,024	4	$ 1,188,096
					Sub Total Labor & Benefits	**$ 5,506,656**

Mining

Description	$ / Unit	Adj. $ / Unit	Units	N/A	N/A	TOTAL $
Equipment Operation		1.20	Cost Adjustment Factor			
1 Face Drill	$ 0.42	0.50	90,200 Tons	Operating cost include all consumables such as Tires, Fuel , Filters, parts and Misc.		$ 45,461
4 LHD	$ 0.90	1.08	419,600 Tons			$ 453,168
2 Bolter	$ 0.97	1.16	419,600 Tons			$ 473,762
2 UG Support Veh	$ 0.10	0.12	419,600 Tons			$ 5,035
2 Lift trucks	$ 0.10	0.12	419,600 Tons			$ 5,035
1 LH Drill	$ 0.58	0.70	419,600 Tons			$ 169,384
2 ITH Drill	$ 0.58	0.70	360,100 Tons			$ 145,365
					Sub Total Equipment Operation	**$ 1,297,210**
Supplies		1.20	Cost Adjustment Factor			
Blasting Supplies	$ 0.86	1.03	419,600 Tons			$ 431,957
Drill Bits	$ 0.60	0.72	419,600 Tons			$ 300,684
Drill Steel	$ 0.25	0.30	419,600 Tons			$ 127,236
General Operating Supplies	$ 1.47	1.76	419,600 Tons			$ 738,798
Cable Bolts	$ 4.00	4.80	147,200 ft			$ 706,560
Rock Bolts	$ 0.57	0.68	300,000 Tons			$ 204,236
Hoses	$ 0.06	0.07	419,600 Tons			$ 28,298
Lubricants	$ 0.04	0.05	419,600 Tons			$ 19,937
Pipe	$ 15.00	18.00	3,070 ft			$ 55,260
Safety Supplies	$ 0.05	0.06	419,600			$ 26,345
Small Tools	$ 0.01	0.01	419,600 Tons			$ 6,122
Vent Bag	$ 0.01	0.02	419,600 Tons			$ 7,365
Spot Coolers	$ 18,611.63	22,334/ cooler/ year	4		4.00 Years	$ 357,343
Shotcrete & Screen	$ 130.00	156.00	2,810cuYd			$ 438,360
Precast Cement Liners	$ 1,300.00	1,300.00	2.499			$ 3,248,700
Spray Liner	$ 5.00	5.00	105,616sqft			$ 528,080
Top Deck Material	$ 20.00	20.00	21,124sqft			$ 422,480
Shop Construction	$ 15.00	18.00	3,416 sq ft			$ 61,488
Diamond Drill	$ 7.00	8.40	6,100 ft			$ 51,240
					Sub Total Supplies	**$ 7,760,490**

Outside contractor		1.20	Cost Adjustment Factor			
Borehole	$ 250.00	300.00	410 ft			$ 123,000
						$ -
					Sub Total Contractors	**$ 123,000**

Note

There is no costs for :

Equipment purchase or lease
Waste Handling
General operation of the mine such as shaft operation and pumping and Main Ventilation system
Engineering
Geology
Other Office functions
Property maintenance
Water consumption
Power Consumption except for coolers