Report

On

The Preliminary Investigation Of The Technical And Economic Factors For The First Stage Remedial Measures At Port Hope, Ontario

For

The Atomic Energy Control Board

April 1976

JAMES F. MacLAREN LIMITED
CONSULTING ENGINEERS, PLANNERS & SCIENTISTS
WINDSOR–LONDON–WATERLOO–TORONTO

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CHAPTER 1

INTRODUCTION

Effective 12 February 1976, James F. MacLaren Limited entered into a contract with the Department of Supply and Services acting for the requisitioning department, the Atomic Energy Control Board to investigate the technical and economic factors related to the cleanup of radioactive contamination at Port Hope, Ontario. The general outline of the work included:

"1. To conduct a preliminary investigation and assessment of the technical and economic factors relevant to:

   a) the removal of radioactively contaminated soil, building materials and other materials from the environs of or within private, public and commercial premises in the Town of Port Hope, Ontario; and

   b) the restoration of such premises to a state consistent with that which existed prior to the commencement of the removal operations.

2. To prepare a program of work to be undertaken by a program manager to be appointed by the Atomic Energy Control Board to effect the expeditious removal of radioactively contaminated soil, building materials and other materials from the environs of or within private, public and commercial premises in the Town of Port Hope, Ontario and the restoration of such premises.

3. To prepare a preliminary estimate of the costs expected to be encountered in the implementation of the above mentioned program of work."

A unique feature of this project at this time, is that sufficient data and criteria are not yet available to permit a precise description of the remedial work to be performed to correct the situation in its entirety. Project characteristics illustrating the problem include the following:

a) The existing external radiation data is suspect in many areas due to the unavoidable snow and ice conditions encountered during the initial surveys and resurveying of these areas is required.

b) New areas requiring surveys are still being determined.

c) Criteria for removal of contaminated material, monitoring procedures and instrumentation for criteria measurement are not yet finalized.

d) The nature of the contamination is such that the precise quantity of material, particularly of excavated material, to be removed will only be apparent once the removal exercise has started.

Because of these special project characteristics the following pertinent observations are made:

a) This study must be envisaged as a first stage recommendation of required remedial measures. Some 47 specific locations requiring remedial measures have been located and these are believed to include locations with the highest potential for contamination. Still further contaminated areas may be determined.

b) The estimates of cost of remedial measures must be regarded as order of magnitude costs.

c) It is to be noted that a quantity of approximately 70,000 cubic yards of material at this time is estimated to require removal. On the other hand, to ensure that adequate disposal capacity is available, the disposal facility is designed to permit disposal of 150,000 cubic yards of material.

All sites in this report have been identified by using the Atomic Energy Control Board location coding system in order to protect the privacy of the individual home owners.

It should be pointed out that in spite of the qualifications regarding the estimated costs, they are believed to be realistic based on the information available and that the cost estimates together with the works description form a satisfactory basis for funding appropriation purposes.

Chapter 2

BACKGROUND

CHAPTER 2

BACKGROUND INFORMATION

A. General

In 1932, Eldorado Gold Mines Limited commenced operation of a plant in Port Hope, Ontario, to process the ores mined at Port Radium, Northwest Territories for the recovery of radium. In 1944, the company was taken over by the Canadian Government and renamed Eldorado Mining and Refining Limited. A further name change occurred in 1966 with the renaming of the Company as Eldorado Nuclear Limited (ENL).

The first residues from the radium recovery operation were produced in 1933 and were disposed of on the plant site from 1933 to 1939. From 1939 to 1944, residues were deposited in the Lakeshore Residue Area. This area is a short distance to the west of the plant and is adjacent to a railway embankment just south of the CNR freight shed (since demolished). In the latter part of the 1939-1944 period, the nature of the residue changed as the plant processes were altered from radium extraction to the production of uranium. Approximately 4,000 to 5,000 tons of radium extraction residues were removed from the Lakeshore Residue Area in 1957 and 1958 and sold to Vitro Corporation in the United States for the recovery of other metals, the remaining residue was transferred to the Port Granby Residue Area, 10 miles west of Port Hope.

The Monkey Mountain Residue Area within the Town of Port Hope was used from 1945 to 1948 for the disposal of residue and large quantities were removed from this site and disposed of at Port Granby in 1959 and 1966. Some 800 tons of this residue were sold to Deloro Smelting and Refining Co. in 1959.

The Welcome Residue Area, about three miles to the northwest of Port Hope, was used from 1948 to 1954. About 4,000 tons of residue from this site were sold in 1956 to the Vitro Corporation in the U.S. for the recovery of other metals, and again in 1959 and 1960 about 1,000 tons of "geiger picker" rejects were sold to Deloro Smelting and Refining. During the early 1950's approximately 900 tons of speiss was also sent from Port Hope to Deloro.

The Port Granby Residue Area was first used in 1955 and remains the principal disposal area at the present time.

From 1948 to 1974, the Pidgeon Hill Storage Area was used for the storage of contaminated equipment and radium waste, and some incineration of combustible wastes was carried out prior to 1954, but no burial of waste was made on this site.

B. Investigation of Contaminated Sites in Port Hope

Investigation by ENL staff of the earlier residue disposal practices revealed that there were areas within the town of Port Hope that could have become contaminated. Possible contamination could have resulted from any of the following causes:

(i) spillage of residue during shipment by road to the residue disposal areas, or during loading at the rail docks;

(ii) during the 1940's residues were stored in a variety of locations awaiting recovery of other materials (e.g. cobalt and silver) and it was possible that these temporary storage locations could have become contaminated;

(iii) there were several periods during which there was an active building programme on the ENL property. In 1938 and 1939 a building which had contained the original radium processing plant set up in 1932 was demolished. The refining of radium ceased in 1953 and in the following two years the radium laboratories were dismantled and buried at the Welcome Residue Area. In 1954 and 1955, the old radium circuit was removed and a new solvent extraction circuit installed; at about this time, several other buildings were demolished. In 1959, the original main office building and the uranium processing building were demolished.

All of these actions produced building rubble, fill and reclaimed building materials, any of which might have been contaminated, and which may have been used in the Town for various purposes.

(iv) surface run-off from the Monkey Mountain Residue Area in particular may have resulted in surface contamination of the surrounding area.

As a result of the above, ENL conducted a very thorough investigation during late summer of 1975 which included interviewing long-term employees, searching plant records, and inviting assistance from local citizens through advertisements in the local newspaper and on the local radio station. This approach has brought to light most of the areas included in this report. Notwithstanding this investigation, the Atomic Energy Control Board (AECB) and the Ontario Ministry of Health (OMH) concluded in December 1975 that a more systematic approach to the problem was called for. As a result, it was decided to conduct a complete survey of the town to search for higher-than-normal levels of external radiation and, if such areas were found, to delineate the areas with a careful survey on foot and, finally, to take selective air samples inside buildings and homes for radon analysis.

To accomplish this survey, a very sensitive detector was borrowed from the Chalk River Nuclear Laboratories of Atomic Energy of Canada Limited. This detector was mounted initially on an Ontario Ministry of Health vehicle and eventually transferred to an Atomic Energy Control Board vehicle in order to carry out a street-by-street survey of the whole community. Whenever abnormal radiation levels were detected, the Ontario Ministry of Health was notified and arrangements made to collect air samples within buildings for careful analysis at the Ministry's Laboratories in Toronto.

The systematic road survey commenced in late December, 1975 and was completed in March, 1976.

In early February the AECB established an office in Port Hope to co-ordinate the survey work. A system was established whereby external gamma radiation surveys of properties and

buildings would be performed on request. These surveys were followed by air sampling when abnormal radiation levels were detected.

As a result of these surveys and the surveys performed by ENL, some 433 site surveys have been documented to March 26, 1976.

C. Background to the Studies Conducted for this Report

At the outset of this preliminary study, information on all the surveys conducted to March 1 had not been compiled under one filing system. In order to expedite the preparation of this report, six areas were identified by the AECB staff in late February as locations containing high priority sites. From these areas a sample of typical sites was selected. Detailed gamma surveys, physical surveys, airphoto interpretation and soils investigations were carried out on these typical sites and a cost of remedial works was estimated. By prorating the cost of remedial measures for these typical sites, an estimate of the cost of remedial works at other locations in the Port Hope area, identified as candidates for remedial action, was made.

The areas selected for detailed studies are listed below and outlined in Figure 1 in the pocket at the back of this report:

1. St. Mary's Separate School;
2. Pidgeon Hill Road between Cavan and Pine Street extension;
3. Cavan Street - between Pidgeon Hill and South Street;
4. John Street - directly west of Eldorado Nuclear Limited;
5. Alexander and Hayward Streets; and
6. Harcourt Street.

Data from the existing surveys was compiled for all locations in these areas and a survey programme outlined to fill in missing data. Detailed external gamma surveys commenced in these areas on March 8, 1976.

As the survey progressed revisions were made to the list as follows:

(i) the John Street area where the sites had been purchased by ENL was omitted from further detailed analysis;

(ii) the detailed survey of the Harcourt street area was not completed in time for this report;

(iii) the Cavan Street area was extended to cover the sites north of Pidgeon Hill Road and west to take in the Craig Street and the Chestnut Hill area;

(iv) the Pidgeon Hill survey was extended to cover the area behind the homes on the north side of the road between Cavan and the Pine Street extension.

In all, some 25 acres were surveyed for gamma radiation between March 8 and March 26, 1976. The areas surveyed are outlined in Figure 1.

During the course of reviewing the existing information on surveys conducted within the area of interest, it became apparent that only a small number of sites with interior contamination problems existed in these study areas. The files were searched for locations where interior problems existed. A list of sites with interior contamination was compiled and a selection made for a detailed survey. The

interior survey work commenced on March 18, 1976. Fourteen sites were surveyed and remedial work cost estimates prepared.

A soil boring and testing programme initially scheduled for early March for the study areas was delayed until property owners' consent could be negotiated. The programme commenced on March 15, 1976 in the Pidgeon Hill area and by April 23, some 106 boreholes had been completed and radiation counts on 630 soil samples documented.

Chapter 3

WASTE MANAGEMENT INVESTIGATION

CHAPTER 3

WASTE MANAGEMENT OPERATIONS

A. Introduction

The materials to be removed in the remedial measures program at Port Hope will require disposal or management in an A.E.C.B. licensed facility. The current classification of sites as described in the A.E.C.B. Information Bulletin 74-1 is as follows:

"Category A Facilities for the collection, packaging and temporary storage of radioactive wastes for periods up to 2 years;

Category B Facilities for storage of radioactive wastes for some intermediate period (up to 50 years);

Category C Facilities for very long term storage and management of radioactive wastes."

It is anticipated that the required site will be classified as a Class B site with the primary characteristic that the waste can be retrieved.

By far the greatest volume of material to be disposed of resembles clean fill with a relatively low moisture content. Thus the material can be piled to significant heights using standard earth moving practices. If it is assumed that 150,000 cubic yards of material require disposal, that the material is piled to a height of 60 feet and that the side slopes are to be four horizontal to one vertical, then an area of approximately 400' x 500' (approx. 5 acres) is required.

The possible approval procedure and alternatives available at this time, to permit licencing of the proposed facility are not clear. However, it is obvious that if a public participation and hearing stage is included, the licencing could be delayed substantially.

B. Site Investigation

The initial aim of the study was to find a site for the disposal or management of material retrieved from the Port Hope remedial action. It was self-evident that the selected site must be acceptable from an environmental and health aspect and that, if the natural hydrogeological conditions were inadequate, then some degree of engineering would be required.

As time is a critical factor in the remedial action to be carried out at Port Hope, it was realized that privately-owned land could not reasonably be considered. This was due to the time involved in negotiating for purchase of the property and the possible subsequent delay in going before the necessary agencies to obtain permission to expropriate. As a result of this, it was decided to restrict this first phase of the study to what are broadly classified as "Crown Lands". In this category consideration was given to all properties held by the Federal or Provincial Governments and attempts were made to locate all such lands within a 50 mile radius of Port Hope. Visits to the Ministry of Natural Resources in Toronto proved relatively unsuccessful and the principal sources of information were the various District Offices.

This search resulted in more than 50 locations of government owned land being identified, in addition to three which had originally been suggested by the A.E.C.B. These three were the rifle range at Cobourg, the land adjoining the prison at Warkworth and the existing ENL site at Port Granby.

It was obviously not possible to make a detailed hydrogeological study of all these sites, and hence a preliminary screening was carried out in which the possible sites were reduced to a short list of 12. The screening process was based on obvious hydrogeological short-comings, that were evident from a study of the available topographic and geological maps. All sites situated in swamps were discarded and those underlain by permeable glacial moraine were also deemed unacceptable.

Finally, having arrived at the list of possible sites, a more detailed hydrogeological appraisal was carried out based on existing data. No field work was undertaken.

The results of this preliminary study indicate that 6 of the 12 sites could probably be engineered to achieve a satisfactory standard of waste management. Only the Cobourg Rifle Range however is reasonably close to Port Hope and reports suggest that development plans for the area would rule out the use of this site.

On the basis of the information available, it would appear that the present properties owned by Eldorado Nuclear Ltd. in the Welcome and Port Granby areas which have been used for waste disposal, may be able to be expanded and utilized for the disposal of materials as intended.

C. Site Design and Development

There are a number of possible alternative methods for the design and development of the site. Without excluding other solutions, nevertheless, for the purposes of this report, it was assumed that the site should be designed to permit the containment and monitoring of all runoff and leachate prior to discharge or treatment. As envisaged at the present, the site would be prepared in the following manner.

- The site would be graded such that all drainage would be to the perimeter.

- Two relatively impermeable holding ponds would be constructed.

- A sheet of heavy gauge plastic would be laid on the ground and connected to a perimeter drain such that all liquid reaching the plastic would be directed in a controlled manner to one of the ponds.

- Nine inches of sand cushion or Granular B type gravel would be placed on top of the plastic.

- Three inches of Granular A type gravel would be placed on top of the Granular B material.

- Three inches of asphalt would be placed on top of the Granular A and connected to a separate perimeter drain such that all surface runoff could be conducted in a controlled manner to the second storage pond.

Following the placement of the contaminated material topsoil would be placed and the area hydra-seeded.

The site would be fenced, would have an adequate buffering zone, access road, on-site haul road and entrance.

Requirements for treatment of the water in the ponds can only be determined by the monitoring experience. Recirculation of this contaminated liquid to the fill area can be practised until treatment facilities etc. can be made operational.

D. Operating Procedure

A truck entering the site would proceed directly to the paved area and the active face of the fill, be spotted and dumped. A Caterpillar D-8 class bulldozer, or equivalent, would spread and compact the load, maintain access on top of the fill, and the operator would spot the trucks for dumping.

The truck would then proceed to a clean area of the paving, where the driver would turn over a copy of the load ticket, be monitored to insure that the vehicle is not contaminated in accordance with the procedures described in Chapter 6 and then be washed and/or proceed back to the job site. Personnel on site would include a labourer to wash the vehicles, a dozer operator and an inspector to survey the vehicles.

Equipment would include a D-8 class of bulldozer, water tanks, pumps and hoses for vehicle washing and flushing the asphalt in the truck washing area, and a trailer for the operating staff.

E. Summary of Estimated Waste Management Site Costs

Development costs for the waste management facility have been broken down into two major sections, variable and fixed costs. Variable costs include such items as temporary buildings, equipment and personnel for a six month period. Fixed cost estimates include order of magnitude costs for such items as fencing, truck wash facilities, ponds, paving, utilities and final covering of the site, and exclude land and legal costs.

The following estimates represent the order of magnitude costs for the preparation and development of the waste management site.

Variable costs	$ 90,000.00
Fixed Costs	$450,000.00
Total Site Cost Estimate	$540,000.00

Chapter 4

REMEDIAL WORKS

CHAPTER 4

REMEDIAL WORKS

A. Data Collection

In light of the variety and complexity of the anticipated remedial works, several methods of data collection were carried out by the study team. Details of these methods are outlined in the following sections.

(i) Physical Surveys

Field surveys were conducted in the selected study areas previously outlined in Chapter 2 of this report, in order to provide physical details of the property, structures and external features which may affect estimates of external remedial work to be undertaken. Included in these surveys were estimates of house, garage and lot dimensions, the location of trees, bushes, wells, etc., and the presence of suspected areas of imported fill material on the property.

The resulting plans of the study areas were then used to plot external gamma survey readings, as described in Section (iv).

(ii) Interviews

Officials of the Town were contacted to discuss the terms of reference of the study, and to obtain a local knowledge of the engineering operations and utility functions within the Town. Subsequently, interviews were held with representatives of the Town Works and Water Works Departments, as well as Port Hope Hydro, Bell Canada, Northern Central Gas and the

Town's consulting municipal engineers Totten Sims Hubicki Associates Limited.

Interviews were held with representatives of Hydrology Consultants Limited who had carried out detailed hydrogeological investigations of the Port Granby and Welcome disposal areas, and with representatives of the University of Toronto who were undertaking a research investigation of radium waste and decay products, with particular emphasis on the Port Hope area.

(iii) Airphoto Interpretation

As previously outlined, residues from the radium recovery program were first produced in 1933. Storage and disposal of these materials took place at a number of locations in subsequent years. It was felt that some of the historical events involving the storage, disposal and private fill operations could be identified and studied with the use of historical airphotos of the Town.

Complete coverage of the Town was provided from airphotos flown in 1940, 1942, 1954, 1963, 1966 and 1974. Stereo prints of this coverage were obtained, as well as enlargements of particular study areas in Town.

(iv) External Gamma Surveys

External gamma surveys were carried out in the study areas previously identified by the Atomic Energy Control Board, as having high radon or gamma readings and are delineated in Figure 1. The surveys were conducted by traversing the lots, using an LB 1200 survey meter, recording and locating the readings on the layout plan of the property. Readings were taken with the instrument three feet above grade, and noting where snow cover existed.

(v) Soil Investigations

Once the physical and external gamma surveys had been completed and reviewed, and the airphotos investigated, borehole locations were identified. The purpose of the borings was to verify and detail areas where fill was suspected, determine the depth of fill and to obtain samples of the fill and underlying natural subsoil for radiation analysis.

The borings were advanced to depths of between 7 and 14 feet below the ground surface and some 3 to 10 feet into the natural subsoil using a bombardier mounted power auger. In each boring, samples of the subsoil were obtained over the full depth of the boring using split spoon sampling equipment. All of the samples, which were placed in either plastic bags or air-tight glass jars, were taken to the AECB office in the Town of Port Hope for radiation analysis.

Samples were taken continuously every two feet, commencing at grade. The samples were weighed and counted with a scintillometer one to four days after removal. All samples were recounted approximately fourteen days after removal to check whether radon daughters were in excess of equilibrium with radium.

Several soil samples were sent to Chalk River, McMaster University and the Ministry of Health for assay tests for such materials as radium and thorium.

Following completion of the borings, a four inch diameter plastic pipe fitted with a cap was installed in the upper three feet at selected locations to permit future monitoring of radon gas.

In five locations where contaminated material was suspected beneath the building foundations, samples were extracted by means of a hand auger, and tested in the aforementioned manner. Several of these samples were sent to the Ministry of Health for assay tests.

At the time of this report, the soil assay results were not available, however, preliminary results indicate that two of the five suspected locations may require remedial works beneath the basement floor slab.

(vi) Interior Gamma Surveys

Gamma surveys were carried out throughout the interior of all homes and buildings previously identified by A.E.C.B. as having a high radon or gamma level. Surface gamma readings were taken to try to identify contaminated building material within the structure. Cost estimates for removal and restoration were then prepared, and are summarized in Chapter 5.

B. Data Analysis and Results

(i) Airphoto Interpretation

The storage and disposal of process residue in the Pidgeon Hill area, and the urban development in that area from 1940 to the present, was investigated using the sequential aerial photography previously outlined. A series of overlays were drawn from the interpretation of each set of photographs using an enlargement of the 1974 photo as a mapping base of the area. Surface drainage, residential development, the staging and operation of the Monkey Mountain disposal site and any other pertinent features were outlined on the overlays.

During this period, Pidgeon Hill Road extended only as far as the disposal site. Surface runoff from the site itself drained to the south east corner. The embankment at the entrance to the site directed any runoff to the south and then east, parallel to Pidgeon Hill Road.

An entrance road and embankment on the south side of Pidgeon Hill Road constricted the flow at that point. The entrance road was graded up toward Pidgeon Hill Road, and consequently, any overtopping of the embankment would take place at the southern extent, the lowest elevation on the road. Drainage from that point flowed east, down to Cavan Street.

North of Pidgeon Hill Road, a major watercourse flowed through what is now part of the municipal dump, and split into two smaller tributaries which drain most of the area east of the Monkey Mountain site. The flow is directed by culvert under Pidgeon Hill road, close to Cavan Street, where it meets drainage from the south side of Pidgeon Hill Road.

In reviewing the historic drainage patterns in the area, a good correlation can be seen between the areas having external gamma readings above background and areas of likely sediment deposition.

Another use of the sequential aerial photographs was to try to establish the year and extent of filling operations on properties where problems were suspected. Although the photographs were useful in identifying the time period of the house construction, in most cases, the extent of fill could not be defined due to scale limitations of the photography.

(ii) Discussion of Results of Gamma and Soil Survey Analysis

a) Above-Grade Surveys

Gamma readings described in Section 4A(iv) were obtained during the late winter period when the ground was frozen and covered with varying amounts of snow. Therefore the readings may not be taken to represent the relative strength of below grade sources, although it may be assumed that there is an unnatural source below grade in the vicinity of any reading which is above background. At locations where high external gamma readings were present at the surface, readings of the borehole samples indicated that the radiation source was highest in the top two feet of soil.

There is evidence also that some of the high readings found are due to concentrated sources. An example of this is the area around location #416 which was rechecked on April 2nd (with no snow or ice cover). The readings at ground level five feet laterally from the maximum readings, were only one half the value of the maximum reading.

b) Activity of Soil Samples from Boreholes

The method of measurement of activity in these soil samples is described in Section 4A. Very little self-shielding of gammas was detected. When the samples in a jar were split in half, the count from the half sample approximated one half the count of the whole sample, within the range of reading accuracy (approximately 4%).

The samples from location #130 were assayed for radium by the Ontario Ministry of Health and the results are as follows:

Sample Depth	Radium ($pCi/gm^{226}Ra$ in dry soil)
0 - 2'	1035
2 - 4'	94
4 - 5'	136
5 - 6'	15
6 - 8'	11

It is of interest to consider the concentration of radium at this location in terms of the normal radium 226 concentration of 1.0 to 2.0 pCi/gram* found in dry natural soil. In these terms the concentration seven feet below grade at location #130 is 5.5 to 11 times that in ordinary soil.

The activities for many samples have been remeasured a number of times and in the majority of the samples the activity has remained constant. However, in a few cases an increase or decrease in activity has been noted indicating that the radon daughters were deficient or in excess (compared to radium) at the time of the first measurement. Excess radon daughter activity in a sample indicates the presence of a stronger source material at the near vicinity, the excess being due to radon diffusing from the region of the higher source.

In most samples from boreholes where high activity was found the activity decreases with depth. The assay for radium at location #130 decreases at approximately 56% per foot. It appears that radium in the near-surface region is moving downward.

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* Private communication with the Ontario Ministry of Health on radium concentration found in natural soil in the Toronto Ontario area.

From the information available at the time of this report, there appears to be a reasonable correlation between the activity measurements made with the counter in Port Hope and the concentration of radium in the soil. We believe, however, that if the criterion for soil removal is based on the radium concentration in the soil, then radium assays should be used at all locations as the final test to determine whether the criterion has been achieved.

C. Selection of Sites for Estimating Purposes

(i) Data Assembly

Detailed surveys described in Section 4A were carried out for sites in the selected study areas as shown on Figure 1 contained in the back of this report.

Data collected from these surveys was analyzed as described in Section 4B and a file prepared for each site containing the photographs, physical layouts, external gamma radiation plots, soil boring logs, soil sample counts and radon gas levels.

A separate summary "Master List" of the results of all surveys conducted by ENL, AECB and OMH as of March 26, 1976 was also prepared. This list contains information on 433 sites.

(ii) Action Levels

At the time this report was prepared, specific guidelines for the determination of remedial works for Port Hope were not available. In order to select sites for the purposes of cost estimating, graded action levels based on guidelines established by the United States Health Service, Department of Health,

Education and Welfare were used. These quidelines were developed for the cleanup of a similar problem now being carried out in Grand Junction, Colorado and apply specifically to dwellings constructed on or with uranium mill tailings. The recommended action levels are referred to as the "Surgeon General's Guidelines" and are outlined below:

RECOMMENDATIONS OF ACTION FOR RADIATION EXPOSURE LEVELS IN DWELLINGS CONSTRUCTED ON OR WITH URANIUM MILL TAILINGS

External gamma radiation:

Level:	Recommendations
Greater than 0.1 mR/hr.....	Remedial action indicated
From 0.05 to 0.1 mR/hr.....	Remedial action may be suggested.
Less than 0.05 mR/hr.....	No action indicated.

Indoor radon daughter products:

Level:	
Greater than 0.05 WL.....	Remedial action indicated
From 0.01 to 0.05 WL.....	Remedial action may be suggested.
Less than 0.01 WL.....	No action indicated.

The term WL or "Working Level" is described as follows and is taken from the Federal Radiation Council Report #8 Revised "Guidance for the Control of Radiation Hazards in Uranium Mining, 1967":

"A Working Level (WL) is the term used to describe radon daughter product activities in air. This term is defined as any combination of short lived radon daughter products in one litre of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha energy. The numerical value

of the WL is derived from the alpha energy released by the total decay through RaC of the short lived radon daughter products, RaA, RaB, and RaC at radioactive equilibrium with 100 pCi of ^{222}Rn per litre of air."

In a house with any ventilation, and into which fresh radon is leaking, the radon daughters are not able to fully achieve equilibrium during the residence time of the radon in the house.

As the number of ventilation air changes per unit time increase, the residence time decreases and hence the extent to which the radon daughters are able to achieve equilibrium reduces. This extent can be expressed as a percentage in terms of the ultimate alpha energy emission capability of the radon daughters compared to their capability when in radioactive equilibrium with 100 pCi per litre of radon in air.

In tests on six unoccupied experimental houses at Colorado State University ("First Progress Report on research conducted for the Environmental Protection Agency under Grant #5R01EC00153" - Schiager and Olson) this percentage after the houses were well caulked ranged from 22% to 40% with a mean of 30%.

Tests by the Ontario Ministry of Health on radon concentration in occupied dwellings in Port Hope show this percentage to range from 15% to 75%.

In the absence of any other more definitive information a percentage of 50 has been assumed for the purpose of this report. Though it is apparently high in the light of the Colorado State University data, the OMH data is likely to be more relevant to occupied buildings in Port Hope.

Thus the radon concentrations in pCi per litre at 50% equilibrium which correspond to the guidelines established by the Surgeon General of the United States of America are as follows:

W.L.	pCi/litre Rn
>0.05	>10
0.01 - 0.05	2 - 10
<0.01	<2

The Surgeon General's guidelines refer to radiation levels in excess of the natural background. For the purposes of this report the following background levels were used:

External gamma radiation - 0.01 mR/hr
Radon level - 1.0 pCi/litre of air.

Therefore the action levels corresponding to the actual readings taken in Port Hope for the purposes of this report are as follows:

External gamma radiation:

Level:	Recommendations
Greater than 0.11 mR/hr.....	Remedial action indicated
From 0.06 to 0.11mR/hr.....	Remedial action may be suggested.
Less than 0.06 mR/hr.....	No action indicated.

Indoor radon daughter products:

Level:	Recommendations
Greater than 11.0 pCi/litre.	Remedial action indicated
From 3.0 pCi/litre to 11.0 pCi/litre.....	Remedial action may be suggested
Less than 3.0 pCi/litre.....	No action indicated.

It is to be especially noted that these action levels have been utilized for the purposes of determining order of magnitude cost estimates for remedial works. The Federal-Provincial Task Force On Radioactivity set up a working group to review the radiation criteria for Port Hope on April 7, 1976. The recommendations from this working group were not available at the time of writing this report.

(iii) Selection of Sites for Estimating

(a) Sites Where Exterior Remedial Action is Indicated

The criteria for this level of action was first applied to the locations in the study areas, and sites with exterior contamination falling into this category were selected for detailed cost estimating. Data compiled on each of these sites was reviewed and the remedial work specified.

The summary "Master List" of sites surveyed to March 26 was also subjected to the same criteria and locations identified where exterior remedial action was indicated. The files on these sites were reviewed and where sufficient external gamma data was available, the site was selected for estimating. The sites were then visited and categorized for remedial works based on the data developed for similar sites in the study areas.

The sites where external remedial work is indicated are noted in Table 4-1. Sites included in this table but not studied in detail as noted above are flagged in this table. All sites have been identified by using the Atomic Energy Control Board location coding system in order to protect the privacy of the individual property owners.

Another group of sites falling into the action category for remedial works were not included in the cost estimate for the following reasons:

- Sufficient data was not available to estimate the remedial action required (6 sites);

- Sites purchased by ENL (9 sites);

- Sites where remedial work has already been started by ENL (6 sites).

(b) Sites Where Interior Remedial Action is Indicated

As discussed in Chapter 2, only a small number of sites with interior contamination problems existed in the study areas. The summary "Master List" of locations compiled from the earlier surveys was therefore searched and a list of sites compiled where interior contamination was suspected. The majority of these sites were not in the study areas and were therefore subjected to a detailed survey for estimating purposes. The sites from this list that are categorized as locations where remedial action is indicated are shown in Table 4-2.

(c) Sites Where Exterior Remedial Action May Be Required

A total of 44 sites classified as having exterior contamination falling into this category (gamma radiation between 0.06 to 0.11 mR/hr., radon levels between 3.0 to 11.0 pCi/litre) were taken from the detailed study areas and the summary "Master List". Since all the sites in this category may not require remedial action, a more stringent action level was applied to select candidate sites for estimating purposes. The following radiation levels were chosen:

- External gamma radiation between 0.085 mR/hr and 0.11 mR/hr.
- Indoor radon levels between 7.0 pCi/l and 11.0 pCi/l of air (0.03 WL and 0.05 WL).

Sites falling into this category within the study areas were reviewed and the remedial works determined in detail. Sites not included in the study areas were visited and categorized for remedial works. Table 4-3 lists the sites included in the cost estimate.

Another three sites falling into this category were omitted from the cost estimate as sufficient data was not available for establishing the required remedial works at the time of preparing this report.

Of the 39 sites not included in the cost estimate, 26 sites had interior radon concentrations below a level of 5.0 pCi/litre of air.

(d) Sites Where Interior Remedial Action May Be Required

Sites classified as having interior contamination and falling into this category (gamma radiation between 0.06 to 0.11 mR/hr., radon levels between 3.0 to 11.0 pCi/litre) are shown in Table 4-4. As only three sites fell into this category the more stringent action level was not applied and all sites were included in the cost estimate for remedial action which may be required.

(iv) Determination of Remedial Works

(a) Exterior Remedial Works

The extent of excavation of contaminated material was determined for the cost estimates using the following criteria:

Area of Soil To Be Removed

- At locations where the radon readings were above the action levels established for this report, removal of material was assumed over an area adjacent to the building where the external gamma radiation reading was found to be above background.

- At locations where the radon readings were below the action levels but where exterior radiation levels were above the acceptable limits established for this report, the area to be removed was estimated from the gamma plots.

Depth of Soil to be Removed

- The depth of soil to be removed was determined using the borehole logs and the activity counts of the soil samples. In cases where fill material was encountered in the soil column with high counts in the upper layers, the total depth to original ground was used in the quantity estimate.

(b) Interior Remedial Works

Detailed radiation surveys were conducted at all sites where high radiation was due to contaminated building materials. The remedial works in each case were identified on site and the quantity of materials measured.

(c) Contaminated Materials Under Buildings

As indicated on Table 4-1, five sites were investigated for contaminated materials under the basement floor slabs. Results of the soil assays of these samples were not available at the time of writing this report. However, preliminary soil counts of these samples indicates that contaminated soil may be present under two of the locations tested. For the purposes of the first stage remedial work estimates, a cost allowance for remedial works at these locations has been included in Chapter 5.

TABLE 4-1

SUMMARY DETAILS OF

LOCATIONS WHERE EXTERIOR REMEDIAL ACTION IS INDICATED*

Location Code	Survey Results*** Gamma (mR/hr)	Radon (pCi/l)	Soil (cpm/Kg)	Recommended Action
#5	0.07	14	1276	11' Fill removal over 100 x 42' area in front, 90' x 15' area adjacent to south and 100' x 100' at back of building. Note: Ventilation system installed Basement soil tested
#6	0.68	63	5552	8' Fill removal over property Note: Basement soil tested Ventilation system installed
#11**	0.2	-	-	3' Fill removal over 100' x 100' area assumed.
#17	1.5	153	104	14' Fill removal 40' x 45' area adjacent to building Note: Ventilation system installed
#20	0.4	17	-	3' Fill removal over 50' x 50' area
#29	0.4	5.1	1496	Remove material in driveway 3' x 100 x 10'
#35**	2.2	-	-	4' Soil removal over 200' x 20' area assumed.
#43	0.12	-	70	3' Soil removal over 30' x 15' area

TABLE 4-1 (cont'd)

Location Code	Survey Results *** Gamma (mR/hr)	Radon (pCi/l)	Soil (cpm/Kg)	Recommended Action
#48	0.2	-	14	5' Soil removal over 100' x 24' area
#68	0.32	-	79	10' Fill removal over 25' x 100' area
#128 - 129	0.05	310	275	8' Fill removal over property Note: Ventilation system installed Basement soil tested
#130	1.1	532	900	5' Fill removal over property Note: Ventilation System Installed Basement soil tested
#135	0.25	-	24	3' Soil removal over area behind building
#139	0.06	45	30	3' Fill removal over yard behind building
#141	0.085	14	-	3' Fill removal in 20' x 20' area behind house
#153	1.0	-	-	5' Soil removal over area
#161	0.03	20	12	3' Fill removal over property
#195**	0.2	-	-	2' Soil removal over 100' x 60' area assumed
#219	0.3	24	992	4' Soil removal over property
#220	0.15	25	238	5' Fill removal over property

TABLE 4-1 (cont'd)

Location Code	Survey Results *** Gamma (mR/hr)	Radon (pCi/l)	Soil (cpm/Kg)	Recommended Action
#233	0.16	-	140	2' Soil removal over 300' x 300' area
#237**	0.2	9.1	-	5' Soil removal over property assumed
#282	0.035	49	32	3' Fill removal over yard behind building. Note: Ventilation system installed
#291 - 300	0.2	-	-	3' Fill removal in 30' x 30' area in yard
#332	0.2	31	19	3' Fill removal over property
#343 - 344	1.8	-	-	Note: Houses abandoned 3' Fill removal over 50' x 30' area in front and 120' x 30' area north side of property.
#345	0.2	38	17	4' Fill removal over property
#355	0.032	71	79	4' Fill removal over property
#400	0.2	22	94	3' Fill removal over property
#416	0.7	-	691	3' Fill removal over area of 100' x 50' north of building
#478	0.25	-	-	4' Fill removal over 10' x 10' area south of building

TABLE 4-1 (cont'd)

Location Code	Survey Results *** Gamma (mR/hr)	Radon (pCi/l)	Soil (cpm/Kg)	Recommended Action
#557	0.25	5	2836	4' Fill removal in driveway 30' x 20' and 50' x 50' area to north

* Action levels based on the following: External gamma radiation greater than 0.11 mR/hr
Radon level above 11.0 pCi/litre of air (see page 4-11)

** Sites not surveyed in detail for this report.

*** Survey results are the maximum readings found at each location. The soil activity readings are in counts per minute per kilogram of the undried sample and represent the maximum reading found in the soil column. The counts are adjusted for the background of the counter.

TABLE 4-2

SUMMARY DETAILS OF

LOCATIONS WHERE INTERIOR REMEDIAL ACTION IS INDICATED*

Location Code	Survey Results ** Gamma (mR/hr)	Radon (pCi/l)	Recommended Action
#15	0.15	16	Replace floor joists Note: Site unoccupied
#30	0.12	6.9	Replace block wall under extension to kitchen
#111	0.5	4.4	Replace columns in stockroom area
#112	0.08	11.1	Replace basement framing and section of exterior wall
#125	0.3	1.9	Replace front porch
#191	0.45	17.0	Replace back porch
#194	0.25	3.6	Replace basement apartment framing

* Action level based on the following: External gamma radiation greater than 0.11 mR/hr. Radon level above 11.0 pCi/litre of air (see page 4-11)

** Survey results are maximum readings found at each location.

TABLE 4-3

SUMMARY DETAILS OF

LOCATIONS WHERE EXTERIOR REMEDIAL ACTION MAY BE REQUIRED*

Location Code	Survey Results *** Gamma (mR/hr)	Radon (pCi/l)	Soil (cpm/Kg)	Remarks
#217**	0.024	7.7	-	3' Fill removal over property assumed
#224	0.03	9.5	43	3' Fill removal over property
#286	0.06	9.3	196	3' Fill removal over property
#289	0.032	10	25	4' Fill removal over property
#338	0.015	9.0	32	3' Fill removal over property

* Action level based on the following: External gamma radiation level 0.085 - 0.11 mR/hr
Radon Level 7.0 - 11.0 pCi/litre of air (See page 4-14)

** Sites not surveyed in detail for this report

*** Survey results are the maximum readings found at each location. The soil activity readings are in counts per minute per kilogram of the undried sample and represent the maximum reading found in the soil column. The counts are adjusted for the background of the counter.

TABLE 4-4

SUMMARY DETAILS OF

LOCATIONS WHERE INTERIOR REMEDIAL ACTION MAY BE REQUIRED*

Location Code	Survey Results** Gamma (mR/hr)	Radon (pCi/l)	Recommended Action
#24	0.05	3.7	Replace staircase, basement columns and kitchen cupboards
#41	0.08	-	Replace staircase
#120	0.03	9.3	Replace joists in N.E. section of basement

* Action level based on the following: External gamma radiation of .06 - 0.11 mR/hr
Radon level 3.0 - 11.0 pCi/litre of air (See page 4-11)

** Survey results are maximum readings found at each location

Chapter 5

COST ESTIMATES

CHAPTER 5

COST ESTIMATES

A. Order of Magnitude Cost Estimate for Exterior Remedial Measures

A field survey of the exterior physical features of sample properties was made and recorded for homes on Pidgeon Hill Rd., Harcourt St. Cavan St. and Alexander St. This data was plotted and used for estimating the quantities of the remedial measures required for these properties.

As the study and investigation progressed, other properties in other areas were identified as requiring remedial measures. Brief surveys of the exterior physical features of these additional homes were made and categorized on the basis of the previously identified sample homes.

Based on the radiation and field survey data collected, a list of remedial measures for the exterior of the affected properties was tabulated as follows:

- Remove and re-erect fences.
- Remove and replant shrubs, small trees.
- Remove and replace shrubs, small trees.
- Remove large trees
- Replace large trees.(where possible)
- Protect large trees.
- Remove and replace concrete walkways and steps.
- Remove and replace patio stones.
- Excavation and disposal of contaminated material.
- Clean and seal exposed foundation walls.
- Supply and place clean fill.

- Replace topsoil and sod.
- Replace driveways and parking areas.
- Protect and/or replace existing utilities.
- Miscellaneous and special items.

As outlined in Section C, estimates were made of the quantities of materials involved at each location and representative costs for the above work items were estimated on the basis of the following assumptions:

(i) Labour, material and equipment costs are based on representative local rates as of February 1976.

(ii) The disposal site for the contaminated material was assumed to be 3 miles from the source. A 10 mile haul distance to the disposal site would add approximately $75,000 to the total cost and, for a 25 mile haul, approximately $200,000 would be added to the total cost.

(iii) The cost for supplying clean fill was based on $2.00 per cubic yard. This cost will vary depending on material type, source and haul distance.

(iv) Excavation costs are based on a considered practical and economic use of local labour and equipment.

(v) The costs included for restoration and reinstatement are intended to represent the cost to restore the ground surfaces and any disturbed physical features to their original conditions. This also includes the cost of protecting and/or replacing existing water services, sanitary and storm services, gas services, buried Hydro or B.T. Co. cables, etc., during the excavation and refilling operations.

(vi) No allowance has been included for any special support systems or shoring where these might be required adjacent to existing roads or sidewalks or properties due to the depth of excavation required.

(vii) Included for the health physics aspects of the remedial measures during working hours are the assessed costs for:

a) covering of vehicles with tarpaulins during transit to minimize dusting.

b) supplying workers with coveralls which are to be changed at the work site.

c) requiring the contractor to remove all loose material from the truck body and tires at the work site prior to transport of the material to the disposal site.

(viii) From the sample homes investigated, it was estimated that approximately 27 families would require accommodation elsewhere during the remedial measures program. This additional cost is estimated to be approximately $20,000.

(ix) On the basis of the investigation carried out to date there are approximately 60,000 cubic yards of contaminated material to be removed where exterior remedial action is indicated and approximately 6,000 cubic yards where exterior action may be required.

B. Order of Magnitude Cost Estimate for Interior Remedial Measures

As previously outlined, interior surveys were made of some 14 structures by a radiation surveyor and a quantity surveyor. Gamma readings were taken using an LB 1200 survey meter.

Efforts were made by the survey team to narrow the problem to a localized area in order to more precisely define the particular materials that were causing the problems in each specific case. In many cases, it was possible to immediately assess which materials were affected, such as the face of block walls, the face of exposed floor joists, etc. However, in some locations, where the particular problem could not be seen, estimates were made on the basis of identifying additions or extensions to the original structure or by comparison with similar problems encountered in other buildings surveyed.

On the basis of the investigations carried out to date on interior contamination problems, it is estimated that approximately 3 to 4 truck loads of contaminated material will need to be removed from these buildings.

Once these estimates were completed, costs were established on the basis of the following parameters:

(i) Removal and replacement of all contaminated material, including removal to an authorized waste disposal area, with due regard to the health physics aspects outlined in Chapter 6.

(ii) Clean material of a similar nature to be used for restoration purposes.

(iii) Where contaminated material is hidden behind existing work, costs are included for removal of existing finishes and replacement with material of equivalent or better quality.

(iv) All estimates used are based on representative local rates as of February 1976.

C. Summary of Estimated Costs

(i) Exterior

Tables 5-1 and 5-2 show the estimated cost for remedial measures required at the sites indicated and exclude the costs for developing and operating the Disposal Site.

These costs represent the order of magnitude of remedial measures for the sites studied.

Estimated costs for sites where exterior remedial action is indicated	$556,300
Estimated costs for sites where exterior remedial action may be required	54,700
Sub Total Exterior	$611,000
Estimated cost of family relocation	$ 20,000
TOTAL Exterior	$631,000

All costs exclude engineering contract administration, contingencies, escalation, land and legal costs.

(ii) Interior

Similarly, Tables 5-3 and 5-4 outline estimated costs of interior remedial measures required at sites indicated. These include:

Total estimated costs for sites where interior remedial action is indicated	$ 29,300
Total estimated costs for sites where interior remedial action may be required	9,500
Sub-Total Interior	$ 38,800
Estimated cost of family relocation	16,400
TOTAL Interior	$ 55,200

(iii) Variation of Disposal Haul Cost

The following costs show the effect of an increase in haul distance beyond the three mile distance estimated:

Total extra cost for a further 7 mile haul to disposal site (total 10 miles)	$ 75,000
Total extra cost for a further 22 mile haul to disposal site (total 25 miles)	$200,000

(iv) Excavation Beneath Floor Slabs

As previously mentioned, soil borings were taken beneath 5 buildings suspected of having contaminated fill beneath the basement floor slabs. These locations are identified by file numbers #5, 6, 128, 129 and 130.

Preliminary soil testing results indicate that contaminated material exists at two of these locations, namely file numbers 5 and 6. Accordingly, an allowance of $160,000 was made for removal of this material at these two locations, considering such factors as the depth of excavation, underpinning and restoration.

TABLE 5-1

SUMMARY OF COSTS

FOR SITES WHERE EXTERIOR REMEDIAL ACTION IS INDICATED

Location Code	Cost
# 5	$ 56,200
# 6	42,600
# 11	10,000*
# 17	11,300
# 20	5,000
# 29	900
# 35	5,900*
# 43	500
# 48	3,700
# 68	1,800
#128-129	18,600
#130	44,800
#135	6,900
#139	11,400
#141	800
#153	97,200
#161	16,900
#195	3,800
#219	11,100
#220	44,100
#233	65,000
#237	16,000*
#282	9,400

* Sites not surveyed in detail

TABLE 5-1

Continued

Location Code	Cost
#291-300	1,900
#332	11,200
#343-344	5,100
#345	27,800
#355	4,800
#400	7,400
#416	5,100
#478	800
#557	8,300
	556,300

* Sites not surveyed in detail

Note: Costs based on 3 mile one-way haul to disposal area.

TABLE 5-2

SUMMARY OF COSTS

FOR SITES WHERE EXTERIOR REMEDIAL ACTION MAY BE REQUIRED

Location Code		Cost
#217 *		$ 11,500
#224		11,300
#286		11,300
#289		13,600
#338		7,000
	TOTAL	$ 54,700

* Sites not surveyed in detail

TABLE 5-3

SUMMARY OF COSTS

FOR SITES WHERE INTERIOR REMEDIAL ACTION IS INDICATED

Location Code	Cost
# 15	$ 8,000
# 30	6,500
#111	2,000
#112	2,000
#129	3,200
#191	2,300
#194	5,300
TOTAL	$ 29,300

TABLE 5-4

SUMMARY OF COSTS

FOR SITES WHERE INTERIOR REMEDIAL ACTION MAY BE REQUIRED

Location Code		Cost
# 24		$ 7,500
# 41		1,000
#120		1,000
	TOTAL	$ 9,500

Chapter 6

HEALTH AND PHYSICS ASPECTS OF REMEDIAL WORKS

CHAPTER 6

HEALTH AND PHYSICS ASPECTS OF REMEDIAL WORKS

A. Introduction

The provision of detailed and specific procedures applicable to the health physics aspects of the proposed remedial actions at Port Hope will require detailed negotiations between the A.E.C.B. and the program manager carrying out the work. It is assumed that one of the results of these negotiations will be that the program manager will be required to have a qualified health physicist available for consultation on short notice. In general the health physics activities should be primarily directed towards the prevention of inadvertent spreading or dispersion of materials during the removal and disposal of contaminated materials and detailing the extent of contamination for tendering purposes. Due attention, of course, must be paid to the safety of the personnel carrying out the work. The procedures adopted at any stage will be subject to amendment as additional information becomes available. The additional information will result primarily from experience gained in carrying out the remedial measures themselves.

Careful co-ordination of health physics operations and contract administration activities is necessary to effect possible economies.

The procedures as outlined are believed to be reasonable and permit order of magnitude cost estimates to be assigned to this phase of the work.

B. Personnel Protection

A review of the likely doses of radiation to be received by the personnel working on the remedial program with officials of

the A.E.C.B. has led to the agreement that the workers would not be classified as "atomic radiation workers" under the terms of the Atomic Energy Control Act.

Nevertheless more than the usual construction activity provisions for job health safety are indicated. For proper observance of these provisions special co-operation will be necessary from the Contractors and the workmen executing the work.

It is recommended that all workmen on a site be issued protective clothing in the form of coveralls and gloves and that this protective clothing be removed and stored in a locked box on site when the workmen leave the job site.

All workmen should be especially instructed as to the hazards of ingesting contaminated material and emphasis will be made on requirements for cleaning the hands prior to eating, drinking or smoking.

Personal dosimeters should be issued to selected members of each work crew and these dosimeters should be monitored on a regular basis to permit rapid discovery of unusual exposures.

C. Contaminated Material Control

It is imperative that all reasonable precautions be taken to insure that contaminated material is not spread further due to the remedial measures activities. The mechanisms that could most readily result in spreading contaminated material are:

a) tracking of contaminated material off the work site by trucks or equipment.

b) truck deliveries of contaminated loads to other than the authorized disposal site.

c) contaminated trucks used for purposes other than hauling contaminated material.

d) spillage during transit to the authorized disposal site

To avoid tracking of material by vehicles from an excavation site and deposition on nearby streets requires that positive action be taken before any vehicle leaves the site. This positive action would be the inspection of tires and vehicle undercarriage and the removal of all loose material. Care will also be required to avoid overloading and to ensure that loads are covered by tarpaulin.

A ticket system will be required to ensure control of movement of loads of excavated material. A three part numbered ticket is envisaged. Each remedial works site inspector will be issued registered tickets. The remedial works site inspector will fill out a ticket, retain one copy and issue two copies to each truck driver as his vehicle leaves the site with material for disposal. The truck driver will, upon leaving the disposal site, have the two copies signed by the disposal site inspector, retain one copy, and turn the remaining copy over to the disposal site supervisor. A daily comparison of the ticket copies signed by the remedial works inspector and the disposal site inspector versus the ticket register, will permit checking to see that loads of potentially contaminated material reach their intended destination.

Each vehicle as it reaches the disposal site will proceed to the dumping area and unload. It will then proceed to an inspection station on the disposal site where the ticket transaction referred to above will occur. In addition the vehicle will be monitored for excess gamma radiation. If no

excess radiation is noted the vehicle will be released from the disposal site. If excess radiation is noted the vehicle will be cleaned and reinspected. Initially a steam generator will be required for cleaning the vehicles. It may be determined from experience that a water hose will be sufficient for the cleaning purpose and the steam generator may be able to be dispensed with.

D. Estimated Costs

Because of the nature of the health physics aspects of the remedial works program it is suggested that a lump sum allowance be made for the required incidental purchases and rentals of items such as dosimeters, tickets, steam generators, etc. The day to day required activities, as envisaged, will be carried out by program management staff and their costs are included elsewhere. The estimated lump sum allowance for this purpose is $15,000.

Chapter 7

PROGRAM MANAGEMENT FOR REMEDIAL WORKS

CHAPTER 7

PROGRAM MANAGEMENT FOR REMEDIAL WORKS

A. General

There are a variety of forms of contract which could be used to acquire the services necessary to affect the required remedial measures in Port Hope. The nature of the work and the desirability of maximizing the involvement of the local construction forces dictates that the form of contract be carefully developed.

The program management activities of the A.E.C.B. or its agent (the program manager) will vary considerably depending on the form of contract. The contracts as eventually drafted will, of course, have to conform to the Federal government requirements for purchasing of construction services.

B. Contracts

(i) Nature of the Work

The work involved in the remedial measures in general involves three rather separate types of activities. One is concerned with the removal and hauling away of contaminated fill material and replacing it with clean borrow material. Another is concerned with the removal from structures of certain contaminated structural or architectural materials, hauling them away and the installation of new materials. The third activity is the operation of a disposal or waste management facility for the materials hauled to the facility. It is anticipated that only one such facility will be required.

The removal and replacement activities will occur at a number of different locations. This will make it possible to carry out the work under a number of different contracts without difficulties in separating the work descriptions.

As mentioned previously, the work involves the handling of low level radioactive materials. The precise levels of radioactivity and the location of materials with higher levels of radioactivity will not be known until such materials are uncovered. Special precautions will be necessary to ensure no hazards to health of the workmen and to avoid any inadvertent new contamination. They will require close co-operation by each contractor in order to be successful. The requirements for special provisions will have to be carefully outlined to the contractor to avoid future claims for costs of unanticipated activities.

(ii) Prequalification of Contractors

The Contractors to be involved in the above remedial measures have to be knowledgeable, responsible and co-operative to a degree in excess of usual requirements. Also the individual property owner and the general public in Port Hope have interests in the expeditious completion of the work. Difficulties in delays of contracts or replacement of contractors on specific projects will have more than normal adverse effects. To assist in obtaining Contractors with these qualifications it is recommended that all potential contractors be prequalified.

Information to be solicited from contractors to permit the development of a list of prequalified contractors would include the following:

a) Type and size of previous construction contracts

b) Experience record of supervision personnel

c) References of owners for whom previous work was completed, banks, material suppliers and bonding companies.

d) Willingness to conform to health safety requirements.

This information would be reviewed and the references checked.

Only prequalified contractors would be invited to bid any contracts. The prequalification list would, of course, be subject to amendment.

(iii) Construction Contract

The individual construction contracts for remedial measures should be separate for each location as a general rule. In some instances where two or more sites have contiguous boundaries the advantages to be gained by including more than one property in one contract should be reviewed in determining the limits of the contract. It will be advantageous to close tendering on more than one contract at the same time to permit the advantages of decreased costs, if any, on bidding for more than one contract to be realized.

The contract specifications format should be common for all contracts with common general conditions and general clauses

to permit, as much as possible, standardizing of bidding and contract administration procedures and field interpretations.

In addition to normal procedures in preparing such contract documents special attention will be required to permit equitable variations of price based on unforeseeable variations in quantities and types of materials to be removed. These variations could be substantial depending on the evidence that develops as removal of materials proceeds.

The Contractor's responsibilities for activities concerned with safety, health standards, decontamination procedures, etc., will also require special attention in the preparation of the contract documents.

The question of performance bonding requirements for each contract should be determined by an evaluation of each proposed contract.

C. Program Management

The primary duties of the A.E.C.B. and/or the program manager in carrying out the remedial measures will be:

a) Continue with radiation monitoring and analysis to determine areas for remedial measures.

b) Prepare design and contract documents for each contract.

c) Develop and maintain a list of prequalified contractors.

d) Receive invited tenders, evaluate and complete contracts with successful tenderers for each contract.

e) Administer construction contracts including carrying out the required radiation monitoring for the construction activities and preparation of payment certificates.

It is anticipated that the bulk of these duties will be carried out by a program manager appointed by the A.E.C.B. as its agent. It is also anticipated that A.E.C.B. will maintain its "store front" office in Port Hope, continue with the investigating radiation monitoring, provide the primary contact with the public and maintain liason and co-ordination with the program manager.

The program manager's primary responsibility will be to ensure that the remedial measures are carried out expeditiously and efficiently and within a predetermined total financial budget. This budget will be subject to amendment as determined by the actual cost of the remedial measures and the extent of the work required. In more detail the program manager's duties will include:

a) The establishment of an office in Port Hope to provide a central works location. The office will include provisions to:

- handle, monitor and store soil samples
- store field monitoring equipment
- provide a central location for field administration crews.
- process and store field records.

This office should be relatively remote from the A.E.C.B. "store front" office.

The program manager will be required to carry out such surveys and soils investigations as are necessary to permit the determination of quantities to be removed for inclusion in the contract documents for each contract. It is not deemed necessary that the actual preparation of the contract documents be in Port Hope.

The monitoring for radioactivity necessary to protect the field crews, satisfy the decontamination protection requirements, and determine the extent of removal of materials should be carried out by the program manager since this requires direct co-ordination with the removal contractor. The A.E.C.B.'s role in this function should be the final monitoring to verify the program manager's conclusions that removal has proceeded far enough.

D. Program Management Costs

Allowances for costs of program management activities have been made under three separate categories, namely contract administration, contract preparation and soil assays.

Contract administration will include provision for a program manager, part time health physicist, a clerk/secretary, a survey crew and inspectors who would double as radiation surveyors on-site to establish quantities of material to be removed. Allowances were made for salary and disbursements for this staff for a six month period.

Contract preparation includes the preparation of the actual contract documents for the remedial works.

For soil assays, estimates were made of the equipment and personnel necessary to provide this service over a five month period.

The estimated costs for these items are summarized below:

Contract Administration	$150,000
Contract preparation	75,000
Soil assays	80,000
Total program management costs	$305,000

Chapter 8

SUMMARY AND RECOMMENDATIONS

CHAPTER 8

SUMMARY AND RECOMMENDATIONS

A. Summary

We have concluded our preliminary investigation of particular areas in Port Hope as outlined in the foregoing chapters. In these areas we have identified certain locations where the first stage remedial works are suggested based on criteria action chosen for this study and have prepared an order of magnitude cost estimate of these actions. Of the 433 locations surveyed to date, we have identified some 110 locations where remedial work is indicated or may be required. Of these locations 47 were included in the cost estimates. For the remaining 63 locations, 9 sites require further detailed surveys in order to define the remedial works required. The remaining sites are locations that either have remedial works underway, have been purchased by ENL, or where discretionary judgement is required to decide whether action is needed.

Sites included in the cost estimate are classified as follows:

1. 32 sites where exterior remedial action is indicated.

2. 7 sites where interior remedial action is indicated.

3. 5 sites where exterior remedial action may be required.

4. 3 sites where interior remedial action may be required.

47 Total sites for the first stage remedial action.

A summary of the total cost estimated to complete the first phase of remedial works as described herein is as follows:

1. Waste Management Facilities

Fixed Site Costs	$450,000	
Variable Site Costs	90,000	
	$540,000 *	
Sub Total		$540,000

2. Remedial Works

Exterior	$631,000 **	
Interior	55,200	
Allowance for Basement Excavation	160,000	
	$846,200 *	
Sub Total		$846,200

3. Health Physics

Lump Sum Allowance		$ 15,000

4. Program Management

Contract Administration	$150,000	
Preparation of contracts	75,000	
Allowance for Soil Assays	80,000	
	$305,000	
Sub Total		$305,000
	TOTAL	$1,706,200

* Exclusive of Land and Legal Costs
** Based on 3 mile haul distance to the waste management area.

It should be noted that the fixed costs for the disposal area can be applied to the on-going remedial measure activities, not just to the 1976 program.

B. Schedule of Works For First Stage Remedial Works in 1976

From our studies we estimate that the works described herein for the first stage remedial measures at Port Hope would require approximately five months total construction time. It would be unreasonable to carry out the excavation and restoration works for the exterior remedial works beyond December 1, 1976, because of the onset of freezing weather. This means that the latest start date for the first construction contract must be underway July 1, 1976. This presupposes that the waste management site will be operational by this July date.

The appointment of the program manager will have to be completed prior to June 1, 1976 to permit contract document preparation and training of staff on the radioactive monitoring apsects of the project. The schedule presupposes that the following vital activities will proceed immediately:

1. Establishment of criteria for the determination of the material to be removed both prior to and during the construction operations.

2. Development of procedures for monitoring the application of these criteria.

3. Development of detailed health physics procedures and the licensing of the program manager if desirable.

4. Acquisition of consent agreements with the property owners.

It is anticipated that the first stage of the remedial works will result in the excavation, disposal and replacement of approximately 70,000 cubic yards of material.

c. Recommendations

As a result of our studies to date we believe the following recommendations are pertinent:

1. That the A.E.C.B. determine in detail the disposal site approval procedures to be followed with a view to making the time required for such approvals as short as possible.

2. That a paved area classified as a Category B radioactive waste disposal site be acquired and developed.

3. That procedures be instituted to carry out the first stage remedial measures outlined in this report in 1976, at an estimated cost of $1,706,200.

4. That contracts be arranged to make maximum use of local construction services.

5. That consideration be given to the setting up of a soil assay laboratory in Port Hope to be used for analyzing soil samples prior to and during the excavation of the contaminated materials.

6. That those items outlined in the section on scheduling be implemented as quickly as possible.

7. That the A.E.C.B. continue to conduct detailed surveys to determine the extent of the radioactive contamination in Port Hope.

8. That the sites investigated in this report be reviewed once formal criteria for remedial action have been established by the A.E.C.B.

that will be the major source of delays.

D. Acknowledgements

A project such as this could not be carried out in the required time without the close co-operation and assistance of a number of agencies and organizations. The co-operation and assistance was forthcoming from all agencies and organizations contacted. We wish to acknowledge our appreciation to all such agencies and organizations and particularly the Atomic Energy Control Board, the Ministry of Health of the Province of Ontario and Eldorado Nuclear Limited.

We also wish to acknowledge the contribution made to this report by L. R. Haywood who acted as a consultant on the project.

All of which is respectfully submitted.

Yours very truly,

JAMES F. MacLAREN LIMITED

D. P. Sexsmith, P. Eng.,
Project Director.

E. J. Chart, P. Eng.,
Project Manager

APPENDIX A

A.E.C.B.
STATEMENT OF WORK

1. GENERAL OUTLINE OF WORK TO BE UNDERTAKEN

1.1 To conduct a preliminary investigation and assessment of the technical and economic factors relevant to:

a) the removal of radioactively contaminated soil, building materials and other materials from the environs of or within private, public and commercial premises in the Town of Port Hope, Ontario; and

b) the restoration of such premises to a state consistent with that which existed prior to the commencement of the removal operations.

1.2 To prepare a program of work to be undertaken by a program manager to be appointed by the Atomic Energy Control Board to effect the expeditious removal of radioactively contaminated soil, building materials and other materials from the environs of or within private, public and commercial premises in the Town of Port Hope, Ontario and the restoration of such premises.

1.3 To prepare a preliminary estimate of the costs expected to be encountered in the implementation of the above-mentioned program of work.

2. SPECIFIC ACTIVITIES TO BE UNDERTAKEN

2.1 A review of the waste management operations of Eldorado Nuclear Limited sufficient to identify the type and nature of radioactive materials and the quantities of such

materials as these matters relate to the effective completion of the work to be undertaken.

2.2 A review of the data obtained by or under the direction of the Atomic Energy Control Board during its investigation of radioactively contaminated locations in Port Hope, Ontario.

2.3 A review of pertinent information in the literature concerning the investigation and program of remedial work undertaken in the United States of America in connection with the use of uranium mill tailings for construction purposes in Grand Junction, Colorado.

2.4 Establishment of a computerized file of data in respect of radioactively contaminated locations in Port Hope, Ontario.

2.5 A review of alternative methods for the management of radioactive wastes to be removed from identified locations in Port Hope, Ontario including liaison with appropriate federal and provincial jurisdictions.

2.6 Selection of representative locations and premises for detailed study and assessment and development of lst order costs for remedial works.

2.7 A review of alternative methods of remedial action to be undertaken based upon representative locations and premises including procedures for obtaining access and owner's consent.

2.8 A review of historical data including aerial photographs, plans and other documents in respect of land fill areas and utilities at representative locations and premises.

2.9 Subsurface drilling and soil testing at representative locations to determine depth and extent of contaminated material.

2.10 Reconnaissance of the interior of representative premises to determine extent of remedial measures required.

2.11 Development of a check list for estimating costs of remedial work at representative locations and premises.

2.12 A review of the methods, procedures and contractual arrangements appropriate to the expeditious completion of remedial work and of procedures for determining the expected extent of such work.

2.13 A review of the methods and procedures expected to be necessary to ensure adequate radiological protection and material control during the removal and disposition of contaminated material.

2.14 Liaison with municipal and other officials and identification of procedures essential to achieving good communication with and cooperation from such officials.

2.15 A review of the availability of local contractors to perform specified remedial work.

2.16 Development and tabulation of 1st order costs for performing remedial work at representative locations and premises.

2.17 Identification of alternative methods of waste management as they apply to the program of work and development of 1st order costs and schedules.

2.18 Development of a preliminary list and schedule for remedial work to be undertaken in 1976.

2.19 Preparation of a report on remedial measures to be undertaken based upon selected representative locations and premises including 1st order costs.

2.20 Preparation of a summary report on a remedial works program for 1976 including estimated costs, schedules and recommended methods of contract management.

2.21 Preparation of a report on recommended methods, procedures and contractual arrangements for remedial works and associated program.

2.22 Preparation of recommendations on the method(s) that could be adopted for the management of radioactive materials removed from locations and premises during the performance of remedial work including 1st order costs.

2.23 Preparation of a report on recommended planning procedures for determining the extent and cost of remedial work at locations and premises identified on a priority basis by the Atomic Energy Control Board in the light of its on-going investigations.