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Rev. 0

Letter Report for Skyshine Abatement Assessment

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United States
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P.O. Box 550
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FIGURES

TABLE

ACRONYMS

ALARA	As Low As Reasonably Achievable
DOE	U.S. Department of Energy
DOE/RL	U.S. Department of Energy, Richland Operations Office
EDT	Emergency Dump Tank
FCGG	Federal Geodetic Control Committee
LWDF	Liquid Waste Disposal Facilities
MEI	maximally exposed individual
PNL	Pacific Northwest Laboratory
R	Roentgen
RCRA	Resource Conservation and Recovery Act
TPA	Tri-Party Agreement
TLD	thermoluminescent dosimeter
WHC	Westinghouse Hanford Company

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EXECUTIVE SUMMARY

The term "skyshine," as used in this report, refers to radiation that originates from the 1301-N/1325-N Liquid Waste Disposal Facilities (LWDF) and reflects back to the surrounding 100 N Area. Skyshine was first observed in 1980 by 100 N Area operators who were able to correlate elevated radiation readings with the amount of water shielding over 1301-N (i.e., depth of water maintained over 1301-N). Since 1980, measures have been taken to hold the errant radiation in abeyance. The most prominent of those measures are the concrete panels that reside atop 1301-N and 1325-N.

This letter report has been issued in support of the overall 100 N Area strategy to address whether the effects of skyshine adversely impact the public who may pass by 1301-N/1325-N in the course of traveling along the Columbia River, or who trespass on the southeastern bank. The most likely trespassers are those who may fish or camp on the 100 N Area shoreline. Although the public is legally prohibited from trespassing along the shoreline, it is possible for the public to gain access to the 100 N Area shoreline. It is legal for the public to boat along the 100 N Area shoreline. In response to this concern, Tri-Party Agreement (TPA) Milestone M-16-12 was established. This report addresses whether a pre-remedial action for abatement of skyshine from 1301-N/1325-N is necessary to protect the general public prior to implementing the *1301-N/1325-N Closure Plan/Corrective Measure Study*. The term "pre-remedial action" is used in this report because remedial actions for final site closure will be addressed in the *1301-N/ 1325-N Closure Plan/Corrective Measure Study*. (TPA Milestone M-15-12B, due March 1997.) Skyshine from 1301-N/1325-N may have an effect on 100 N Area workers; however, such exposures are being addressed in numerous other ways such as

Hanford Site safety procedures, the *1301-N/1325-N Closure Plan/Corrective Measure Study*, and the 100-NR-1*Closure Plan/Corrective Measure Study*.

As a part of the overall Hanford Site cleanup, the 100 N Area has undergone extensive studies. The 1301-N/1325-N units are currently being addressed under the Tri-Party Agreement and are subject to *Resource Conservation and Recovery Act (RCRA)* action. A characterization effort is planned for 1301-N/1325-N, to support a limited field investigation and qualitative risk assessment for 1301-N/1325-N (TPA Milestone M-15-12A, due July 1996). The information from this characterization effort will be incorporated into the *1301-N/1325-N Closure Plan/Corrective Measure Study* in support of the TPA draft Milestone M-15-12B.

This skyshine report addresses potential exposures from the 1301-N/1325-N skyshine to individuals from the public who trespass along the 100 N Area shoreline, or who boat in the Columbia River along this area's shoreline. In order to address exposure to the public, this report deals with the following questions:

- To what degree is the public subjected to the adverse effects of skyshine?
- If warranted, what sort of abatement action would be justified?

The U.S. Department of Energy, in DOE Order 5400.5, set a limit of 100 mrem/yr as the amount of radiation the general public may receive in one year. However, a new regulation in the proposed 10 CFR 834 has set this limit at 25 mrem/yr. Both the 100 and 25 mrem/yr limit apply to realistic exposure scenarios in areas where the public can legally gain access or reside. The 25 mrem/yr limit has been used in this report to determine if pre-remedial actions

to abate skyshine are necessary to protect the public. In pursuing the public exposure issue 100 N Area monitoring data were evaluated. In addition, public exposure opportunities along the 100 N Area shoreline and water's edge (assumed to have comparable exposure levels) were identified and evaluated. In the final analysis, the following conclusion was reached:

> It is highly unlikely that individuals from the public would receive a dose above the annual 25 mrem/yr limit from 1301-N/1325-N skyshine.

Because exposures to the public from 1301-N/1325-N skyshine are less than regulatory limits, no pre-remedial action has been identified for 1301-N and 1325-N.

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1.0 PROJECT BACKGROUND

The term "skyshine" refers to ionizing energy (radiation) that emanates from radiation sources and showers down from the sky to the ground on the 100 N Area at the Hanford Site in southeast Washington. Radiation emanating upwards from a ground-level source is "scattered" or "reflected" off oxygen, hydrogen, nitrogen and other atoms in the atmosphere. A significant portion of this air-scattered radiation returns to the earth. This phenomenon is commonly referred to as "skyshine."

Preliminary studies indicate that two Hanford Site waste management units (1301-N and 1325-N) are the primary sources of skyshine (Westinghouse Hanford Company [WHC] 1994a). The units were designed to receive radioactive effluent originating in the N Reactor building. The effluents originate from the primary reactor coolant system, periphery reactor cooling systems, decontamination of these systems, and drainage from reactor support facilities (DOE 1993a). The 1301-N and 1325-N trenches are long, with waste management cribs at the wastewater inlet. The trenches of 1301-N and 1325-N have the following nominal dimensions: Unit 1301-N measures 15 m wide, 490 m long, 3.7 m deep, and is located approximately 270 m from the Columbia River. Unit 1325-N measures 17 m wide, 910 m long, 2 m deep, and is located about 600 m from the Columbia River (Figure 1).

Between 1962 and 1987 it was standard practice at the Hanford Site to discharge radioisotope-contaminated effluent into the cribs and associated extension trenches. The effluent percolated into the surrounding soil. During that time, percolation was an accepted practice for waste disposal. It was this discharge and leaching process that contaminated the surrounding soil with the radioactive effluent. Because the cribs are located next to the wastewater inlet, the trenches were used as overflow units that received wastes containing lower concentrations of radioisotope-contaminated effluent than the cribs.

As a result of the discharges, the materials in 1301-N and 1325-N act as sources of ionizing radiation that are believed to be the cause of skyshine in that area. The area includes portions of the Columbia River shoreline near 1301-N and 1325-N. It is expected that the highest concentrations of residual waste will be located within and immediately adjacent to the cribs (especially near the wastewater inlet), with diminishing concentrations of radioisotope-contaminated soil to be found near the trench tailwater extremities. Cobalt (^{60}Co) and Cesium (^{137}Cs), the major contributing radioactive isotopes in the units, have half-lives of 5.26 yr and 30.17 yr, respectively (DOE 1993a).

Other potential sources within the N Area which may contribute to skyshine include the emergency dump basin (EDB) and the emergency dump tank (EDT). The EDB will be addressed as a part of the deactivation effort as described in the *N Reactor Deactivation Program Plan* (WHC 1993d). Completion of deactivation of the EDB will be completed by September 30, 1997.

Deactivation of the EDT was initially completed in the 1989/1990 timeframe. The exposure to the general public from the EDT is being evaluated by N Reactor Facilities and appropriate mitigative measures will be implemented, if deemed necessary. If no immediate cleanup action is warranted, final removal of the EDT will be accomplished by the N Reactor Decontamination and Decommissioning Group after fiscal year 1998.

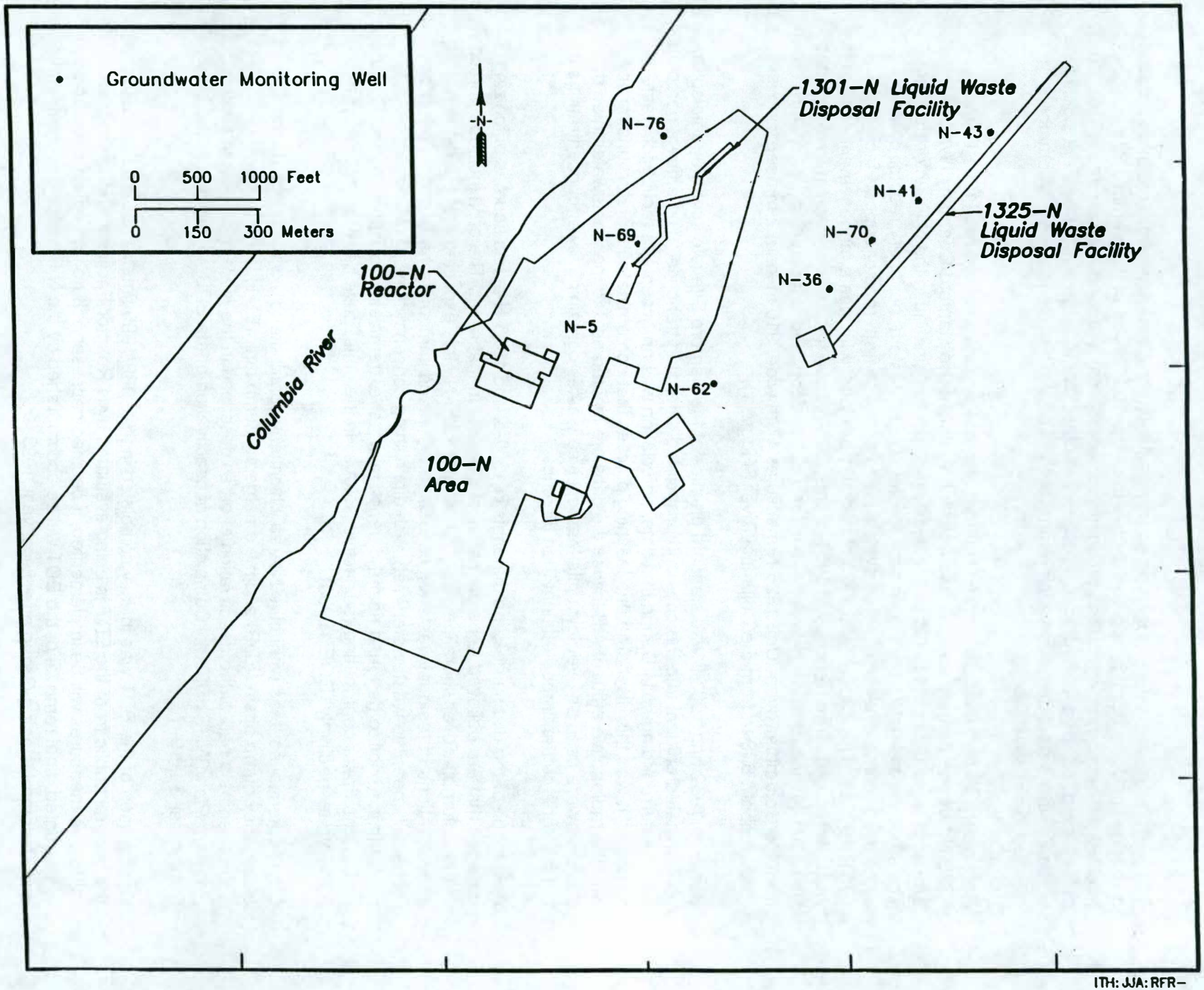

Figure 1. Site Map.

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Should a source at N Area be identified which contributes to an off-site dose above regulatory concerns, assessment of the potential remedial alternatives, scheduling, and funding will be conducted.

2.0 PROJECT DESCRIPTION

In recent years there has been increased interest in learning whether skyshine has an adverse impact on members of the public who boat along the Columbia River and pass the 1301-N and 1325-N areas, or who trespass on this area's southeastern bank. In response to this public exposure question, TPA Milestone M-16-12 was established.

In order to satisfy the terms of the milestone, the following questions were addressed in the form of a report:

1) To what degree is the public subjected to the adverse effects of skyshine?

2) If warranted, what form of pre-remedial action would be justified?

To answer these questions, potential public exposures to skyshine were evaluated.

3.0 100 N AREA RADIATION EXPOSURE RATES

3.1 Review of Radiation Exposure Rate Data

3.1.1 Summary of Data

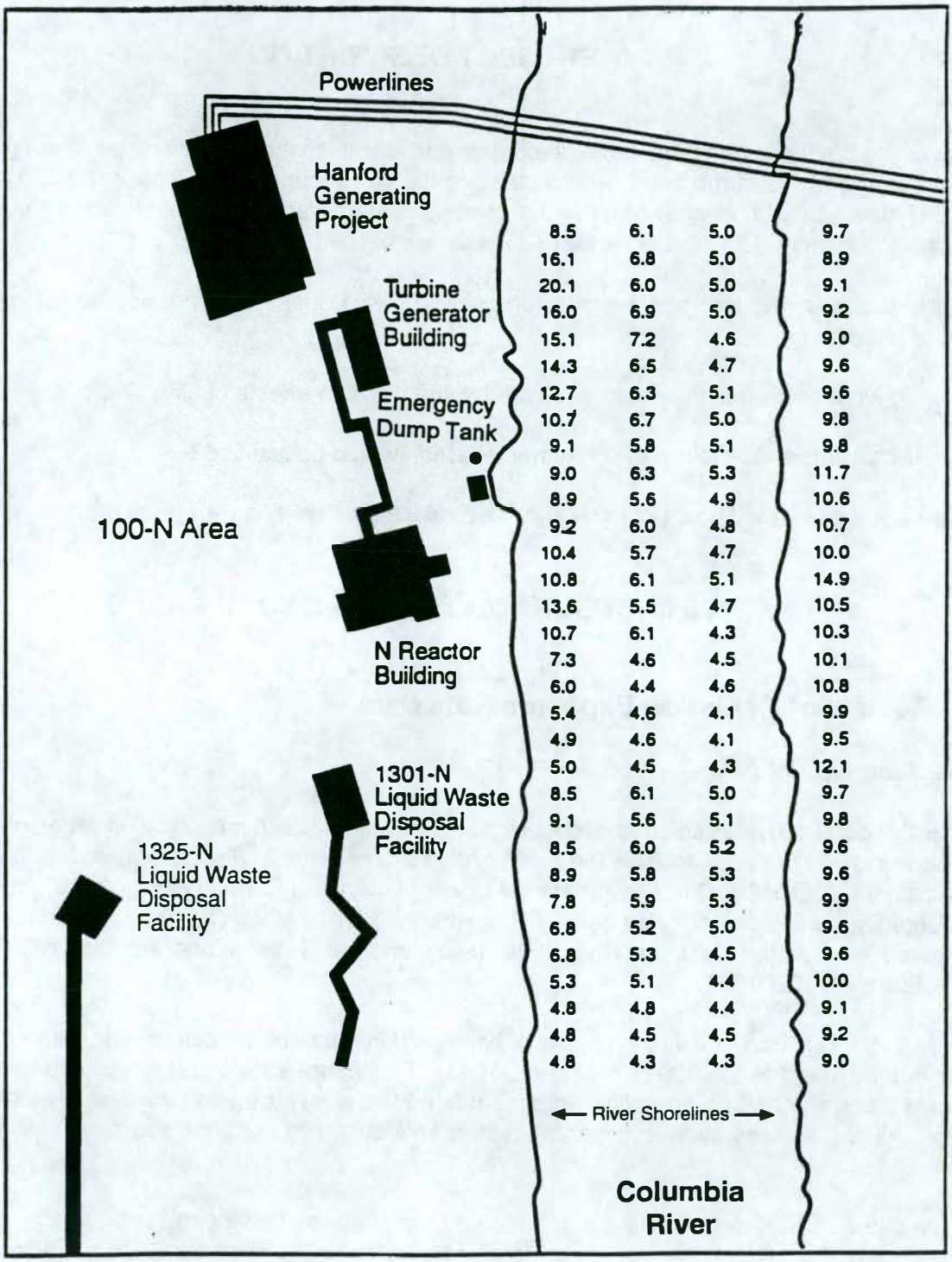
Several reports provide radiation exposure rate information about the skyshine areas of concern in 100 N. These include the *Hanford Site Environmental Report* (Pacific Northwest Laboratory [PNL] 1994), the *Environmental Monitoring Annual Report* (WHC 1994b), the *Investigation of Exposure Rates and Radionuclide and Trace Metal Distribution Along the Hanford Reach of the Columbia River* (PNL 1993), and the *Transmittal of Radiation Exposure Rate Survey* (WCB 1994).

Figure 2 in this report shows the results of hand-held instrument measurements taken from 128 locations adjacent to the 100 N Area (PNL 1993). This figure shows that radiation levels are highest along the N Area shoreline when compared to the levels measured over the Columbia River. All of these radiation levels are, however, influenced by radiation sources in the 100 N Area.

Figure 3 shows that radiation levels, measured from 1988 to 1993 along the shoreline, rise across from 1301-N/1325-N (approximately locations 40 to 70) when compared to adjacent levels. The peak in radiation levels near location 15 are assumed to be from the EDT.

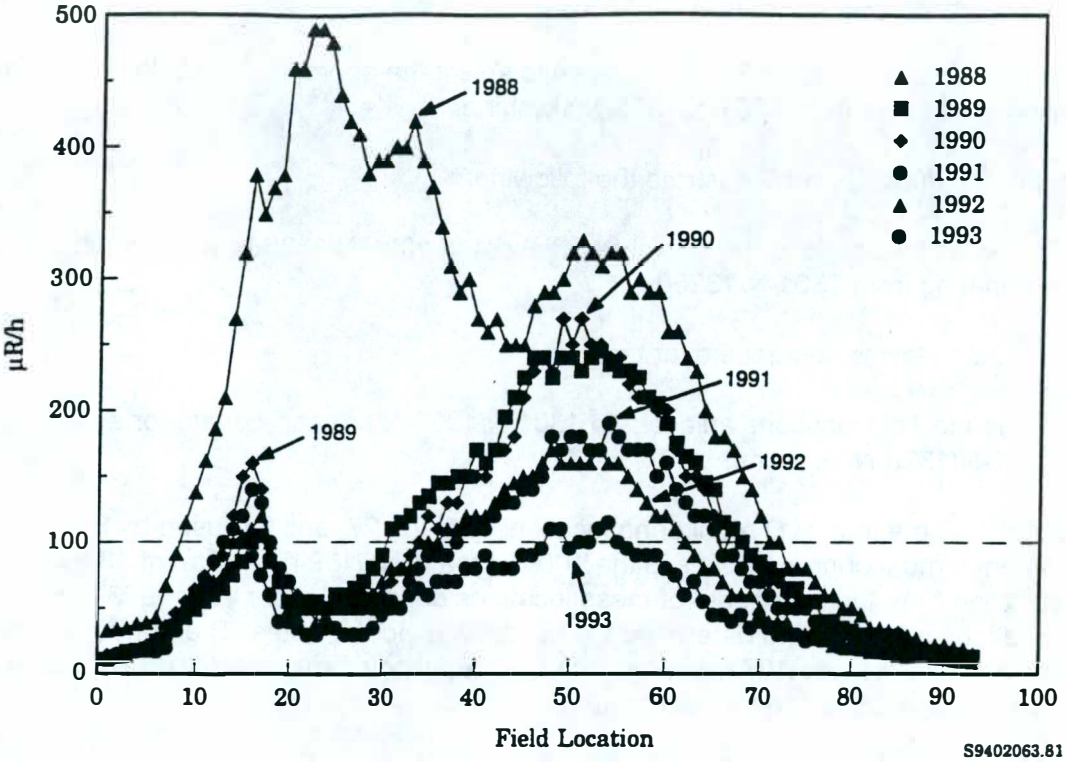
Figure 3 also shows radiation levels decreasing over time. An examination of this phenomenon (utilizing thermoluminescent dosimeter [TLD] data) indicates that the combination of

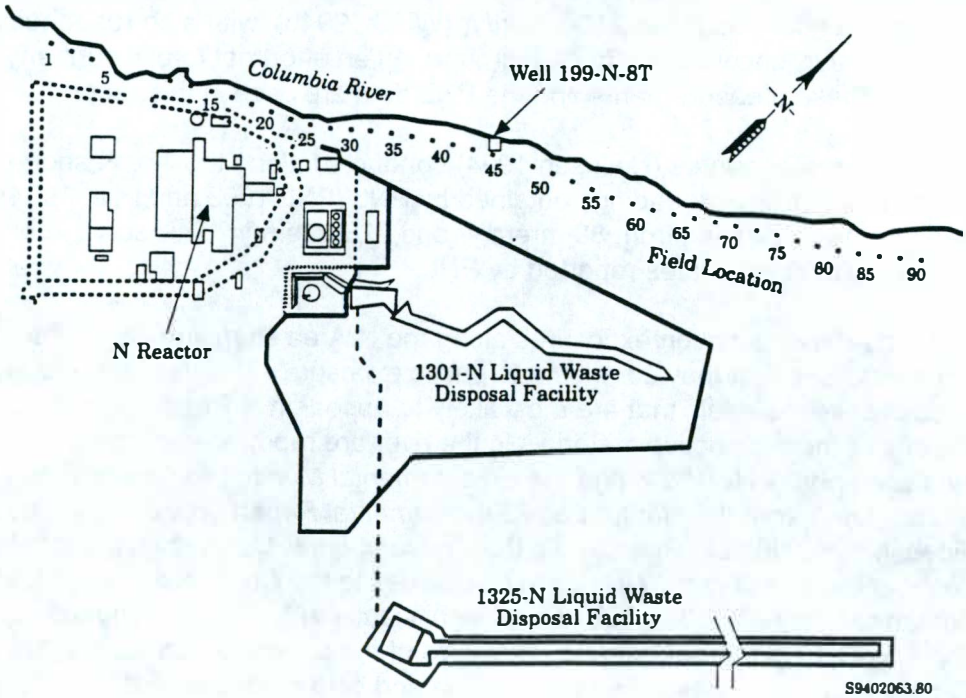
Figure 2. Exposure Rates on the Columbia River Adjacent to the 100 N Area (μRem/hr).



Source: Modified from PNL 1993

Figure 3. Radiation Measurements Along the 100 N Area Shoreline.





Source: Modified from PNL 1994

radionuclides producing the skyshine are decaying, with an effective half-life of 6.6 years, as indicated by Figure 4. The exposure rates measured during calendar 2000 would, therefore, be expected to be significantly reduced from the 1993 values.

The information from Figures 2 and 3 is used to select the appropriate TLD locations for evaluating exposures from 1301-N/1325-N skyshine.

In summary, Figures 2 and 3 illustrate the following:

- Radiation levels along the shoreline adjacent to 1301-N/1325-N are a result of radiation emanating from 1301-N/1325-N,
- Radiation levels decrease over time, and
- Shoreline TLD locations adjacent to 1301-N/1325-N are appropriate for evaluation of the 1301-N/1325-N skyshine.

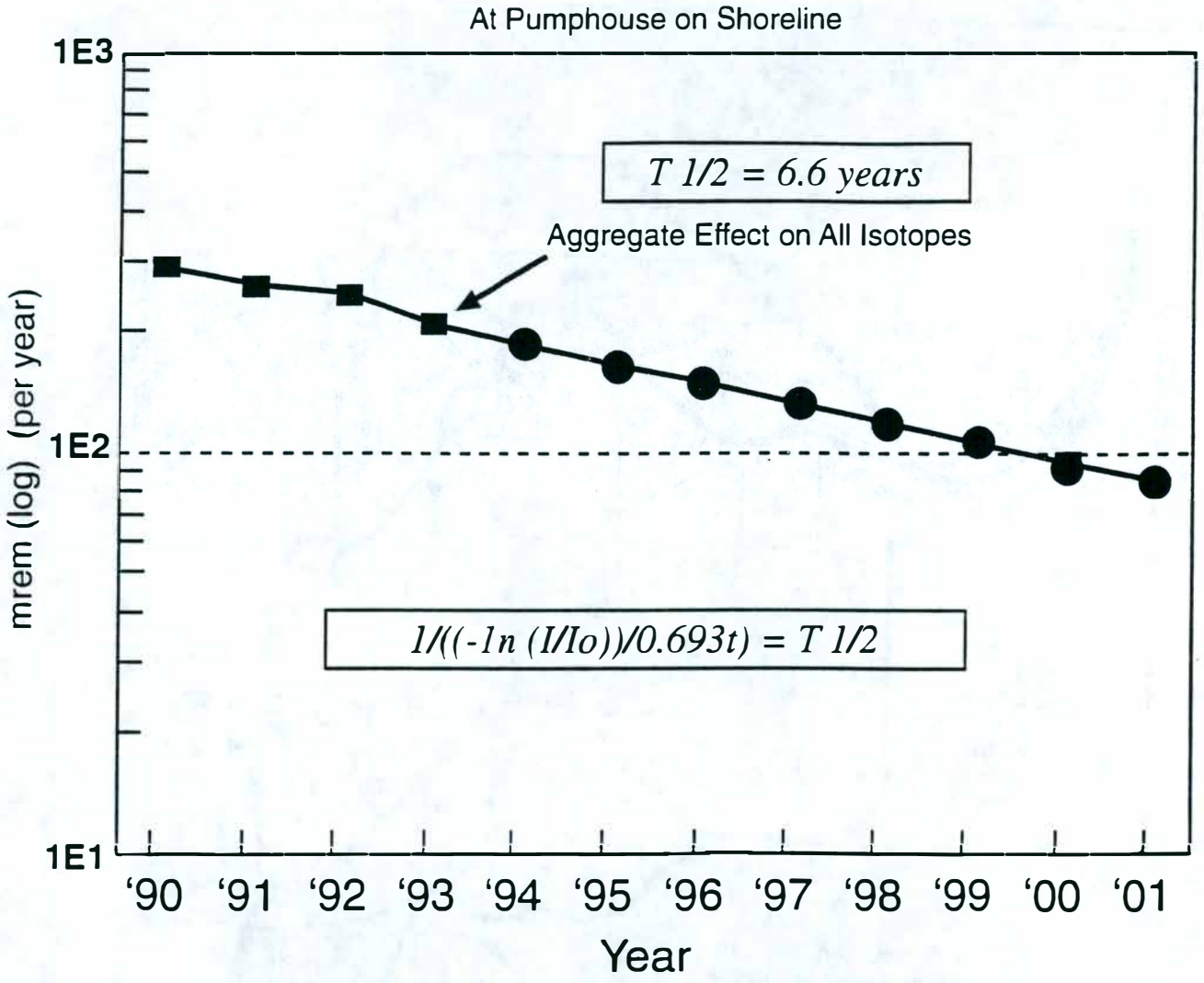
Figure 5 shows the four TLD monitoring locations (25, 26, 27, and 28) used by PNL for environmental monitoring purposes in the 100 N Area (PNL 1994). A total of 13 measurements were obtained from the aggregate of these locations during calendar year 1993. Data from these locations were used to determine the radiation exposure rates. The annual average for these measurements was 197 mrem/yr, with a corresponding maximum value of 256 mrem/yr. Both values are uncorrected for background.

Westinghouse Hanford Company uses one TLD monitoring location that is in the same general area as PNL's (see Location 26 on Figure 6). The average of four measurements made at this location during calendar 1993 was 210 mrem/yr (WHC 1994b), with a corresponding maximum value of 250 mrem/yr, uncorrected for background. In an effort not to discount any reports of skyshine levels, these measurements and the PNL data are used in this report.

A special micro-R meter survey (Nellesen 1994) conducted along the 100 N shoreline for comparison to the instrument readings obtained by PNL (PNL 1993 and PNL 1994) indicated annual measurements ranging from 88 mrem/yr and 228 mrem/yr. This survey confirms the range of skyshine exposure rates reported by PNL.

In addition to the direct radiation exposures along the N-Area shoreline, the Columbia River contains radionuclides that may contribute to public exposure. The river is routinely sampled for those radioactive materials that are most likely to appear in N Reactor liquid effluent. Concentrations of the radioactive materials in the river are reported in both the *Hanford Site Environmental Report* (PNL 1994) and the *Environmental Monitoring Annual Report* (WHC 1994b). Data from the *Hanford Site Environmental Report* provide concentrations of radionuclides in the Columbia River, while the *Environmental Monitoring Annual Report* provides concentrations of radionuclides in discharges to the Columbia River. From these data, only the tritium results (~29,000 pCi/L) are of significance. All other radionuclide concentrations are less than 5 pCi/L, in their aggregate (exclusive of the 5.1 pCi/L total activity from the gross alpha and beta measurements.) The gross alpha and beta measurements are not radionuclide specific, and have been discounted for the purpose of this report.

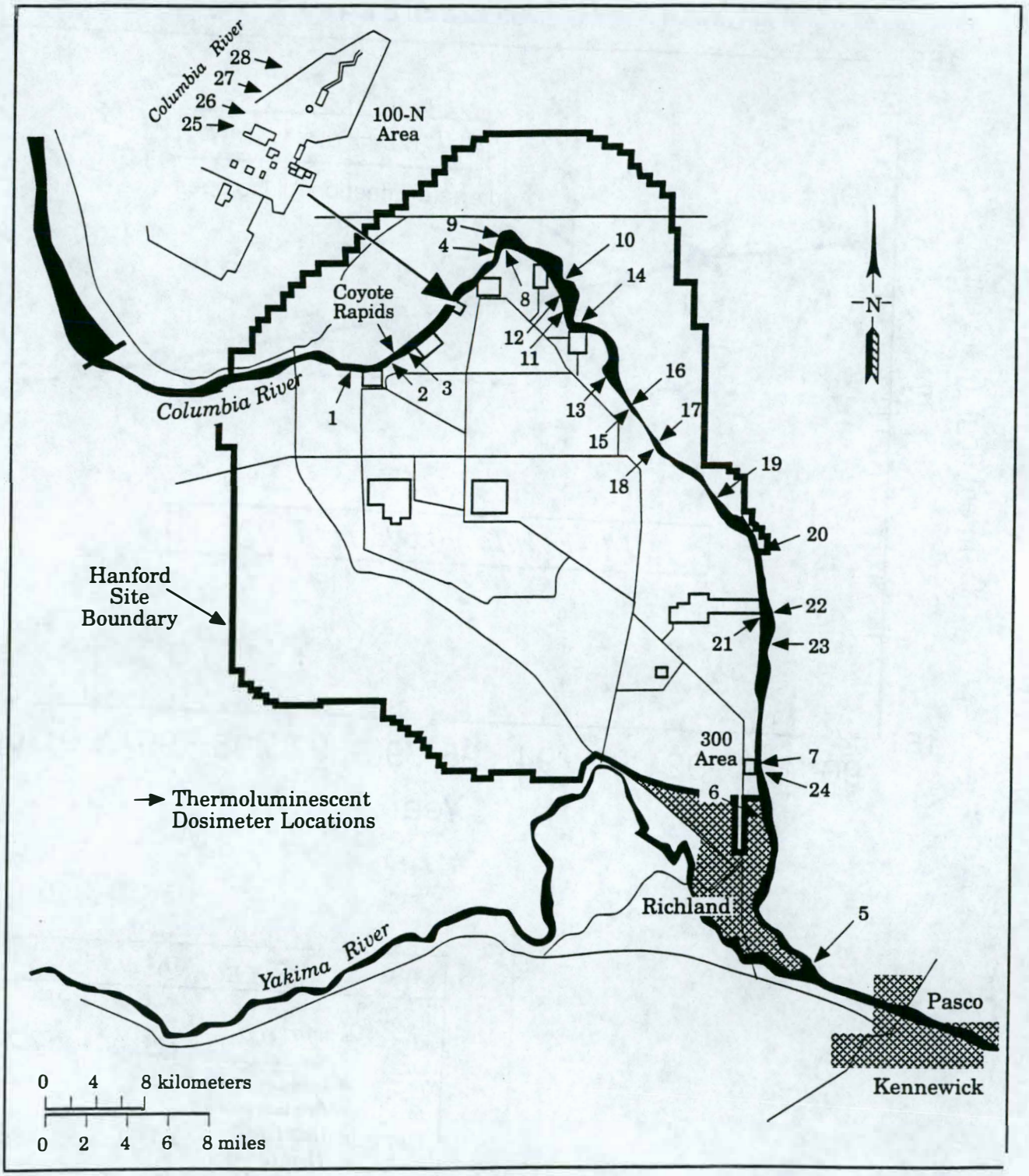
Figure 4. N-Springs Skyshine Decay Estimate.



LEGEND

■	= *WHC TLD*
1n	= *Natural Log (Mathematical Function)*
I	= *Intensity at Time t*
Io	= *Original Intensity*
T 1/2	= *Half Life*
t	= *Time Between I and Io*
●	= *Projected TLD Data*

Figure 5. Thermoluminescent Dosimeter (TLD) Locations and Station Numbers Established by PNL on the Hanford Reach of the Columbia River.



Source: PNL 1993

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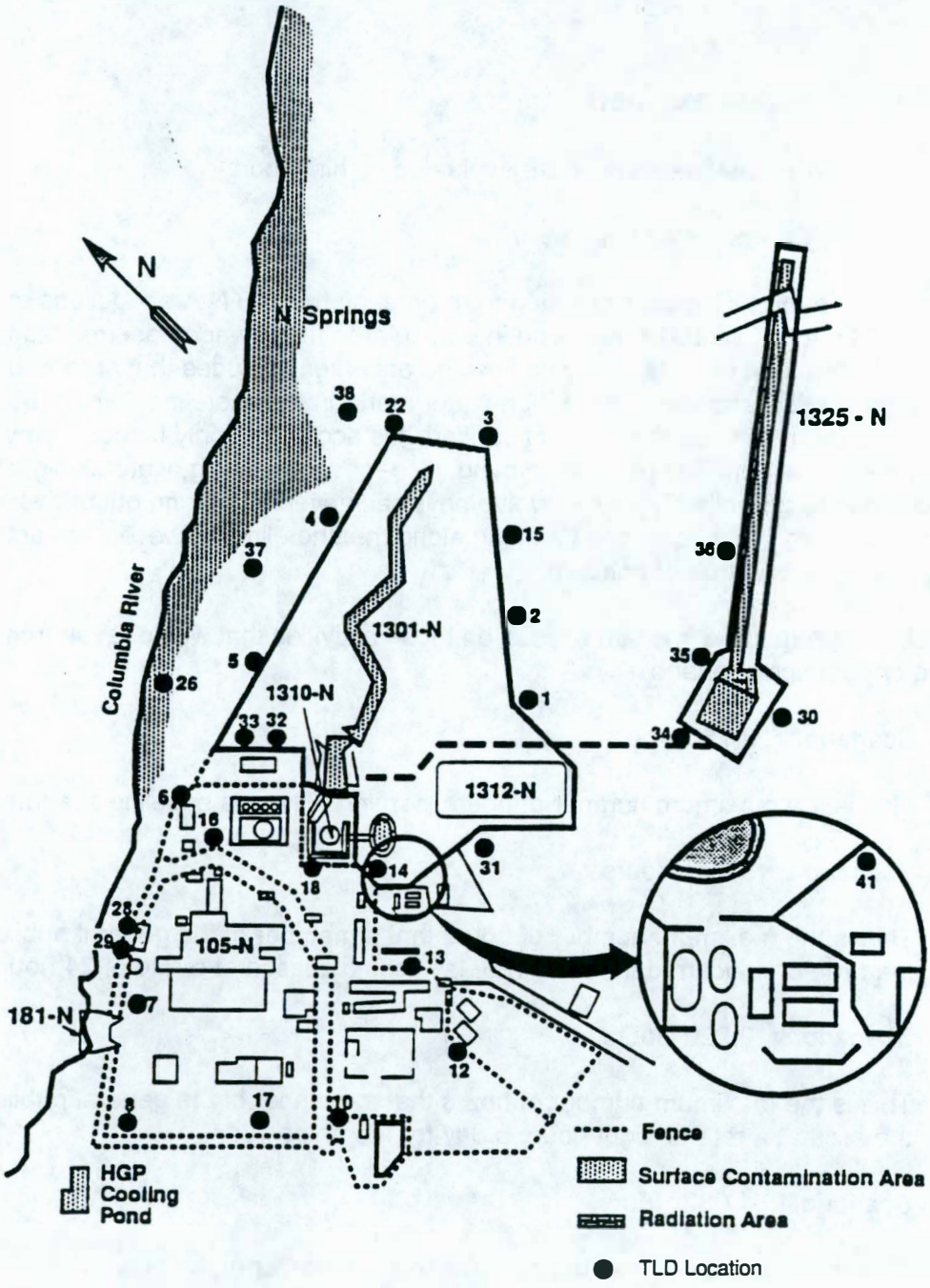
Figure 6. Thermoluminescent Dosimeter Locations (TLD) in the 100 N Area.



Source: WHC 1994

3.1.2 Data Analysis

The TLD data was used to estimate public exposure from 1301-N/1325-N because TLD's are placed in the same position each year, are relatively energy-independent, and are continually measuring radiation levels. The appropriate TLD stations selected for use in this report (PNL 26 and WHC 25, 26, 27, and 28) are based on the hand-held surveys presented in Figures 2 and 3.

3.2 Exposure Assessment

Both direct and indirect exposures are evaluated in this report.

3.2.1 Direct Exposure Assessment

Although the public is legally prohibited from entering the 100 N Area, access to the shoreline along the Hanford Site 100 Areas, and in particular to the flowage easement lands adjacent to the 100 N Area, can be obtained. The flowage easement includes that area bounded by the Columbia River's waterline and the high-water mark on the shoreline (WHC 1991). The flowage easement (referred to as the "area of concern") is accessible only by boat or by swimming. Most recreational activities (e.g., swimming, skin- or scuba diving, waterskiing, and certain fishing styles [e.g., trolling]) would involve physical movement in and out of this area. Fishing from the shoreline or a boat, and camping along the shoreline, however, are activities that result in occupancy of the area of concern.

The following exposure scenarios focus on those activities that would result from a shoreline fishing or camping scenario.

- Scenario 1: 8,760 Hours

  This is the maximum number of hours, serving only as a baseline scenario.

- Scenario 2: 3,096 Hours

  This is the maximum number of hours that a member of the general public could occupy the area of concern during the 129 day fishing season at a rate of 24 hours a day.

- Scenario 3: 2,920 Hours

  This is the maximum number of hours that a member of the general public could occupy the area at a rate of eight hours a day for the entire year.

- Scenario 4: 1,032 Hours

  This is the maximum number of hours that a member of the general public could occupy the area at a rate of eight hours a day during the 129-day fishing season.

- Scenario 5: 888 Hours

  This is the maximum number of hours that a member of the general public could occupy the area of concern at a rate of 24 hours a day for two days of each week during the fishing season (a total of 37 weekdays).

- Scenario 6: 296 Hours

  This is the maximum number of hours that a member of the general public could occupy the area of concern at a rate of eight hours a day for two days of each week during the fishing season.

3.2.2 Indirect Exposure Assessment

In addition to exposure to direct radiation as a result of occupancy in the area of concern, an individual could theoretically be exposed by drinking water from the river, eating fish taken from the river, eating sediments from the bottom of the river, or swimming in the river. Each of these scenarios was examined by PNL (PNL 1994) for the "maximally exposed individual" (MEI), and for the sportsman who eats game (including fish). In their aggregate, these exposure scenarios represent an annual dose of less than 0.2 mrem/yr. Although of little significance, a value of 1.0 mrem/yr has been added to the TLD data from PNL and WHC to account for indirect exposure in the Table 1 presentation of radiation exposures for the various occupancy scenarios one through six.

Table 1. Comparison of Radiation Exposure Scenarios Based on TLD Data[a] 1301-N/1325-N Skyshine.

Exposure Scenario	Occupancy Time (Hr/Yr)	Exposure Including Background				Exposure Subtracting Background			
		PNL		WHC		88 mrem/yr background		100 mrem/yr background	
		Avg[b]	Max[c]	Avg[d]	Max[e]	Avg[b]	Max[c]	Avg[b]	Max[c]
1	8,760	198	257	211	251	110	169	98	157
2	3,096	71	91	75	89	40	60	35	56
3	2,920	67	86	71	84	37	57	33	53
4	1,032	24	31	26	30	14	21	12	19
5	888	21	27	22	26	12	18	11	17
6	296	8	10	8	9	5	7	4	6

Notes:
a Annual doses include 1.0 mrem/yr from other exposure pathways
b Average PNL exposure rate is 197 mrem/yr.
c Maximum PNL exposure rate is 256 mrem/yr.
d Average WHC exposure rate is 210 mrem/yr.
e Maximum WHC exposure rate is 250 mrem/yr.

According to PNL (PNL 1994), the direct radiation background rate from varies from 88 mrem/yr (~10 μrem/yr) for locations outside the 100 N Area to 100 mrem/yr (~11.4 μrem/yr) for locations along the perimeter of the Hanford Site. Also included in Table 1 are the exposure scenario results corrected for this background. The PNL TLD data were used for the background corrected values, rather than the WHC data, because PNL had four stations versus one WHC station, and because PNL reported the highest maximum value.

When corrected for background, the exposures in Table 1 range from a low of 4 mrem/yr to a maximum of 169 mrem/yr for continuous occupancy at the area of concern. Because access to the area of concern is limited to the Columbia River and because access is prohibited by law, it is not reasonable to assume continuous occupancy. Such occupancy would be noticed by maintenance or environmental sampling personnel and by Hanford Site security forces. In addition, the Washington State Department of Fish and Wildlife patrols the entire river weekly during the spring, summer, and fall, and twice a month during the winter. In conjunction with the Hanford Site security forces, this agency has enforcement authority for removal of trespassers.

3.3 Interpretation of the Data

The foregoing discussion indicates that existing institutional controls are sufficient to limit a trespasser from attempting to continuously occupy the area of concern. The chances that existing institutional controls would identify and remove the trespasser are proportional to the amount of time the intruder occupies the area of concern. In other words, the longer intruders remain, the more likely they are to be identified and removed. Scenarios 5 and 6 are selected as the most realistic scenarios because they include occupancy during the fishing season and do not rely on institutional controls to remove an intruder from the area of concern. It has been assumed that trespassers (scenarios 1 through 4) would be identified and removed before they could accumulate as many hours as in scenarios 5 and 6, where occupancy is limited to the fishing season two days each week. The decision on whether there is an immediate threat to the public from 1301-N/1325-N skyshine has been based on scenarios 5 and 6. Based on these exposure scenarios, it is highly unlikely that any member of the public would receive a dose above the annual 25 mrem/yr limit from 1301-N/1325-N skyshine.

4.0 RECOMMENDATIONS

Because exposures to the public from 1301-N/1325-N skyshine are less than regulatory limits, no pre-remedial action has been identified for 1301-N and 1325-N.

5.0 REFERENCES

Dataquest, 1993, *Cost Reference Guide for Construction Equipment*, Dataquest Inc., San Jose, California.

DOE, 1993a, *Limited Field Investigation Report for the 100-NR-1 Operable Unit*, DOE/RL-93-80, Draft A.

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WHC, 1991, *1301-N Shoreline Dose Reduction Study*, Westinghouse Hanford Company, WHC-SD-NR-ES-009, Revision 0, December 20, 1991.

WHC, 1994a, *Engineering Study of "1301-N Shoreline Dose Reduction Study," The Skyshine Problem*, WHC-SD-NR-ES-009, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994b, *Environmental Monitoring Annual Report, CY 1993*, Westinghouse Hanford Company, WHC-EP-0573-2/UC-570, July 1994.

WHC, 1994c, *Runoff Estimates for Trenches 1301-N and 1325-N*, Draft Copy, Westinghouse Hanford Company, Richland, Washington.

WHC, 1993d, *N Reactor Deactivation Program Plan,* WHC-SP-0615, Rev.4, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX A

ALTERNATIVES

1.0 SKYSHINE ABATEMENT ALTERNATIVES

The following two alternatives were evaluated in a draft of this report. Although no action is recommended and an evaluation of alternatives is not warranted, the details of this evaluation from a previous draft are included in this appendix. The two alternatives evaluated follow:

1) Perform no additional action and allow the radionuclides in 1301-N and 1325-N to decay;

2) Cover the cribs and trenches with a shielding material to reduce the exposure rate.

An additional alternative targeting source removal was not evaluated because this remediation effort would subject remediation workers to excessive radioactive exposures. In 1993 and 1994, exposure rate readings indicated as much as 1 R/hr within 1 m above the concrete surface of the 1301-N crib.

The alternatives presented were evaluated for effectiveness, implementability, and cost. An alternative is considered effective in protecting the public when exposure levels are below the 100 mrem/yr limit (the 100 mrem/yr limit was used in previous drafts). Both alternatives are equally effective in this regard because current limits are met; however, the cover alternative will further reduce skyshine radiation levels. Whether or not the alternative can be used depends on the ease of its implementation and the resulting exposure to remediation workers.

2.0 NO ACTION ALTERNATIVE

2.1 No Action Alternative Definition

Radiation emanating from 1301-N and 1325-N is believed to be the primary source of skyshine along the shoreline of the Columbia River at the 100 N Area. The no action alternative involves continuing access restrictions to 1301-N/1325-N, continuing the *1301-N/1325-N Closure Plan/Corrective Measures Study*, and maintaining the existing radiation monitoring program.

2.2 Advantages Associated with No Action Alternative

Except for costs incurred from ongoing custodial maintenance of 1301-N/1325-N, there would be no other significant expenditures until closure of the cribs was begun. In addition, remediation workers would not be subject to excessive radiation exposures because no action would occur near the cribs/trenches.

2.3 Disadvantages Associated with No Action Alternative

The no action alternative is disadvantageous because current radiation levels in the 100 N Area are not abated. However, both physical and administrative controls limit access to areas producing the elevated exposure rates. Personnel radiation exposure monitoring data indicate

that these controls are effective in limiting 100 N Area personnel exposures to acceptable levels.

3.0 COVER ALTERNATIVE

3.1 Cover Alternative Description

The cover alterative involves placing cover material over 1301-N and 1325-N to shield the radioactive material. In addition, the ongoing radiation monitoring program, access restrictions, and *1301/1325 Closure Plan/Corrective Measure Study* would continue.

3.2 Comparison of Materials Used to Achieve the Cover Alternative

3.2.1 Project Criteria

In order to identify preferred materials to be selected for the cover, three criteria were selected:

1) **Effectiveness**: This criterion evaluates whether the alternative is effective at maintaining the exposure limit below 100 mrem/yr, the current DOE order 5400.5 limit on public exposure.

2) **Implementability**: This criterion evaluates ease of placement and convenience of shielding cover removal. This criterion also includes a discussion on the risk to remediation workers placing the cover over the cribs/trenches.

3) **Project Cost**: This criterion evaluates cost effectiveness.

3.2.2 Shielding Media Eligible for Consideration

1) Original Spoil. Spoil includes material that remains near the 1301-N and 1325-N units. Spoil would be returned to the excavations where it originated.

2) Pit Run Gravel. Pit run gravel is obtained from other Hanford Site sources and subsequently trucked to the 1301-N and 1325-N units.

3) Concrete Panels. Concrete panels that are fabricated onsite would be rigged and crane-placed over the 1301-N and 1325-N units.

4) Thixotropic Mud. Thixotropic mud is a form of Bentonite that would be delivered to the Hanford Site in rail cars, transferred to pneumatic tank trailers, and educted into the trenches pneumatically. After placement of the mud, a 1-ft-thick layer of native soil would be placed immediately above the thixotropic mud to prevent the mud from blowing away.

A computer program was used to determine the shielding thicknesses required for fill materials. The results follow: To reduce from the present reading of 1 R/hr down to 100 mrem/hr, use 24

in. of pit run gravel or original spoil, or 17 in. of concrete, or 32 in. of thixotropic mud, or 5.6 in. of steel plate, or 39 in. of water.

3.2.3 Shielding Media Ineligible for Consideration

1) A re-engagement of the water blanket was dismissed as a possibility because of the following two considerations:

   a. Flooding the 1301-N and 1325-N units with water would mobilize radioactive contamination, thereby producing a "new" waste stream.

   b. Once produced, the "new" waste stream would migrate downward into the groundwater which, by definition, would constitute an "uncontrolled release."

2) Sheet Steel available from recycling operations was considered impractical for the following reasons:

   a. The thickness of steel required (5.6 in.) would create a static load of 250 lb/ft^2 on top of the existing concrete panels, surpassing the design stress for the panel structure, which is 56 lb/ft^2.

   b. Multiple handling and placement activities (e.g., the placement of 5 layers of 1.1-in.-thick plate steel) would introduce increased opportunities for industrial accidents and radiological exposure.

It has been assumed that the existing concrete panels on top of 1301-N and 1325-N are too weak to hold a cover; therefore the panels would break and fall into the crib/trench if a cover were placed on top of them.

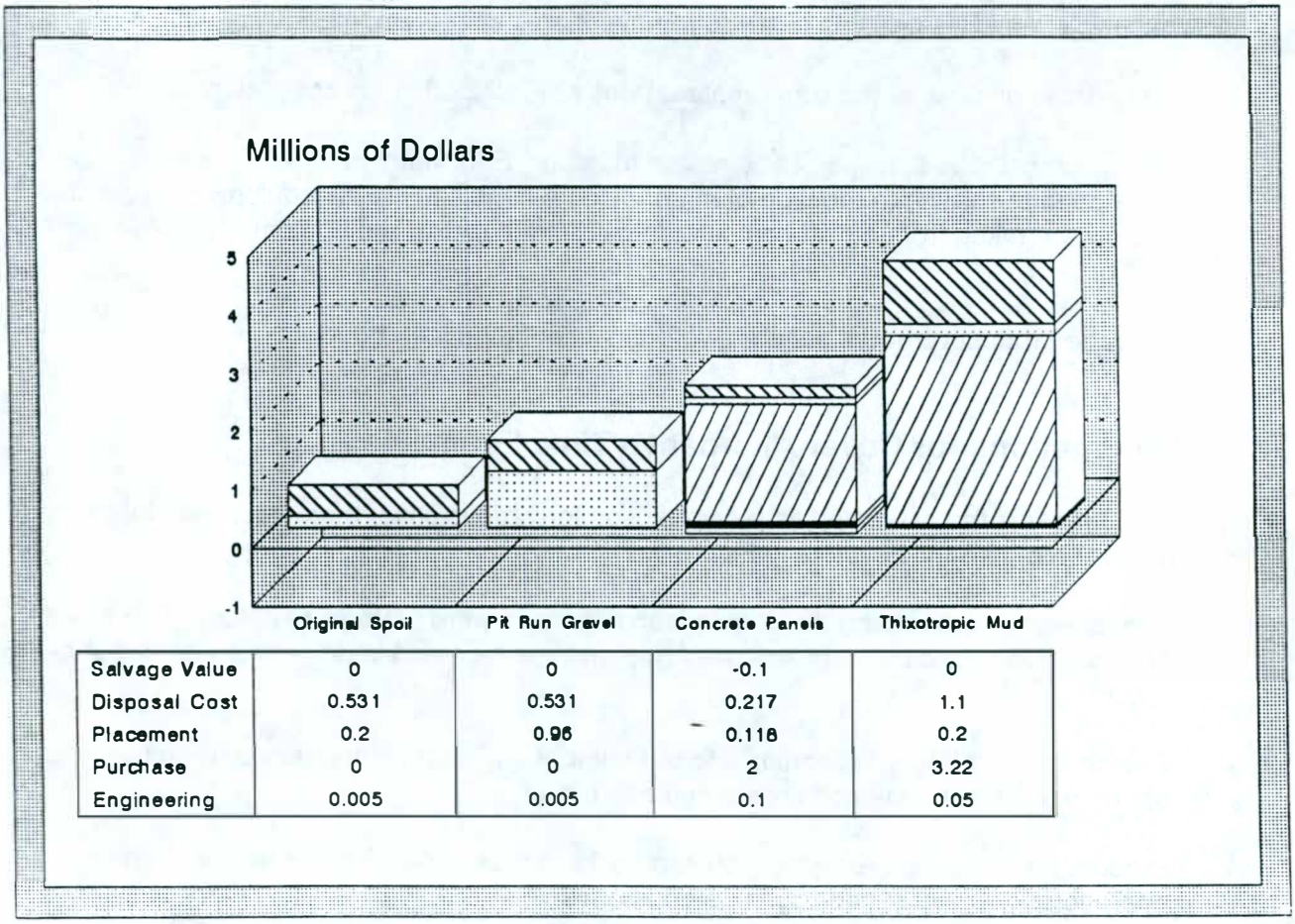
3.3 Assumptions for Cover Alternative Cost Estimate

Figure A-1 presents estimated remediation costs.

Costs used in developing the comparison estimates were uniformly applied. Therefore, any variations in actual numbers had no impact on visible differences among the four options. Operating labor, equipment operation, equipment rental, and materials were included in determining cost comparisons. Other comparison factors are as follows:

- Purchased-material costs shown in Figure A-1 were taken directly from vendor quotes. Equipment operating costs were developed from equipment hours required to perform the work.

Figure A-1. Remediation Costs for 1301-N/1325-N.



	Original Spoil	Pit Run Gravel	Concrete Panels	Thixotropic Mud
Salvage Value	0	0	-0.1	0
Disposal Cost	0.531	0.531	0.217	1.1
Placement	0.2	0.96	0.118	0.2
Purchase	0	0	2	3.22
Engineering	0.005	0.005	0.1	0.05

- Labor costs are for operating labor only, and reflect Hanford Site bargaining unit rates (with fringes).

- The cost to remove the newly installed cover once the *1301-N/1325-N Closure Plan/Corrective Measure Study* is implemented has been included in remediation costs. This cost has been shown to indicate that if mud were placed on the existing concrete panels, it would be twice as costly to remove than if spoil were used.

- The cost to dispose of the cover material was not included in the cost estimate.

- All equipment was assumed to be rented monthly. Equipment productivity was developed according to the type of material to be handled. Hourly equipment operating costs were taken from a cost comparison guide for construction equipment (Dataquest 1993).

- Average productive hours per shift were assumed to be 5.25 hours.

3.4 Assumptions for Cover Alternative Time Estimates

Figure A-2 presents the estimated time comparison for various cover materials. The following assumptions were used in developing Figure A-2:

- Times used in developing the comparison estimates were uniformly applied. Therefore, any variations in actual numbers used had no impact on visible differences among the options.

- Design time is directly proportional to the number and kind of materials and unit operations involved in each considered alternative.

- Procurement time is directly proportional to the number and kind of materials and unit operations involved in each considered alternative.

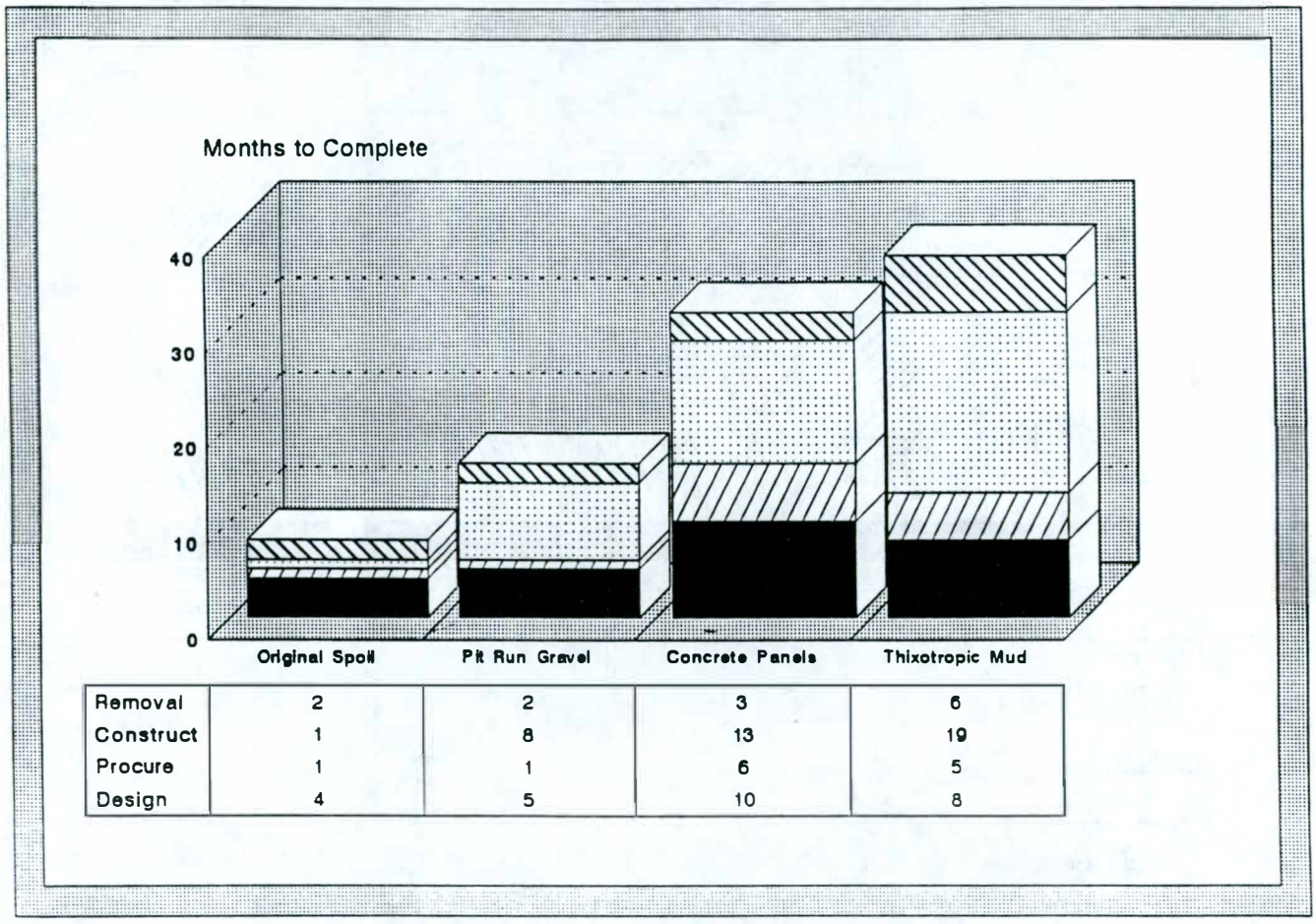
- Construction times are directly linked to the number and kind of materials used and unit operations engaged.

3.5 Assumptions for Cover Alternative Industrial Accident Potential

Figure A-3 presents the remediation estimated industrial accident potential comparison (including radiological exposure potential). The following assumptions were used in developing Figure A-3.

- Estimates were uniformly applied to determine the potential for accidents occurring during cover placements. Therefore, any variations in actual numbers used had no impact on visible differences among the four options. Accident potential units were developed for the design phase, procurement phase, and construction phase.

Figure A-2. Remediation Times for 1301-N/1325-N.

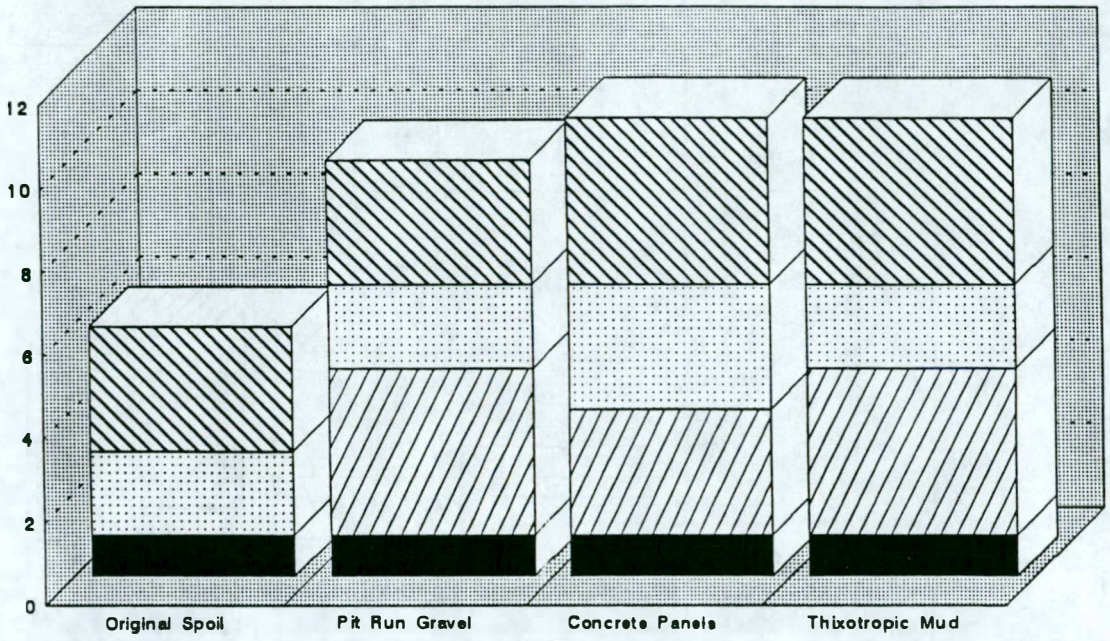


	Original Spoil	Pit Run Gravel	Concrete Panels	Thixotropic Mud
Removal	2	2	3	6
Construct	1	8	13	19
Procure	1	1	6	5
Design	4	5	10	8

Figure A-3. Industrial Accident Potential for 1301-N/1325-N.

Skyshine

Discrete Number of Unit Operations



Removal	3	3	4	4
Construct	2	2	3	2
Procure	0	4	3	4
Design	1	1	1	1

A direct association can be made between the number of unit operations and the industrial accident/radiological exposure potential. Simply put, the more unit operations there are, the greater the opportunity for accidents and/or exposure. On the other hand, elementary operations are easier to control because they have fewer unit operations.

Other criteria follow:

- The number of unit operations associated with each phase of every alternative was determined.
- Unit operations were considered for both off-site and on-site activities. In this instance, pit run gravel would be loaded elsewhere and trucked to 100 N Area represented two unit operations.
- For the purposes of this report, individual operations were not analyzed other than to identify an operation's accident potential.
- Multiple unit operations were assigned to multiple-phase unit operations; for example, placing and removing forms may be represented by two unit operations.

3.6 Advantages of the Cover Alternative

The data summarized in Figure A-4 show that the cover alternative with existing spoil has cost, time, and safety advantages. A study of the evaluation criteria provided the following results:

a) The cover with the spoil alternative has the fewest opportunities for interruption and is judged to be the simplest cover to install.

b) Substituting pit-run gravel for original spoil introduces quarry and transportation activities to the process, creating opportunity for problems and complications.

c) The placement of concrete panels or the layering of thixotropic mud creates the need for special placement apparatus, as well as additional personnel requirements.

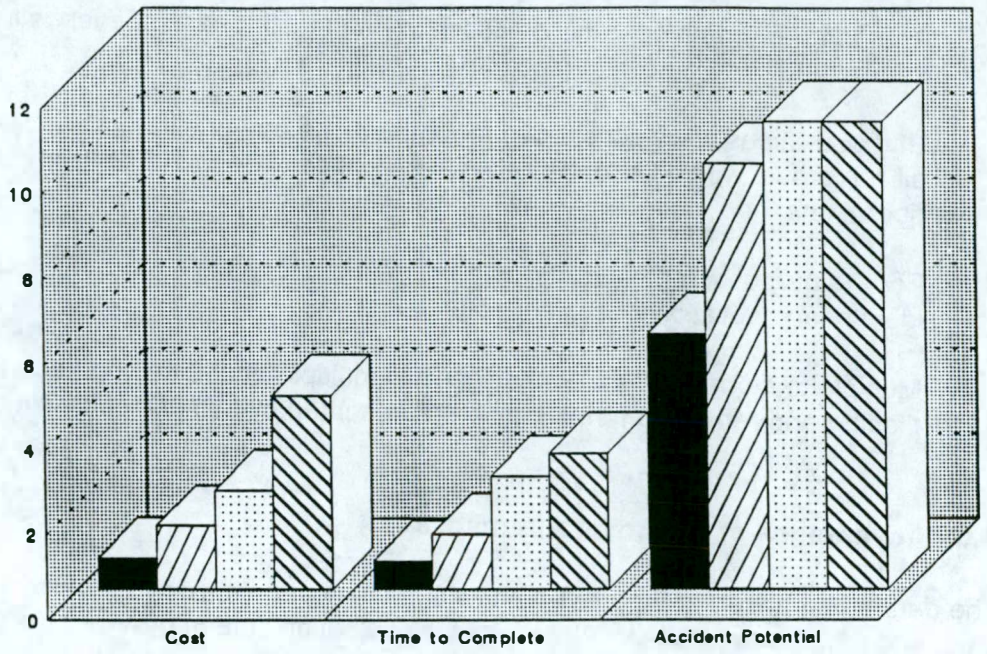
In consideration of "a" through "c" above, the cover with the spoil alternative offers the safest and simplest cover to install and maintain. Therefore, if the skyshine phenomenon is to be abated, existing spoil (or suitable equivalent) should be used to accomplish the shielding activity.

3.7 Disadvantages of the Cover Alternative

The disadvantages of placing a cover over the 1301-N and 1325-N are the expected high direct radiation exposures to remediation workers and air emission concerns when the concrete panels are broken. Breaking the concrete panels also provides an opportunity for

Figure A-4. Remediation Alternative Totals for 1301-N/1325-N.

Skyshine



Original Spoil	$ 0.736	0.67	6
Pit Run Gravel	$ 1.5	1.3	10
Concrete Panels	$ 2.335	2.67	11
Thixotropic Mud	$ 4.57	3.2	11

Units: Cost in Millions, Time in Years, Industrial Accidents in Potential

ecological exposure. Covering the units would require significant administrative, engineering, and protective clothing controls. Significant site preparation, and health and safety issues would need to be addressed to keep exposures as low as reasonably achievable (ALARA).

4.0 IMPLEMENTATION SCHEDULE

4.1 No Action Alternative

All the components of the no action alternative are in place and do not require implementation.

4.2 Cover Alternative

In implementing the cover alternative, the following four-phase approach should be established.

During the first phase, the best scheme for the placement of shielding material will be developed. An engineering analysis will be performed to determine the best scheme for placement of the shielding material, which should take 60 days to implement. The following objectives should be pursued for this analysis:

1) Minimize dust emissions to the point where an "air permit" would be unnecessary

2) Reduce opportunities for excessive radioactive exposure

3) Reduce opportunities for industrial accidents

4) Preserve the continuity of usefulness in vector and weed control as provided by the existing concrete panels

5) Pursue a shielding placement scheme that does not complicate final removal efforts expected to be performed at a later date, as determined in the *1301-N/1325-N Closure Plan/Corrective Measure Study*

During the second phase, construction documents will be developed. The engineering plans and specifications will comprise the bidding package. The estimated time to complete this phase is four months.

The following considerations should be implemented for the project specifications:

1) Design Considerations

- For convenience, continuity, and cost effectiveness the alternative chosen for the abatement of skyshine should be consistent with remediation practices planned for other areas at the Hanford Site.

- The shielding design should require little maintenance.

- The construction activities should be phased to accommodate pause periods. During such pause periods construction activities should stop long enough to allow for the collection and evaluation of skyshine reduction data.

  If, for instance, it is found that the skyshine phenomenon is adequately reduced after shielding the first third of unit 1301-N, no further abatement activity would be warranted. It is possible that the skyshine abatement action may be shortened or discontinued after partial shielding is complete.

- The grading plan must accommodate run-on/run-off control.

- The design must provide mechanisms for weed and rodent control.

- The design must be compatible with long-term (i.e., permanent) remediation goals for the skyshine units as determined in the *1301-N/1325-N Closure Plan/Corrective Measure Study*.

- Land surveying practices must adhere to standards that are presented in the *Standard Specifications for Geodetic Control Networks* (Federal Geodetic Control Committee [FGCC] 1984).

2) Related Work: In specifying the interim and final abatements for the skyshine phenomenon, the following elements of related work should be considered:

   - Skyshine units 1301-N and 1325-N should be covered in a way that is similar to other land disposal units (both in appearance and composition), except that the existing concrete panels should be used to minimize biotic transport pathways. If similarity is achieved, final remediation for the skyshine units may be accommodated through other work packages that target similar units. Exposure rates should be kept ALARA.

   - Custodial activities (e.g., weed and rodent control) should be combined with similar activities planned for other units.

   - Other 100 N Area environmental restoration projects must not be impeded.

During the third phase, work will begin. The estimated time to complete this phase is two months, if the preferred alternative of native spoil placement is used. During phase three, the installation of the shielding layer will be completed. The portions of the 1301-N and 1325-N units that have the highest surface dose rates be started first.

During the fourth phase, project acceptance and close out will take place. The estimated time to complete this phase is one month. The following activities must be accomplished: (1) Site survey control points established, (2) Skyshine phenomenon readings recorded, (3) As-built drawings prepared (complete with certifications), (4) Measurement and payment for services rendered, and (5) Area cleaned; work crews and equipment evacuated.