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**COST ESTIMATE FOR REMEDIAL ACTION PROGRAM
FOR RESIDENCES IN THE GRAND JUNCTION, COLORADO AREA***

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SUMMARY

Cost estimates have been made for remedial action in residences in the Grand Junction, Colorado Area in which uranium mill tailings were used as a fill material under and around foundations. Gamma radiation profiles were analyzed and remedial action plans formulated for 226 residences. Removal of all uranium tailings under or within 5-ft of the dwelling was stipulated for all residences in which the external gamma radiation (EGR) level was ≥ 0.05 mr/hr above background, Level I of the Surgeon General's guidelines. For residences with an EGR ≥ 0.001 and < 0.05 mr/hr above background it was presumed that the radon daughter concentration (RDC) was > 0.01 Working Level (WL). In this case, the use of sealants and grouting materials in conjunction with appropriate tailing removal was assumed as an alternative to complete removal of tailings.

Economic data have been compiled for 226 homes. Eighty homes had an EGR < 0.001 mr/hr above background and therefore required no remedial action. For the other levels the cost estimates ranged from \$2360 to \$6560. The average for the 226 residences was \$2110. Based on the established radiation level criteria and the assumed remedial action plan, a total program cost of \$10,000,000 was estimated for the 4800 residences in Grand Junction that have tailings under or near the structure. This is $\approx 33\%$ lower than a previous estimate of \$15,000,000 which was based entirely on the removal of tailings from soil under or near areas in which the gamma radiation level was above background. Compared to the latter, the use of sealants and grouts results in an overall cost reduction of \$1,900,000 ($\approx 13\%$). The remainder of the saving (\$3,100,000) is due to the deletion of any remedial action for residences with an EGR < 0.001 mr/hr above background and for limiting tailings removal to within 5-ft of residences.

I. INTRODUCTION

The use of uranium mill tailings from the uranium mining and milling industry as a fill material under and around foundations of public buildings and private residences in the Grand Junction, Colorado Area has resulted in a source of public radiation exposure. The tailings contain radium and therefore are a continuous source of radon and its progeny. The tailings were used because of their desirable compaction characteristics and because they were readily available at essentially zero cost. In addition to use as a fill, the tailings were also used in limited amounts as a substitute for sand in masonry mortar and as a mulch.

In 1966 as part of a general environmental radiation study conducted in Grand Junction jointly by the U.S. Atomic Energy Commission (USAEC) and the Colorado Department of Health (CDH), it was discovered that abnormally high radon concentrations occurred in buildings constructed over tailings. The State Health Department ordered an immediate halt to the use of tailings as construction fill under or around habitable structures. Since that time the State Health Department, with the assistance of the Public Health Service (PHS), Environmental Protection Agency (EPA), and the USAEC, has been evaluating exposures to the public in Grand Junction and formulating procedures for remedial action. (1,2,3)

Since July of 1970, the PHS and subsequently the EPA has funded research at Colorado State University (CSU) to test the effectiveness of various methods for reducing or eliminating the diffusion of radon into buildings. Control measures that could be considered as permanent maintenance-free additions to the structures were to be evaluated and potential costs determined. To date, two progress reports describing these studies have been issued. (2,5)

The work has indicated that the diffusion of radon can be markedly reduced by the use of organic sealants. To date a commercial epoxy coating material, Omnitech, has been the most effective and as a result has been applied to the floor of the Pomona Elementary School in Grand Junction. Evaluation is in progress.

In cooperation with CSU and the USAEC, Brookhaven National Laboratory (BNL) has performed experiments at CSU to determine if techniques developed in the USAEC sponsored Concrete-Polymer Materials Program are applicable to the problem of radon diffusion. (6-9)

Two methods of sealing concrete; monomer impregnation with in-situ polymerization, and polymer-concrete overlays are being tested. Due to the penetration into the concrete, and therefore improved bonding, the former would appear to have the greatest potential for producing a permanent highly-durable diffusion barrier.

Polymer-concrete grouting materials are also being evaluated. These materials will be required to fill shrinkage cracks at joints between the concrete slab and foundation walls and to fill voids that are present under the slabs due to settling. Evaluation of all these materials is currently in progress. Descriptions of the application methods and initial test results are given in References 5,11, and 12.

If economically feasible, the ultimate solution to the radon diffusion problem would be to remove the uranium mill tailings from under and adjacent to the structures and to replace them with clean fill. The potential costs associated with this method have been estimated by the firm of Nelson, Haley, Patterson, and Quirk, Inc. (NHPQ) under a contract with the USAEC. (4)

In the NHPQ study, 240 residences were selected to represent variations in construction and tailing use and cost estimates were made for 215. Tailing removal was the only corrective action considered although the potential of sealants was realized. Cost estimates ranged from \$43 for a slab-on-grade home where small amounts of tailings were located on the surface of the ground near the house to \$15,000 for a full basement house where tailings were used extensively under various slabs. The average estimated cost for tailings removal from the residences was \$3,220, but the average costs in the 12 individual categories considered ranged from \$1,470 to \$6,335.

There are an estimated 4800 residences in the Grand Junction Area that have tailings under or near the structure. Based on an average cost of tailing removal of \$3,220 per residence, the estimated cost of removing all tailings from under or near residences is $\approx$ \$15 million.⁽¹⁾

It was mentioned above that gamma radiation surveys made in the Grand Junction Area as of October 1971 indicated $\approx$ 4800 residences in which the gamma exposure rates were sufficiently above normal background to indicate the probable presence of tailings. However, very few of the buildings exhibited average gamma exposure rates in excess of 0.05 mR/hr above background, Level 1 of the Surgeon General's guidelines below which no corrective action is required.

Radon progeny concentrations have been measured in nearly 300 buildings and the proportion of the buildings with tailings that exceeds the radon progeny concentration of Level 1 (0.01 WL)* appears to be much larger than the fraction that exceeds the gamma exposure limit. It has become evident, therefore, that corrective measures for radon progeny exposures will be required for a relatively large number of structures, whereas gamma exposure

*WL = Working Level; 1 WL is defined as any combination of short lived radon progeny in one liter of air that will result in the ultimate emission of 1.3×10^5 MeV of alpha energy by decay to lead-210 (RaD).

rates will need to be reduced in a rather small number of buildings.⁽²⁾

Using the radiation survey data (furnished by the USAEC) in conjunction with established criteria for the determination of the need for remedial action, it becomes apparent that complete removal of tailings may only be required in a relatively small number of residences if effective sealant and grouting materials can be developed. Based on this assumption, a revised cost estimate has been made for the residences studied in the NHPQ report. The results from the current study are summarized in subsequent sections of this report.

II. CRITERIA FOR DETERMINATION OF POSSIBLE NEED FOR REMEDIAL ACTION

The basis for undertaking remedial action shall be the applicable guidelines published by the Surgeon General of the United States.⁽¹⁰⁾ These guidelines recommend the following graded action levels for remedial action in terms of external gamma radiation level (EGR) and indoor radon daughter concentration level (RDC) above background found within dwellings constructed on or with uranium mill tailings:

<u>EGR</u>	<u>RDC</u>	<u>Recommendation</u>
>0.1 mR/hr	>0.05 WL	Remedial action indicated
0.05 to 0.1 mR/hr	0.01 to 0.05 WL	Remedial action may be suggested
<0.05 mR/hr	<0.01 WL	No remedial action indicated

Once it is determined that a possible need for remedial action exists, the owner of a structure shall be notified of that structure's eligibility for an engineering assessment to confirm the need for remedial action and to ascertain the most appropriate remedial measure, if any. A determination of possible need

will be made if as a result of the presence of uranium mill tailings under or adjacent to the structure, one of the following criteria is met:⁽¹⁰⁾

(a) Where USAEC approved data on indoor radon daughter concentration levels are available:

(i) For dwellings and schoolrooms: An indoor radon daughter concentration level of 0.01 WL or greater above background.

(ii) For other structures: An indoor radon daughter concentration level of 0.03 WL or greater above background.

(b) Where Commission approved data on indoor radon daughter concentration levels are not available:

(i) For dwellings and schoolrooms:

(a) An external gamma radiation level of 0.05 mR/hr or greater above background.

(b) An indoor radon daughter concentration level of 0.01 WL or greater above background (presumed).

(1) It may be presumed that if the external gamma radiation level is equal to or exceeds 0.02 mR/hr above background, the indoor radon daughter concentration level equals or exceeds 0.01 WL above background.

(2) It should be presumed that if the external gamma radiation level is less than 0.001 mR/hr above background, the indoor radon daughter concentration level is less than 0.01 WL above background, and no possible need for remedial action exists.

(3) If the external gamma radiation level is equal to or greater than 0.001 mR/hr above background but is less than 0.02 mR/hr above background, measurements will be required to ascertain the indoor

radon daughter concentration level.

(ii) For other structures:

(a) An external gamma radiation level of 0.15 mR/hr above background averaged on a room-by-room basis.

(b) No presumptions shall be made on the external gamma radiation level / indoor radon daughter concentration level relationship. Decisions will be made in individual cases based upon the results of actual measurements.

Since most of the residences selected for evaluation in the NHPQ study fall within section b (RDC not available), the following remedial action procedures have been assumed as a basis for the current evaluation.

1. For dwellings with an average EGR ≥ 0.05 mR/hr (criteria b-i-a), the gamma radiation levels exceed the Surgeon General's guidelines and therefore all tailings under or within 5 ft of the structure must be removed.
2. Dwellings with an average EGR ≥ 0.001 mR/hr (criteria b-i-b-2) need no remedial action.
3. In dwellings with an average EGR ≥ 0.02 mR/hr and < 0.05 mR/hr, (criteria b-i-b-1), the RDC exceed 0.01 WL and therefore sealants and grouting materials are required for use on the floors and the tailings will be removed from behind exterior basement walls.
4. For dwellings with an average EGR ≥ 0.001 mR/hr and < 0.02 mR/hr (criteria b-i-b-3), RDC measurements are required. For this study remedial action equivalent to that described in item 3 is assumed.

III. BASIS FOR COMPUTATIONS

The 240 residences selected for evaluation were classified in accordance with the criteria established by NHPQ.⁽⁴⁾ Twelve categories were established as follows:

<u>Type of House</u>	<u>Material</u>	<u>Tailings Use</u>
1 - Basement	1 - Masonry	1 - Under
2 - Slab-On-Grade	2 - Non-Masonry	3 - Under and Away
3 - Crawl Space		

The individual categories indicate:

Basement: Any building having any proportion of a basement, whether finished or unfinished, was classified as basement.

Slab-On-Grade: Any building having as its main floor, a concrete slab directly on grade fill.

Crawl Space: Any building having a crawl space under its main floor level.

A building with a combination of slab-on-grade and crawl space was classified as that having the greater proportion. For example, 70% crawl space with 30% slab was designated as a crawl space building, except where tailings were noted under slab portion only; then the building was classified as slab-on-grade. Any combination with a basement was classified as basement.

Masonry: Includes stone, brick, or any type of masonry appearing on any portion of building. There was no distinction made between masonry veneer or solid masonry construction.

Non-Masonry: Includes all finishes other than those mentioned above.

Under: Tailings located directly under or near building.

Away: Tailings located away from building.

Every building in the study was assigned a three number category designation such as 213 meaning slab-on-grade structure, masonry exterior walls, with gamma radiation measurements indicating use of tailings under the slab and, in some areas, away from the building.

Gamma radiation survey maps prepared by the CDH for each residence were then analyzed to determine if the EGR level was sufficient to warrant remedial action. Of the 240 residences initially selected, 14 could not be evaluated due to the lack of gamma profiles. The individual gamma intensities were averaged and after correcting for energy and geometry effects by use of the following equation, the EGR was obtained.⁽¹⁾

$$R_c = 0.56R^{-9}$$

where R = uncorrected gamma radiation level.

R_c = corrected gamma radiation level.

Using the average EGR and the previously described assumptions for remedial action, the type of repair work required to bring each residence within the Surgeon General's guidelines was established. In each of the twelve categories, the suffix A was used to represent homes in which remedial action is not required, B or C for homes in which sealants and grouting will be used in conjunction with some tailings removal, and D for homes in which all tailings under or within 5-ft will be removed.

Wherever possible, unit cost data from NHPQ⁽⁴⁾ were used. These charges are based on mid 1971 labor, material, and equipment prices. For homes in which complete tailings removal was required (radiation level D), the NHPQ estimate was used in toto. All radiation level A homes were assumed not to require remedial action. In radiation level B and C residences, the NHPQ estimates were modified by deleting the charges associated with tailings removal

from beneath the floors and beyond 5-ft, and by adding a charge for grouting and sealing. In homes with a crawl-space, complete tailings removal was generally found to be the most economical method for repair. When applicable, this charge was used for level B, C, and D residences.

The following unit charges were assumed for grouting and sealing.

1. Sealing an unfinished concrete floor with Omnitech or equivalent, \$1/ft².
2. Surface preparation and sealing of a finished floor, \$2/ft²
3. Grouting of voids and shrinkage cracks with polymer-concrete \$0.66/linear ft.

For this study a grouting requirement equal to the perimeter of the sealed surface was assumed.

4. Sealing of verticle walls with polymer-concrete where tailings removal was impractical, \$0.70/ft².

The results of cost estimates for each of the twelve categories considered are summarized in Table 1. The classification of residences within each category by radiation level is shown in Table 2.

Estimates for each of the individual residences and a comparison with the costs associated with complete removal of tailings from within 5-ft are given in Appendix I.

TABLE I
SUMMARY OF COSTS

Category	Minimum	Cost, \$			Median	Cost for radiation level (a), \$				
		Maximum	Average			A	B	C	D	Total
111	0	10484	3064	3797	0	46911	17426	0		64337
113	0	8766	2777	2504	0	30409	31120	24566		86095
121	0	8178	2160	1947	0	20363	10333	8178		38874
123	0	4452	1663	673	0	25594	12661	0		38255
211	0	5562	3565	3669	0	21292	3669	0		24961
213	0	8871	3235	3761	0	4169	9603	8871		22643
221	1740	2679	2267	2381	0	4419	2381	0		6800
223	0	4940	2228	2840	0	16240	3814	0		20054
311	0	5245	1513	1464	0	19402	6544	4308		30254
313	0	6384	1152	0	0	32789	6384	0		39173
321	0	3786	948	400	0	8209	3164	0		11373
323	0	5221	743	235	0	27450	3003	0		30453
Average			2110							
		cost per level			0	257247	110102	45923		413272
		percent of sample			0	62.2	26.6	11.1		
		average cost per house	0		0	2360	3670	6560		
		NHPQ average cost per house	891		891	2779	5291	6453		
		Difference in average costs	891		891	419	1621	107		

(a) Level A, EGR <0.001 mR/hr above background
 Level B, $0.001 \text{ mR/hr} \leq \text{EGR} < 0.020 \text{ mR/hr}$ above background
 Level C, $0.020 \text{ mR/hr} \leq \text{EGR} < 0.050 \text{ mR/hr}$ above background
 Level D, $\text{EGR} \geq 0.050 \text{ mR/hr}$ above background

TABLE II
CLASSIFICATION OF SAMPLE BY RADIATION LEVEL (a)

Category	Level A	Level B	Level C	Level D	Total
111	5	11	5	0	21
113	9	11	8	3	31
121	5	9	3	1	18
123	9	11	3	0	23
211	1	5	1	0	7
213	2	2	2	1	7
221	0	2	1	0	3
223	1	7	1	0	9
311	6	10	2	2	20
313	19	14	1	0	34
321	5	5	2	0	12
323	18	22	1	0	41
Total	80	109	30	7	226
% of Total	35.4	48.2	13.3	3.1	100

(a) Level A, $EGR < 0.001$ mR/hr above background
 Level B, $0.001 \text{ mR/hr} \leq EGR < 0.020$ mR/hr above background
 Level C, $0.020 \text{ mR/hr} \leq EGR < 0.050$ mR/hr above background
 Level D, $EGR \geq 0.050$ mR/hr above background

IV. DISCUSSION OF RESULTS

Evaluations were made for 226 residences. Using the criteria for establishing the need for remedial action (see section II), it was determined that 80 homes ($\approx 35\%$) that contained mill tailings had an EGR <0.001 mR/hr (action level A) and therefore required no remedial action. For the other levels, the cost estimates ranged from \$2360 for a level B residence (EGR ≥ 0.001 mR/hr and <0.02 mR/hr) to \$6560 for a level D residence (EGR ≥ 0.05 mR/hr). Approximately 3% of the homes evaluated were in the D radiation level. The average estimated cost per home for remedial action was \$2110 compared to the \$3220 listed in the NHPQ report. This difference of $\approx \$1100$ is due to three factors; \$315 for deleting remedial action for level A residences, \$418 for substituting sealing, grouting, and selected tailings removal for complete tailing removal, and \$370 for deleting tailings removal beyond 5 ft. Based on an estimated 4800 residences in the Grand Junction Area that have tailings under or near the structure and assuming that the 226 residences used in this study are a representative sample, the total cost of the remedial action program is $\approx \$10,000,000$. Compared to previous estimates⁽¹⁾, this represents a savings of $\approx \$5,000,000$. Approximately 38% (\$1,900,000) of this saving is attributable to the use of sealants and grouts and therefore represents an overall reduction in cost of $\approx 13\%$.

The potential for further reductions in cost exist. As mentioned previously, $\approx 35\%$ of the homes evaluated required no remedial action since the EGR were <0.001 mR/hr. An additional 109 residences, which constitute 48% of the homes evaluated and 62% of the total cost for remedial action, are in level B (EGR ≥ 0.001 mR/hr <0.02 mR/hr). If RDC measurements are made in these homes, it is probable that in many cases the radon levels

will be below 0.01 WL and no remedial action will be required. Improved gamma monitoring methods would also define the location of the tailings more accurately and would allow localized repairs rather than sealing the entire floor area as assumed in this study.

Additional savings may also be accrued in residences containing a crawl space (categories 311, 313, 321, and 323). Charges associated with these categories represent $\approx 26\%$ of the total remedial action program. For these homes, many of which have a slab in conjunction with crawl space, the remedial action plan for levels B and C was based on excavation of tailings and, when applicable, removal of tailings from under the slabs. In practice, after individual structural conditions have been evaluated, it should be possible to seal most of the slabs. This could result in substantial cost reductions.

V. CONCLUSIONS AND RECOMMENDATIONS

Based on the assumptions made, it appears that a saving in cost for the remedial action program in Grand Junction, Colorado of $\approx \$5,000,000$ can be obtained. This is accomplished by applying the criteria for the determination of need for remedial action and by the use of sealants and grouting materials as a diffusion barrier in homes where RDC and not EGR is a problem. The saving is due to three factors; \$1,430,000 for deleting remedial action for level A residences, \$1,900,000 for substituting sealing, grouting, and selected tailings removal for complete tailings removal, and \$1,670,000 for deleting tailings removal beyond 5-ft. Compared to the estimated cost of \$15,000,000 for complete tailings removal, the use of sealants and grouts results in an overall

cost reduction of $\approx 13\%$.

Further savings could be accrued. If RDC data were obtained for level B residences ($EGR \geq 0.001$ mR/hr and < 0.02 mR/hr), it is probable that in many cases the RDC will be < 0.01 WL and no remedial action would be required. This could result in a maximum cost reduction of $\approx \$5,500,000$.

As a result of these potentially large savings, experimental work to determine the validity of the assumptions appears justifiable. The following work is recommended

1. RDC measurements should be made in all homes where the EGR is ≥ 0.001 mR/hr and < 0.02 mR/hr.

2. Continue the program to determine the long term effectiveness as a radon barrier of commercial coating materials such as Omnitech.

3. Determine the effectiveness of polymer-impregnated concrete and polymer-concrete as a barrier to radon diffusion. Cost factors and durability data should be compared with data for the commercially available coating materials. This work should be started in prototype modules and be field evaluated in representative homes in Grand Junction.

4. In conjunction with recommendations 2 and 3, the effectiveness and cost of polymer-concrete grouting materials should be determined. Injection techniques should be developed and tested.

5. The effectiveness of tailings removal as a means of reducing radiation levels should be experimentally verified. Potential problems such as tailings adhering to the foundations and leaching due to ground water should be studied.

6. Test sites in Grand Junction should be selected as soon as possible for demonstration of a complete remedial action plan.

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12. Report of trip to Colorado State University Sept. 11-13, 1972, Colombo, P., Nov. 29, 1972.

APPENDIX I

1

SUMMARY OF ESTIMATES OF REMEDIAL ACTION COSTS

Category	NHPQ residence number	Value of structure, \$	NHPQ remedial action cost (a), \$	Proposed remedial action cost (b), \$
111-A	111-10	18000	0	0
	-19	26000	5171	0
	-3	31000	0	0
	-22	45000	0	0
	-13	50000	7783	0
111-B	111-12	31000	11659	10484
	-7	22000	6104	4335
	-1	19000	0	1208
	-23	25000	0	3023
	-4	51000	4787	4787
	-21	27000	7074	4467
	-18	35000	6906	3797
	-14	49000	5919	2326
	-16	33000	4053	4047
	-20	21000	2650	2044
	-24	35000	9646	6393
111-C	111-11	26000	881	284
	-9	27000	6640	3865
	-8	19000	4859	3928
	-6	30000	7646	5400
	-25	44000	2743	3949
111-D	N O N E			
113-A	113-3	16000	472	0
	-4	18000	96	0
	-5	18000	162	0
	-12	32000	2039	0
	-28	29000	937	0
	-32	26000	0	0
	-29	12000	0	0
	-22	22000	232	0
	-18	43000	0	0

(a) Based on removal of tailings under and within 5-ft. of dwelling.

(b) Based on sealing, grouting, and removal of tailings where applicable.

APPENDIX I (cont'd)

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SUMMARY OF ESTIMATES OF REMEDIAL ACTION COSTS

Category	NHPQ residence number	Value of structure, \$	NHPQ remedial action cost (a), \$	Proposed remedial action cost (b), \$
113-B	113-13	34000	1699	1699
	-21	26000	4188	4188
	-7	45000	2315	5479
	-24	25000	6671	3187
	-1	20000	5516	3496
	-15	26000	990	1387
	-17	43000	6255	3590
	-10	20000	3403	2777
	-25	31000	2042	1066
	-20	17000	2732	1716
	-19	25000	1824	1824
113-C	113-16	21000	2254	2112
	-34	26000	4599	3908
	-8	28000	5779	3424
	-11	34000	7994	6587
	-30	31000	9195	4383
	-27	22000	4683	2416
	-9	28000	7526	4011
	-6	24000	7205	4279
113-D	113-2	38000	8334	8334
	-33	27000	7466	7466
	-26	50000	8766	8766
121-A	121-9	13000	116	0
	-8	13000	283	0
	-3	14000	546	0
	-17	22000	0	0
	-13	15000	749	0
121-B	121-10	18000	5669	2727
	-12	18000	6837	3470
	-16	11000	222	222
	-18	26000	0	1413
	-19	16000	4795	2961
	-1	18000	3722	3722
	-5	13000	400	400
	-15	23000	1253	1101
	-4	2400	6946	4347

SUMMARY OF ESTIMATES OF REMEDIAL ACTION COSTS

Category	NHPQ residence number	Value of structure, \$	NHPQ remedial action cost (a), \$	Proposed remedial action cost (b), \$
121-C	121-2	15000	3061	2481
	-7	26000	4835	3904
	-6	18000	5555	3948
121-D	121-14	22000	8178	8178
123-A	123-12	12000	629	0
	-19	13000	2136	0
	-18	14000	0	0
	-22	18000	0	0
	-23	19000	610	0
	-1	20000	2781	0
	-4	20000	1112	0
	-6	15000	532	0
	-8	12000	95	0
123-B	121-20	15000	110	2417
	-13	21000	82	2005
	-21	16000	3051	3146
	-16	31000	2077	3125
	-14	10000	1212	673
	-17	23000	3792	3315
	-3	19000	4261	3179
	-5	21000	3066	3312
	-7	9000	519	421
	-9	38000	825	647
	-24	17000	4532	3354
123-C	123-11	30000	7822	3985
	-2	26000	7905	4452
	-10	53000	5357	4224
123-D	N O N E			
211-A	211-4	21000	756	0
211-B	211-3	19000	399	4091
	-1	21000	218	4650
	-2	11000	5244	3361
	-7	18000	6508	5562
	-8	22000	1576	3628

SUMMARY OF ESTIMATES OF REMEDIAL ACTION COSTS

Category	NHPQ residence number	Value of structure, \$	NHPQ remedial action cost (a), \$	Proposed remedial action cost (b), \$
211-C	211-5	35000	9694	3669
211-D	N O N E			
213-A	213-3	13000	496	0
	-2	21000	1280	0
213-B	213-7	48000	9971	0
	-8	33000	7809	4169
213-C	213-6	42000	5172	3761
	-1	31000	10662	5842
213-D	213-4	27000	8871	8871
221-A	N O N E			
221-B	221-1	15000	1740	1740
	-2	11000	2679	2679
221-C	221-4	9000	5953	2381
221-D	N O N E			
223-A	223-7	11000	322	0
223-B	223-3	10000	829	829
	-6	14000	6155	4004
	-9	12000	4267	3877
	-1	9000	1184	1184
	-4	6000	141	141
	-8	11000	1265	1265
	-2	7000	7160	4940
223-C	223-5	12000	6614	3814
223-D	N O N E			

SUMMARY OF ESTIMATES OF REMEDIAL ACTION COSTS

Category	NHPQ residence number	Value of structure, \$	NHPQ remedial action cost (a), \$	Proposed remedial action cost (b), \$
311-A	311-6	18000	1451	0
	-10	14000	0	0
	-16	20000	184	0
	-3	24000	0	0
	-13	19000	43	0
	-17	21000	0	0
311-B	311-8	20000	3338	3338
	-7	14000	1899	1899
	-9	22000	2917	2056
	-14	17000	1040	1040
	-19	12000	742	742
	-15	20000	4100	4100
	-11	26000	1952	1952
	-18	26000	2242	2242
	-5	19000	1629	1629
	-4	16000	404	404
311-C	311-2	20000	5245	5245
	-1	15000	1299	1299
311-D	311-12	31000	1966	1966
	-20	54000	1587	2342
313-A	313-3	15000	427	0
	-2	18000	199	0
	-33	13000	1410	0
	-34	19000	899	0
	-1	12000	256	0
	-36	16000	996	0
	-35	15000	1134	0
	-30	15000	1430	0
	-28	20000	1995	0
	-27	30000	2559	0
	-26	14000	3703	0
	-24	29000	8647	0
	-21	17000	4522	0
	-15	16000	0	0
	-12	17000	735	0

SUMMARY OF ESTIMATES OF REMEDIAL ACTION COSTS

Category	NHPQ residence number	Value of structure, \$	NHPQ remedial action cost (a), \$	Proposed remedial action cost (b), \$
313-A	-10	32000	840	0
	-7	18000	1891	0
	-8	30000	0	0
	-4	21000	1570	0
313-B	313-6	26000	1796	1209
	-5	23000	5611	5611
	-9	21000	2343	1638
	-11	31000	4022	3972
	-13	20000	3093	3093
	-17	28000	906	906
	-16	32000	691	314
	-20	12000	792	792
	-19	25000	2851	2156
	-25	20000	3846	2366
	-23	19000	1370	1370
	-22	19000	2001	1223
	-29	15000	4152	4152
	-31	15000	3987	3987
313-C	313-18	28000	6384	6384
313-D	N O N E			
321-A	321-1	10000	274	0
	-11	20000	1581	0
	-9	13000	0	0
	-10	17000	0	0
	-3	13000	0	0
321-B	321-6	14000	674	674
	-4	13000	203	203
	-8	17000	1338	1338
	-7	21000	3786	3786
	-12	22000	2208	2208
321-C	321-5	22000	2566	2566
	-2	14000	598	598
321-D	N O N E			

SUMMARY OF ESTIMATES OF REMEDIAL ACTION COSTS

Category	NHPQ residence number	Value of structure, \$	NHPQ remedial action cost (a), \$	Proposed remedial action cost (b), \$
323-A	323-19	17000	0	0
	-7	15000	0	0
	-9	13000	995	0
	-10	16000	0	0
	-11	16000	300	0
	-12	8000	0	0
	-16	6000	0	0
	-17	10000	0	0
	-15	12000	0	0
	-18	19000	0	0
	-2	17000	0	0
	-37	13000	0	0
	-42	13000	0	0
	-39	13000	1506	0
	-24	14000	792	0
	-26	31000	0	0
	-28	12000	483	0
	-31	11000	1122	0
323-B	323-8	14000	581	581
	-6	14000	330	330
	-4	13000	400	400
	-3	14000	995	995
	-13	14000	1058	1058
	-14	19000	585	585
	-21	15000	0	0
	-20	11000	1853	953
	-40	16000	1049	1049
	-41	16000	578	578
	-1	15000	134	134
	-38	25000	704	704
	-22	19000	2935	2935
	-23	13000	591	591
	-25	8000	1929	1929
	-27	21000	5221	5221
	-29	9000	235	235
	-30	15000	2229	2229
	-36	19000	2176	2176

SUMMARY OF ESTIMATES OF REMEDIAL ACTION COSTS

Category	NHPQ residence number	Value of structure	NHPQ remedial action cost (a), \$	Proposed remedial action cost (b), \$
	-34	19000	2411	2411
	-33	13000	1721	0
	-32	20000	2356	2356
323-C	323-5	21000	3003	3003
323-D	N O N E			