



February 8, 2011

Nuclear Regulatory Commission
Decommissioning Branch
US Nuclear Regulatory Commissions, Region III
2443 Warrenville Road, Suite 210
Lisle, IL 60532-4352

ATTN: Mike McCann
Katie Streit

RE: Response to RAI for the Lagoon Decommissioning

Dear Mr. McCann and Ms. Streit:

This is in response to the NRC request for additional information of August 2010 in regard to the proposed decommissioning of the lagoon and surrounding area at ABC Laboratories in Columbia, MO. Also today, I am submitting a substantially revised Decommissioning Plan (DP) that I hope you will find to be clearer and more straightforward than previous versions. With regard to your request of August 2010, I am addressing each topic below.

Possible Chemical Impacts

ABC has undertaken a significant effort to investigate the potential for chemical residue that might necessitate the disposal of any sediment or soil as RCRA. An engineering firm has been retained, a sampling program (that has been shared with MDNR) has been started and the first set of chemical analyses is complete. While a second phase of testing is planned, data to date indicate that no chemical hazards are present in the lagoon sediment. ABC is making every effort to comply with all applicable Missouri and federal statutes as this lagoon is closed.

DCGL Development

A Derived Concentration Guideline Limit of 210 pCi/g was developed by our contractor – SEC – using a RESRAD resident farmer scenario; this RESRAD evaluation was submitted previously. The value of 210 pCi/g (DCGL_w) corresponds to an annual dose to the most impacted resident of 25 mrem. After evaluation of the characterization data, a site specific value of 45 pCi/g has been selected as the remediation criteria. Characterization data suggest that, post-remediation, soil concentration values should be near background – though this value is to be determined by the final status survey. Characterization data indicate that the screening value of 12 pCi/g in remaining soil post-excavation is anticipated to be met.

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Construction and Design of the Lagoon

The sanitary lagoon is approximately 1/3 acre (81 by 117 ft at the bottom) in area, and a maximum of eight feet in depth (top of berm to floor of the lagoon). It was removed from service as a sanitary lagoon in 2004. The native soil in the area is clay, and that clay was used to form a liner by "tracking in." The depth of the clay, based on well logs resulting from the installation of nearby monitoring wells, is at least eleven feet.

Upon further analysis and review of the characterization data, we believe that any radiological contamination is best understood by the following model. The lagoon sediment contains the vast majority of any radioactivity as insoluble ^{14}C , best estimated by two independent samplings using controlled sampling and analyzed with validated methods having a mean value of 476 pCi/g. This is only ^{14}C , reflecting the history of use and the characterization analyses. The water contains very little radioactivity, reflecting the insolubility of remaining radioactivity. The clay very sharply attenuates the radioactivity concentration, reducing the concentration by more than an order of magnitude with a depth of only three inches. This attenuation as a function of depth will be further characterized by additional core sampling to define the necessary depths to excavate beneath the lagoon, which is expected to allow remediation to a level of less than 12 pCi/g.

Commitment to Sample Below the Clay Liner

ABC is committed to inclusion of the underlying clay as part of our sampling program in two respects: 1) as a characterization effort that will guide the eventual excavation; and, 2) as a part of the final status survey after excavation. Current characterization data indicates that the carbon-14 is strongly attenuated by the clay liner and even at a depth of 3 inches the concentration of ^{14}C is decreased by more than an order of magnitude. Additional characterization sampling is expected to show the excavation depth necessary to remove the clay to reach an optimal result. In our next characterization, the sampling through the clay liner will be performed to show what depth is necessary to achieve an average concentration of less than 12 pCi/g.

Commitment to Perform Groundwater Sampling

Ground water sampling will be included in the final status survey. Based on a conversation with Matthew Meyer, and consistent with characterization data, the groundwater will be sampled using a set three monitoring wells, at a depth necessary to attain replenishment using a continuous flow sampling technique – about 40 ft at the current time. A continuous flow technique will be used, so that sampling of perched water is ensured. Characterization data, though few, indicate that perched water is beneath the limit of quantitation for the method used – 25 pCi/L for carbon-14.

Sampling of the Water from the Lagoon

Water directly taken from the lagoon has been quantified by liquid scintillation counting and is below the level of quantitation; likely owing to the insoluble nature of any remaining ^{14}C in the lagoon. Presently, the water is less than 230 pCi/L, allowing disposal to the sanitary sewer or as effluent as part of any necessary dewatering. Water is not expected to remain and will be removed prior to any effective remediation of the sediment. Hence, water in the lagoon is not anticipated to be part of the final status survey.

Information on Nearby Private Wells

A search of the public records was done to indicate any wells within a 2 mile radius of ABC labs. This search indicates that 41 wells are on record, 4 of which are on the ABC property. Of the 41 wells, thirteen are shown as monitoring wells, 11 are for heat pumps, 9 are abandoned (presumably to public water supply), six are shown as a current well and 2 are shown for water supply – presumed to be for irrigation. A list is attached to this letter.

Communications with MDNR

We are working very actively with a Missouri engineering firm to address the concerns of MDNR and the appropriate closure process for the lagoon with respect to state requirements. To that end, and with advice from that experienced firm, we have performed a major sampling of the lagoon and have scheduled further sampling to cover the surrounding area. We have shared with MDNR our work plan for analysis, results and have requested a response to that plan. As data are received and reviewed, we will be communicating again with MDNR staff and hope to establish a more regular communication.

Characterization Data to be Withdrawn from Consideration

Unfortunately, a significant quantity of the previously submitted data concerning the concentrations of ^{14}C in the lagoon sediment, and adjoining field, taken in 2007 and used as characterization data, are technically inadequate, and I am requesting that they be withdrawn from consideration. The revised DP does not include data that are not authentic, well-documented and technically defensible.

This flawed data in the earlier versions has led to two significant errors in the characterization process that I hope to correct with the revision concurrently being submitted (2.0). First, carbon-14 radioactivity concentration has been systematically overestimated in the lagoon sediment, leading to the conclusion that the sediment contains a few thousand pCi/g, when in fact it contains only about 476 pCi/g, on average. Secondly, the surface of the area identified as the drain field has an average value only 7 pCi/g, and very likely will not need remediation – subject to further characterization, examination of the underlying portions of the drain field and final status survey.

On the other hand, the banks of the lagoon and the underlying soil (0.5 to 3 ft depth) were not sampled in the previous samplings, and this has led to the underestimation of sediment volume to be removed. Further characterization of the deeper portions of the drain field will be required to determine how much soil will need to be removed as part the remediation.

Historical Lagoons

ABC recognizes that additional documentation and characterization of the historical lagoons is needed. Specifically, we need to survey their location and, with controlled sampling methods, characterize any radiological content that may be present. It is unclear from the operating history how much, if any radioactivity can be expected. We are requesting a delay, so that we may properly investigate these, characterize their radionuclide content and then proceed on that basis. We believe this can be accomplished over the next 90 days, so that any remediation necessary can be pursued in the spring.

We would like to address the RAI concerning the historical lagoons at a later date as we have data to do so authoritatively. In the interim, we have hired a surveyor to locate the historical sanitary ponds precisely, and will characterize them using technically proficient methods to determine what remediation is necessary.

Please let me know if you have any questions.

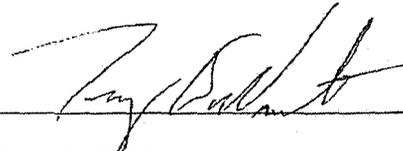
Sincerely,

A handwritten signature in black ink that reads "Bradley D. Keck". The signature is written in a cursive style with a large, prominent initial "B".

Bradly D. Keck, PhD, CHP
Radiation Safety Officer, ABC Laboratories, Inc.

**Site Characterization and Remediation Plan
in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories
Sanitary Lagoon,
Application Area and Drain Field,
Revision 2.0**

Authored By:  9 FEB 11
Bradly D. Keck, PhD, CHP, RSO
ABC Laboratories, Inc. Date

Reviewed By:  9 FEB 2011
Troy DeVault
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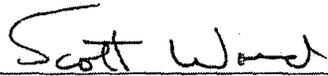
Approved By:  9 Feb. 11
Scott Ward
Sr. Vice-President, RSC Chairman
ABC Laboratories, Inc. Date

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EXECUTIVE SUMMARY

Site Characterization and Remediation Plan in Support of Decommissioning for Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field, Revision 2.0.

Analytical Biochemistry Laboratories (ABC) at 7200 ABC Lane in Columbia, Missouri (Bradly D. Keck, RSO) is submitting this plan for the purpose of removing from their radioactive materials license a sanitary lagoon, which has been replaced by a connection to the public sewer system. This is the second plan submitted and is a revision of the first.

This sanitary lagoon served an office and laboratory site of approximately 200 people, and sits on a 56-acre tract, a portion to which this plan pertains. The lagoon has served the needs of a research based lab and office complex, and as such has received incidental effluent from a wide variety of laboratory processes in addition to the sanitary function – chiefly, bioanalysis, chromatography and radiosynthesis. Radioactive waste *per se* has been collected into normal waste streams and has not been introduced into the lagoon. The lagoon was in service from 1986 until 2004.

Radiological contamination of the lagoon is limited to carbon-14 and is principally in the sediment of the lagoon at an average concentration of 476 picocuries per gram (pCi/g), based on qualified characterization data. Beyond the sediment and the immediate layer of clay forming the lagoon, areas are less than 12 pCi/g (to be augmented by additional characterization data). While an additional monitoring well is needed to show that groundwater is not impacted, current analyses of properly sampled groundwater show no measurable radiocarbon. Hence, it is believed that after removal of the sediment and proximate clay, the site will be at a level of less than 12 pCi/g, and will permit unrestricted release.

RESRAD modeling was performed by a contractor assuming a 20,000 m² area surrounding the lagoon, and a DCGL_w of 210 pCi/g was found. Since contamination is concentrated within the sediment, removal of the sediment and proximate clay above a 45 pCi/g level is expected to result in a site average concentration of less than 12 pCi/g; to be demonstrated by a final status survey using discrete sampling.

Since an unrestricted release is anticipated and the sediment and soil to be disposed of will directly result in a dose to the most impacted person of less than a few millirems per year, this plan is ALARA. The highest potential dose will be well beneath the 25 mrem per year decommissioning standard. Respiratory pathways during removal via possible dust generation will result in less than 10% of the derived air concentration (10.CFR. 20 Appendix B) and also less than 10% of a the annual limit of intake (10.CFR.20. Appendix B). (Dust management practices will still be used in the removal as a good practice.)

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The licensee is requesting that this plan be incorporated into license 24-13365-01, and separately is requesting an alternate disposal method per 10.CFR.20.2002 to allow sediment and soil at less than 8,000 pCi/g to be disposed at local landfill facility.

1.0 INTRODUCTION

Analytical Bio-Chemistry Laboratories, Inc. (ABC) is in the process of closing a former sanitary lagoon which has been out of service since 2004. This sanitary lagoon includes a drain field (underground distribution system) and application area (soil surface where lagoon effluent may have had contact due to overflow). We propose, via this decommissioning plan, to remediate the current lagoon which contains sediment with carbon-14 of approximately 500 picocuries per gram (pCi/g) on average, to a value less than 12 pCi/g using an excavation process. Based on our current and ongoing characterization, this can be achieved by removing the lagoon sediment, which is the only area contaminated above 45 pCi/g – the proposed action level (the level at which excavation will be performed). Based on data from wells on site, and supported by the thick clay layer underlying the lagoon, there does not appear to be an impact to groundwater.

Based on NUREG 1757 – “Consolidated NMSS Decommissioning Guidance,” this will be a Group 3 decommissioning process as we do not expect groundwater impact and we do anticipate the excavation and removal of material in excess of the Derived Concentration Guidance Level (DCGL) of 210 pCi/g, albeit within a small portion of the site. Provided our final status survey (FSS) bears out our characterization data, we anticipate this area can be released without restriction beneath the screening level (12 pCi/g on average).

A Residual Radioactivity (RESRAD) model was developed by Andy Lombardo of SEC, and this was used to derive the DCGL for the site, assuming a 20,000 square meter area of possible contamination.

Separately from this decommissioning plan, an amendment request for alternate disposal via 10.CFR.20.2002 is being submitted for License 34-13365-01, under which we propose to dispose of sediment and necessary underlying soil at a RCRA or municipal landfill.

1.1 Facility Background

The ABC Laboratories facility is located at 7200 East ABC Lane in Columbia, Missouri. The Site is approximately 56 acres in size and is zoned as Planned Office, General Industrial, and Controlled Industrial Districts in central Boone County. There are two active main laboratory/office buildings, two greenhouses, a warehouse, and waste storage facility (both LLRW and hazardous).

ABC Laboratories is a contract laboratory that provides chemical and biological testing services and custom synthesis services to the Pharmaceutical and

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Chemical industries. ABC Laboratories incorporated and purchased the Site property in 1968; operation at the Site also began in 1968. An Atomic Energy Commission License was obtained in 1972 for possession and use of electron capture detectors in gas chromatography instruments, and has grown into a license of broad scope. As part of their research and development activities, the facility uses radioactive materials (primarily carbon-14) under the NRC license 24-13365-01.

The Missouri Department of Natural Resources (MDNR) issued Construction Permit 26-1030 on May 15, 1986, and a Letter of Approval on June 6, 1986, authorizing the construction of a single-cell 13,500-square foot (0.31-acre) surface lagoon with a design operating depth of three feet and a maximum depth of approximately 6 feet. Discharges to the lagoon were conveyed by a single sanitary PVC sewer line, four inches in diameter. This lagoon served the sanitary needs of the facility until March 2, 2004, when sewage discharge was diverted to Boone County Regional Sewer District. The conveyance was terminated by plugging the influent portion of the discharge pipe at the facility with concrete. The remainder of pipe that leads to the lagoon is open. This lagoon system is regulated by MDNR under the National Pollutant Discharge Elimination System (NPDES) permit number MO-0104591. The sanitary lagoon application area and drain field are situated in the General Industrial District (M-P zone). Storm water that accumulates in the lagoon [since cessation of the designed function] is discharged to the Boone County Regional Sewer District.

Effluent to the Lagoon

In addition to sanitary waste waters (from facility restrooms, drinking fountains, locker rooms, and break areas), the effluent to the lagoon included aqueous solutions with trace amounts of radioactive materials (carbon-14 is the only isotope presently detected).

The effluent may have also included chemical wastes from analytical testing methods. In general, typical analytical laboratory activities include extractions (from crops, soils, and water), cleanup, and instrumental analysis of pesticide residues. Samples received at the laboratory typically contain trace levels of the target chemical, with concentrations usually in the range of 10 ppm down to non-detectable (typically <0.01 ppm). Samples are extracted into organic solvents.

1.2 Facility Description

The sanitary lagoon was built in 1986 and served the laboratories' sanitary and sewer needs until 2004. Due to the native soils, it sits on a large, deep basin of clay which forms the basin of the lagoon with a depth of 11 to 17 feet of clay. A "liner" was formed upon construction by using a bulldozer to compress the near surface clay by tracking in (this compressed layer is sometimes referred to as a "liner" even though it is composed of native clay). It has an engineered structure to distribute effluent water to an underground distribution system, and was connected to the facility by a sewer line that is now disconnected from the lagoon and connected to the public sewer).

The lagoon lies over a thick deposit of clay (11 – 17 feet, based on drilling logs) which protects the underlying soil by allowing little permeation of any contaminant. It is an effective barrier to water penetration so that it protects any soluble compounds, and it has a low permeability, so it also protects against insoluble compounds (which now represent essentially all of the carbon-14 present). Characterization data show that a three-inch distance into the clay beneath the lagoon has a very sharp attenuation of radioactivity, and it is thought, subject to FSS, that a six-inch excavation will completely remediate the sediment radioactivity.

It has been shown by analysis that the lagoon contains sediment that contains the bulk of the radioactivity, which we propose to remove as the principal remediation, and that the radioactivity concentration is greatly attenuated by the clay – of which approximately six inches will need to be removed.

2.0 AREAS REQUIRING REMEDIATION

The lagoon sediment, lagoon floor, and surrounding wall will all need excavation. We are proposing to remove the proximate layer of clay to a depth of approximately six inches, with the exact depth to be determined by further characterization. We are also proposing to remove the unused portion of the inlet sewer pipe and the distribution system, characterize those for radioactivity and dispose of them based on any residual radioactivity found (per Reg Guide 1.86). The drain field itself appears to be below the target level, and provided this is borne out by additional characterization, this would not be remediated further. However, if the additional characterization shows that elevated areas are within the drain field, these also will be excavated and removed to landfill.

3.0 AREAS WITH ELEVATED LEVELS

Outside the areas described above, which will be excavated, there are no areas of elevated radioactivity within the scope of this decommissioning plan. (Previous versions of this plan (Rev 1.0 and 0.0) included the "historical" sanitary ponds, which are not within the scope of this plan, but which are undergoing definition and characterization.)

4.0 CHARACTERIZATION DATA

4.1 Background

We have analyzed several components that are relevant to the decommissioning process. In order of importance, these are: the lagoon sediment which contains the bulk of the radioactivity, the clay from which the floor and banks of the lagoon are formed (though all native clay, the layer immediate to the floor and bank was compressed by "tracking in" with a bulldozer and is referred to as a "liner" though the depth of clay is at least eleven feet); soil in the drain field, near the outlets of the distribution system, soil near the surface of the field application area; and groundwater. The water which is in the lagoon will be removed as either evaporate or by pumping to the current public sewer at concentrations below those allowable 10.CFR.20.2001.

There is a large body of analyses that involves this decommissioning project, dating back to 2004, and encompassing both internal and external analyses. The current decommissioning plan is based entirely on data that has the following characteristics: 1) The sample analytical result is well documented as to the sample type and origin; 2) the sample represents the appropriate matrix and is not strongly influenced by the mixture of multiple matrices; and, 3) the analytical method is demonstrably appropriate to the result attained, including any necessary isotope separations (in all cases here it is an EPA-validated method or NVLAP-accredited method). In so doing, it is assured that the characterization data is authentic, appropriately documented and technically defensible. Elimination of non-qualified data has eliminated a significant amount of characterization data submitted in previous plans, but has also greatly improved the quality reliability of this plan.

A significant portion of data included in previous decommissioning plans is not included in the present plan, due to being deficient in these parameters. The data that is included provides a systematic analysis of the lagoon components and provides a sound basis for determining which components need to be removed to achieve a free release.

4.2 Sanitary Lagoon and Embankment Area (Berm)

4.2.1 Lagoon

The lagoon, and particularly the sediment within the lagoon, is the primary focus of this decommissioning. In sampling the lagoon, it is useful and necessary to consider that the lagoon consists of three phases: the sediment within the lagoon lying along the bottom and sidewalls, the clay from which the floor and sidewalls are formed and the water (when water is present). Since water will be removed prior to any excavation, the sediment and soil (clay) are shown below, using only qualified data which is authentic, well documented and defensible.

4.2.1.1 *Sample Description*

Samples shown as sediment samples were removed from the lagoon using a pipe and plunger sampling system. Since the sediment is visually distinct, the sediment sample was separated from the clay, so that only sediment was visually apparent in the sample analyzed as sediment. Similarly, the clay sample most proximate to the sediment was separated so that only clay was visually. In practice, separation of the clay away from the sediment is both more difficult as there is complex mixing at the interface, and more important as a small bit of sediment of relatively high concentration can readily interfere with the analysis of the clay, but small amounts of clay in sediment have little effect on the result. For the lagoon sidewalls, sediment and clay are intimately mixed and a composite sample of the first six inches was taken for analysis. There are 17 sediment samples, 10 clay soil samples and 4 sidewall composite samples.

4.2.1.2 *Results*

Results of each sample set and a table of the results for each matrix appear in Appendix 2.1, 2.2 and 2.3. On average the radiochemical concentration of carbon-14 in sediment is 476 pCi/g, where clay immediately beneath the sediment is less than 9.5 pCi/g and the sidewall composites are 98.9 pCi/g. The large difference in concentrations between sediment and clay, despite years of proximity, indicate the clay was an effective barrier to ^{14}C migration.

4.3 Field Application Area

4.3.1 Sample Description

Soil samples were taken over the field application area at a depth of either 0 – 6 inches from the surface, or 6 – 18 inches from the surface to obtain a potentially maximally exposed sample. These were done in 2007. (Additional samples of this type are to be included in the March characterization data.)

4.3.2 Results

Results of these samples and a table showing all results are shown in Appendix 2.4. The average radiochemical concentration in the field application area was 7.04 pCi/g.

4.4 Drain-field

4.4.1 Sample Description

The overlay material was removed and soil samples were taken from the area most proximate to the distribution pipe outlets. Five samples, taken from immediately beneath the pipe to a depth of six inches beneath the pipe were taken for analysis. These were analyzed for ^{14}C , ^3H and ^{40}K (not a nuclide of interest for decommissioning purposes).

4.4.2 Results

Results of these samples and a table showing all results are shown in Appendix 2.5. The average radiochemical concentration was less than 9.5 pCi/g. (Data beneath the limit of quantitation was not used in average calculation here.)

4.5 Groundwater Samples

A third monitoring well will be installed during the March characterization sampling. At that time a set of three samples from a triangulated collection system will be collected - all with continuous flow technique to ensure perched water. Provided that this is consistent with previous data – that the radiocarbon concentration is less than the drinking water standard – this data will serve as both characterization and final status survey data. No proper sampling (simultaneous, triangulated, continuous flow sampling) has occurred at this time. Non-qualified data indicates that true groundwater is beneath the level of detection, qualified data will be added to this plan when available.

5.0 REMEDIATION PLAN

5.1 Overview

The remediation of the lagoon will consist of removing water to sewer or evaporation (weather permitting), removing the sediment and removing a six-inch layer of clay from the surface of the lagoon floor and embankment. Both sediment and clay will be hauled under the proposed alternate disposal to either a Part C or Part D landfill. Following removal of the sediment and clay "liner," a final status survey will be performed. This will be done using an EPA validated method with adequate sensitivity to show that the radiocarbon concentration of remaining soil is less than 12 pCi/g on average.

In addition, and as guided by the future characterization of the drain field and application area, any areas that need remediation in the drain field or application area will also be excavated and removed.

5.2 Anticipated Waste Volumes and Type

The most abundant waste will be a combination of sediment and soil. We estimate that, as hauled, this will be approximately 300 pCi/g of carbon-14. We expect to remove approximately 800 cubic yards of sediment/soil mix. Chemical analyses to date indicate that this will not be regarded as hazardous waste.

5.3 Excavation and Packaging

Excavation will be with heavy equipment using a local contractor. In addition to a conventional safety plan done in concert with the contractor, plans will be in place for dust control (though the DAC will not be exceeded) and a wash station will be in place to prevent any contaminated soil from leaving the premises on heavy equipment. Packaging will use covered dump trucks to prevent loss of material in transit. A work plan, inclusive of radiation safety, will be developed in concert with the contractors and will be approved by the ABC Radiation Safety Committee prior to any excavation of the site.

5.4 Staging Area

A gravel pad is very close to the lagoon and may be used for drying activities and loading activities. If weather allows, and drying is not needed, loading will be done directly upon excavation from the lagoon. A wash station will be in place prior to any trucks or heavy equipment leaving the site.

5.5 Disposal Shipments

Pursuant to the license amendment request for alternate disposal, the mixture of sediment and soil will be transferred either to the Peoria Pike County landfill or an acceptable local alternative. A description of the controls at Pike County landfill is being submitted with this Plan. We anticipate that approximately 88 loads of 10 yards each will be transferred to Peoria Disposal or a local landfill such as the Maple Hill landfill in Macon, MO.

6.0 ALARA ANALYSIS

Based on characterization data alone, the overall site could be closed well beneath the DCGL_w of 210 pCi/g simply by filling in the current lagoon with fill dirt. Thus, the "dollars per man-rem" evaluation is not of significant utility here, and is not used as the basis for this plan.

ABC Laboratories does recognize, however, that it has a regulatory and ethical obligation to close the site properly and ALARA, and does wish to maximize the potential uses of the real estate looking forward as well as to remediate the site in a maximally responsible manner, which must be balanced with economic feasibility. This plan achieves a high degree of removal (to less than a site average of 12 pCi/g) based on characterization data and produces only soil and sediment that are, pursuant to a successful alternate disposal request under 10.CFR.20.2002, disposable in local facility, at a dose of less than 1 millirem per year long term. In addition, much of the remediation cost can potentially be recovered as real estate value and site aesthetics. We believe that this plan provides for excellent remediation in an economically justifiable manner. Based on the DCGL_w of 210 pCi/g over 20,000 square meters, this plan will leave (assuming <12 pCi/g averaged over 20,000 square meters) a dose to the most impacted person of less than 1.5 millirems in the most impacted year. Since an average person receives approximately 400 millirem per year from natural and medical sources, this a very low potential dose.

7.0 PROJECT SCHEDULE AND COST

7.1 Schedule

See Appendix 3.

The excavation process is dependent upon having dry conditions, so that removal of the sediment can occur.

7.2 Cost

Cost for characterization, excavation, disposal (assuming to Peoria Landfill), and site restoration are currently being gathered and evaluated for the most efficient and cost effective methods, and are expected to be well within the current financial assurance surety bond.

8.0 DECOMMISSIONING MANAGEMENT ORGANIZATION - RADIATION HEALTH & SAFETY PROGRAM

The decommissioning will take place under the authority of Analytical Bio-Chemistry Laboratories (ABC) Radiation Safety Committee and Radiation Safety Officer. Engineering contractors and heavy equipment contractors will be employed for various aspects of the decommissioning efforts. As firms and individuals are engaged, work and safety plans will be co-developed and approved by the ABC RSO and RSC prior to the initiation of work with a particular contractor. In addition to the work and safety programs associated with the physical aspects of a particular effort (e.g., backhoe operation), material control, airborne particulates (the principal radiation concern due to possible dust generation) and equipment decontamination procedures will be developed and approved.

Resumes of key ABC personnel are on file (S. Ward, T. DeVault and B. Keck) with the NRC license, and are attached to this plan.

9.0 ALTERNATE DISPOSAL REQUEST

As an amendment to license 24-13365-01, a request for alternate disposal for soil and sediment with low levels of ^{14}C as contamination is being submitted to Mr. Kevin Null of Region III. If granted, this alternate disposal request

10.0 RADIOACTIVE WASTE MANAGEMENT PROGRAM

10.1 Solid Waste

A combination of soil and sediment is expected. These will be well beneath the exempt concentrations for ^{14}C and an alternate disposal is being sought as part of NRC License 24-13365-01. Totals expected are approximately 800 tons.

10.2 Liquid Waste

No liquid waste is expected to be generated. Any existing water will be disposed via public sewer in accordance with 10.CFR.20, Appendix B.

10.3 Mixed Waste

No mixed waste is anticipated. Chemical analyses to date indicate that the sediment and soil are not hazardous.

11.0 QUALITY ASSURANCE

All samples for use in the final status survey will be collected under protocol, with a chain of custody and will be analyzed at General Engineering Laboratories using EPA methods EERF C01 for radiocarbon in soil or the same method – modified for matrix - for radiocarbon in water, per GEL SOP's (or a qualified laboratory using methods of equivalent performance). Per that SOP QCs will be evaluated and included in the data package for each matrix. All data will be reviewed by GEL staff and by the ABC RSO and other appropriate ABC staff.

12.0 FINAL STATUS SURVEY PLAN

Since field instrumentation is not of adequate sensitivity to show the desired limit of 12 pCi/g, discrete samples will have to be used for the purpose of final status survey, and analyzed using the methods shown above.

12.1 Area Beneath the Current Lagoon, Post-excavation

Following our pattern for characterization data, at least six samples will be taken from the area nearest the excavated floor (spread uniformly over the entire excavated surface), and will be composited over a depth of 12 inches from the surface; each of these composites will be analyzed for radiocarbon using the above method. An arithmetic mean of all the composites will be used to determine the radiocarbon (^{14}C) concentration in pCi/g – wet weight. In addition at least 2 samples will be evaluated for tritium to confirm its absence. In the event that any tritium is quantified, a release level analogous to that of ^{14}C DCGL_w will be developed and used to evaluate release, using a sum of fractions approach. Six samples from the floor, using good sampling practices, chain of custody and validated methods have been shown to be adequate in previous characterization work (i.e., six are capable of showing the level to be above or below 12 pCi/g). If additional samples are analyzed, they will be included in the mean.

12.2 Groundwater

An additional monitoring well will be installed upgrade from the current monitoring wells, so that three “surrounding” sampling locations are included. Using a qualified environmental engineering team and continuous flow sampling,

three samples (one from each monitoring well) will be taken for analysis and a reserve sample for each location will be collected. The reserve sample will be used in the event that any sample is lost, or is analyzed in a way that requires – per GEL SOP's – reanalysis. Each location and an arithmetic mean will be compared to the drinking water standard for ^{14}C . One sample will be analyzed for tritium, to confirm the absence thereof, and if any is quantifiable, a sum of fractions approach will be used for evaluation (^3H observed/ ^3H drinking water standard + ^{14}C Observed/ ^{14}C drinking water standard <1).

12.3 Drain Field

Areas adjacent to the piping distribution system will be further evaluated during the net characterization slated for March. In this characterization, areas immediate to and below the piping will be sampled to evaluate the length of the distribution system. At six locations along the piping distribution that are most subject to contamination, the overlay (soil and gravel above the pipe) will be removed and immediately adjacent to the pipe, two composite samples will be taken: one from 0 – 6 inches vertically and another from 6 – 12 inches vertically. These will each be assessed analytically and an arithmetic mean of all 12 locations will be used to assess whether this area will be excavated. Provided the arithmetic mean is less than 12 pCi/g-wet, this area will not be excavated and the characterization data will be used as the final status survey data. If excavation is necessary based upon the additional characterization data, then this pattern would be repeated immediate to the excavation zone and this additional sampling would be used for the purpose of final status survey.

12.4 Application Area

The so called application area (where excess effluent may have had contact with the soil surface) will also be further examined as additional characterization. While previous characterization data indicates that remediation will not be necessary, this will be further investigated with an additional four samples. Using the two areas most potentially exposed to runoff, samples from 0-6 inches from the surface and 6-12 inches from the surface will be collected and analyzed. Provided the arithmetic mean is less than 12 pCi/g-wet when averaged with existing characterization data, this area will not be excavated and the characterization data will be used as the final status survey data. If excavation is necessary based upon the additional characterization data, then this pattern would be repeated immediate to the excavation zone and this additional sampling would be used for the purpose of final status survey.

12.5 Sidewalls, Post excavation

Following removal of the sediment and adjoining sidewall during the excavation, one composite sample (0 -12 inches) from each wall (N,E,S, and W) will be analyzed for radiocarbon (pCi/g). An arithmetic mean of all four composites will be used to judge the completion of excavation with regard to the sidewalls.

13.0 FINANCIAL ASSURANCE

This decommissioning effort is part of the financial assurance surety bond associated with NRC license 24-13365-01.

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14.0 APPENDICES

APPENDIX 1

**DERIVED CONCENTRATION GUIDELINE VALUES FOR
ANALYTICAL BIOCHEMISTRY LABORATORIES, INC.**

Resident Farmer Exposure Scenario/Critical Group

Analytical Bio-Chemistry Laboratories, Inc.
7200 East ABC Lane
Columbia, Missouri 65202

Prepared by Safety and Ecology Corporation

Draft
November 26, 2007

Revised
June 25, 2008

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DCGL Derivation Report

1 Introduction

This document has been prepared by Safety and Ecology Corporation (SEC) on behalf of Bionomics, to document the derivation of Derived Concentration Guideline Values (DCGLs) for the unrestricted release of the Analytical Bio-Chemistry (ABC) Laboratories Sanitary Lagoon(s) and Drain-Field(s) (SLDF) in Columbia, Missouri, post remediation.

A dose model was used to derive DCGLs that would result in a dose (total effective dose equivalent or REDE) to the critical group below the selected standard. The DCGL values are used to plan remediation activities and to demonstrate compliance with the selected standard at the completion of remediation. The cleanup standards and methodology found in 10 Code of Federal Regulations (CFR) 20.1402 "Radiological Criteria for Unrestricted Use". The DCGLs, were developed in accordance with 10 CFR 20.1402, which states:

"A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year, including that from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA)."

The scenario, the critical group, and the exposure pathways define a dose model. The Resident Farmer Scenario was selected to model exposure from the SLDF area for the next 1000 years. The resident Farmer Scenario includes exposure from the following exposure pathways:

- Direct exposure to external radiation from the contaminated soil material;
- Internal dose from inhalation of airborne radionuclides, excluding radon progeny; and
- Internal dose from ingestion of
 - Plant foods grown in the contaminated soil and irrigated with contaminated water,
 - Meat and milk from livestock fed with contaminated fodder and water,
 - Drinking water from a contaminated well or pond,
 - Fish from a contaminated pond, and
 - Contaminated soil.

The RESidual RADioactivity (RESRAD) code was selected for modeling the resident farmer scenario. The deterministic mode of RESRAD Version 6.3 was used for the calculation of REDEs and DCGLs for the urban resident.

Site specific input parameter values were used where available. For the majority of additional inputs for which no site specific value was available, the default (conservative) value was used.

The remainder of this report is structured as follows: Chapter 2 provides the details of the assumptions and the non-default RESRAD input parameter values used, Chapter 3 provides a summary table of all of the RESRAD input parameters, Chapter 4 presents a summary of the dose assessment results, Chapter 5 presents supporting documentation including RESRAD output files and graphs and Chapter 6 references.

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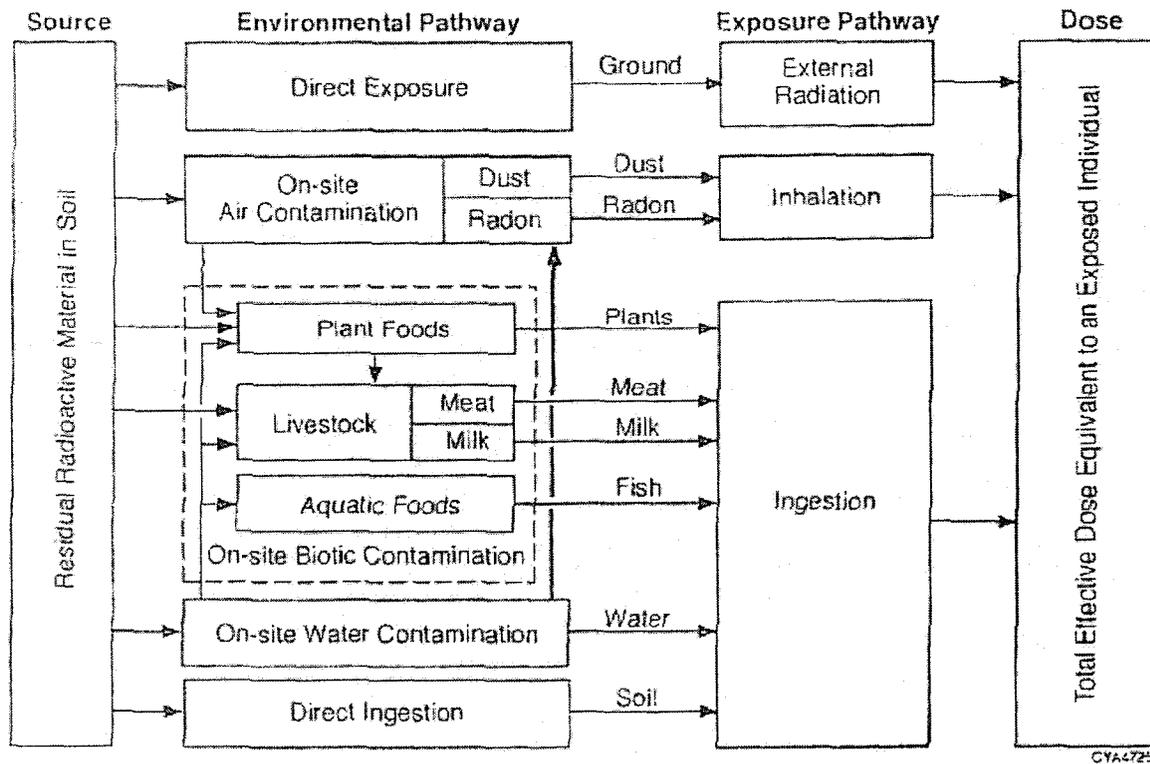
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2 Assumptions and Input Parameter Values

2.1 Dose Assessment

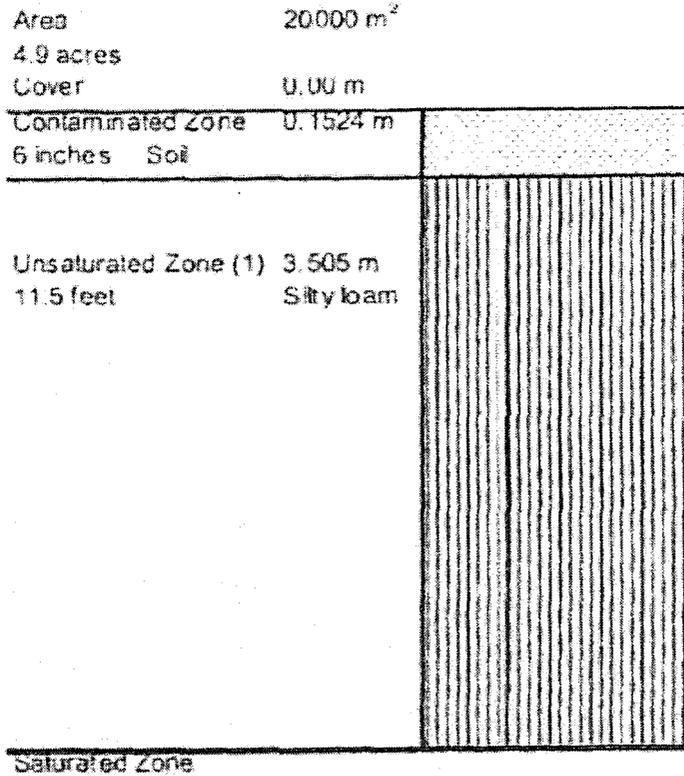
The RESRAD code with the resident farmer scenario was selected with all environmental and exposure pathways active, except radon. Figure 1 illustrates the exposure pathways. Figure 2 is an illustration of the RESRAD model cover, contaminated zone, unsaturated zone, and saturated zone strata post remediation.

Figure 1 – RESRAD Environmental and Exposure Pathways – SLDF excludes Radon



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Figure 2 – Dose Assessment As-Left Strata



Note:
The figure is not to scale.

2.2 DCGL Derivation Dose Assessment

The DCGL values are derived from the dose based standard of the USNRC (10CFR20.1402), mainly the radiological criteria for unrestricted use as follows:

"A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year."

Therefore, the dose resulting from projected as-left condition of the site post remediation were derived and the results were then used to determine limiting DCGLs values as appropriate.

AS-Left Sanitary Lagoon(s) and Drain Field(s) – SLDF

The as-left condition of the site (SLDF), i.e., the condition of the site post remediation, is defined by the following:

- Contaminated zone area = 20,000 m² (for areas modeled greater than 10,000 m² there is no increase in dose with the exception of the fish from pond consumption pathway).

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- Contaminated zone depth = 0.152 m (6-inch surface layer based on the characterization data for the site).
- Cover depth = 0.000 m (i.e., there is no cover. The contaminated zone is on the surface).
- The unsaturated zone (the depth of soil between the contaminated zone and the saturated (groundwater bearing zone) zone – 3.505 m (based on the approximate 11.5 feet to groundwater from the surface of the site provided by the State of Missouri, Environ-Geology Group)

DCGLs based on the projected as-left condition of the site are presented in Section 4.

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2.3 Site Specific Non-Default Input Parameter Values

Table 1 – Site Specific Non-Default Parameters for As-Left

Parameter Name ¹	Unit	Default Value	Site Specific	Remarks
Area of contaminated zone	m ²	10000	20000	Application Field area
Thickness of contaminated zone	m	2	0.1524	Average contaminated zone thickness 6 inches
Initial principal radionuclides	pCi/g	-	C-14 20	Application Field average
Unsaturated zone thickness	m	4.00	3.505	Unsaturated zone – 11.5 feet (State of Missouri)
Unsaturated zone soil density	g/cm ³	1.5	1.28	Dry density for silt loam DCH – Table 2.1
Unsaturated zone total porosity	-	0.4	0.45	Representative Porosity Value for silt DCH – Table 3.2
Unsaturated zone Hydraulic conductivity	m/yr	10	227	Representative Value of Saturated Hydraulic Conductivity for Silty loam DCH – Table 5.2

DCH – Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil
Environmental Assessment and Information Sciences Division
Argonne National Laboratory, April 1993

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3 Input Parameter Assignments Summary

Table 2 – Input Parameters

RESRAD Input Parameter Assignments				
Screen	Name	Value	Units	Description
R016	ALEACH(i)	0	L/yr	Default Leach Rate for N(i)
R011	AREA	Refer to Table 1	m ²	Area of Contaminated Zone
R013	BCZ	5.30	--	Default Contaminated Zone Exponential <i>b</i> Parameter
R011	BRDL	25	mrem/yr	Radiation Dose Limit
R014	BSZ	5.30	--	Saturated Zone Exponential <i>b</i> Parameter
R015	BUZ(1)	5.30	--	Uncontaminated Unsaturated Zone 1 – Exponential <i>b</i> Parameter
R013	COVER0	0	m	Cover Depth
R016	DCNUCC(i)	0	cm ³ /g	Default Distribution Coefficient for C-14 in Contaminated Zone
R016	DENSAQ	0	cm ³ /g	Distribution Coefficient for C-14 in Saturated Zone
R016	DENSCV	0	cm ³ /g	Distribution Coefficient for C-14 in Unsaturated Zone
R021	DENSFL	1.50	g/cm ³	Density of Saturated Zone
R015	DENSUZ(1)	Not Used	g/cm ³	Default Density of Cover Material
R018	DIET(1)	1.50	g/cm ³	Density of Contaminated Zone
R018	DIET(2)	Not Used	g/cm ³	Bulk Density of Building Foundation
R018	DIET(3)	Refer to Table 1	g/cm ³	Uncontaminated Unsaturated Zone 1 – Soil Density
R018	DIET(4)	160	kg/yr	Fruit, Vegetable, and Grain Consumption
R018	DIET(5)	14	kg/yr	Leafy Vegetable Consumption
R018	DIET(6)	92	L/yr	Milk Consumption
R021	DIFCV	63	kg/yr	Meat and Poultry Consumption
R021	DIFCZ	5.4	kg/yr	Fish Consumption
R021	DIFFL	0.90	kg/yr	Other Seafood Consumption
R019	DM	Not Used	m ² /s	Diffusion Coefficient for Radon Gas in Cover Material
R021	DMFL	Not Used	m ² /s	Diffusion Coefficient for Radon Gas in Contaminated Zone Soil
R019	DROOT	Not Used	m ² /s	Diffusion Coefficient for Radon Gas in Foundation material
R019	DWI	0.15	m	Default Depth of Soil Mixing Layer
R014	DWIBWT	Not Used	m	Building Foundation Depth Below Ground Surface
R019	ED	0.90	m	Depth of Roots
R018	EMANA(1)	510	L/yr	Drinking Water Intake

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RESRAD Input Parameter Assignments				
Screen	Name	Value	Units	Description
R014	EMANA(2)	10	m	Well Pump Intake Depth
R013	EPS	30	yr	Default Exposure Duration
R014	EPSZ	Not Used	d.d.f. ^a	Emanating Power of ²²² Rn Gas
R015	EPUZ(1)	Not Used	d.d.f.	Emanating Power of ²²⁰ Rn Gas
R013	EVAPTR	0.001	--	Accuracy for Water/Soil Computations
R021	FAI	0.20	d.d.f.	Saturated Zone Effective Porosity
R018	FDW	0.2	d.d.f.	Uncontaminated Unsaturated Zone 1 - Effective Porosity
R019	FGWDW	0.5	--	Default Evapotranspiration Coefficient
R021	FGWIR	Not Used	d.d.f.	Building Interior Area Factor
R019	FIND	1.0	d.d.f.	Drinking Water Fraction from Groundwater
R021	FLOOR	1.0	d.d.f.	Irrigation Fraction from Groundwater
R017	FOTD	1.0	d.d.f.	Livestock Water Fraction from Groundwater
R017	FR9	0.50	d.d.f.	Fraction of Time Spent Indoors Onsite
R021	FRACA(1)	Not Used	m	Thickness of Building Foundation
R017	FS1	0.25	d.d.f.	Fraction of Time Spent Outdoors Onsite
R015	H(1)	0.5	d.d.f.	Fraction of Aquatic Food from Site
R013	HCCZ	Not Used	d.d.f.	Fraction of Annular Area 1 Within AREA
R014	HCSZ	1 - Circular	--	Shape Factor for External Gamma Radiation
R015	HCUZ(1)	Refer to Table 1	m	Uncontaminated Unsaturated Zone 1 - Thickness
R014	HGWT	10.0	m/yr	Contaminated Zone Hydraulic Conductivity
R021	HMIX	100	m/yr	Saturated Zone Hydraulic Conductivity
R021	HRM	Refer to Table 1	m/yr	Uncontaminated Unsaturated Zone 1 - Hydraulic Conductivity
R013	IDITCH	0.02	d.d.f.	Saturated Zone hydraulic Gradient
R017	INHALR	Not Used	m	Radon Vertical Dimension of Mixing
R011	LCZPAQ	Not Used	m	Building/Room Height
R019	LFI5	Overhead	--	Default irrigation Mode
R019	LFI6	8400	m ³ /yr	Default Inhalation Rate
R019	LWI5	100	m	Length of Contaminated Zone Parallel to Aquifer Flow
R019	LWI6	68	kg/d	Livestock Fodder Intake for Meat
R019	MLFD	55	kg/d	Livestock Fodder Intake for Milk
R019	MLINH	50	L/day	Livestock Water Intake for Meat
R019	MODEL	160	L/day	Livestock Water Intake for Milk
R019	NX ≤ 5	0.0001	g/m ³	Mass Loading for Foliar Deposition
R021	PH2OCV	0.0001	g/m ³	Default Mass Loading for Inhalation

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RESRAD Input Parameter Assignments				
Screen	Name	Value	Units	Description
R021	PH20FL	Not Used	--	Model: Nondispersion (ND) or Mass-Balance (MB)
R013	PRECIP	1	--	Number of Uncontaminated Unsaturated Zone Strata
R021	REXG	Not Used	d.d.f.	Volumetric Water Content of Cover Material
R013	RI	Not Used	d.d.f.	Volumetric Water Content of Building Foundation
R013	RUNOFF	1.0	m/yr	Precipitation
R012	S(i)	Not Used	1/h	Average Building Air Exchange Rate
R012	S(i)	0.2	m/yr	Irrigation
R012	S(i)	0.2	--	Default Runoff Coefficient
R012	S(i)	20.0	pCi/g	Initial Concentrations of C-14
R012	S(i)	0.7	d.d.f.	Shielding Factor – External Gamma Radiation
R012	S(i)	0.4	d.d.f.	Default Shielding Factor – Inhalation
R012	S(i)	36.5	g/yr	Default Soil Ingestion Rate
R012	S(i)	1,3,10,30, 100,300, 1000	yr	Default Calculation Times
R012	S(i)	Refer to Table 1	m	Thickness of Contaminated Zone
R017	SHF1	0	yr	Default Elapsed Time of Waste Placement
R017	SHF3	Not Used	d.d.f.	Total Porosity of Cover Material
R018	SOIL	0.4	d.d.f.	Contaminated Zone Total Porosity
R011	T(2)	Not Used	d.d.f.	Total Porosity of Building Foundation
R011	T(3)	0.4	d.d.f.	Saturated Zone Total Porosity
R011	T(4)	Refer to Table 1	d.d.f.	Uncontaminated Unsaturated Zone 1 – Total Porosity
R011	T(5)	Not Used	d.d.f.	Individual's Use of Groundwater
R011	T(6)	Not Used	m/yr	Cover Depth Erosion Rate
R011	T(7)	0.001	m/yr	Contaminated Zone Erosion Rate
R011	T(8)	0.001	m/yr	Water Table Drop Rate
R011	T(9)	0	pCi/g	Groundwater Concentration of N(i)
R011	T(10)	1000000	m ²	Watershed Area for Nearby Stream or Pond
R011	THICK(0)	2.0	m/s	Default Average Annual Wind Speed
R011	TI	0	L/yr	Default Leach Rate for N(i)
R021	TPCV	Refer to Table 1	m ²	Area of Contaminated Zone
R013	TPCZ	5.30	--	Default Contaminated Zone Exponential <i>b</i> Parameter

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RESRAD Input Parameter Assignments				
Screen	Name	Value	Units	Description
R021	TPFL	25	mrem/ yr	Radiation Dose Limit
R014	TPSZ	5.30	--	Saturated Zone Exponential <i>b</i> Parameter
R015	TPUZ(1)	5.30	--	Uncontaminated Unsaturated Zone 1 – Exponential <i>b</i> Parameter
R014	UW	0	m	Cover Depth
R013	VCV	0	cm ³ /g	Default Distribution Coefficient for C-14 in Contaminated Zone
R014	VWT	0	cm ³ /g	Default Distribution Coefficient for C-14 in Saturated Zone
R013	WAREA	0	cm ³ /g	Default Distribution Coefficient for C-14 in Unsaturated Zone
C14	C12WTR	2.0E-5	g/cm ³	C12 Concentration in water
C14	C12CZ	0.03	G	C12 Concentration in contaminated soil
C14	CSOIL	0.02	d.d.f.	Fraction of vegetation carbon from soil
C14	CAIR	0.98	d.d.f.	Fraction of vegetation carbon from air
C14	DMC	0.30	m	C14 Evasion layer thickness in soil
C14	EVSN	7.0E-07	1/sec	C14 Evasion flux rate from soil
C14	REVSN	1.0E-10	1/sec	C12 Evasion flux rate from soil
C14	AVFG4	0.80	d.d.f.	Fraction of grain in beef cattle feed
C14	AVFG5	0.20	d.d.f.	Fraction of grain in milk cow feed
C14	CO2F	123.4	d.d.f.	DCF correction factor for gaseous forms of C14

a – d.d.f. = dimensionless decimal fraction

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4 Dose Assessment/DCGL Determination Summary

4.1 10CFR20.1402 DCGLs

Summary results of the C-14 dose assessment are presented in the following tables.

Table 3 – Dose Assessment Summary

Assessment	Max TDOSE(t) (mrem/yr)	t _{max} (years)	Soil Guideline DCGL _w (pCi/g)
ABC Labs Application Field	5.593	3.885	89.40

Table 4 – Area Factors and DCGLEMC Values

Contaminated Area (m ²)	20,000	10,000	1,000	500	100	10
Area Factor	-	1.66	4.14	4.47	6.28	59.76
DCGL _{EMC} (pCi/g):	89.40	148.2	369.8	399.7	561.4	5,343

Table 5 – Dose in Max Year by Pathway

Contaminated Area (m ²)	40000	30000	20000	10000	1000	500	100	10
Water (mrem)	7.806E-01	7.806E-01	7.806E-01	7.806E-01	7.766E-01	7.766E-01	6.046E-01	6.476E-02
Fish (mrem)	8.513E+00	6.385E+00	4.257E+00	2.128E+00	2.647E-01	1.841E-01	8.252E-02	8.566E-03
Plant (mrem)	3.098E-01	2.686E-01	2.197E-01	1.561E-01	5.073E-02	3.657E-02	1.373E-02	5.670E-04
Meat (mrem)	1.470E-01	1.342E-01	1.189E-01	9.902E-02	6.587E-02	6.144E-02	4.228E-02	4.079E-03
Milk (mrem)	2.294E-01	2.239E-01	2.174E-01	2.090E-01	1.940E-01	1.921E-01	1.475E-01	1.562E-02
Total (mrem)	9.980E+00	7.792E+00	5.594E+00	3.373E+00	1.352E+00	1.251E+00	8.906E-01	9.359E-02

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Table 6 – Percentage of Total Dose in Max Year by Pathway

Contaminated Area (m ²)	40000	30000	20000	10000	1000	500	100	10
Water	7.8	10.0	14.0	23.1	57.4	62.1	67.9	69.2
Fish	85.3	81.9	76.1	63.1	19.6	14.7	9.3	9.2
Plant	3.1	3.4	3.9	4.6	3.8	2.9	1.5	0.6
Meat	1.5	1.7	2.1	2.9	4.9	4.9	4.7	4.4
Milk	2.3	2.9	3.9	6.2	14.4	15.4	16.6	16.7

4.2 Summary of Results

All of the exposure from residual C-14 in soil is delivered via groundwater (water dependent pathways). Because of this, the total dose from residual C-14 continues to increase for some of the pathways, specifically fish consumption, even after the contaminated area increased beyond the 20,000 m² used to determine the DCGL values. However, the contaminated area of 20,000 m² was still used based on the following:

- Greater than 76% of the dose from a 20,000 m² contaminated area is from fish consumption.
- The fish consumption dose is dependent on the size of the contaminated zone feeding C-14 through groundwater into the pond, and the assumption: 50% of fish consumed by the resident farmer in one year comes from the pond.
- It is highly unlikely the site pond will capture the C-14 run off in groundwater for an area greater than 20,000 m².
- It is highly unlikely a resident farmer will eat 50% of his annual fish intake from the site pond. It is much more likely he will not eat any of his fish from the pond, or a much lower percentage annually such as 5%.
- To receive the annual limit of 25 mrem from residual C-14 in soil, the entire 20,000 m² contaminated area would have to average the DCGL_w (89.4 pCi/g). The post remediation activity concentrations over any 20,000 m² area of the site addressed in the plan will be well below the DCGL_w.

Therefore, the DCGL values derived assuming a 20,000 m² contaminated area will be used to decommission the west portion of the site.

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5 Attachments

5.1 RESRAD Output File and Graphs (refer to table)

RESRAD File Name	RESRAD File Description
ABC Labs FA	ABC Labs DCGL Derivation
ABC Labs 062408 40K, 30K, 20K, 10K, 1K, 500, 100, 10	ABC Labs Area Factor Derivation

6 References

1. 10CFR20.1402
2. RESRAD Computer Code 6.3 – Environmental Assessment Division of Argonne National Laboratory, August 25, 2005
3. User's manual for RESRAD Version 6 – Environmental Assessment Division of Argonne National Laboratory, July 2001
4. Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil – Environmental Assessment and Information Sciences Division of Argonne National Laboratory, April 1993

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RESRAD, Version 6.3 75 limit = 180 Days 05/14/2008 21:08 Page 3
Summary : ABC Labs Application Field C-14 RF File: ABC Labs PA.MAD

Site-Specific Parameter Summary

Para	Parameter	User Input	Default	Used by RESRAD (if different from user input)	Parameter Name
RD11	Area of contaminated zone (m**2)	2.000E+01	1.000E+04	---	AREA
RD11	Thickness of contaminated zone (m)	1.524E-01	2.000E+00	---	THICKS
RD11	Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	---	LCZPAR
RD11	Basic radiation dose limit (rem/yr)	2.500E+01	5.000E+01	---	BRDL
RD11	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
RD11	Times for calculations (yr)	1.000E+00	1.000E+00	---	TI 3)
RD11	Times for calculations (yr)	3.000E+00	3.000E+00	---	TI 3)
RD11	Times for calculations (yr)	1.000E+01	1.000E+01	---	TI 4)
RD11	Times for calculations (yr)	3.000E+01	3.000E+01	---	TI 5)
RD11	Times for calculations (yr)	1.000E+02	1.000E+02	---	TI 6)
RD11	Times for calculations (yr)	3.000E+02	3.000E+02	---	TI 7)
RD11	Times for calculations (yr)	1.000E+03	1.000E+03	---	TI 8)
RD11	Times for calculations (yr)	not used	5.000E+00	---	TI 9)
RD11	Times for calculations (yr)	not used	0.000E+00	---	TI(10)
RD12	Initial principal radionuclide (pCi/g): C-14	2.000E+01	0.000E+00	---	SI: 1)
RD12	Concentration in groundwater (pCi/L): C-14	not used	0.000E+00	---	WI: 1)
RD13	Cover depth (m)	0.000E+00	0.000E+00	---	COVERD
RD13	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
RD13	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
RD13	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSC2
RD13	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VC2
RD13	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
RD13	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
RD13	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
RD13	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BC2
RD13	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
RD13	Humidity in air (g/m**3)	not used	8.000E+00	---	HMHD
RD13	Evapotranspiration coefficient	5.000E-01	5.000E-01	---	EVAPTR
RD13	Precipitation (m/yr)	1.000E+00	1.000E+00	---	PRECIP
RD13	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
RD13	Irrigation mode	overhead	overhead	---	IDITCH
RD13	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
RD13	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
RD13	Accuracy for water/soil computations	1.000E-03	1.000E-02	---	EPS
RD14	Density of saturated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSAQ
RD14	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPS2
RD14	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPS2
RD14	Saturated zone field capacity	2.000E-01	2.000E-01	---	FCS2
RD14	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCS2
RD14	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
RD14	Saturated zone b parameter	5.300E+00	5.300E+00	---	BS2
RD14	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
RD14	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWLWWT
RD14	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
RD14	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	QW
RD15	Number of unsaturated zone strata	1	1	---	NS

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RESRAD, Version 6.3 74 Limit = 100 days 05/14/2008 21:24 Page 8
Summary: ABC Labs Application Field C-14 RI File: ABC Labs FA.RAD

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (if different from user input)	Parameter Name
R015	Unsat. zone 1, thickness (m)	3.500E+00	4.000E+00	---	R11
R015	Unsat. zone 1, soil density (g/cm**3)	1.280E+00	1.500E+00	---	DENSUD(1)
R015	Unsat. zone 1, total porosity	4.500E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.000E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	2.000E-01	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	2.270E-02	1.000E+01	---	KCUZ(1)
R016	Distribution coefficients for C-14				
R016	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNCCC(1)
R016	Unsat. zone 1 (cm**3/g)	0.000E+00	0.000E+00	---	DCNCSU(1,1)
R016	Saturated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.022E-01	ALRACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R017	Inhalation rate (M**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/M**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SFIB
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SFPI
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.200E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radius of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)

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RESRAD, Version 6.3 T4 Limit = 150 days 05/14/2008 21:28 Page 5
Summary : ABC Labs Application Field C-14 RC File: ABC Labs FA-RAD

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (if different from user input)	Parameter Name
RD18	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(1)
RD18	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
RD18	Milk consumption (L/yr)	9.200E+01	9.200E+01	---	DIET(3)
RD18	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET(4)
RD18	Fish consumption (kg/yr)	5.400E+00	5.400E+00	---	DIET(5)
RD18	Other seafood consumption (kg/yr)	9.000E+01	9.000E+01	---	DIET(6)
RD18	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
RD18	Drinking water intake (L/yr)	5.100E+02	5.100E+02	---	DW
RD18	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
RD18	Contamination fraction of household water	not used	1.000E+00	---	FHW
RD18	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
RD18	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIW
RD18	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FRF
RD18	Contamination fraction of plant food	5.000E-01	-1	---	FPLANT
RD18	Contamination fraction of meat	1.000E+00	-1	---	FMEAT
RD18	Contamination fraction of milk	1.000E+00	-1	---	FMILK
RD19	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
RD19	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
RD19	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
RD19	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
RD19	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
RD19	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLPD
RD19	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
RD19	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
RD19	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGDW
RD19	Household water fraction from ground water	not used	1.000E+00	---	FHWN
RD19	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
RD19	Irrigation water fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
RD19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
RD19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
RD19B	Wet weight crop yield for Fodder (kg/m**2)	1.100E+00	1.100E+00	---	YV(3)
RD19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
RD19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
RD19B	Growing Season for Fodder (years)	8.000E-02	8.000E-02	---	TE(3)
RD19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
RD19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
RD19B	Translocation Factor for Fodder	1.000E+00	1.000E+00	---	TIV(3)
RD19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRI(1)
RD19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRI(2)
RD19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRI(3)
RD19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
RD19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
RD19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(3)
RD19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAN
C14	C-12 concentration in water (g/cm**3)	2.000E-05	2.000E-05	---	C12WR
C14	C-12 concentration in contaminated soil (g/g)	3.000E-02	3.000E-02	---	C12CS
C14	Fraction of vegetation carbon from soil	2.000E-02	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	9.800E-01	9.800E-01	---	CAIR

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RESRAD, Version 6.3 90 Limit = 180 days 05/14/2003 21:08 Page 6
Summary : ABC Labs Application Field C-14 BF File: ABC Labs FA.RAD

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (if different from user input)	Parameter Name
C14	C-14 evasion layer thickness in soil (m)	3.000E-03	3.000E-03	---	DHC
C14	C-14 evasion flux rate from soil (1/sec)	7.000E-07	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	1.000E-10	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	6.000E-01	4.000E-01	---	AVFC4
C14	Fraction of grain in milk cow feed	2.000E-01	2.000E-01	---	AVFC5
C14	DCF correction factor for gaseous forms of C14	1.034E+02	0.000E+00	---	CCDF
STOR	Storage times of contaminated foodstuffs (days):				
STOR	fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	fish	1.000E+00	7.000E+00	---	STOR_T(5)
STOR	crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm ³)	not used	2.400E+00	---	DENSEL
R021	Total porosity of the cover material	not used	4.000E-01	---	TFCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TFFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2FCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2GFL
R021	Diffusion coefficient for radon gas (m ² /sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCS
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	RMSX
R021	Average building air exchange rate (1/hr)	not used	3.000E-01	---	REXC
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	7.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITLE	Number of graphical time points	32	---	---	NPTS
TITLE	Maximum number of integration points for dose	17	---	---	LYMAX
TITLE	Maximum number of integration points for risk	257	---	---	KYMAX

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

RESRAD, Version 6.3 T_{1/2} Limit = 180 days 05/14/2008 21:28 Page 37
Summary : ABC Labs Application Field C-14 RF File: ABC Labs FA.RAD

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	active
5 -- milk ingestion	active
6 -- aquatic foods	active
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

Site Characterization and Remediation Plan in Support of Decommissioning for
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Revision 2.0

RESRAD, Version 5.3 T_{1/2} Limit = 100 days 05/14/2008 11:28 Page 8
Summary: ABC Labs Application Field C-14 RF File: ABC Labs SA.RAD

Contaminated Zone Dimensions	Initial Soil Concentrations, pCi/g
Area: 20000.00 square meters	C-14 2.000E+01
Thickness: 0.15 meters	
Cover Depth: 0.00 meters	

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	1.599E+00	5.529E+00	5.538E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
M(t):	6.396E-02	2.209E-01	2.215E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Maximum TDOSE(t): 5.538E+00 mrem/yr at t = 3.885 ± 0.008 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.885E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.885E+00 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.										
C-14	7.806E-01	0.1396	4.257E-00	0.7610	0.000E+00	0.0000	2.197E-01	0.0393	1.189E-01	0.0213	2.174E-01	0.0389	5.593E+00	1.0000
Total	7.806E-01	0.1396	4.257E+00	0.7610	0.000E+00	0.0000	2.197E-01	0.0393	1.189E-01	0.0213	2.174E-01	0.0389	5.593E+00	1.0000

*Sum of all water independent and dependent pathways.

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

RESRAD, Version 6.3 Tm Limit = 360 days 05/14/2008 21:26 Page 9
Summary : ABC Labs Application Field C-14 RF File: ABC Labs FA-RAD

Total Dose Contributions TD05E(I,P,t) for Individual Radionuclides (I) and Pathways (P)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	5.210E-06	0.0000	1.981E-04	0.0001	0.000E+00	0.0000	4.838E-01	0.3026	5.663E-01	0.4167	1.258E-01	0.0787	3.755E-05	0.0000
Total	5.210E-06	0.0000	1.981E-04	0.0001	0.000E+00	0.0000	4.838E-01	0.3026	5.663E-01	0.4167	1.258E-01	0.0787	3.755E-05	0.0000

Total Dose Contributions TD05E(I,P,t) for Individual Radionuclides (I) and Pathways (P)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.										
C-14	6.092E-02	0.0381	2.400E-01	0.1501	0.000E+00	0.0000	6.975E-03	0.0044	8.161E-04	0.0005	1.400E-02	0.0088	1.599E+00	1.0000
Total	6.092E-02	0.0381	2.400E-01	0.1501	0.000E+00	0.0000	6.975E-03	0.0044	8.161E-04	0.0005	1.400E-02	0.0088	1.599E+00	1.0000

*Sum of all water independent and dependent pathways.

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

RESRAD, Version 4.3 T4 Limit = 180 days 05/14/2008 21:29 Page 18
Summary: ABC Labs Application Field C-14 RF File: ABC Labs FA.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Soil		Plant		Meat		Milk		Soil	
	mrem/yr	fract.												
C-14	4.681E-20	0.0000	1.768E-18	0.0000	0.000E+00	0.0000	3.112E-14	0.0000	6.307E-13	0.0000	4.801E-14	0.0000	5.373E-19	0.0000
Total	4.681E-20	0.0000	1.768E-18	0.0000	0.000E+00	0.0000	3.112E-14	0.0000	6.307E-13	0.0000	4.801E-14	0.0000	5.373E-19	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.												
C-14	7.721E-01	0.1399	4.207E+00	0.7622	0.000E+00	0.0000	2.168E-01	0.0393	1.098E-01	0.0199	2.138E-01	0.0387	5.520E-00	1.0000
Total	7.721E-01	0.1399	4.207E+00	0.7622	0.000E+00	0.0000	2.168E-01	0.0393	1.098E-01	0.0199	2.138E-01	0.0387	5.520E+00	1.0000

*Sum of all water independent and dependent pathways.

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

RESRAD, Version 4.3 T4 Dose: = 180 days 05/14/2008 21:18 Page 11
Summary: ABC Labs Application Field C-14 RF File: ABC Labs FA-RAD

Total Dose Contributions TD0SE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
At nrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	nrem/yr	fract.	nrem/yr	fract.	nrem/yr	fract.	nrem/yr	fract.	nrem/yr	fract.	nrem/yr	fract.	nrem/yr	fract.
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TD0SE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
At nrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	nrem/yr	fract.	nrem/yr	fract.										
C-14	7.728E-01	0.1395	4.715E+00	0.7610	0.000E+00	0.0000	2.176E-01	0.0393	1.179E-01	0.0213	2.153E-01	0.0359	5.538E+00	1.0000
Total	7.728E-01	0.1395	4.715E+00	0.7610	0.000E+00	0.0000	2.176E-01	0.0393	1.179E-01	0.0213	2.153E-01	0.0359	5.538E+00	1.0000

*Sum of all water independent and dependent pathways.

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

RESRAD, Version 6.3 TM Limit = 100 days 05/14/2008 21:26 Page 12
Summary: ABC Labs Application Field C-14 RF File: ABC Labs FA.RAD

Total Dose Contributions TDOSC(I,P,t) for Individual Radionuclides (I) and Pathways (P)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSC(L,P,t) for Individual Radionuclides (L) and Pathways (P)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.										
C-14	0.000E+00	0.0000	0.000E+00	0.0000										
Total	0.000E+00	0.0000	0.000E+00	0.0000										

*Sum of all water independent and dependent pathways.

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

RESRAD, Version 5.3 T_{1/2} limit = 180 days 05/14/2008 21:28 Page 13
Summary: ABC Labs Application Field C-14 RF File: ABC Labs RA.RAD

Total Dose Contributions TDCSE(L,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.												
C-14	0.000E+00	0.0000												
Total	0.000E+00	0.0000												

Total Dose Contributions TDCSE(L,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.												
C-14	0.000E+00	0.0000												
Total	0.000E+00	0.0000												

*Sum of all water independent and dependent pathways.

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

MESHAD, Version 6.0 TH Limit = 180 days 05/14/2008 21:28 Page 14
Summary: ABC Labs Application Field C-14 RF File: ABC Labs FA.RAD

Total Dose Contributions TD05E(1,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excluded radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	frac.												
C-14	0.000E+00	0.0000												
Total	0.000E+00	0.0000												

Total Dose Contributions TD05E(1,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	frac.												
C-14	0.000E+00	0.0000												
Total	0.000E+00	0.0000												

*Sum of all water independent and dependent pathways.

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

RESRAD, Version 6.2 7% Limit = 150 days 05/14/2008 2:52P Page 15
Summary: ABC Labs Application Field C-14 RI File: ABC Labs FA.AAD

Total Dose Contributions YDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.00E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meal		Milk		Soil	
	mrem/yr	fract.												
C-14	0.000E+00	0.0000												
Total	0.000E+00	0.0000												

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.00E+02 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.												
C-14	0.000E+00	0.0000												
Total	0.000E+00	0.0000												

*Sum of all water independent and dependent pathways.

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

HESRAD, Version 6.3 T_{1/2} Limit = 390 days 05/14/2008 21:28 Page 16
Summary : ABC Labs Application Field C-14 RF File: ABC Labs FA.SAD

Total Dose Contributions TD05E(s,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.												
C-14	0.000E+00	0.0000												
Total	0.000E+00	0.0000												

Total Dose Contributions TD05E(s,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.												
C-14	0.000E+00	0.0000												
Total	0.000E+00	0.0000												

*Sum of all water independent and dependent pathways.

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

SPSRM, Version 5.2 T4 Limit = 180 days 05/14/2008 21:24 Page 17
Summary : ABC Labs Application Field C-14 RF File: ABC Labs CA-RAT

Dose/Source Ratio Summed Over All Pathways
Percent and Priority Principal Radionuclide Contributions Indicated

Percent	Product	Thread	DSR(i,t) At Time in Years (mrem/yr)/(pCi/g)							
(%)	(%)	Fraction	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
C-14	C-14	1.000E+00	7.455E-02	2.760E-01	2.760E-01	0.400E+00	0.500E+00	0.500E+00	0.000E+00	0.000E+00

The DSR includes contributions from associated (half-life < 180 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 2.500E-01 mrem/yr

Nuclide	t = 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
C-14	3.127E+02	9.059E+01	9.028E+01	*4.450E+12	*4.455E+12	*4.455E+12	*4.455E+12	*4.455E+12

*At specific activity limit

Summed Dose/Source Ratio DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 3.895 ± 0.008 years

Nuclide	Initial	tmin	DSR(i,tmin)	G(i,tmin)	DSR(i,tmax)	G(i,tmax)
(i)	(pCi/g)	(years)	(mrem/yr)	(pCi/g)	(mrem/yr)	(pCi/g)
C-14	2.000E+01	3.895 ± 0.008	2.797E-01	2.899E+01	2.797E-01	2.899E+01

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

RESRAD, Version 6.3 To Limit = 100 days 05/16/2008 21:08 Page 18
Summary: ABC Labs Application Field C-14 WF File: ABC Labs RA,BAD

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide	Parent	TF(i)	DOSE(j), mrem/yr							
(j)	(i)		1	2	3	4	5	6	7	8
C-14	C-14	1.000E+00	1.199E+00	5.520E+00	5.520E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

TF(i) is the thread fraction of the parent nuclide.

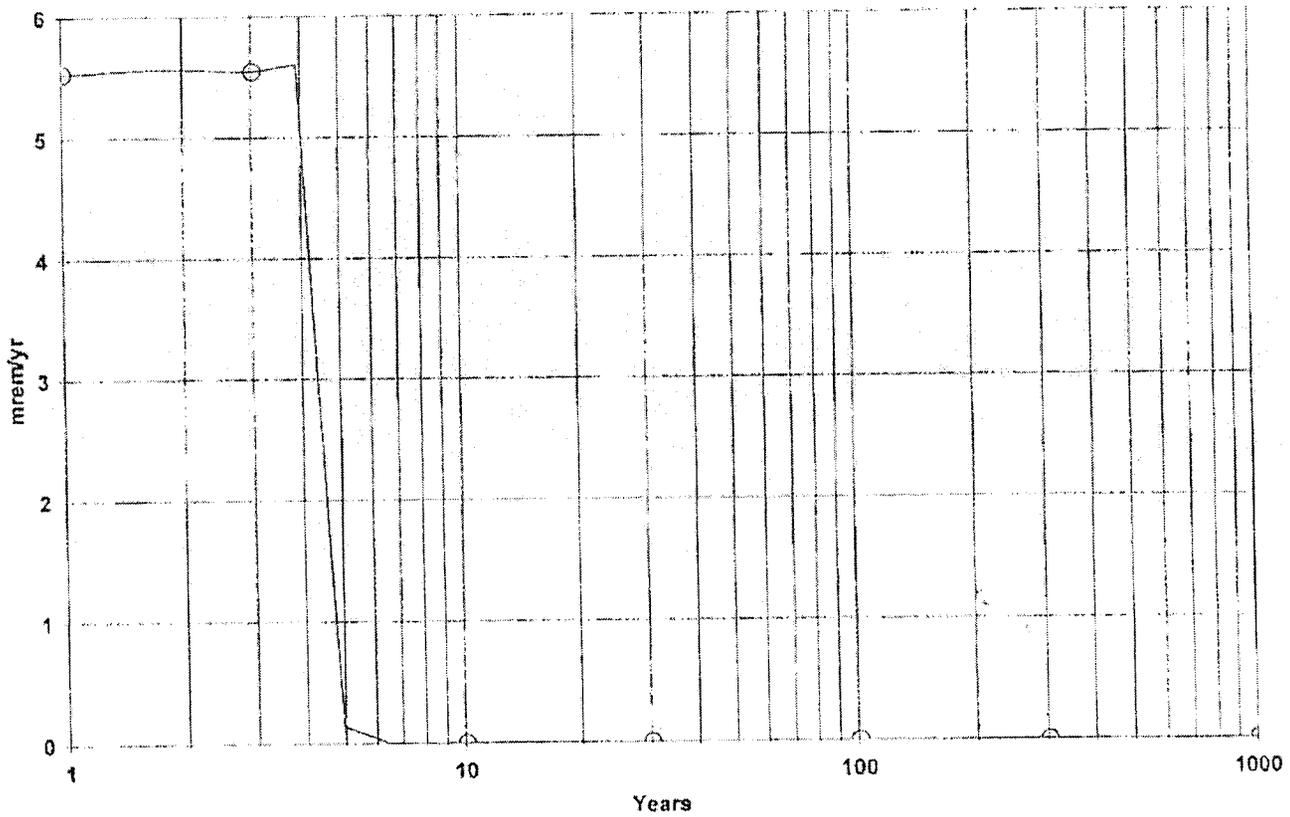
Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide	Parent	TF(i)	C(j), pCi/g							
(j)	(i)		1	2	3	4	5	6	7	8
C-14	C-14	1.000E+00	2.000E+01	1.797E-13	1.449E-41	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

TF(i) is the thread fraction of the parent nuclide.

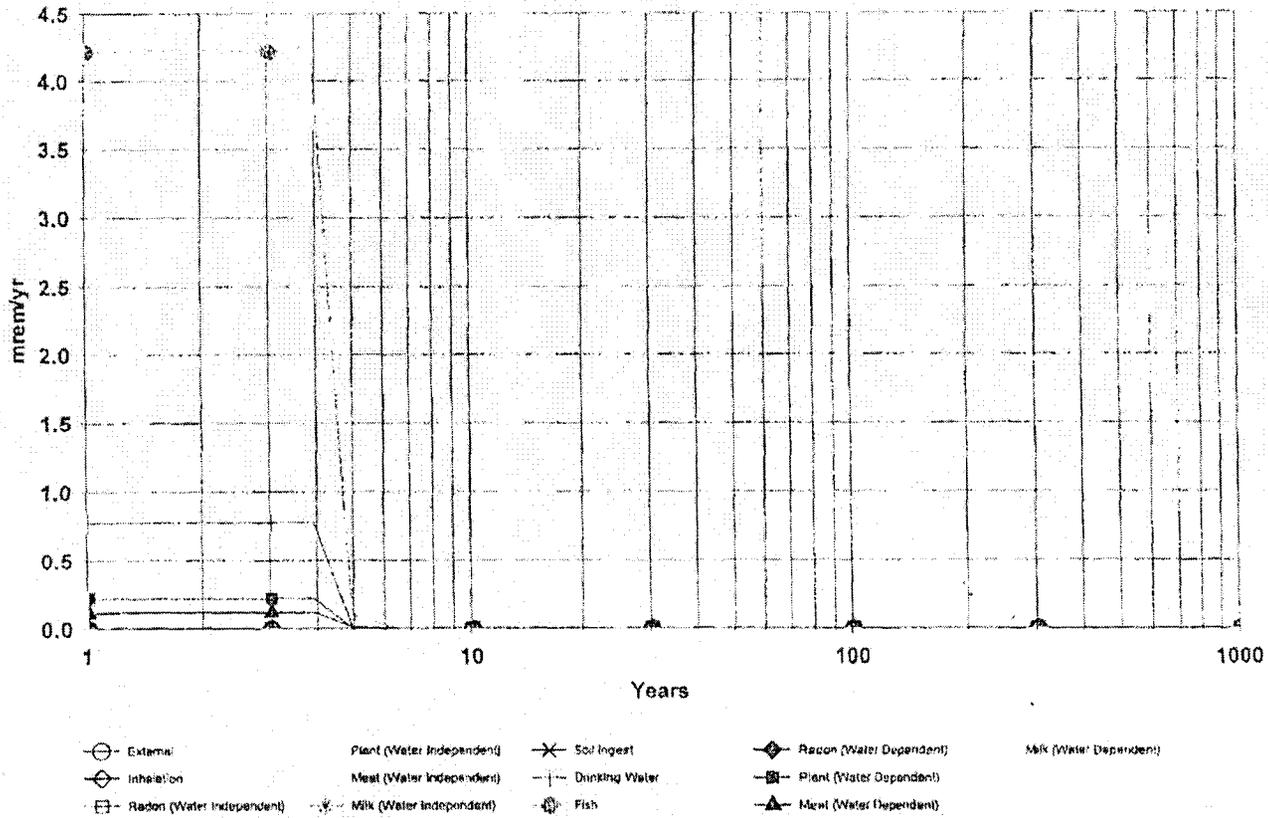
RESRAD.DAT execution time = 2.39 seconds

DOSE: C-14, All Pathways Summed



ABC Labs FA.RAD 05/14/2008 21:28 GRAPHICS.ASC Includes All Pathways

DOSE: C-14, Component Pathways



ABC Libs FA.RAD 05/14/2008 21:28 GRAPHICS.ASC

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

RESRAD, Version 5.3 T_{1/2} Limit = 100 days 06/24/2008 13:20 Page 8
Summary : ABC Labs Application Field C-14 RF File: ABC Labs 062408 49K.RAD

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	40000.00 square meters	C-14	2.000E+01
Thickness:	0.15 meters		
Cover Depth:	0.50 meters		

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	2.364E+00	9.852E+00	5.882E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
M(t):	9.457E-02	3.941E-01	3.953E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Maximum TDOSE(t): 9.980E+00 mrem/yr at t = 3.885 ± 0.008 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.885E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	frac.												
C-14	0.000E+00	0.0000												
Total	0.000E+00	0.0000												

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.885E+00 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways	
	mrem/yr	frac.												
C-14	7.800E-01	0.0782	8.513E+00	0.8530	0.000E+00	0.0000	0.000E-01	0.0310	1.470E-01	0.0147	2.294E-01	0.0230	9.980E+00	1.0000
Total	7.800E-01	0.0782	8.513E+00	0.8530	0.000E+00	0.0000	0.000E-01	0.0310	1.470E-01	0.0147	2.294E-01	0.0230	9.980E+00	1.0000

*Sum of all water independent and dependent pathways.

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

RESRAD, Version 6.3 T_{1/2} Limit = 120 days 06/24/2005 13:16 Page 9
Summary : ABC Labs Application Field C-14 AF File: ABC Labs 062406.30K.RAD

Contaminated Zone Dimensions	Initial Soil Concentrations, pCi/g
Area: 10000.00 square meters	C-14 2.000E+01
Thickness: 0.15 meters	
Cover Depth: 0.00 meters	

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	2.000E+00	7.691E+00	7.716E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
M(t):	8.015E-02	3.075E-01	3.066E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Maximum TDOSE(t): 7.792E+00 mrem/yr at t = 3.685 ± 0.006 years

Total Dose Contributions TDOSE(i,p,t) for individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.685E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.685E+00 years

Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways	
	mrem/yr	frac.	mrem/yr	frac.										
C-14	7.806E-01	0.1002	6.385E+00	0.8194	0.000E+00	0.0000	2.686E-01	0.0345	1.342E-01	0.0172	2.239E-01	0.0287	7.792E+00	1.0000
Total	7.806E-01	0.1002	6.385E+00	0.8194	0.000E+00	0.0000	2.686E-01	0.0345	1.342E-01	0.0172	2.239E-01	0.0287	7.792E+00	1.0000

*Sum of all water independent and dependent pathways.

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

RESRAD, Version 6.3 T_{1/2} Limit = 180 days 05/24/2008 12:04 Page 8
Summary: ABC Labs Application Fluid C-14 AP File: ABC Labs 062408 2DR.LAB

Contaminated Zone Dimensions	Initial Soil Concentrations, pCi/g
Area: 20000.00 square meters	C-14 2.000E+01
Thickness: 0.15 meters	
Cover Depth: 0.00 meters	

Total Dose TDSE(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDSE(t):	1.599E+00	5.520E+00	5.538E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
M(t):	6.395E-02	2.208E-01	2.215E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Maximum TDSE(t): 5.538E+00 mrem/yr At t = 3.885 ± 0.028 years

Total Dose Contributions TDSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.885E+00 years

Water Independent Pathways (Inhalation excluded radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.885E+00 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways	
	mrem/yr	frac.	mrem/yr	frac.										
C-14	7.805E-01	0.1396	4.257E+00	0.7610	0.000E+00	0.0000	2.187E-01	0.0393	1.189E-01	0.0213	2.174E-01	0.0389	5.593E+00	1.00
Total	7.805E-01	0.1396	4.257E+00	0.7610	0.000E+00	0.0000	2.187E-01	0.0393	1.189E-01	0.0213	2.174E-01	0.0389	5.593E+00	1.00

*Sum of all water independent and dependent pathways.

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

RESRAD, Version 6.3 TM Limit = 180 days 06/24/2008 11:44 Page 8
Summary : ABC Labs Application Field C-14 RF File: ABC Labs 067408 10K.RAD

Contaminated Zone Dimensions	Initial Soil Concentrations, pCi/g
Area: 10000.00 square meters	C-14 2.000E+01
Thickness: 0.15 meters	
Cover Depth: 0.03 meters	

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	1.104E+00	3.329E+00	3.340E+00	5.000E+00	5.000E+00	6.000E+00	6.000E+00	6.000E+00
M(t):	4.430E-02	1.331E-01	1.336E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Maximum TDOSE(t): 2.373E+00 mrem/yr at t = 3.885 ± 0.008 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.885E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.00
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.00

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.885E+00 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways	
	mrem/yr	frac.	mrem/yr	frac.										
C-14	7.906E-01	0.2314	2.128E+00	0.6310	0.000E+00	0.0000	1.561E-01	0.0463	3.902E-02	0.0294	2.090E-01	0.0620	3.373E+00	1.00
Total	7.906E-01	0.2314	2.128E+00	0.6310	0.000E+00	0.0000	1.561E-01	0.0463	3.902E-02	0.0294	2.090E-01	0.0620	3.373E+00	1.00

*Sum of all water independent and dependent pathways.

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

RESRAD, Version 6.3 T_{1/2} Limit = 100 days 06/24/2008 11:55 Page #
Summary: ABC Labs Application Field C-14 RF File: ABC Labs 062408 1K.RAD

Contaminated Area Dimensions	Initial Soil Concentrations, pCi/g
Area: 1000.00 square meters	C-14 1.600E+01
Thickness: 0.15 meters	
Cover Depth: 0.20 meters	

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 mrem/yr
Total Mixture Sum H(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	3.893E-01	1.341E+00	1.345E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
H(t):	1.557E-02	5.366E-02	5.382E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Maximum TDOSE(t): 1.357E+00 mrem/yr at t = 1.761 ± 0.004 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.761E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	frac.	mrem/yr	frac.										
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.447E-25	0.0000	2.933E-24	0.0000	2.234E-25	0.0000	0.000E+00	0.00
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.447E-25	0.0000	2.933E-24	0.0000	2.234E-25	0.0000	0.000E+00	0.00

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.761E+00 years

Water Dependent Pathways

Radio- Nuclide	Water		Plnh		Radon		Plant		Meat		Milk		All Pathways	
	mrem/yr	frac.	mrem/yr	frac.										
C-14	7.766E-01	0.5744	2.647E-01	0.1958	0.000E+00	0.0000	5.073E-02	0.0375	6.567E-02	0.0487	1.940E-01	0.1435	1.352E+00	1.00
Total	7.766E-01	0.5744	2.647E-01	0.1958	0.000E+00	0.0000	5.073E-02	0.0375	6.567E-02	0.0487	1.940E-01	0.1435	1.352E+00	1.00

*Sum of all water independent and dependent pathways.

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

RESRAD, Version 6.3 7% Limit = 0.80 days 06/24/2009 11:53 Page 8
Summary: ABC Labs Application Field C-14 RF File: ABC Labs 062408 500.RAD

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	585.00 square meters	C-14	2.00E+01
Thickness:	0.15 meters		
Cover Depth:	0.05 meters		

Total Dose TD05E(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 mrem/yr
Total Mixture Sum Mit) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TD05E(t):	3.017E-01	1.242E+00	3.062E-01	0.300E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Mit):	1.207E-02	4.367E-02	1.225E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Maximum TD05E(t): 1.251E-00 mrem/yr at t = 1.762 ± 0.004 years

Total Dose Contributions TD05E(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.762E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
C-14	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.024E-23	0.0000	2.076E-24	0.0000	1.582E-25	0.0000	0.000E+00	0.00
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.024E-23	0.0000	2.076E-24	0.0000	1.582E-25	0.0000	0.000E+00	0.00

Total Dose Contributions TD05E(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.762E+00 years

Water Dependent Pathways

Radio- Nuclide Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways	
	mrem/yr	fract.	mrem/yr	fract.										
C-14	7.766E-01	0.6208	1.841E-01	0.1472	0.000E+00	0.0000	3.657E-02	0.0292	6.144E-02	0.0491	1.921E-01	0.1536	1.251E+00	1.00
Total	7.766E-01	0.6208	1.841E-01	0.1472	0.000E+00	0.0000	3.657E-02	0.0292	6.144E-02	0.0491	1.921E-01	0.1536	1.251E+00	1.00

*Sum of all water independent and dependent pathways.

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

RESRAD, Version 6.3 TM Limit = 180 days 06/24/2008 12:15 Page 3
Summary: ABC Labs Application Field C-14 RF File: ABC Labs 062408 180.RAD

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	100.00 square meters	C-14	2.000E+01
Thickness:	0.15 meters		
Cover Depth:	0.00 meters		

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t):

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	1.698E-01	8.443E-01	3.712E-17	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
M(t):	6.756E-03	3.377E-02	1.485E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Maximum TDOSE(t): 8.906E-02 mrem/yr at t = 0.554 ± 0.002 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 9.548E-01 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.
C-14	1.747E-18	0.0000	5.550E-15	0.0000	0.000E+00	0.0000	1.112E-14	0.0000	2.256E-13	0.0000	1.719E-14	0.0000	1.451E-15	0.00
Total	1.747E-18	0.0000	5.550E-15	0.0000	0.000E+00	0.0000	1.112E-14	0.0000	2.256E-13	0.0000	1.719E-14	0.0000	1.451E-15	0.00

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 9.548E-01 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways	
	mrem/yr	frac.	mrem/yr	frac.										
C-14	5.046E-01	0.6788	8.252E-02	0.0927	0.000E+00	0.0000	1.373E-02	0.0154	4.228E-02	0.0475	1.475E-01	0.1656	8.906E-01	1.00
Total	5.046E-01	0.6788	8.252E-02	0.0927	0.000E+00	0.0000	1.373E-02	0.0154	4.228E-02	0.0475	1.475E-01	0.1656	8.906E-01	1.00

*Sum of all water independent and dependent pathways.

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

RESRAD, Version 6.3 T_{1/2} Limit = 140 days 06/24/2008 12:17 Page 8
Summary : ASE Labs Application Field C-14 RF File: ASE Labs 062408 10_KAO

Contaminated Area Dimensions		Initial Soil Concentrations, pCi/g	
Area:	10.00 square meters	C-14	2.000E+01
Thickness:	0.15 meters		
Cover Depth:	0.00 meters		

Total Dose TDSE(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 mrem/yr
Total Mixture Sum Hit) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E-08	3.000E+00	1.000E-01	3.000E+01	1.000E+02	3.000E-02	1.000E-03
TDSE(t):	5.392E-02	7.045E-02	2.296E+77	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Hit):	2.553E-03	2.819E-03	0.382E-29	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Maximum TDSE(t): 0.355E-02 mrem/yr at t = 0.573 ± 0.001 years

Total Dose Contributions TDSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.231E-01 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.	mrem/yr	frac.
C-14	1.234E-13	0.0000	1.997E-13	0.0000	0.000E+00	0.0000	5.140E-09	0.0000	1.043E-07	0.0000	1.967E-09	0.0000	1.683E-14	0.00
Total	1.234E-13	0.0000	1.997E-13	0.0000	0.000E+00	0.0000	5.140E-09	0.0000	1.043E-07	0.0000	1.967E-09	0.0000	1.683E-14	0.00

Total Dose Contributions TDSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 5.231E-01 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways	
	mrem/yr	frac.	mrem/yr	frac.										
C-14	5.476E-02	0.6920	8.566E-03	0.0915	0.000E+00	0.0000	5.670E-04	0.0061	4.079E-03	0.0436	1.562E-02	0.1669	9.353E-02	1.00
Total	5.476E-02	0.6920	8.566E-03	0.0915	0.000E+00	0.0000	5.670E-04	0.0061	4.079E-03	0.0436	1.562E-02	0.1669	9.353E-02	1.00

*Sum of all water independent and dependent pathways.

ATTACHMENT 2.1

CARBON-14 CONCENTRATIONS IN LAGOON SEDIMENT (PCI/G)

Table 2.1 Samples of lagoon sediment and concentrations of carbon-14 in pCi/g.

Sample ID	Concentration of ¹⁴ C (pCi/g)*
LGNOCT2010 0001	409
LGNOCT2010 0003	727
LGNOCT2010 0005	280
LGNOCT2010 0007	659
LGNOCT2010 0009	537
LGNOCT2010 0011	645
LGNOCT2010 0013	362
LGNOCT2010 0015	346
LGNOCT2010 0017	444
LGNOCT2010 0019	576
LBS1a-101102	93.1
LBS2a-101102	565
LBS3a-101102	158
LBS4a-101102	291
LBS5a-101102	313
LBS6a-101102	128
LBS7a-101102	1,560
Mean +/- STDEV	476 +/- 337

*No Significant figures are indicated here: the result is displayed without rounding.

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Company:	ARC Laboratories, Inc.	Report Date: November 3, 2010
Address:	7200 East ABC Lane	
	Columbia, Missouri 65202	
Contact:	Dr. Bradley D. Keck	
Project:	Routine Analytical - Keck	

Client Sample ID: LGNOCT2010_0001	Project: ABCL00107
Sample ID: 265547001	Client ID: ABCL001
Matrix: Solid	
Collect Date: 25-OCT-10 12:00	
Receive Date: 27-OCT-10	
Collector: Client	

Parameter	Qualifier	Result	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Liquid Scintillation Analysis										
<i>Liquid Scint C14, Solid "As Received"</i>										
Carbon-14		409	±8.16	1.94	2.00	pCi/g	EXK2 10/31/10 1323	1042790		1

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA EERF C-01 Modified	

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

GEL LABORATORIES LLC

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Certificate of Analysis

Company:	ABC Laboratories, Inc	Report Date: November 3, 2010
Address:	7200 East ABC Lane	
	Columbia, Missouri 65202	
Contact:	Dr. Brady D. Keck	
Project:	Routine Analytical - Keck	
Client Sample ID:	LONOC2010_0003	Project: ABCL00107
Sample ID:	265547002	Client ID: ABCL001
Matrix:	Solid	
Collect Date:	25-OCT-10 12:00	
Receive Date:	27-OCT-10	
Collector:	Client	

Parameter	Qualifier	Result	DL	RL	Unit	DF	AnalysisDate	Time	Batch	Method
Rad Liquid Scintillation Analysis										
<i>Liquid Scint C14, Solid "As Received"</i>										
Carbon-14		727 +/-14.3	2.52	2.00	pCi/g		EKK2 10/31/10 1336	1042790		

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA ERF C-01 Modified	

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

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Certificate of Analysis

Company :	ABC Laboratories, Inc.	Report Date: November 3, 2010
Address :	7200 East ABC Lane	
Contact:	Columbia, Missouri 65202	
Project:	Dr. Bradley D. Keck	
	Routine Analytical - Keck	
<hr/>		
Client Sample ID:	LGN0CT2010_0005	Project: ABCL00107
Sample ID:	265547003	Client ID: ABC1.001
Matrix:	Solid	
Collect Date:	25-OCT-10 12:00	
Receive Date:	27-OCT-10	
Collector:	Client	

Parameter	Qualifier	Result	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Liquid Scintillation Analysis										
<i>Liquid Scint C14, Solid "As Received"</i>										
Carbon-14		280	-45.63	1.68	2.00	pCi/g	EXX2 10/31/10	1344	1042790	1

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA BERT C-01 Modified	

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

GEL LABORATORIES LLC

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Certificate of Analysis

Company :	ABC Laboratories, Inc.	Report Date: November 3, 2010
Address :	7200 Ees: ABC Lane	
	Columbia, Missouri 65202	
Contact:	Dr. Bradley D. Keck	
Project:	Routine Analytical - Keck	
Client Sample ID:	LGNOC12010_0007	Project: ABCL00107
Sample ID:	265547005	Client ID: ABCL001
Matrix:	Solid	
Collect Date:	25-OCT-10 12:00	
Receive Date:	27-OCT-10	
Collector:	Client	

Parameter	Qualifier	Result	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Liquid Scintillation Analysis										
<i>Liquid Scint C14, Solid "As Received"</i>										
Carbon-14		659	~13.0	2.41	2.00	pCi/g	EXK2 10/31/10 1449	1042790		1

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA EERP C-01 Modified	

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

GEL LABORATORIES LLC

2640 Savage Road Charleston SC 29407 - (843) 558-8171 - www.gel.com

Certificate of Analysis

Company:	ABC Laboratories, Inc.	Report Date: November 3, 2010
Address:	7206 East ABC Lane	
	Columbia, Missouri 65203	
Contact:	Dr. Bradley D. Keck	
Project:	Routine Analytical - Keck	

Client Sample ID: LGNOCT2010_0909	Project: ABCL00107
Sample ID: 265547006	Client ID: ABCL001
Matrix: Solid	
Collect Date: 25-OCT-10 12:00	
Receive Date: 27-OCT-10	
Collector: Client	

Parameter	Qualifier	Result	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Liquid Scintillation Analysis										
<i>Liquid Scint. C14, Solid "As Received"</i>										
Carbon-14		537	+/-10.7	2.30	2.00	pCi/g	EXK2 10/31/10	1458	1042790	1

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA EERF C-01 Modified	

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

GEL LABORATORIES LLC
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Certificate of Analysis

Company:	ASC Laboratories, Inc.	Report Date: November 3, 2010
Address:	7200 East ABC Lane	
	Columbia, Missouri 65202	
Contact:	Dr. Bradley D. Keck	
Project:	Routine Analytical - Keck	

Client Sample ID: LGNOCT2010_0511	Project: ABCL00107
Sample ID: 265547067	Client ID: ABCL001
Matrix: Solid	
Collect Date: 25-OCT-10 12:00	
Receive Date: 27-OCT-10	
Collector: Client	

Parameter	Qualifier	Result	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Liquid Scintillation Analysis										
<i>Liquid Scint C14, Solid "As Received"</i>										
Carbon-14		645	+/-12.7	2.40	2.00	pCi/g	EXK2 10/31/10 1508	1042790		1

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA EERF C-01 Modified	

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

GEL LABORATORIES LLC
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Certificate of Analysis

Company:	ABC Laboratories, Inc.	Report Date: November 3, 2010
Address:	7200 East ABC Lane	
	Columbia, Missouri 65202	
Contact:	Dr. Bradley D. Keck	
Project:	Routine Analytical - Keck	
Client Sample ID:	LGNOCT2010_0013	Project: ABCL00107
Sample ID:	265547038	Client ID: ABCL001
Matrix:	Solid	
Collect Date:	25-OCT-10 12:00	
Receive Date:	27-OCT-10	
Collector:	Client	

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Liquid Scintillation Analysis											
<i>Liquid Scint. C14, Solid "As Received"</i>											
Carbon-14		362 +/-7.21	1.86	2.00	pCi/g		EXK2	10/31/10	15:17	1042790	1

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA EERF C-01 Modified	

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

GEL LABORATORIES LLC
2640 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Company:	ABC Laboratories, Inc.	Report Date: November 3, 2010
Address:	7200 East ABC Lane	
	Columbia, Missouri 65202	
Contact:	Dr. Bradley D Keck	
Project:	Routine Analytical - Keck	
Client Sample ID:	LGNOCT2010_0015	Project: ABCL00107
Sample ID:	265547009	Client ID: ABCL001
Matrix:	Solid	
Collect Date:	25-OCT-10 12:00	
Receive Date:	27-OCT-10	
Collector:	Client	

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst/Date	Time	Batch	Method
RAD Liquid Scintillation Analysis										
<i>Liquid Scint C14, Solid "As Received"</i>										
Carbon-14		546	-76.94	1.85	2.00	pCi/g	EXK2	10/31/10	.532	1042790 1

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA ERF C-01 Modified	

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

GEL LABORATORIES LLC

2040 Savage Road, Charleston SC 29407 - (843) 556-8771 - www.gel.com

Certificate of Analysis

Company:	ABC Laboratories, Inc.	Report Date: November 3, 2010
Address:	7200 East ABC Lane	
Contact:	Columbia, Missouri 65202	
Project:	Dr. Bradley D. Keck	
	Routine Analytical - Keck	
Client Sample ID:	LGNOC2010_0017	Project: ABCL00107
Sample ID:	265547011	Client ID: ABCL031
Matrix:	Solid	
Collect Date:	25-OCT-10 12:00	
Receive Date:	27-OCT-10	
Collector:	Client	

Parameter	Qualifier	Result	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Liquid Scintillation Analysis										
<i>Liquid Scint C14, Solid "As Received"</i>										
Carbon-14		444	+/-5.82	2.01	2.00	pCi/g	EKK2	10/31/10	1634	1042790

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA EERF C-01 Modified	

Site Characterization and Remediation Plan in Support of Decommissioning for
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Revision 2.0

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Company: ABC Laboratories, Inc
Address: 7206 East ABC Lane

Columbia, Missouri 65202
Contact: Dr. Brady D. Keck
Project: Routine Analytical - Keck

Report Date: November 3, 2010

Client Sample ID: LGNOCT2010_0019
Sample ID: 263547013
Matrix: Solid
Collect Date: 25-OCT-10 12:00
Receive Date: 27-OCT-10
Collector: Client

Project: ABCL00107
Client ID: ABCL001

Parameter	Qualifier	Result	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Liquid Scintillation Analysis										
<i>Liquid Scint C14, Solid "As Received"</i>										
Carbon-14		576	-4-11.4	2.27	2.00	pCi/g	EXX2 10/31/10	1732	1042790	1

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA EERF C-01 Modified	

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Certificate of Analysis

Company: ABC Laboratories, Inc.
 Address: 7200 East ABC Lane
 Columbia, Missouri 65202
 Contact: Dr. Bradley D. Keck
 Project: Routine Analytical - Keck

Report Date: November 18, 2010

Client Sample ID: LBS1a-101102
 Sample ID: 266303003
 Matrix: Solid
 Collect Date: 02-NOV-10 11:05
 Receive Date: 04-NOV-10
 Collector: Client

Project: ABCL00107
 Client ID: ABCL001

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Liquid Scintillation Analysis											
<i>Liquid Scint C14, Solid "As Received"</i>											
Carbon-14		93.1	-12.53	1.66	2.00	pCi/g	EXK2	11/17/10	1543	1045453	1

The following Analytical Methods were performed

Method	Description
	EPA EERF C-01 Modified

Analyst Comments

Selmont

Site Characterization and Remediation Plan in Support of Decommissioning for
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Certificate of Analysis

Company: ABC Laboratories, Inc.
 Address: 7200 East ABC Lane
 Columbia, Missouri 65202
 Contact: Dr. Brady D. Keck
 Project: Routine Analytical - Keck

Report Date: November 18, 2010

Client Sample ID: LBS2a-101102
 Sample ID: 266303005
 Matrix: Solid
 Collect Date: 02-NOV-10 12.40
 Receive Date: 04-NOV-10
 Collector: Client

Project: ABCL00107
 Client ID: ABCL061

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Liquid Scintillation Analysis											
Liquid Scint C14, Solid "As Received"											
Carbon-14		565	+/-11.3	2.98	2.89	pCi/g	EXX2	11/17/10	1706	1049453	

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA ERF C-6 Modified	

Sediment

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Certificate of Analysis

Company: ABC Laboratories, Inc.
 Address: 7200 East ABC Lane
 Columbia, Missouri 65202
 Contact: Dr. Bradley D. Keck
 Project: Routine Analytical - Keck

Report Date: November 18, 2010

Client Sample ID: LBS5a-101102
 Sample ID: 266305007
 Matrix: Solid
 Collect Date: 02-NOV-10 13:40
 Receive Date: 04-NOV-10
 Collector: Client

Project: ABCL00107
 Client ID: ABCL001

Parameter	Qualifier	Result	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Liquid Scintillation Analysis										
<i>Liquid Seln C14, Solid "As Received"</i>										
Carbon-14		158 +/-3.32	1.74	2.00	pCi/g		EXK2 11/17/10	1800	1649453	1

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA EERF C-01 Modified	

Solid next

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Certificate of Analysis

Company : ABC Laboratories, Inc.
 Address : 7200 East ABC Lane
 Columbia, Missouri 65202
 Contact: Dr. Bradly D. Keck
 Project: Routine Analytical - Keck

Report Date: November 18, 2010

Client Sample ID: LBS4a-101102
 Sample ID: 266303015
 Matrix: Solid
 Collect Date: 02-NOV-10 16:30
 Receive Date: 04-NOV-10
 Collector: Client

Project: ABCL09107
 Client ID: ABCL001

Parameter	Qualifier	Result	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Liquid Scintillation Analysis										
<i>Liquid Scint C14, Solid "As Received"</i>										
Carbon-14		293 +/-5.93	2.27	2.00	pCi/g		EXK2 11/17/10	2222	1049453)

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA EERF C-01 Modified	

Sediment

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Certificate of Analysis

Company:	ABC Laboratories, Inc.	Report Date: November 18, 2010
Address:	7200 East ABC Lane	
	Columbia, Missouri 65202	
Contact:	Dr. Bradley D. Keck	
Project:	Routine Analytical - Keck	
Client Sample ID:	LBS5a-101162	Project: ABCL00107
Sample ID:	26603005	Client ID: ABCL001
Matrix:	Solid	
Collect Date:	02-NOV-10 14:15	
Receive Date:	04-NOV-10	
Collector:	Client	

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Liquid Scintillation Analysis											
<i>Liquid Scint. C14, Solid "As Received"</i>											
Carbon-14		313 +/-6.36	2.24	2.09	pCi/g		EXK2	11/17/10	1912	1049453	1

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA ERF C-01 Modified	

Sediment

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

GEL LABORATORIES LLC

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Certificate of Analysis

Company : ABC Laboratories, Inc
Address : 7200 East ABC Lane

Columbia, Missouri 65202
Contact: Dr. Bradley D. Keck
Project: Routine Analytical - Keck

Client Sample ID: LBS6a-101102
Sample ID: 266303013
Matrix: Solid
Collect Date: 02-NOV-10 15:45
Receive Date: 04-NOV-10
Collector: Client

Report Date: November 18, 2010

Project: ABCL00107
Client ID: ABCL001

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst/Date	Time	Batch	Method
Rad Liquid Scintillation Analysis										
<i>Liquid Scint C14, Solid "As Received"</i>										
Carbon-14		128 +/-2.79	1.76	2.00	pCi/g		EXK2 11/17/10	2100	1049453	1

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EPA EERF C-01 Modified	

Sediment

Site Characterization and Remediation Plan in Support of Decommissioning for
 Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
 Revision 2.0

GEL LABORATORIES LLC

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Certificate of Analysis

Company : ABC Laboratories, Inc.
 Address : 7200 East ABC Lane

Report Date: November 18, 2010

Contact: Columbia, Missouri 65202
 Project: Dr. Bradley D. Keck
 Routine Analytical - Keck

Client Sample ID: LBS7a-101102
 Sample ID: 266303011
 Matrix: Solid
 Collect Date: 02-NOV-10 14:55
 Receive Date: 04-NOV-10
 Collector: Client

Project: ABCL00707
 Client ID: ABCL007

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Liquid Scintillation Analysis											
<i>Liquid Scint C14, Solid "As Received"</i>											
Carbon-14		1560	+/-50.6	4.65	2.00	pCi/g	EKK2	11/17/10	2012	1049453	1

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EPA EERF C-01 Modified	

Sediment

ATTACHMENT 2.2

CARBON-14 CONCENTRATIONS IN CLAY SOIL (0-3") (PCI/G)

Table 2.2 Samples of Clay Soil and Concentrations of carbon-14 in pCi/g.

Sample ID	Concentration of ¹⁴ C (pCi/g)*
LGNOCT2010 0006	15.9
LGNOCT2010 0016	8.62
LGNOCT2010 0018	83.1
LBS1b-101102	9.44
LBS2b-101102	15.0
LBS3b-101102	21.0
LBS4b-101102	10.6
LB5ba-101102	10.6
LBS6b-101102	14.2
LBS1a-101102	8.33
Mean +/- STDEV	19.6 +/- 22.6

*No Significant figures are indicated here; the result is displayed without rounding.

Site Characterization and Remediation Plan in Support of Decommissioning for
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Revision 2.0

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Certificate of Analysis

Company:	ABC Laboratories, Inc.	Report Date: November 3, 2010
Address:	7200 East ABC Lane	
	Columbia, Missouri 65203	
Contact:	Dr. Bradley D. Keck	
Project:	Routine Analytical - Keck	

Client Sample ID: LGNOCT2010_0006	Project: ABCL00107
Sample ID: 265547004	Client ID: ABCL001
Matrix: SoBs	
Collect Date: 25-OCT-10 12:00	
Receive Date: 27-OCT-10	
Collector: Client	

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst/Date	Time	Batch	Method
<i>Rad Liquid Scintillation Analysis</i>										
<i>Liquid Scint C-14, Solid "As Received"</i>										
Carbon-14		15.9	4-1.09	1.24	2.60	pCp/g	EXK2	10/31/10	1403	1042790

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA EEPF C-01 Modified	

Site Characterization and Remediation Plan in Support of Decommissioning for
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Certificate of Analysis

Company :	ABC Laboratories, Inc.	Report Date: November 3, 2010
Address :	7200 Eas: ABC Lane	
	Columbia, Missouri 65202	
Contact:	Dr. Bradley D. Keck	
Project:	Routine Analytical - Keck	

Client Sample ID: LGNOCT2010_0016	Project: ABCL00107
Sample ID: 265547010	Client ID: ABCL001
Matrix: Solid	
Collect Date: 25-OCT-10 12:00	
Receive Date: 27-OCT-10	
Collector: Client	

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Liquid Scintillation Analysis											
<i>Liquid Scint: C14, Solid "As Received"</i>											
Carbon-14		8.62	-/-0.925	1.21	2.60	pCi/g	EXX2	10/31/10	1:54	1042790	

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA EERF C-61 Modified	

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Certificate of Analysis

Company :	ABC Laboratories, Inc.	Report Date: November 3, 2010
Address :	7300 East ABC Lane	
	Columbia, Missouri 65202	
Contact:	Dr. Brady D. Keck	
Project:	Routine Analytical - Keck	
Client Sample ID:	LGNOC2010_0018	Project: ABCL00107
Sample ID:	265547012	Client ID: ABCL001
Matrix:	Solid	
Collect Date:	25-OCT-10 12:00	
Receive Date:	27-OCT-10	
Collector:	Client	

Parameter	Qualifier	Result	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Liquid Scintillation Analysis										
<i>Liquid Scint C14, Solid "As Received"</i>										
Carbon-14		83.1	+/-2.00	1.22	2.00	pCi/g	EXK2 10/31/10	1646	1042790	i

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA EERF C-01 Modified	

Site Characterization and Remediation Plan in Support of Decommissioning for
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Certificate of Analysis

Company:	ABC Laboratories, Inc.	Report Date: November 15, 2010
Address:	7200 East ABC Lane	
	Columbia, Missouri 65202	
Contact:	Dr. Bradley D. Keck	
Project:	Routine Analytical - Keck	

Client Sample ID: LBCH-101102	Project: ABCL00107
Sample ID: 266303004	Client ID: ABCL001
Matrix: Solid	
Collect Date: 02-NOV-10 11:10	
Receive Date: 04-NOV-10	
Collector: Client	

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Liquid Scintillation Analysis											
<i>Liquid Scint C14, Solid "As Received"</i>											
Carbon-14		9.44	1.70	2.00	pCi/g	EXX2	11/17/10	1625	1049453		1

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA HERF C-01 Modified	

Soil

Site Characterization and Remediation Plan in Support of Decommissioning for
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 Revision 2.0

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Certificate of Analysis

Company :	ABC Laboratories, Inc.	Report Date: November 18, 2010
Address :	7200 East ABC Lane	
	Columbia, Missouri 65202	
Contact:	Dr. Bradley D. Keck	
Project:	Routine Analytical - Keck	

Client Sample ID:	LBC2b-101102	Project:	ABCL00107
Sample ID:	266303006	Client ID:	ABCL001
Matrix:	Solid		
Collect Date:	02-NOV-10 12:45		
Receive Date:	04-NOV-10		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Liquid Scintillation Analysis										
<i>Liquid Scint C14, Solid "As Received"</i>										
Carbon-14		15.0	1.29	1.57	2.00	pCVg	EXX2	11/17/10	1718	1048453

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA EFRF C-01 Modified	

Clay

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

GEL LABORATORIES LLC

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Certificate of Analysis

Company :	ABC Laboratories, Inc.	Report Date: November 18, 2010
Address :	7200 East ABC Lane	
	Columbia, Missouri 65202	
Contact:	Dr. Bradly D. Keck	
Project:	Routine Analytical - Keck	

Client Sample ID: LBC5b-101102	Project: ABCL00107
Sample ID: 266303008	Client ID: ABCL001
Matrix: Solid	
Collect Date: 02-NOV-10 13:45	
Receive Date: 04-NOV-10	
Collector: Client	

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Liquid Scintillation Analysis											
<i>Liquid Scint C14, Solid "As Received"</i>											
Carbon-14		21.0 +/-1.44	1.73	2.00	pCi/g		EXX2	11/17/10	1851	1049453	1

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA EERP C-01 Modified	

clay

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

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Certificate of Analysis

Company:	ABC Laboratories, Inc.	Report Date: November 18, 2010
Address:	7200 East ABC Lane	
	Columbia, Missouri 65202	
Contact:	Dr. Brady D. Keck	
Project:	Routine Analytical - Keck	

Client Sample ID: LBC4b-101102	Project: ABCL00107
Sample ID: 266303016	Client ID: ABCL001
Matrix: Solid	
Collect Date: 02-NOV-10 16:35	
Receive Date: 04-NOV-10	
Collector: Clicut	

Parameter	Qualifier	Result	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Liquid Scintillation Analysis										
<i>Liquid Scint C14, Solid "As Received"</i>										
Carbon-14		10.6	+/-1.20	1.65	2.00	pC/g	EXK2 11/17/10 2242	1049453		1

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA EERF C-01 Modified	

clay

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Company : ABC Laboratories, Inc. Report Date: November 18, 2010
Address : 7209 East ABC Lane

Contact: Columbia, Missouri 65202
Project: Dr. Bradley D. Keck
Routine Analytical - Keck

Client Sample ID: LBC55-101102	Project: ABCL00107
Sample ID: 266303010	Client ID: ABCL001
Matrix: Solid	
Collect Date: 02-NOV-10 14:20	
Receive Date: 04-NOV-10	
Collector: Client	

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Liquid Scintillation Analysis											
<i>Liquid Scint C14, Solid "As Received"</i>											
Carbon-14		10.6	+/-1.27	1.78	2.00	pCi/g	EXX2	11/17/10	1931	10-9453	1

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA EERF C-01 Modified	

Clay

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

GEL LABORATORIES LLC

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Certificate of Analysis

Company:	ABC Laboratories, Inc.	Report Date: November 12, 2010
Address:	7200 East ABC Lane	
Columbia, Missouri 65202		
Contact:	Dr. Bradley D. Keck	
Project:	Routine Analytical - Keck	
Client Sample ID:	L3C5b-107102	Project: ABCL00107
Sample ID:	266303014	Client ID: ABCL001
Matrix:	Solid	
Collect Date:	02-NOV-10 15:50	
Receive Date:	04-NOV-10	
Collector:	Client	

Parameter	Qualifier	Result	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
<i>Rad Liquid Scintillation Analysis</i>										
<i>Liquid Scint C14, Solid "As Received"</i>										
Carbon-14		14.2	+/-1.31	1.73	2.30	pCi/g	EXK2 11/17/10	2140	1049453	1

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA EERF C-01 Modified	

Clay

Site Characterization and Remediation Plan in Support of Decommissioning for
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Revision 2.0

GEL LABORATORIES LLC

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Certificate of Analysis

Company :	ABC Laboratories, Inc.	Report Date: November 18, 2010
Address :	7200 East ABC Lane	
	Columbia, Missouri 65202	
Contact:	Dr. Bradley D. Keck	
Project:	Routine Analytical - Keck	

Client Sample ID: LBS75-101102	Project: ABCL00107
Sample ID: 266303012	Client ID: ABCL001
Matrix: Solid	
Collect Date: 02-NOV-10 15:00	
Receive Date: 04-NOV-10	
Collector: Client	

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
<i>Rad Liquid Scintillation Analysis</i>											
<i>Liquid Scint C14 Solid "As Received"</i>											
Carbon-14		R33 47-1.11	1.58	3.00	pCi/g		EKK2	11/17/10	2617	1043453	1

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EPA EERP C-01 Modified	

Chy

ATTCHMENT 2.3

CARBON-14 CONCENTRATIONS IN SIDEWALL COMPOSITE SOIL (PCI/G)

Table 2.3 Samples of Sidewall Soil and Concentrations of carbon-14 in pCi/g.

Sample ID	Concentration of ¹⁴ C (pCi/g)*
LSW8a-101101	38.6
LSW9a-101101	108
LSW10a-101101	121
LSW11a-101101	128
Mean +/- STDEV	98.9 +/- 41

*No Significant figures are indicated here; the result is displayed without rounding.

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Revision 2.0

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Certificate of Analysis

Company:	ABC Laboratories, Inc.	Report Date: November 18, 2010
Address:	7200 East ABC Lane	
	Columbia, Missouri 65202	
Contact:	Dr. Bradley D. Keck	
Project:	Routine Analytical - Keck	
Client Sample ID:	LSW8a-101101	Project: ABCL00107
Sample ID:	266303017	Client ID: ABCL001
Matrix:	Solid	
Collect Date:	01-NOV-10 16:50	
Receive Date:	04-NOV-10	
Collector:	Client	

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Liquid Scintillation Analysis											
<i>Liquid Semi C14, Solid "As Received"</i>											
Carbon-14		38.6	+A1.72	1.73	2.00	Bq/g	EXK2	11/17/10	2324	1049453	

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA EERF C-01 Modified	

*Sidewalk 0-6"
Sediment*

Site Characterization and Remediation Plan in Support of Decommissioning for
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Revision 2.0

GEL LABORATORIES LLC

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Certificate of Analysis

Company:	ABC Laboratories, Inc.	Report Date: November 16, 2010
Address:	7200 East ABC Lane	
	Columbia, Missouri 65202	
Contact:	Dr. Brady D. Keck	
Project:	Routine Analytical - Keck	

Client Sample ID: LSW9a-101101	Project: ABCL00107
Sample ID: 266303019	Client ID: ABCL001
Matrix: Solid	
Collect Date: 01-NOV-10 17:10	
Receive Date: 04-NOV-10	
Collector: Client	

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Liquid Scintillation Analysis											
<i>Liquid Scint C14 Solid "As Received"</i>											
Carbon 14		108	-/-2.44	1.62	2.06	pCi/g	EXK2	11/14/10	0:120	1049453	1

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA EERF C-01 Modified	

*Sidewalk 0-6"
Soils next*

Site Characterization and Remediation Plan in Support of Decommissioning for
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Revision 2.0

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Certificate of Analysis

Company:	ABC Laboratories, Inc.	Report Date: November 18, 2010
Address:	7200 East ABC Lane	
	Columbia, Missouri 65202	
Contact:	Dr. Bradley D. Keck	
Project:	Routine Analytical - Keck	
Client Sample ID:	LSW10a-101101	Project: ABCL00107
Sample ID:	266303021	Client ID: ABCL001
Matrix:	Solid	
Collect Date:	02-NOV-10 17:45	
Receive Date:	04-NOV-10	
Collector:	Client	

Parameter	Qualifier	Result	DL	RL	Units	DF	Analyst/Date	Time	Batch	Method
Rad Liquid Scintillation Analysis										
<i>Liquid Scint. C14, Solid "As Received"</i>										
Carbon-14		121	+/-2.64	1.67	2.00	pCi/g	EXK2	11/18/10	0203	1049453 1

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA EERF C-01 Modified	

Sidwell 0-611
Sidwell

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 555-8171 - www.gel.com

Certificate of Analysis

Company: ABC Laboratories, Inc. Report Date: November 18, 2010
Address: 7200 East AEC Lane

Contact: Columbia, Missouri 65262
Project: Dr. Bradly D. Keck
Routine Analytical - Keck

Client Sample ID:	LSW11a-101101	Project:	ABCL00107
Sample ID:	266303001	Client ID:	ABCL001
Matrix:	Solid		
Collect Date:	01-NOV-10 18:10		
Receive Date:	04-NOV-10		
Collector:	Client		

Parameter	Qualifier	Result	DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Liquid Scintillation Analysis										
<i>Liquid Scint C14, Solid "As Received"</i>										
Carbon-14		128	-2.82	1.86	2.00	pC/g	EXK2	1/18/10	1150	1049453

The following Analytical Methods were performed

Method	Description	Analyst Comments
	EPA 8090 C-01 Modified	

Sediment

ATTACHMENT 2.4

CARBON-14 CONCENTRATIONS IN APPLICATION AREA SOIL (PCI/G)

Table 2.4 Samples of Application Area Soil and Concentrations of carbon-14 in pCi/g.

Sample ID	Concentration of ¹⁴ C (pCi/g)*
ABC-FA-QC06-6	5.62
ABC-FA-QC06-24	36.7
ABC-FA-QC06-28	1.41
ABC-FA-QC618-10	NR**
ABC-FA-QC618-11	NR
Mean +/- STDEV	<9.5***

*No Significant figures are indicated here; the result is displayed without rounding.

**NR = not reportable due to method quantitation limits

*** Mean computed using method reporting limit of 2 as a concentration.

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GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Company: ABC Laboratories, Inc.
Address: 7200 East ABC Lane
Columbia, Missouri 65202

Contact: Sheila Hecht
Project: Routine Analytical - Hecht

Report Date: November 1, 2007

Client Sample ID:	ABC-FA-OC06-6	Project:	ABCL00107
Sample ID:	195047006	Client ID:	ABCL001
Matrix:	Solid		
Collect Date:	19-SEP-07 15:00		
Receive Date:	04-OCT-07		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis												
<i>Gamma spec, Gamma, Solid (Standard List)</i>												
Potassium-40		13.0	+/-2.33	1.22	1.00	pCi/g		MJH1	10/27/07	0906	690323	1
Rad Liquid Scintillation Analysis												
<i>LSC, Tritium Dist, Solid</i>												
Tritium	U	6.555	+/-1.87	3.33	6.00	pCi/g		BXF1	10/30/07	1052	691743	1
<i>Liquid Scint C14, Solid</i>												
Carbon-14		5.62	+/-1.10	1.56	2.00	pCi/g		BXF1	10/23/07	2315	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXF1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

Site Characterization and Remediation Plan in Support of Decommissioning for
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Certificate of Analysis

Company : ABC Laboratories, Inc.
Address : 7200 East ABC Lane
Columbia, Missouri 65202

Report Date: November 1, 2007

Contact: Sheila Hecht
Project: Routine Analytical - Hecht

Client Sample ID:	ABC-FA-OC06-24	Project:	ABCL00107
Sample ID:	195047009	Client ID:	ABCL001
Matrix:	Solid		
Collect Date:	20-SEP-07 09:00		
Receive Date:	04-OCT-07		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spect Analysis												
<i>GammaSpec, Gamma, Solid (Standard List)</i>												
Potassium-40		17.7	+/-2.25	0.955	1.00	pC/g		MJH	10/26/07	1632	690323	1
Rad Liquid Scintillation Analysis												
<i>LSC, Tritium Dist. Solid</i>												
Tritium	U	1.38	+/-2.40	4.15	6.00	pCi/g		BXF	10/30/07	1142	691743	2
<i>Liquid Scint C14, Solid</i>												
Carbon-14		36.7	+/-1.81	1.48	2.00	pC/g		BXF	10/24/07	0635	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXF	10/27/07	1724	690675

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.G Modified	
3	EPA EERF C-01 Modified	

Site Characterization and Remediation Plan in Support of Decommissioning for
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Revision 2.0

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Certificate of Analysis

Company: ABC Laboratories, Inc.
Address: 7200 East ABC Lane
Columbia, Missouri 65202

Report Date: November 1, 2007

Contact: Sheila Hecht
Project: Routine Analytical - Hecht

Client Sample ID:	ABC-FA-OC06-28	Project:	ABCL00107
Sample ID:	195047010	Client ID:	ABCL001
Matrix:	Solid		
Collect Date:	20-SEP-07 09:00		
Receive Date:	04-OCT-07		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis												
<i>Gamma Spec, Gamma, Solid (Standard List)</i>												
Potassium-40		13.2	±2.34	1.10	1.00	pCi/g		MJH1	10/26/07	1633	680323	1
Rad Liquid Scintillation Analysis												
<i>LSC, Tritium Dist, Solid</i>												
Tritium	U	0.405	±1.208	3.74	6.00	pCi/g		BXF1	10/30/07	1158	691742	2
<i>Liquid Scint C14, Solid</i>												
Carbon-14	U	1.4	±0.916	1.50	2.05	pCi/g		BXF1	10/24/07	0021	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXF1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300.4.5.2.3	
2	EPA 906.0 Modified	
3	EPA 808.0-01 Modified	

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Revision 2.0

GEL LABORATORIES LLC

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Certificate of Analysis

Company: ABC Laboratories, Inc.
Address: 7200 East ABC Lane
Columbia, Missouri 65207

Contact: Sheila Hecht
Project: Routine Analytical - Hecht

Report Date: November 1, 2007

Client Sample ID: ABC-FA-OC618-10 Project: ABCL00107
Sample ID: 19S047008 Client ID: ABCL001
Matrix: Solid
Collect Date: 19-SEP-07 17:15
Receive Date: 04-OCT-07
Collector: Client

Parameter	Qualifier	Result	Uncertainty	DL	RI	Units	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis												
<i>GammaSpec, Gamma, Solid (Standard List)</i>												
Potassium-40		11.6	+/-1.78	0.880	1.00	pCi/g		MUH	10/26/07	1630	690323	1
Rad Liquid Scintillation Analysis												
<i>LSC, Tritium Dist, Solid</i>												
Tritium	U	0.752	+/-1.93	3.41	6.00	pCi/g		BXF1	10/30/07	1123	691743	2
<i>Liquid Scint C14, Solid</i>												
Carbon-14	U	-0.387	+/-0.740	1.32	2.00	pCi/g		BXF1	10/25/07	2348	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

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Certificate of Analysis

Company: ABC Laboratories, Inc.
Address: 7200 East ABC Lane
Columbia, Missouri 65202

Contact: Sheila Hecht
Project: Routine Analytical - Hecht

Report Date: November 1, 2007

Client Sample ID:	ABC-FA-QC618-11	Project:	ABCL00107
Sample ID:	195047097	Client ID:	ABCL001
Matrix:	Solid		
Collect Date:	19-SEP-07 17:15		
Receive Date:	04-OCT-07		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis												
<i>GammaSpec, Gamma, Solid (Standard List)</i>												
Potassium-40		8.24	+/-1.85	1.17	1.00	pCi/g		MJH	10/27/07	1111	690323	1
Rad Liquid Scintillation Analysis												
<i>LSC, Tritium Diss, Solid</i>												
Tritium	U	-0.501	+/-1.88	3.54	6.00	pCi/g		BXF1	10/30/07	1108	691743	2
<i>Liquid Scint C14, Solid</i>												
Carbon-14	U	0.484	+/-0.893	1.52	2.00	pCi/g		BXF1	10/23/07	2331	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

ATTACHMENT 2.5

CARBON-14 CONCENTRATIONS IN DRAIN FIELD SOIL (PCI/G)

Table 2.5 Samples of Drain Field Soil and Concentrations of carbon-14 in pCi/g.

Sample ID	Concentration of ¹⁴ C (pCi/g)*
ABC-DF-QC06-003	4.43
ABC-DF-QC06-13	13.2
ABC-DF-QC06-17	10.0
ABC-DF-QC06-25	4.59
ABC-DF-QC06-28	2.96
Mean +/- STDEV	7.04 +/- 4.36

*No Significant figures are indicated here; the result is displayed without rounding.

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

GEL LABORATORIES LLC

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Certificate of Analysis

Company: ABC Laboratories, Inc.
Address: 7200 East ABC Lane
Columbia, Missouri 65202

Report Date: November 1, 2007

Contact: Sheila Hecht
Project: Routine Analytical - Hecht

Client Sample ID:	ABC-DF-OC05-003	Project:	ABCL00107
Sample ID:	195047019	Client ID:	ABCL001
Matrix:	Solid		
Collect Date:	18-SEP-07 17:00		
Receive Date:	04-OCT-07		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis												
<i>GammaSpec, Gamma, Solid (Standard List)</i>												
Potassium-40		11.8	+/-2.76	1.24	1.00	pCi/g		MJH	10/29/07	1046	690323	1
Rad Liquid Scintillation Analysis												
<i>LSC, Tritium Dist. Solid</i>												
Tritium	U	-1.42	+/-1.84	3.62	6.00	pCi/g		BXF1	10/30/07	1429	691743	2
<i>Liquid Scint C14, Solid</i>												
Carbon-14		4.43	+/-1.00	1.46	2.00	pCi/g		BXF1	10/24/07	0252	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

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Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Company: ABC Laboratories, Inc.
Address: 7700 East ABC Lane
Columbia, Missouri 65202

Contact: Sheila Hecht
Project: Routine Analytical - Hecht

Report Date: November 1, 2007

Client Sample ID:	ABC-DF-OC06-13	Project:	ABCL00107
Sample ID:	195047015	Client ID:	ABCL001
Matrix:	Solid		
Collect Date:	19-SEP-07 11:30		
Receive Date:	04-OCT-07		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis												
<i>GammaSpec, Gamma, Solid (Standard Liv)</i>												
Potassium-40		9.29	+/-1.72	0.855	1.00	pCi/g	MHI1	10/26/07	1638	690323		1
Rad Liquid Scintillation Analysis												
<i>LSC, Tritium Dist, Solid</i>												
Tritium	U	0.660	+/-1.94	3.44	6.00	pCi/g	BXF1	10/30/07	1322	691743		2
<i>Liquid Scint C14, Solid</i>												
Carbon-14		13.2	+/-1.28	1.49	2.00	pCi/g	BXF1	10/24/07	0145	690715		3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERFC-01 Modified	

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Revision 2.0

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Company : ABC Laboratories, Inc.
Address : 7200 East ABC Lane
Columbia, Missouri 65202

Contact: Sheila Hecht
Project: Routine Analytical - Hecht

Report Date: November 1, 2007

Client Sample ID:	ABC-DF-OC06-17	Project:	ABCL00107
Sample ID:	195047018	Client ID:	ABCL001
Matrix:	Solid		
Collect Date:	19-SEP-07 11:30		
Receive Date:	04-OCT-07		
Collector:	Client		

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis												
<i>GammaSpec, Gamma, Solid (Standard List)</i>												
Potassium-40		13.8	+/-2.07	0.855	1.00	pCvg		MJH	10/26/07	1647	690323	1
Rad Liquid Scintillation Analysis												
<i>LSC, Tritium Dist, Solid</i>												
Tritium	U	0.575	+/-1.94	3.45	6.00	pCvg		BXF1	10/30/07	1412	691743	2
<i>Liquid Scint C14, Solid</i>												
Carbon-14		10.0	+/-1.20	1.49	2.00	pCvg		BXF1	10/24/07	0235	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 303, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Company : ABC Laboratories, Inc.
Address : 7200 East ABC Lane
Columbia, Missouri 65202

Contact: Sheila Hecht
Project: Routine Analytical - Hecht

Report Date: November 1, 2007

Client Sample ID: ABC-DF-OC06-25 Project: ABCL00107
Sample ID: 195047017 Client ID: ABCL001
Matrix: Solid
Collect Date: 19-SEP-07 11:30
Receive Date: 04-OCT-07
Collector: Client

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis												
<i>GammaSpec, Gamma, Solid (Standard List)</i>												
Potassium-40		12.9	+/-2.01	0.765	1.00	pCi/g		MJH	10/26/07	1646	690323	1
Rad Liquid Scintillation Analysis												
<i>LSC, Tritium Dist, Solid</i>												
Tritium	U	0.380	+/-1.95	3.51	6.00	pCi/g		BXF	10/30/07	1355	691743	2
<i>Liquid Scint C14, Solid</i>												
Carbon-14		4.59	+/-1.11	1.63	2.00	pCi/g		BXFI	10/24/07	0218	690715	3

The following Prep Methods were performed

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ1	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EML HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

GEL LABORATORIES LLC

2040 Savage Road Charleston, SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Company: ABC Laboratories, Inc.
Address: 7200 East ABC Lane
Columbia, Missouri 65202

Contact: Sheila Hecht
Project: Routine Analytical - Hecht

Report Date: November 1, 2007

Client Sample ID: ABC-DF-QC06-28 Project: ABCL00107
Sample ID: 195047016 Client ID: ABCL001
Matrix: Solid
Collect Date: 19-SEP-07 14:00
Receive Date: 04-OCT-07
Collector: Client

Parameter	Qualifier	Result	Uncertainty	DL	RL	Units	DF	Analyst/Date	Time	Batch	Method
Rad Gamma Spec Analysis											
<i>GammaSpec, Gamma, Solid (Standard List)</i>											
Potassium-40		15.2	+/-2.26	0.652	1.00	pCi/g		M1H: 10/26/07	1640	690323	1
Rad Liquid Scintillation Analysis											
<i>LSC, Tritium Dis, Solid</i>											
Tritium	U	1.28	+/-2.08	3.58	6.00	pCi/g		BXF: 10/30/07	1339	691743	2
<i>Liquid Scint C14, Solid</i>											
Carbon-14		2.96	+/-0.976	1.50	2.00	pCi/g		BXF: 10/24/07	0202	690715	3

The following Prep Methods were performed

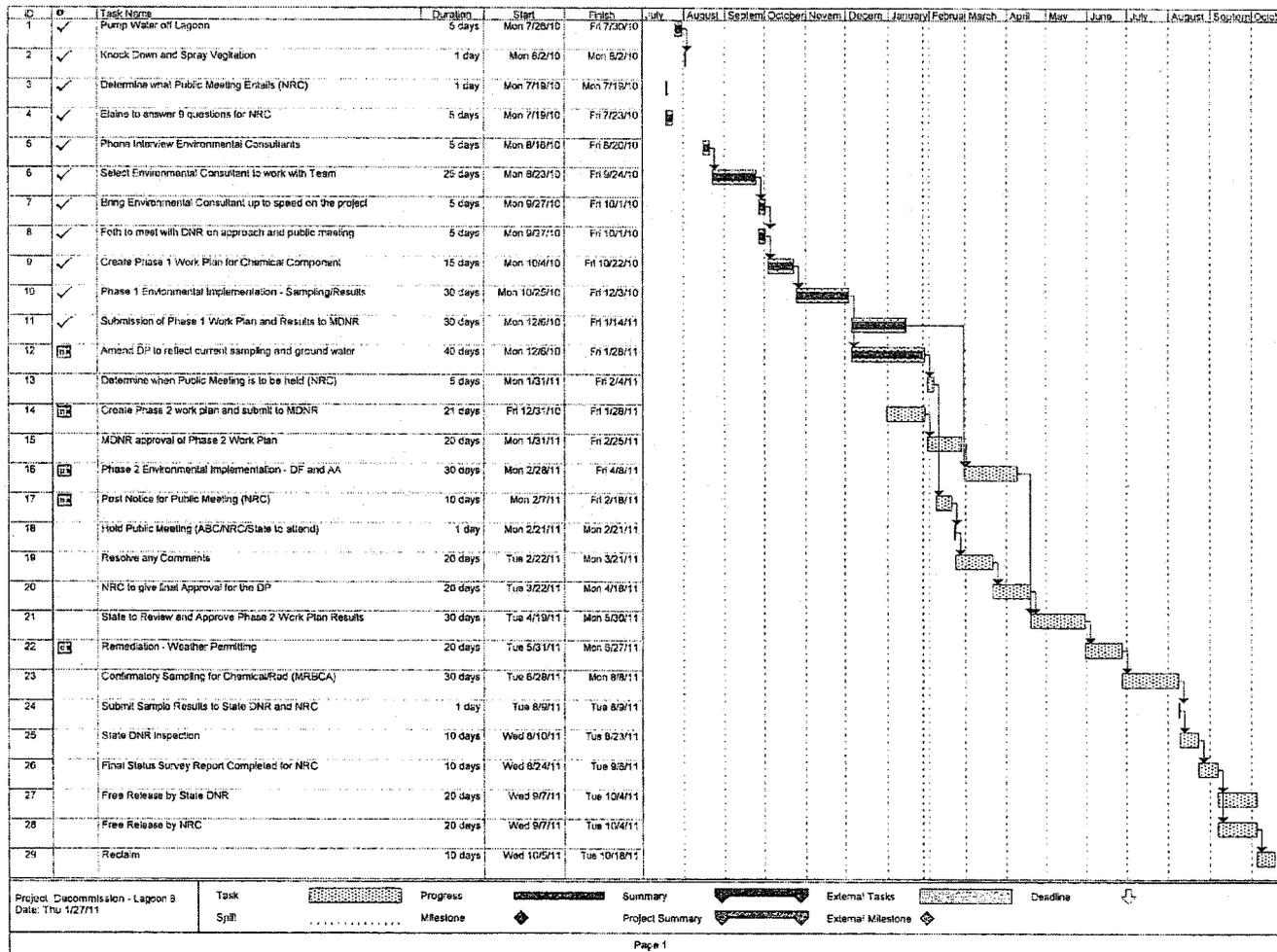
Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	BXJ	10/22/07	1724	690075

The following Analytical Methods were performed

Method	Description	Analyst Comments
1	EMU HASL 300, 4.5.2.3	
2	EPA 906.0 Modified	
3	EPA EERF C-01 Modified	

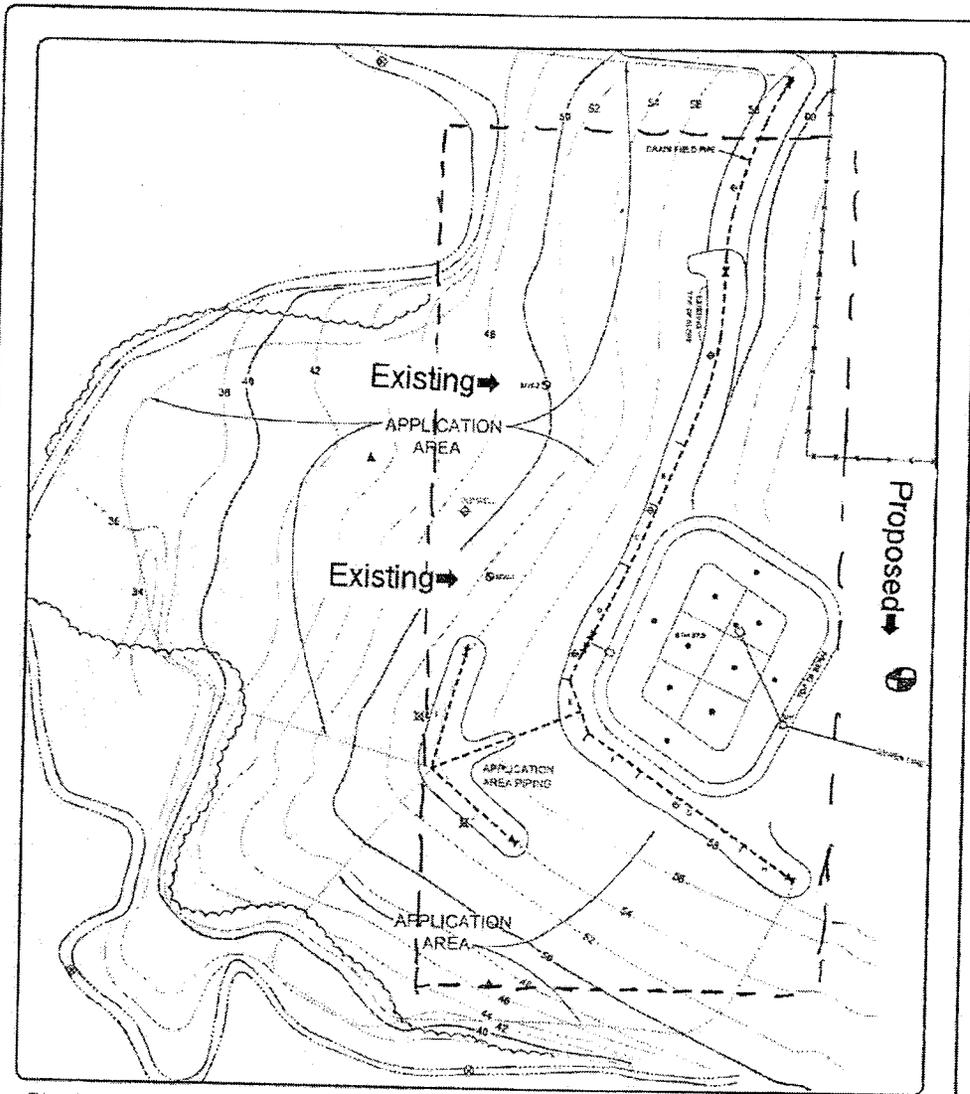
Site Characterization and Remediation Plan in Support of Decommissioning for
Analytical Bio-Chemistry Laboratories Sanitary Lagoon, Application Area and Drain Field
Revision 2.0

ATTACHMENT 3
PROJECT TIMELINE



ATTACHMENT 4.2

AREA OF INTEREST



This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. This drawing is a compilation of records, information and data used for reference purposes only.

LEGEND	
	Proposed Sediment Creek Samples
	Proposed Downslope Samples
	Proposed Application Piping Samples
	Proposed Lagoon Sample Location
	Proposed Drain Field Pipe Sample Location
	Gate Valve (47)

NOTE: Letters = Piping Section



ANALYTICAL BIO-CHEMISTRY LABORATORIES	
SAMPLE LOCATION MAP 7200 EAST ABC LANE COLUMBIA, MISSOURI	
SCALE 0 50 100	PROJECT ID: 0010A034.00
DATE: 10/20/2010	
PREPARED BY: ADM	FOOTH Infrastructure & Environment, LLC
CHECKED BY: SLP	FIGURE NO. 3

modified 11/22/10 - SDX

ATTACHMENT 5

RESUMES

February 2010

CURRICULUM VITAE

NAME: G. Scott Ward

TITLE: Senior Vice President & General Manager, Chemical Services

EDUCATION: University of West Florida, Pensacola, Florida 1975-1980
Completed course work for M.S.

Texas A&M University, College Station, Texas 1975 B.S., Biology

PROFESSIONAL MEMBERSHIP(S):
Soc. For Human Resource Management (SHRM) 2005 to present

SUMMARY OF PERTINENT EXPERIENCE:

ABC LABORATORIES, INC.

Senior Vice-President & General Manager, Chemical Services, January 2008 to Present

Mr. Ward has overall authority for the Chemical Services operations (two laboratory sites: ABC Laboratories in Columbia, MO, and Morse Laboratories in Sacramento, CA) including technical operations, finances, business development, and quality assurance. Mr. Ward is responsible for leading and directing the implementation of business strategy including the identification of strategic acquisitions.

Senior Vice-President & Chief Administrative Officer, May 2006 to January 2008

Responsibilities include management of facilities, human resources (including training and development), contracting, Environmental, Health & Safety (including radiation safety), and administration groups, as well as legal and governmental affairs.

Vice-President of Administration, March 2005 to May 2006

Responsibilities included management of facilities, human resources, centralized project planning and document control groups, legal, and governmental affairs.

Vice-President Relationship Mgmt. & Process Improvement, December 2003-March 2005

Established a team of Relationship Managers (experienced technical and sales individuals whom served as client liaisons for existing clients), trained in relationship management procedures, and managed team efforts. Also served as project leader in the development of new business processes for the organization including: a uniform cost and pricing model for operations and sales use, and business processes and procedures for sales, operations, and accounting. These processes included implementation of a company wide data base to track sales quotations and leads; development of a system for forecasting revenues based upon backlog, outstanding quotations, and leads; and a process for invoicing and revenue recognition.

Vice-President/Director Chemical Development Group, October 2000 – December 2003

Mr. Ward has overall managerial responsibility for the Chemical Development Group and all services offered which include product chemistry, environmental fate, ecotoxicity testing, microbiology, residue analysis, and plant sciences/field research. His responsibilities include management support for studies, attainment of unit financial goals, and business development. Mr. Ward also serves as a Program Manager within the Chemical Development Group. The role of the Program Manager is to ensure uniformity of all reports to client style and specifications, adherence to agreed project time lines, and to provide the sponsor with a single point of contact within ABC Laboratories, for obtaining program updates, quotations, and general information.

Vice-President/Director, E-Fate & Effects Division, December 1998-October 2000

Mr. Ward had managerial responsibility for product chemistry, environmental fate and ecotoxicity testing services offered by ABC Laboratories. These responsibilities included: technical and management support for studies, attainment of unit financial goals, and business development. Mr. Ward also serves as a Program Manager, coordinating and monitoring the progress of all environmental studies contracted by a sponsor.

Director, Environmental Toxicology Division, January 1998 - November 1998

As the Director of the Environmental Toxicology Division, Mr. Ward had managerial responsibility for environmental toxicity testing services offered by ABC Laboratories. These responsibilities included: technical and management support to projects, attainment of unit financial goals, and business development. As a technical manager, Mr. Ward served both as a Study Director/Principal Investigator on selected projects and as a Program Manager for large client programs.

TOXIKON ENVIRONMENTAL SCIENCES

Director, September 1995 - December 1997

Mr. Ward was the Director for Toxikon Environmental Sciences in Jupiter, Florida, and reported directly to the president of Toxikon Corporation. In this role, he directed the daily activities in aquatic and terrestrial toxicity testing, aquatic and terrestrial field studies, and analytical services (including toxicology study support, product chemistry, environmental fate, and residue). Mr. Ward provided technical and managerial support for all projects. Mr. Ward worked closely with the Manager of Corporate Operations and the QA Unit to insure that Good Laboratory Practices were fully implemented and followed and in obtaining and maintaining required business and regulatory licenses and registrations for work conducted at Toxikon Environmental Sciences. Mr. Ward was responsible for all aspects of the business including finances and marketing.

Operations Manager, September 1993 - September 1995

In this role, Mr. Ward managed the daily activities in aquatic and terrestrial toxicity testing, aquatic and terrestrial field studies, and analytical services. Mr. Ward also provided technical and managerial support and served as a Study Director on selected projects. In addition, Mr. Ward conducted reviews of ecotoxicological studies, performed ecological risk assessments, and developed new test procedures.

Laboratory Manager, August 1989 - September 1993

In his position as Laboratory Manager, Mr. Ward provided technical and managerial support for all laboratory aquatic toxicity and environmental fate studies. He also served as a Study Director for special aquatic toxicity testing projects. He performed technical and editorial reviews of most laboratory studies. Mr. Ward worked closely with the Technical Director and QA Manager to insure that appropriately educated and trained staff were available to conduct laboratory and field studies and that the facilities were properly equipped to carry out these studies.

In addition to his laboratory management duties, Mr. Ward assisted in performing terrestrial field studies, provided technical direction for terrestrial plant toxicity studies, developed new aquatic testing and organism culture procedures, reviewed ecotoxicological studies, and conducted aquatic ecological risk assessments.

HUNTER/ENVIRONMENTAL SCIENCES & ENGINEERING

Manager, Aquatic Toxicology Dept./Sr. Staff Scientist, January 1985-August 1989

Mr. Ward was the Manager of the Hunter/ESE's Aquatic Toxicology Laboratory. He supervised all departmental personnel and was responsible for the overall quality of toxicity testing services. His responsibilities included all financial operations of the department, development of all

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department marketing literature, marketing calls, and preparation of proposals. Mr. Ward also served as Project Manager/Study Director for many toxicity studies, including freshwater and saltwater organism tests of effluents, pure compounds, sediments, drilling fluids and leachates. Mr. Ward also supervised all aquaculture operations for the department. Special activities included the following items:

Prepared and presented a 3-day workshop on pesticide toxicity testing to EPA's Office of Pesticide Programs (OPP) in June 1988.

Prepared and presented a 5-day workshop on effluent testing procedures to City of Detroit wastewater treatment plant personnel.

Served as an expert witness in a lawsuit which resulted from an alleged contamination of a tropical fish farm by an adjacent landfill.

Managed a risk assessment on a pesticide for human and aquatic effects. The risk assessment was conducted because of the link between a fish kill in a river in Jacksonville, Florida to the release of pesticide-contaminated runoff water from a sod farm.

Asst. Mgr., Aquatic Toxicology Dept./Staff Scientist , July 1985 - March 1986

Mr. Ward supervised technical operations in the department and was responsible for developing new services. He was also responsible for training of department staff in acceptable toxicity testing procedures under NPDES, TSCA, and FIFRA. He served as Project Manager/Study Director on numerous aquatic toxicity testing studies, principally pesticide registration tests with saltwater organisms. Tests included both acute and chronic studies conducted under static and flow-through conditions.

Staff Scientist, January 1985 - July 1985

Mr. Ward was responsible for developing the Quality Assurance Plan for the Bioassay Department and implementation of all aspects of the plan. He also was responsible for developing pure chemical testing capabilities at ESE and marketing of FIFRA and TSCA testing. He served as Project Manager/Study Director on some effluent testing studies and most pure compound tests.

EG&G/SPRINGBORN BIONOMICS MARINE RESEARCH LABORATORY

Biologist III, January 1983- January 1985

Supervised all biological testing and field studies. Testing included fish and invertebrate acutes and chronics, as well as freshwater and saltwater algal acute studies. Prepared reports and

responsible for proposals and cost estimates to clients. Responsible for all communications with clients on studies and financial aspects of the studies.

Served as consultant to University of Guam personnel on methods and quality assurance in effluent toxicity testing during February 1981.

Biologist II, July 1978 - December 1982

Supervised acute and chronic toxicity tests, bioaccumulation studies, dredged material testing, estuarine community studies, biological monitoring, and baseline surveys. Responsible for invertebrate taxonomic identifications in all community, monitoring, and baseline studies. Performed statistical analyses of test results and prepared reports. Assisted in preparation of proposals.

Participated in National Response Team (NRT) Scientific Response Oil Spill Workshop in 1978 in Tampa, Florida.

Biologist I, June 1975 - June 1978

Collected and maintained saltwater invertebrates and fishes. Designed, constructed, and used exposure systems for toxicity testing. Conducted invertebrate and fish static and chronic tests. Also conducted bioaccumulation studies.

TEXAS A&M UNIVERSITY, DEPT. OF BIOLOGY

Laboratory Technician, July 1972- May 1975

As a part-time laboratory technician, Mr. Ward aided in research projects dealing with environmental pollutants (mainly oil) and their effects on estuarine and marine organisms. The studies involved animal respiration, ionic and osmotic regulation, uptake and depuration of certain oil fractions, behavior, reproduction and development of polychaetes and fish.

PUBLICATIONS AND PRESENTATIONS:

Zillioix, E., I.C. Johnson, Y. Kiparissis, C.D. Metcalfe, J.V. Wheat, G. S Ward, and H. Liu. 2001. The Sheepshead Minnow as, an *In Vivo* Model for Endocrine Disruption in Marine Telosts: A Partial Life-Cycle Test with 17 %-Ethinylestradiol. *Environmental Toxicology and Chemistry*. 20 (9): 1968-1978.

Zillioix, E., I. Johnson, Y. Kiparissis, C. Metcalfe, J. Wheat, S. Ward, and H. Liu. 1997. An Estuarine Fish Model for Assessing Threshold Estrogenic Effects. Presented at the SETAC Annual Meeting, San Francisco, CA, November 16-20, 1997.

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Johnson, I., Y. Kiparissis, C. Metcalfe, G. Balch, S. Ward, J. Wheat and T. Potter. 1997. Partial Life-Cycle Studies Using the Estuarine Fish Sheepshead Minnow to Evaluate the Potential Reproductive and Estrogenic Effects of a Nonylphenol Ethoxylate Surfactant. Presented at the SETAC Annual Meeting, San Francisco, CA, November 16-20, 1997.

Trimm, D., G.S. Ward and B.A. Vittor. 1997. Ecological Risk Assessment of an Estuarine Site in Pensacola Bay, Florida. Presented at the SETAC Annual Meeting, San Francisco, CA, November 16-20, 1997.

Clark, J., S. Artz, S. Ward, F. Cunningham, and K. Eyler. 1996. Water Effect Ratios From Parallel Laboratory/Outdoor Acute Aquatic Toxicity Studies. Presented at the 17th Annual Meeting of the Society of Environmental Toxicology and Chemistry, November 19, 1996.

Ward, G.S. 1995. Chapter 3, Saltwater Toxicity Tests. In FUNDAMENTALS OF AQUATIC TOXICOLOGY (Second Edition), Gary M. Rand, Ed., 1125 pp.

Ward G.S. 1994. FDA Environmental Effects Tests - A Review. Presented at Toxikon Environmental Sciences' FDA Workshop, January 27-28, 1994, in Jupiter, Florida.

Ward, G.S. 1988. Toxicity Reduction -- A Municipal Case Study. Presented at the Center for Training, Research, and Education for Environmental Occupations. Seminar on Toxicity Reduction and Treatability in Gainesville, Florida.

Ward, G.S., A.J. Tolmsoff, and S.R. Petrocelli. 1986. Acute Toxicity of Trichloroethylene to Saltwater Organisms. BULL. ENVIRON. CONTAM. TOXICOL., 37:830-836.

Ward, G.S. 1984. Biomonitoring - Specific Applications to Saltwater Organisms. Presented at the Chemical Manufacturers Association's biomonitoring seminar in Arlington, Virginia.

Ward, G.S. and L. Ballantine. 1984. Acute and Chronic Toxicity of Atrazine to Estuarine Fauna. ESTUARIES, 8(1): 22-27.

Ward, G.S., G.C. Cramm, P.R. Parrish, and S.R. Petrocelli. 1982. Effects of Ammonium Jarosite on Early Life Stages of a Saltwater Fish, *Cyprinodon variegatus*. MARINE POLLUTION BULLETIN, 13(6): 191-195.

Ward, G.S. and P.R. Parrish. 1982. Manual of Methods in Aquatic Environmental Research. Part 6. Toxicity Tests. FAO FISH. TECH. PAP. 185: 23 pp.

Ward, G.S., T.A. Hollister, P.T. Heitmuller and P.R. Parrish. 1981. Acute and Chronic Toxicity of Selenium to Estuarine Organisms. *NORTHEAST GULF SCIENCE*. 4(2): 73-78.

Ward, G.S., G.C. Cramm, P.R. Parrish, H. Trachman, and A. Slesinger. 1981. Bioaccumulation and Chronic Toxicity of (Bis) Tributyltin Oxide (TBTO): Tests with a Saltwater Fish. In *AQUATIC TOXICOLOGY AND HAZARD ASSESSMENT: FOURTH CONFERENCE*, ASTM STP 737, D.R. Branson and K.L. Dickson, Eds., American Society for Testing and Materials, pp. 183-200.

Ward, G.S., P.R. Parrish, and R.A. Rigby. 1981. Early Life Stage Tests with a Saltwater Fish: Effects of Eight Chemicals on Survival, Growth, and Development of Sheepshead Minnows (*Cyprinodon variegatus*). *JOURNAL OF ENVIRONMENTAL TOXICOLOGY AND ENVIRONMENTAL HEALTH*, 8(1-2): 225-240.

Parrish, P.R., P.T. Heitmuller, G.S. Ward, and L.G. Ballantine. 1981. Chemical Effects on Estuarine Communities. Presented at "The First Annual SETAC Symposium."

Hollister, T.A., G.S. Ward, and P.R. Parrish. 1980. Acute Toxicity of a #6 Fuel Oil to Marine Organisms. *BULL. ENVIRON. CONTAM. TOXICOL.* 24: 656-661.

Ward, G.S. and P.R. Parrish. 1980. Evaluation of Early Life-Stage Toxicity Tests with Embryos and Juveniles of Sheepshead Minnows (*Cyprinodon variegatus*). In: *AQUATIC TOXICOLOGY*, ASTM STP 707. J.G. Eaton, P.R. Parrish, and A.C. Hendricks, Eds. American Society for Testing and Materials. pp. 243-247.

Gibson, J.R. and G.S. Ward. 1977. Pulsed Exposure of *Cyprinodon variegatus* and *Palaemonetes pugio* to Alkaline and Acidic Industrial Wastewaters. Presented at "The Second Annual ASTM Symposium on Aquatic Toxicology."

Anderson, J.W., D.B. Dixit, G.S. Ward, and R.S. Foster. 1977. Effects of Petroleum Hydrocarbons on the Rate of Heart Beat and Hatching Success of Estuarine Fish Embryos. In: *PHYSIOLOGICAL RESPONSES OF MARINE BIOTA TO POLLUTANTS*. pp. 241-258.

Rossi, S.S., J.W. Anderson, and G.S. Ward. 1976. Toxicity of Water-Soluble Fractions of Four Test Oils for the Polychaeteous Annelids, *Neanthes arenaceodentata* and *Capitella capitata*. *ENVIRON. POLLUT.* 10(1): 9-18.

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Petrocelli, S.R., S.W. Anderson, G.S. Ward, B.J. Presley, and R.P. Sims. Sublethal Effects of Mercury on Sheepshead Minnow Fry. Presented at "International Conference on Heavy Metals in the Environment" 27-31 October 1975, in Toronto, Canada.

I hereby certify that the above information is accurate.

Name: _____ Date: _____

September 2010

CURRICULUM VITAE

NAME: Troy DeVault
TITLE: Vice President, Corporate Services
EDUCATION: B.S., Operations Management, University of Missouri, Columbia

SUMMARY OF PERTINENT EXPERIENCE:

ABC Laboratories, Inc.

Vice-President, Corporate Services, August 2010 - Present

Responsible for facility infrastructure and centralized administrative support functions for the company including; Information Services, Procurement, Environmental Health & Safety, Radiation Safety, and Facilities Maintenance. In addition, provides due diligence support related to merger and acquisition activities. Reports to the President and CEO of the company.

Director of Corporate Services, July 2008 – July 2010

Responsible for facility infrastructure and centralized administrative support functions for the company including; Information Services, Procurement, Metrology, Project Planning Office and Facilities Maintenance. Also responsible for Materials Management support to Pharmaceutical Services. In addition, provides due diligence support related to merger and acquisition activities. Reports to the President and CEO of the company.

Operations Manager, December 2006 – June 2008

Overall responsibility for the operations and facility at ABC Laboratories. This includes management responsibility for Facilities Maintenance, Materials Management, Metrology, and the Project Planning Office. Additional responsibilities include assisting the VP of Operations with the successful management of the 4 technical operating groups which includes the Chemical Services, Synthesis, Bio-Analytical, and Analytical groups. Also serves as Project Lead on the Discovery Ridge Building Project.

Vesuvius USA, Inc.

Director of North American Operations – Linings Division, December 2005 – December 2006

Executive responsibility for the operations of the Linings Division which included 5 Monolithic Refractory Production Facilities in the USA, 1 in Canada, and 1 in Mexico. Product lines included Alumino Silicate Monolithics, Basic Monolithics, Carbon Paste, and Precast Shapes. Total budgetary responsibility of \$110,000,000 representing over 250,000 MT of refractory production annually. Span of control included 75 Salaried and 300 Hourly employees. Held management responsibility of all Tolling Operations (4) for the Linings Division.

Responsibilities included Human Resources, Health and Safety, and Cost Accounting for the Division. Operations were a mix of Union and Non-Union facilities. Directly reporting were 2 HR Managers and 2 Cost Accountants.

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September 2010

Plant Manager – Chicago Heights, IL / Crown Point, IN Facilities, February 2002 – Nov 2005

Executive responsibility for the operations of the Chicago Heights and Crown Point manufacturing facilities. Product lines included Alumino Silicate Monolithics and Precast Shapes. Total budgetary responsibility of \$48,000,000 representing 105,000 MT of refractory production annually. Span of control included 31 Salaried and 135 Hourly employees.

Responsibilities included Human Resources, Cost Accounting and IT for the Great Lakes Region.

A.P. Green Industries, Inc.

Plant Manager – Oak Hill, OH Facility, April 2001 – January 2002

Assistant Plant Manager – Mexico, MO Facility, January 1998 – March 2001

Production Superintendent – Fulton, MO Facility, May 1997 – December 1997

Manufacturing Team Leader – Mexico, MO Facility, January 1994 – March 1995

Production Supervisor – Sulphur Springs, TX Facility, May 1992 – December 1993

Quality Assurance Supervisor – Mexico, MO Facility, September 1991 – April 1992

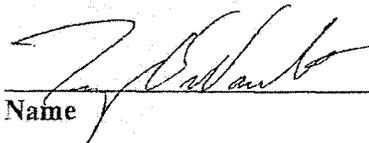
Quality Facilitator – Mexico, MO Facility, March 1991 – August 1991

National Refractories and Minerals Corp.

Production Superintendent – Mexico, MO Facility, May 1996 – April 1997

Quality Systems Engineer – Mexico, MO Facility, April 1995 – April 1996

I hereby certify that the above information is accurate.


Name

9/30/10
Date

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Revised 12/17/10

CURRICULUM VITAE

Name: Bradly D. Keck

CONTACT:
6753 Weathered Oaks Court
Hamilton OH 45011
(513) 894-8776

EDUCATION

MAJOR

DEGREE/DATE

University of Arkansas
University of Arkansas

Nuclear Chemistry
Zoology

Ph. D. / 1986
B. S. / 1982

CERTIFICATIONS

American Board of Health Physics, 1997

EXPERIENCE

Date

July, 2010 – current
Principal, Keck Consulting
Radiation Safety Officer, ABC Laboratories, Columbia MO 65202

2008 – July, 2010
Chief Technology Officer, Vitalea Science, Inc.

Responsible for experimental design, regulatory approvals, customer interfacing, and overall experimental execution for AMS based clinical studies. Provided radiochemical, health physics and regulatory expertise, in addition to marketing support for an AMS startup.

1989 – 2008
Procter and Gamble, Procter and Gamble Pharmaceuticals

Senior Research Scientist in PGP (1994 - 2008)
Research Scientist in P&GP (1990 - 1994)

Responsible for radioanalytical/bioanalytical project support across health care at all levels; design and/or coordinate radiosyntheses, provide radiochemical/safety/clinical support; develop nuclear methods in pharmaceutical discovery and development and manage cross-divisional support. Active in Actonel Scientific Exchange Program (2000 - 2001, 2005)

1992 - 2001

Corporate Radiation Safety Officer

Responsible for managing the radiation safety office for the Cincinnati Technical Centers; includes review of all radioisotope use, training of all radioisotope users, procurement of all radiochemicals and interactions with government agencies at the federal and state level, including an advisory role as Ohio adopted Agreement State status from the NRC.

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2002 – 2008: Chairman of the Radiation Safety Committee; Responsible for all uses of radioisotopes within Cincinnati and for consulting with other company functions globally in all technical and regulatory aspects of radioisotope use, mentoring health physics staff, professional relations with agencies and safety/perception.

<u>Date</u>	<u>Employer</u>	<u>Position/Description</u>
1987 - 1989	University of Missouri	Research Scientist/Assistant Professor Nuclear Methods Development/Application and Instruction, Isotope Production
1988 - 1989	Lincoln University	Visiting Assistant Professor, Taught Physical Chemistry
1983 - 1986	University of Arkansas	Graduate Research Assistant Conducted Original Research in Nuclear and Cosmochemistry

CONTINUING EDUCATION

Drug Metabolism - 1990	Quality Assurance, ACS, 1990
Interpersonal Management - 1990	Internal Radiation Dosimetry, Canberra, 1991
Time Management - 1990	Pharmacology, University of Wisconsin, 1992
Oral Communications - 1990	Certification in Health Physics-Part 1, 1994
Implementing Total Quality - 1990	MIRD dosimetry, Oak Ridge, 1995
Media Communications - 1995	DOT Transportation of Radioactives, HPS - 1996
Leadership Conference – 1997	Certification prep, Part 2, Skrabale - 1997
Technical Support in the Field - 2000	

PROFESSIONAL MEMBERSHIPS/HONORS

American Chemical Society, 1986 - present
International Isotope Society, 1989 - present; Treasurer - 1995 – 98, Secretary – 1999, Pres – 2000, Chairman
Low Level Radioactive Waste Committee 2003 - present
Health Physics Society, 1992 - present
Ohio Radioactive Materials Users Group - 1992 – 2002, Board of Directors, 2000 to 2002; Chairman Scholarship
Committee 2003.
State of Ohio Advisory Committee - 1996 - 2003

A.B.H.P. Certification in Health Physics, 1997

ATTENDANCE AT PROFESSIONAL MEETINGS

International Isotope Society Midwest Region, 1990, 1991, 1992, 1993, 1994 (Host), 1995, 1996, 1997, 1998,
1999, 2000, 2001 (host), 2002, 2003, 2004, 2005, 2006, 2007, 2008
International Isotope Society International Meeting, 1991, 1997, 2000, 2003, 2006, 2009
Pittsburgh Conference, 1990, 1991
Pharmaceutical Manufacturers Association; Drug Metabolism Section, 1991, 1992, 1993
Ohio Radioactive Materials Users Group, 1992 - present
P & G Analytical Symposium, 1990 – present
Society for Biomolecular Screening, 1997
Society for Nuclear Imaging in Drug Development, 1998, 1999, 2000
American Society of Mass Spectrometry, 2009, 2010

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PUBLICATIONS/PRESENTATIONS/PATENTS

Refereed Papers

1. Guimon, R.K., Weeks, K. S.; Keck, B. D.; and Sears, D. W. G. (1984) Thermoluminescence as a Paleothermometer. Nature 311, 363 - 365
2. Sears, D. W. G.; Bakhtiar, N.; Keck B. D.; and Weeks, K. S. (1984) Thermoluminescence and the shock and reheating history of meteorites II: Annealing studies of the Kernouve meteorite. Geochimica et Cosmochimica Acta 48, 2265 - 2272.
3. Guimon, R. K.; Keck, B. D.; Weeks, K. S.; DeHart, J.; and Sears, D. W. G. (1985) Chemical and Physical studies of a type 3 chondrites IV: Annealing Studies of a type 3.4 ordinary chondrite and the metamorphic history of meteorites. Geochimica et Cosmochimica Acta 49, 1515 - 1524.
4. Rubin, A. E.; James, J. A.; Keck, B. D.; Weeks, K. S.; Sears, D. W. G. and Jarosewich, E. (1985) The Colony meteorite and variations in CO₃ chondrite properties. Meteoritics 26, 175 - 196.
5. Hasan, F. A.; Keck, B. D.; Hartmetz, C. and Sears, D. W. G. (1986) Anomalous fading of thermoluminescence in meteorites. Journal of Luminescence 24, 327 - 335
6. Keck, B. D.; Guimon, R. K.; and Sears, D. W. G. (1986) Chemical and Physical studies of a type 3 chondrites VII: Annealing studies of the Dhajala H3.8 chondrite and the thermal history of chondrules and chondrites. Earth and Planetary Science Letters 77, 419 - 427.
7. Keck, B. D. and Sears, D. W. G. (1987) Chemical and Physical studies of a type 3 chondrites VIII: Thermoluminescence of the CO chondrites. Geochimica et Cosmochimica Acta 51, 3013 - 3021.
8. Lansberger S., Arendt A., Keck B. D. and Glascock M. D. (1990) Aluminum Analysis in Biological Reference Materials by Non-Destructive Methods. Transactions of the American Nuclear Society 56, 230-231.
9. Mao X. Y., Ward B. J., Grossman L. and Keck B. D. (1991) Chemical Composition of T-21 Silica Tubing and Implications for Neutron Activation Analysis, J. Radioanalytical and Nuclear Chemistry 149, Vol. 1, 97 - 108.
10. Reilman, R. A., Wimalasena, R. and Keck, B. D. (2003) A Radioimmunoassay Based on Scintillation Proximity Technology for the Measurement of Risedronate in Rat Serum. Journal of Labeled Compounds and Radiopharmaceuticals, Proceedings of the International Isotope Society.
11. Timothy F. Christian, MD¹, Kevin Peters, MD, Bradly Keck, PhD, Jill Allen¹, Thomas Owens CNMRT¹, and Babul Borah PhD (2005) Gated SPECT Imaging to Detect Changes in Myocardial Blood Flow during Progressive Ischemia and Coronary Collateral Development in the Ischemic Pig. Int J Cardiovasc Imaging. 2008 Mar;24(3):269-76.
12. Isfort, R., Wehmeyer, K. W., Reilman, R. A. and Keck, B. D.; (2006) Modifications of the human urocortin 2 peptide that improve pharmacological properties; Peptides, Jul;27(7):1806-13.
13. B. D. Keck, T. Ognibene and J.S. Vogel (2010) Analytical validation of accelerator mass spectrometry for pharmaceutical development, Bioanalysis 2(3), 469.
14. J.S. Vogel, J.A. Giacomo, T. Schulze-Konig, B.D. Keck, P. Lohstroh and S.R. Dueker, Accelerator mass spectrometry best practices for accuracy and precision in bioanalytical ¹⁴C measurements. Bioanalytical 2(3), 455.
15. S.R. Dueker, P.Lohstroh, J.A. Giacomo, L.T. Vuong, B.D. Keck and J.S. Vogel, Early ADME using microdoses dn microtracers: bioanalytical considerations (2010) Bioanalysis 2(3), 441.

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PRESENTATIONS

- Radiochemical determinations of loperamide bioavailability, tissue distribution and metabolism. B. D. Keck, R. M. Deibel, C. A. Cruze, K. Parsell, R. L. Smith, R. E. Smyth, M. L. Hunnicutt and N. Singh; P&G Analytical Symposium, 1991.
- Radiochemical and mass spectrometric determinations of chemical purity in carbon-14 labeled compounds: a new methodology with minimal consumption of material. B. D. Keck and T. R. Baker, P&G Analytical Symposium, 1992.
- Distribution and metabolism studies of tritium labeled clonidine. G. O. Kinnett, M. A. Coombs, R. L. Smith, R. E. Smyth and N. N. Singh; P&G Analytical Symposium, 1992.
- Analytical studies on metabolic N-acetylation pathways of p-aminoclonidine. N. N. Singh, M. A. Coombs, B. D. Keck, G. O. Kinnett, T. R. Baker, S. R. Ward, R. L. Smith, R. E. Smyth and M. K. Dirr; P&G Analytical Symposium, 1992.
- Recent advances in radioanalytical technology and their applications in health care research, Keck B and Kinnett G.; 1994.
- Radiochemistry in modern pharmaceutical research, University of Kentucky Seminar Series, Keck, B; 1994.
- Fees in Agreement States, ORMUG, 1997.
- An automated PKA phosphorylation assay using quantitative nuclear imaging. P. M. Knight, R.A. Reilman and B.D. Keck, P&G Analytical Symposium, 1998.
- Measurement of Bacterial Peptidoglycan Synthesis by Scintillation Proximity Assay, P. Renick, C. Henson, T. Morris and B. D. Keck, US Central IIS meeting, 1998.
- A Scintillation Proximity Assay for Penicillin Binding Protein 2a, W. P. Lu, R. Reilman, Y. Sun, M. Bauer and B. D. Keck, US Central IIS meeting, Kalamazoo and P&G Analytical Symposium, 1999.
- Nuclear Imaging in Drug Development and Discovery, AAPS Indianapolis-Cincinnati Discussion Group, University of Cincinnati College of Pharmacy, 1999 & 2000.
- Nuclear Imaging in Drug Development, IIS International Symposium, Dresden, Germany, 2000.
- Applications of AMS in pharmacokinetic studies: advantages, requirements and comparison with conventional radiometric analysis, Keck, B. D., Joly, J., Phipps, R. M. and Vogel, J. S., American Chemical Society Annual Meeting, Orlando, 2002.
- Use of AMS in Conventional Pharmacokinetic Studies, Joly, J., Phipps, R. M. and Vogel, J. S., International Isotope Society, US Central Meeting, Indianapolis, 2002.
- A Radioimmunoassay Based on Scintillation Proximity Technology for the Measurement of Risedronate in Rat Serum, Reilman, R. A., Wimalasena, R. and Keck, B. D., International Isotope Society Triennial Meeting, Boston, 2003.
- Comparison of Risedronate and Alendronate Pharmacokinetics, C. Christiansen, R. Phipps, D. Burgio, L. Sun, D. Russell, B. Keck, R. Lindsay International Osteoporosis Foundation, Nice, 2003.
- Long Term Studies of Bisphosphonates in Dogs and Humans Using Accelerator Mass Spectrometry, Bradly D. Keck, Roger M. Phipps and John S. Vogel, AAPS, 2003.

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Use of Accelerator Mass Spectrometry in Conventional Pharmacokinetic Studies.

Keck, B. D., Joly, J., Phipps, R. M. and Vogel, J. S., International Isotope Society U. S. Central Meeting, 2004

+Exploring the Potential of ^{41}Ca in Bone Research, Bradly D. Keck, International Food Harmonization, Zurich, 2004

Comparative quantitation of AMS and scintillation counting un ultra-trace isotopic bioanalysis, B.D. Keck and J.S> Vogel, AMS 5, 2005.

Microdosing Technology and AMS, Bradly D. Keck, Land O' Lakes Bioanalytical, 2005

Calcium absorption in the presence of psyllium fiber: AMS measurement of ^{41}Ca form calcium carbonate and calcium citrate-maieate, B.D. Keck, K. Best, H. Tse and D. Hilligonds, 2006, International Isotope Society.

Carbon-14 labeled pharmaceuticals in the drug registration process: improved sensitivity can reduce volunteer exposure and provide better knowledge of human/drug behavior, 2009, B.D. Keck, J.S. Vogel and S.R. Dueker, International Isotope Society

Microdosing – an AMS roundtable, B.D. Keck and G. Lappin, 2009, International Isotope Society.

Absolute quantitation without internal standards. AMS and microtracers for pharmacokinetics and discovery. 2009, P. Lohstroh, B.D. Keck, L. Vuong, J.S. Vogel and S.R. Dueker, American Society of Mass Spectrometry.

The performance of accelerator mass spectrometry for the determination of $^{14}\text{C}/\text{C}$ ratios using a newly installed BioMICADAS AMS, B.D. Keck, P. Lohstroh, J. Giacomo, J. S. Vogel, American Society for Mass Spectrometry, 2010.

R & D REPORTS

Numerous reports, not listed due to confidentiality.

Patents

SODIUM-24 IMAGING (2005), Bradly Dwight Keck and Robert M. Beihn, Pending.

COLLIMATOR (2005), Bradly Dwight Keck and Robert M. Beihn, Granted 2007.

Signature

Initials

Date Reviewed/Update