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December 21, 1998

To: Bill Boyle

From: Zell Peterman

Subject: Chlorine-36 validation study

Here are a three copies of the proposal that was faxed to you this morning. The cost certainly expanded beyond what I would have originally guessed, but 58 percent of the cost is associated with drilling and drilling support. The proposal is predicated on the assumption that any objective validation should be totally independent in all aspects including new sampling; hence, the large cost. The analytical cost for the U-Th-Ra isotopes will be covered from the AECL budget according to Bill Seddon. The salary cost for Mel Gascoyne is currently shown as part of the USGS budget because of the difficulty of AECL being able to hire Mel back for this project. The USGS can do this under its contract with Pacific Western Technologies.

June Fabryka-Martin called earlier today. She was upset about this, and I apologized for not contacting her sooner. Nonetheless, I told her that it was in her best interest to cooperate in this endeavor, that we needed her input, and that we wanted her at the planning task. Also emphasized that the project was designed to be an independent validation and that I would make the final technical decisions after discussion with and input from the other participants.

As you can see in the proposal, the approach is to evaluate two of the more significant anomalies in the ESF—the Sundance fault and the Drill Hole Wash fault. If the cost is thought to be too large, the scope of work could be reduced to one of these anomalies, or the work could be phased over a longer period of time with an evaluation period between phase one and phase two. If one anomaly is validated in phase one, it might not be necessary to evaluate phase two. At the same time, an argument can be made for conducting the drilling before further dryout occurs so as to be able to obtain water for tritium analyses.

PROPOSAL: Conduct Validation Study of Bomb-pulse $^{36}Cl$ Occurrences in the ESF

PARTICIPANTS: Atomic Energy of Canada Ltd., Lawrence Livermore National Laboratory, U.S. Geological Survey

PROJECT MANAGEMENT: U.S. Geological Survey

## 1.0 Introduction

Validation of scientific findings is commonly conducted by independent replication of experiments or analyses. For example, the discovery of cold fusion by University of Utah scientists received global attention. However, subsequent attempts to replicate the work by other laboratories failed, and the potentially far-reaching discovery was relegated to the scientific trash heap. In contrast, engineering projects rely on explicit and detailed plans with implementation controlled by strict quality assurance programs; it is just not practical to replicate complex and expensive construction projects as a means of validation. Because of the profound hydrologic implications, the reported occurrence of bomb-pulse $^{36}Cl$ at several localities in the ESF requires the scientific approach to validation even though the work has been conducted under detailed quality assurance procedures.

## 2.0 Proposed Project

A consortium of scientists from Atomic Energy of Canada, Ltd., Lawrence Livermore National Laboratory, and the U.S. Geological Survey, with support from the YMP M&O Technical Coordination Office, are presenting this plan to conduct independent validation of bomb-pulse $^{36}Cl$ anomalies in the ESF. The plan entails sampling by dry drilling, and analyses for bomb-pulse isotopes $^{36}Cl$, $^{99}Tc$, and $^{3}H$, supplemented by analyses of uranium, thorium, and radium isotopes.

### 2.1 Statement of Work

Elevated concentrations of $^{36}Cl$ relative to total Cl in pore-water salts at a few localities in the ESF have been interpreted as indicating the presence of modern water (less than 50 years old). The source of the $^{36}Cl$ is assumed to have been the large influx of this isotope into the atmosphere during nuclear testing in the western Pacific Ocean in the mid-fifties. Such anomalies have been reported in the north ramp and the main drift up to ESF Station 45. Few anomalous occurrences have been reported beyond Station 45 including the south ramp. Anomalies documented by more than a few samples occur near the Drill Hole Wash structure and the Sundance Fault structure. These will be the targets of the validation study proposed here.

## 2.2 Project Design

The difficulty in replicating anomalous $^{36}Cl$ values has led to the conclusion that this bomb-pulse isotope is inhomogeneously distributed at a centimeter or decimeter scale. Any attempt to replicate the existing results through resampling and analyses must consider this in designing a validation study. The approach must be based on the probability of encountering bomb-pulse values along reaches of the ESF where previous studies have identified numerous occurrences. As noted, two multisample anomalies occur between the north portal and Station 45. Within a 50-m interval corresponding to a bounding fault along the Drill Hole Wash structure, four of six samples have elevated $^{36}Cl$ values interpreted to be bomb-pulse in origin (*Attachment 1*). Similarly, along an approximate 150-m reach of the ESF near the Sundance Fault sampling has yielded 10 bomb-pulse values in 15 samples analyzed (*Attachment 2*). Although individual analyses may not be reproducible, the fundamental premise in this proposal is that a sufficiently detailed resampling along these anomalies, should they exist, will yield approximately the same proportion of anomalous values simply from a probabilistic standpoint. Thus, we propose sampling a total of 50 localities proportioned between these two anomalies according to their approximate width as defined by existing data.

Sampling will be conducted by dry coring of 50, 3-to-4-m-long holes drilled into the right rib of the ESF at the localities previously indicated. These will allow ample intersections of potentially transmissive features such as fractures, cooling joints, and other physical openings in the rock. Furthermore, the deeper portion of these core will extend beyond the effects of construction-induced dry out which will allow the extraction of pore water for tritium analyses. This is an important element of the validation study because the $^{36}Cl$ peer-review panel strongly urged coincident sampling and analyses for $^{36}Cl$ and for tritium. If anomalous values of $^{36}Cl$ are found in the validation study, ten or more samples will be selected for $^{99}Tc$ analyses. Analyses for bomb-pulse isotopes will be supplemented by analyses of uranium, thorium, and radium isotopes to further evaluate the possibility of relatively recent water-rock interaction ($^{234}U/^{238}U$, $^{234}U/^{230}Th$, and $^{226}Ra/^{230}Th$). Lack of such interaction would be concluded if these ratios are in secular equilibrium. Strontium isotope analyses will also be conducted on pore salts to augment the existing data from drill holes SD-7, SD-9, and SD-12. These data are currently being used in refinement of the UZ flow model by LBL.

## 2.3 Operational Responsibilities

### 2.3.1 Drilling

Core drilling will be conducted by the Technical Coordination Office (TCO), and core documentation, preservation, and handling will be done by personnel from the Sample Management Facility (SMF). Specific location of boreholes will be established by the USGS and AECL.

### 2.3.2 Sample Selection

The deepest portions of the core (approximately 0.5 m) will be preserved for water extraction for tritium analyses. A larger interval of core may be preserved if deemed desirable during the detailed project design (Tasks 2 and 3, *Attachment 3*). For $^{36}Cl$, $^{99}Tc$, and uranium-thorium-radium isotope analyses, subsampling of core intervals containing potential transport pathways will be emphasized.

### 2.3.3 Analyses

Analyses for $^{36}Cl$ and $^{99}Tc$ will be conducted at the Center for Accelerator Mass Spectrometry (CAMS) at Lawrence Livermore National Laboratory. The analytical procedures will entail the preparation of core samples, extraction of pore-water salts, and the analyses of $^{36}Cl$ and $^{99}Tc$. Water for tritium analyses will be extracted by vacuum distillation at the USGS YMPB UZ Hydrochemistry Laboratory in Denver, CO. Tritium analyses will be conducted through the USGS National Water Quality Laboratory. Uranium, thorium, and radium isotope analyses will be conducted at the AECL laboratory at Pinawa, Manitoba. Strontium isotope analyses will be done at the YMPB Environmental Science Team Isotope Laboratory in Denver. All analyses will be conducted under approved QA procedures.

### 2.3.4 Deliverable

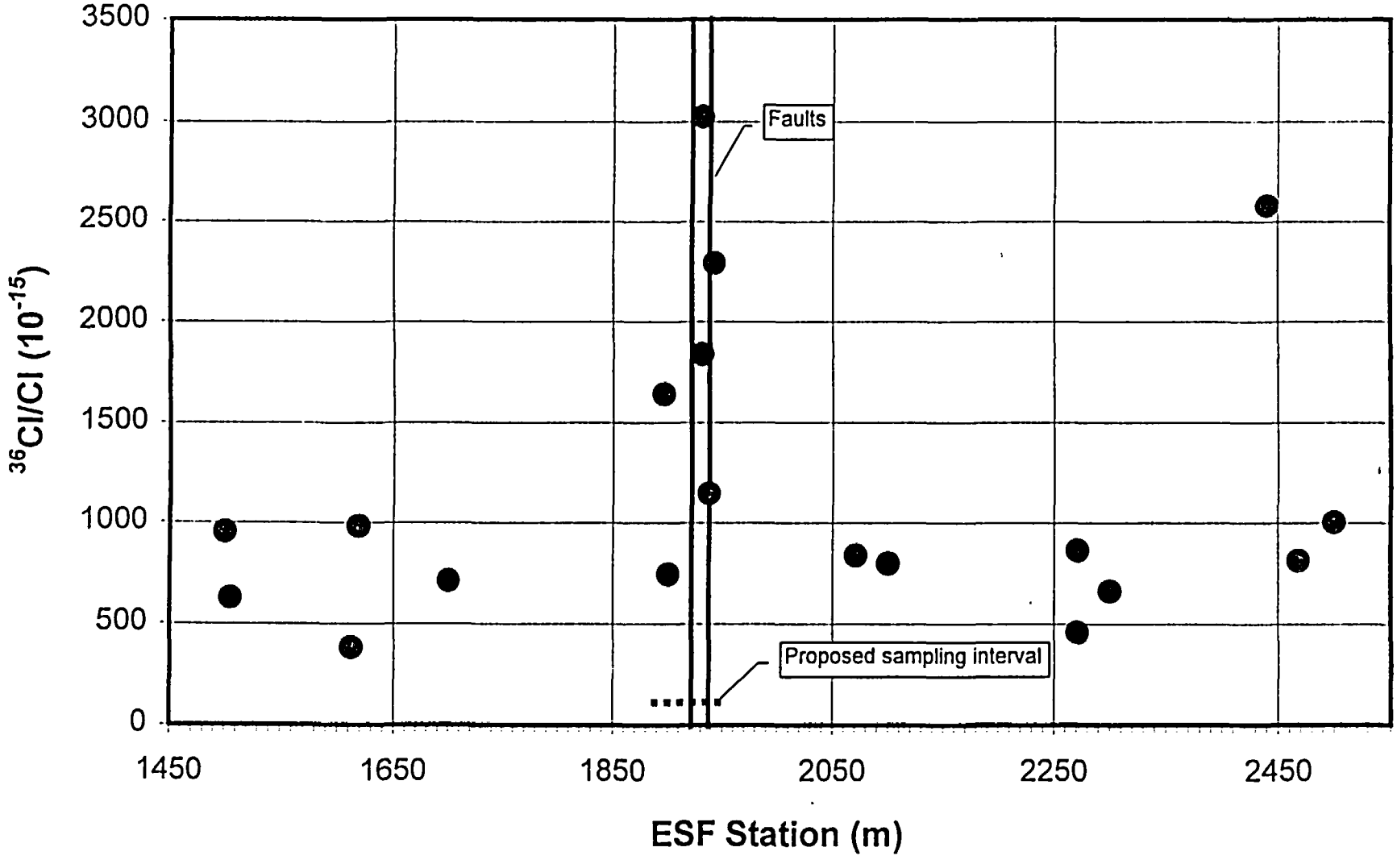
The results obtained in this investigation will be delivered to the DOE in a report containing all of the analytical data and interpretations to be prepared jointly by the participating units at the end of the project.

### 2.3.5 Schedule and Budget

A provisional schedule with major tasks is shown in *Attachment 3*. The project as planned would cost $639k. The schedule shows an early start of January 11, 1999 for planning and project design with sampling to begin on March 1. The project would end on November 11, 1999 with submittal of the deliverable report to the DOE. The finish date may be slightly modified during detailed planning of the project. The budget estimate was developed from input supplied by LLNL, AECL, and the TCO. The costs associated with individual tasks are shown on *Attachment 4* and the costs are summarized both by major activity and by participant on *Attachment 5*.

Zell Peterman
December 21, 1998

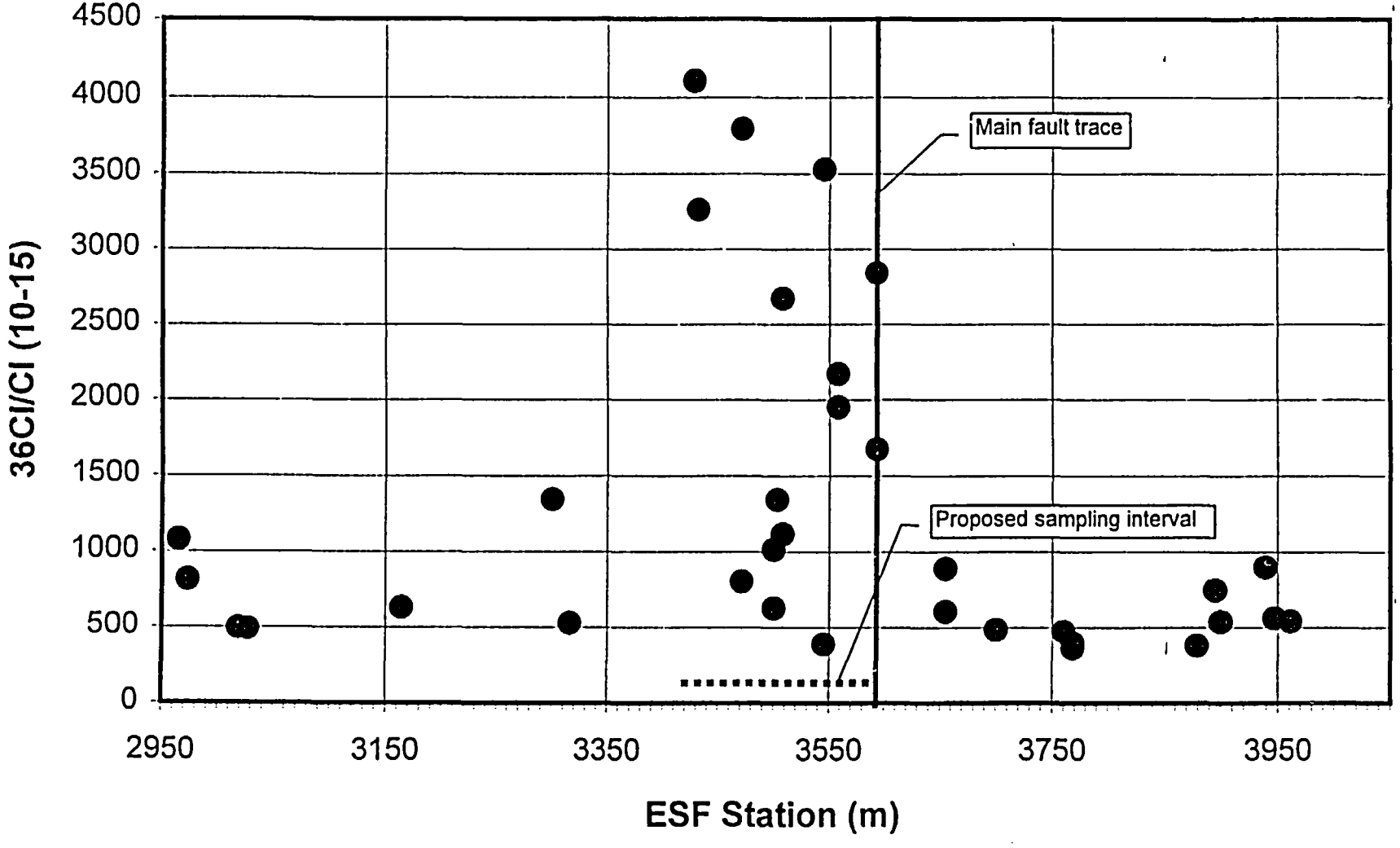
## Drill Hole Wash Structure




Attachment 1

Data from YMP Site and Engineering Database

## Sundance Fault Structure




Attachment 2

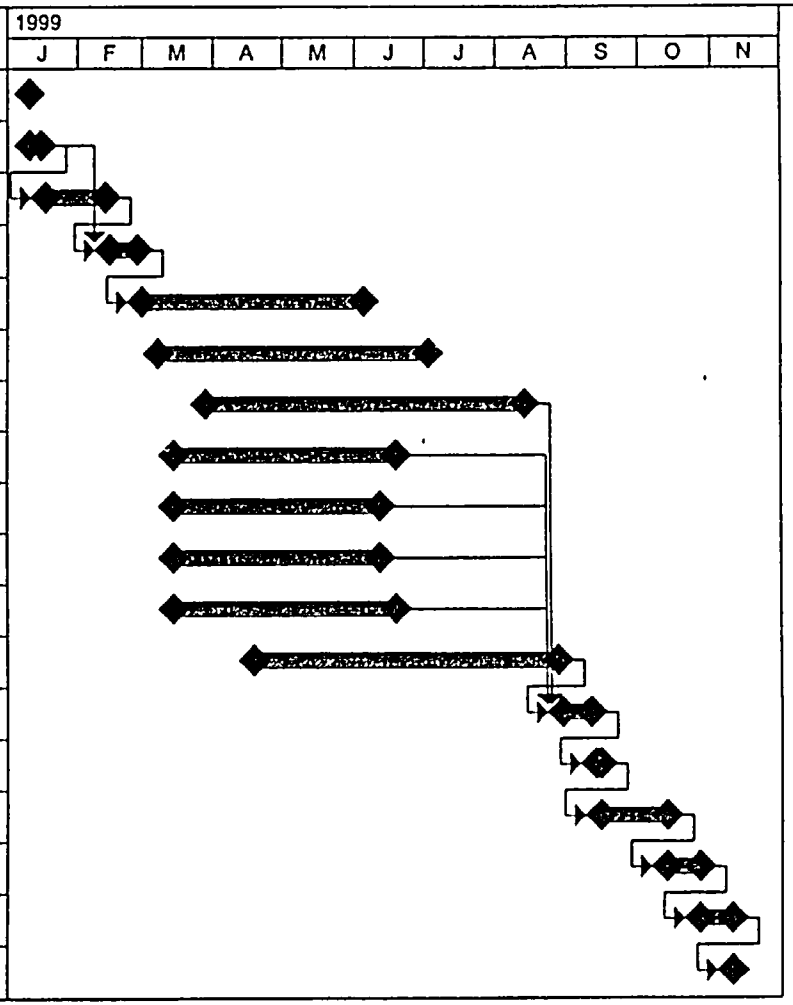
Data from YMP Site and Engineering Database

# *Cl-36 Validation Project*

Participants: Atomic Energy of Canada Ltd., Lawrence Livermore National Laboratory, U.S. Geological Survey

Project Manager: Zell Peterman

| ID | Task Name | Duration | Start | Finish |
|---|---|---|---|---|
| 1 | Approve Project | 1 day | Mon 1/11/99 | Mon 1/11/99 |
| 2 | Plan Project, Schedule, and Cost | 5 days | Mon 1/11/99 | Fri 1/15/99 |
| 3 | Develop Sampling Plan, Finalize Schedule | 20 days | Mon 1/18/99 | Fri 2/12/99 |
| 4 | Develop QA Procedures for Cl-36 and Tc-99 | 10 days | Mon 2/15/99 | Fri 2/26/99 |
| 5 | Conduct Drilling and Allocate Samples | 70 days | Mon 3/1/99 | Fri 6/4/99 |
| 6 | Extract Water for Tritium Analyses | 85 days | Mon 3/8/99 | Fri 7/2/99 |
| 7 | Conduct Tritium Analyses | 100 days | Mon 3/29/99 | Fri 8/13/99 |
| 8 | Strontium Isotope Analyses (WR and Pore Salts) | 70 days | Mon 3/15/99 | Fri 6/18/99 |
| 9 | Uranium/Thorium/Radium Isotope Analyses (AECL) | 65 days | Mon 3/15/99 | Fri 6/11/99 |
| 10 | Monitor/Interpret U/Th/Ra Analyses (AECL) | 65 days | Mon 3/15/99 | Fri 6/11/99 |
| 11 | Cl-36 Analyses (Pore Salts) | 70 days | Mon 3/15/99 | Fri 6/18/99 |
| 12 | Tc-99 Analyses (Pore Salts) | 95 days | Mon 4/19/99 | Fri 8/27/99 |
| 13 | Synthesize Data | 10 days | Mon 8/30/99 | Fri 9/10/99 |
| 14 | Plan Report | 2 days | Mon 9/13/99 | Tue 9/14/99 |
| 15 | Prepare Review Draft | 20 days | Wed 9/15/99 | Tue 10/12/99 |
| 16 | Technical Review | 10 days | Wed 10/13/99 | Tue 10/26/99 |
| 17 | Revise Report | 10 days | Wed 10/27/99 | Tue 11/9/99 |
| 18 | Submit Report to the DOE | 1 day | Wed 11/10/99 | Wed 11/10/99 |




Project: Chlorine 36 Validation
Date: Sun 12/20/98

Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress
Split
External Tasks
Project Summary

Attachment 3

Attachment 4

Budget Report as of Mon 12/21/98
Chlorine 36 Validation
Zell E. Peterman

| ID | Task Name | Fixed Cost | Fixed Cost Accrual | Total Cost | Baseline | Variance |
|---|---|---|---|---|---|---|
| 1 | Approve Project | $0.00 | Prorated | $0.00 | $0.00 | $0.00 |
| | *Notes* The subsequent schedule assumes that this project will be approved by January 11, 1999. Any slippage in approval will, of course, slip all tasks accordingly. | | | | | |
| 2 | Plan Project, Schedule, and Cost | $0.00 | Prorated | $8,860.00 | $0.00 | $8,860.00 |
| | *Notes* USGS, AECL, and LLNL scientists will meet in Denver to prepare detailed project plans and schedules. In the preliminary planning, maximum task durations were assumed. Each task will now be reviewed to evaluate duration and reduced where appropriate. | | | | | |
| 3 | Develop Sampling Plan, Finalize Sch | $0.00 | Prorated | $13,998.00 | $0.00 | $13,998.00 |
| | *Notes* A detailed sampling plan including exact locations of drill holes will be jointly established by participants. Existing locations of samples collected for chlorine-36 analyses in the intervals of interest will be reviewed on site to aid in planning DDH locations. | | | | | |
| 4 | Develop QA Procedures for Cl-36 an | $0.00 | Prorated | $9,600.00 | $0.00 | $9,600.00 |
| | *Notes* LLNL personnel will develop QA procedures and protocols for Cl-36 and Tc-99 analyses. The procedures will be approved before analytical work is started. | | | | | |
| 5 | Conduct Drilling and Allocate Sampl | $0.00 | Prorated | $374,922.00 | $0.00 | $374,922.00 |
| | *Notes* Diamond drilling (3 to 4 meters) will be completed at sites define by Task 3. Drill core will be preserved and curated by staff from the Sample Managment Facility. Cores will be photographed at the drill site d to aid in subsequent subsampling. | | | | | |
| 6 | Extract Water for Tritium Analyses | $0.00 | Prorated | $28,880.00 | $0.00 | $28,880.00 |
| | *Notes* Water for tritium analyses will be extracted from 18-inch lengths of core by vacuum distallation. The capacity of the current USGS laboratory is 3 samples per week. Core for water extraction will be selected to include likely pathways of flow such as tectonic or cooling fractures and other physical openings that may be encountered. | | | | | |
| 7 | Conduct Tritium Analyses | $0.00 | Prorated | $22,530.00 | $0.00 | $22,530.00 |
| | *Notes* Tritium analyses will be conducted under contract through a laboratory selected by the USGS National Water Quality Laboratory. The procedure will involve an enrichment process to provide the lowest possible analytical detection limit. | | | | | |
| 8 | Strontium Isotope Analyses (WR and | $0.00 | Prorated | $15,800.00 | $0.00 | $15,800.00 |
| | *Notes* Pore-water salts will be extracted from selected intervals of core for strontium isotope analyses. Although this task will not provide direct evidence of the presence of bomb-pulse isotopes, the strontium isotope composition of pore water will have evolved in parallel with the growth of radiogenic strontium in the rock mass; hence, the isotope ratio may provide some age indication for the pore water. | | | | | |
| 9 | Uranium/Thorium/Radium Isotope A | $0.00 | Prorated | $32,500.00 | $0.00 | $32,500.00 |
| | *Notes* Uranium and thorium isotopic analyses will be conducted on bulk-rock samples prepared from selected intervals of core to detect isotopic disequilibrium that may have been induced by relatively recent water-rock interaction. Isotopes analyzed will incude U-234, U-238, Th-230, and Ra-226. Fifty samples will be selected for U and Th isotopes, and twenty of these will be analyzed for radium-226. | | | | | |
| 10 | Monitor/Interpret U/Th/Ra Analyses ( | $0.00 | Prorated | $13,000.00 | $0.00 | $13,000.00 |
| | *Notes* Mel Gascoyne (formerly of AECL) will be the PI for the U/Th/Ra study. His reponsibility is listed here as a task separate from the actual analytical work that will be conduced at the AECL laboratories in Pinawa, Manitoba. | | | | | |
| 11 | Cl-36 Analyses (Pore Salts) | $0.00 | Prorated | $48,000.00 | $0.00 | $48,000.00 |
| | *Notes* Chlorine isotopic analyses will be conducted by accelerator mass spectrometry to establish Cl-36/total Cl ratios of pore water salts extracted from selected intervals of core. All analytical procedures, including extraction of pore water salts from the core samples, will be conducted at the Center for Accelerator Mass Spectrometry at Lawrence Livermore National Laboratory. In the present budget, 65 samples from 50 boreholes are scheduled for analyses. | | | | | |

Attachment 4

Budget Report as of Mon 12/21/98
Chlorine 36 Validation
Zell E. Peterman

| ID | Task Name | Fixed Cost | Fixed Cost Accrual | Total Cost | Baseline | Variance |
|---|---|---|---|---|---|---|
| 12 | Tc-99 Analyses (Pore Salts) | $0.00 | Prorated | $20,200.00 | $0.00 | $20,200.00 |
| | *Notes* Technicium 99 analyses will be conducted on selected core samples for which bomb-pulse Cl-36 ratios have been detected. The present plan calls for 10 analyses of samples selected on the basis of elevated Cl-36 analyses. | | | | | |
| 13 | Synthesize Data | $0.00 | Prorated | $11,608.00 | $0.00 | $11,608.00 |
| | *Notes* The analytical results of this study will be synthesized by the PI's from the USGS, AECL, and LLNL and evaluated as to their significance with regard to the presence of bomb-pulse isotopes in the ESF. | | | | | |
| 14 | Plan Report | $0.00 | Prorated | $7,744.00 | $0.00 | $7,744.00 |
| | *Notes* A technical report will be designed by the PI's. An annotated outline will be prepared to facilitate preparation of the draft report. | | | | | |
| 15 | Prepare Review Draft | $0.00 | Prorated | $17,536.00 | $0.00 | $17,536.00 |
| | *Notes* The principal participants will prepare a detailed report of results following the organization designed in Task 14. The report will include an assessment of the presence or absence of bomb-pulse isotopes at the ESF level. | | | | | |
| 16 | Technical Review | $0.00 | Prorated | $4,296.00 | $0.00 | $4,296.00 |
| | *Notes* The technical report prepared in Task 15 will be subjected to two technical reviews. | | | | | |
| 17 | Revise Report | $0.00 | Prorated | $15,720.00 | $0.00 | $15,720.00 |
| | *Notes* The technical report will be modified according to comments received in the technical review (Task 16). | | | | | |
| 18 | Submit Report to the DOE | $0.00 | Prorated | $0.00 | $0.00 | $0.00 |
| | *Notes* The technical report will be submitted to the DOE. | | | | | |
| | | $0.00 | | $645,194.00 | $0.00 | $645,194.00 |

## *Cost Summary*

| RESOURCE OR ACTIVITY | RESPONSIBLE ORGANIZATION | COST | SUBTOTALS |
|---|---|---|---|
| **Drilling:** | | | |
| Drilling, 50 3-4 meter holes | M&O | $250,000 | |
| SMF Support for Drilling | M&O | $81,000 | |
| TCO Support for Planning and Drilling | M&O | $30,000 | |
| USGS Support for Drilling | USGS | $13,922 | |
| | | | $374,922 |
| **Direct Analytical Costs:** | | | |
| Cl-36 Analyses | LLNL | $45,500 | |
| Cl-36 Lab Supplies | LLNL | $2,500 | |
| Tc-99 Analyses | LLNL | $16,200 | |
| Tc-99 Lab Supplies | LLNL | $4,000 | |
| Water Extraction for Tritium | USGS | $27,880 | |
| Tritium Analyses | USGS | $19,250 | |
| Strontium Isotope Analyses | USGS | $2,500 | |
| Uranium/Thorium/Radium Analyses | AECL | $32,500 | |
| Sample Prep for Strontium | USGS | $6,720 | |
| | | | $157,050 |
| **Project Management** | USGS | $15,812 | |
| | | | $15,812 |
| **Other Labor:** | | | |
| LLNL CAMS (236 hrs) | LLNL | $29,500 | |
| USGS Environ. Science Team | USGS | $28,320 | |
| AECL (through USGS)* | USGS | $31,000 | |
| | | | $88,820 |
| **Other Direct Costs:** | | | |
| Travel | USGS | $8,590 | |
| | | | $8,590 |
| | *PROJECT TOTAL* | | $645,194 |

| COST BY PARTICIPANT | |
|---|---|
| **M&O** | $361,000 |
| **LLNL** | $97,700 |
| **AECL** | $32,500 |
| **USGS** | $153,994 |
| *TOTAL* | $645,194 |

*Salary cost for Dr. Mel Gascoyne if contracted through the USGS. Can also be contracted through AECL.

## *Cost Summary*

| RESOURCE OR ACTIVITY | RESPONSIBLE ORGANIZATION | COST | SUBTOTALS |
|---|---|---|---|
| **Drilling:** | | | |
| Drilling, 50 3-4 meter holes | M&O | $250,000 | |
| SMF Support for Drilling | M&O | $81,000 | |
| TCO Support for Planning and Drilling | M&O | $30,000 | |
| USGS Support for Drilling | USGS | $13,922 | |
| | | | $374,922 |
| **Direct Analytical Costs:** | | | |
| Cl-36 Analyses | LLNL | $45,500 | |
| Cl-36 Lab Supplies | LLNL | $2,500 | |
| Tc-99 Analyses | LLNL | $16,200 | |
| Tc-99 Lab Supplies | LLNL | $4,000 | |
| Water Extraction for Tritium | USGS | $27,880 | |
| Tritium Analyses | USGS | $19,250 | |
| Strontium Isotope Analyses | USGS | $2,500 | |
| Uranium/Thorium/Radium Analyses | AECL | $32,500 | |
| Sample Prep for Strontium | USGS | $6,720 | |
| | | | $157,050 |
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| | | | $15,812 |
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| | | | $88,820 |
| **Other Direct Costs:** | | | |
| Travel | USGS | $8,590 | |
| | | | $8,590 |
| | ***PROJECT TOTAL*** | | $645,194 |

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|---|---|
| M&O | $361,000 |
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| USGS | $153,994 |
| *TOTAL* | $645,194 |

*Salary cost for Dr. Mel Gascoyne if contracted through the USGS. Can also be contracted through AECL.

Last week

Peña Blanca brought them up to speed

we need to get OGC involved COI.

Don Hassell 2/2/98

COI Nacho

IRSA procedure

10 week process once comments on VA are completed

CLST & RDTME can be moved to be // to any others later in year.

Items to work out

1) Standard format

2) Process