Chapter 1

Executive Summary

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SUMMARY

In 1980, the Federal Government decided that a potential health threat existed **in an area near Love Canal, beyond the canal itself and two inner rings. This outer area was termed the emergency declaration area (EDA). In cooperation with New York State, the Federal Government provided assistance for residents who wished to move out of the area. There was no clear evidence at the time of substantial and widespread contamination of the EDA by toxic chemicals from Love Canal.**

From August to October 1980, the Environmental Protection Agency (EPA) conducted a monitoring study to provide evidence for determining whether the EDA was contaminated or could become so. Later, the Department of Health and Human Services (DHHS) became responsible for deciding, on the basis of the EPA study and other data, whether the EDA was habitable. In July 1982, after considering comments by the National Bureau of Standards (NBS) on the procedures EPA had used, and after further consultation with EPA, DHHS affirmed its earlier provisional decision that the EDA was habitable. The decision was contingent on effective safeguards against leakage from the canal, and cleaning up contamination in the EDA.

OTA has reviewed and analyzed the EPA monitoring study, documents prepared by other Federal agencies, plans for remedial action developed by EPA and New York State, and various independent critiques. OTA's primary goal was to examine the technical basis for the decision reached by DHHS, in conjunction with EPA, that the EDA is habitable.

OTA's principal finding is that: With **available information it is not possible to conclude either that unsafe levels of toxic contamination exist or that they do not exist in the EDA. The OTA analysis does not support an interpretation of the DHHS decision that would lead to the immediate and complete rehabitation of the EDA. There remains a need to demonstrate more unequivocally that the EDA is safe immediately and over the long term for human habitation. If that cannot be done, it may be necessary to accept the original presumption that the area is not habitable.**

Four arguments that support the principal finding are:

1. **The current activities and long-term plans for EDA cleanup and operation and maintenance of the Love Canal remedial action program pose difficulties and uncertainties.**
2. **The design of the EPA monitoring study, particularly its sampling strategy, was inadequate to detect the true level and pattern of toxic chemical contamination that might exist in the EDA.**
3. **The EPA monitoring study contains important uncertainties over the levels of the toxic chemicals detected, and the possible levels of those not detected. There are also uncertainties over possible** *synergistic* **human health effects of multiple toxic chemicals present at low concentrations. These two areas of uncertainty, as well as the lack of detailed documentation** by **DHHS** of its **analyses, place the decision on habitability by DHHS in doubt.**
4. **OTA's analysis of some data obtained in the EPA monitoring study provides limited, but not conclusive, indication that there may be contamination in the EDA by toxic chemicals from Love Canal. OTA examined those data for chemicals known to have been disposed in Love Canal, as compared to the much larger universe of data analyzed by EPA.**

Incremental rehabitation of the EDA is a possible alternative to complete rehabitation, or to a presumption that the area is not habitable. OTA has outlined several steps that could be taken to move in this direction. By incremental rehabitation we mean a paced, cautious approach. Improvements in scientific certainty to assure safe-

ty of the EDA are necessary for the success of this approach. Another benefit of improved certainty is to increase public confidence in policy decisions that are based on technically complex data and analyses. Four key steps for moving toward incremental rehabitation are:

1. To address the technical problems and uncertainties in the current cleanup activities in the EDA and in the long-term plans for operation and maintenance of the waste containment system at Love Canal.
2. To address the uncertainties related to institutional stability and effectiveness over the very long terms (i.e., hundreds of years) that reflect the long lifetimes of the chemicals in Love Canal.
3. To consider performing additional monitoring for carefully defined areas of the EDA, perhaps for individual homesites. This would make use of what has been learned from the EPA monitoring study.
4. To develop a program for finding a permanent solution to deal with the large amounts of toxic wastes still in Love Canal (i.e., waste destruction or detoxification instead of the waste isolation approach now in effect).

OTA's case study of the Love Canal EDA touches on a number of issues of general importance to the Federal Superfund program for cleanup of uncontrolled hazardous waste sites. EPA is now aware of about 16,000 uncontrolled hazardous waste sites nationwide. The use of monitoring studies to answer questions on relocation and habitability will likely continue to be necessary. Therefore, it is important to learn as much as possible from the Love Canal experience to make future efforts more effective and efficient. There are needs to:

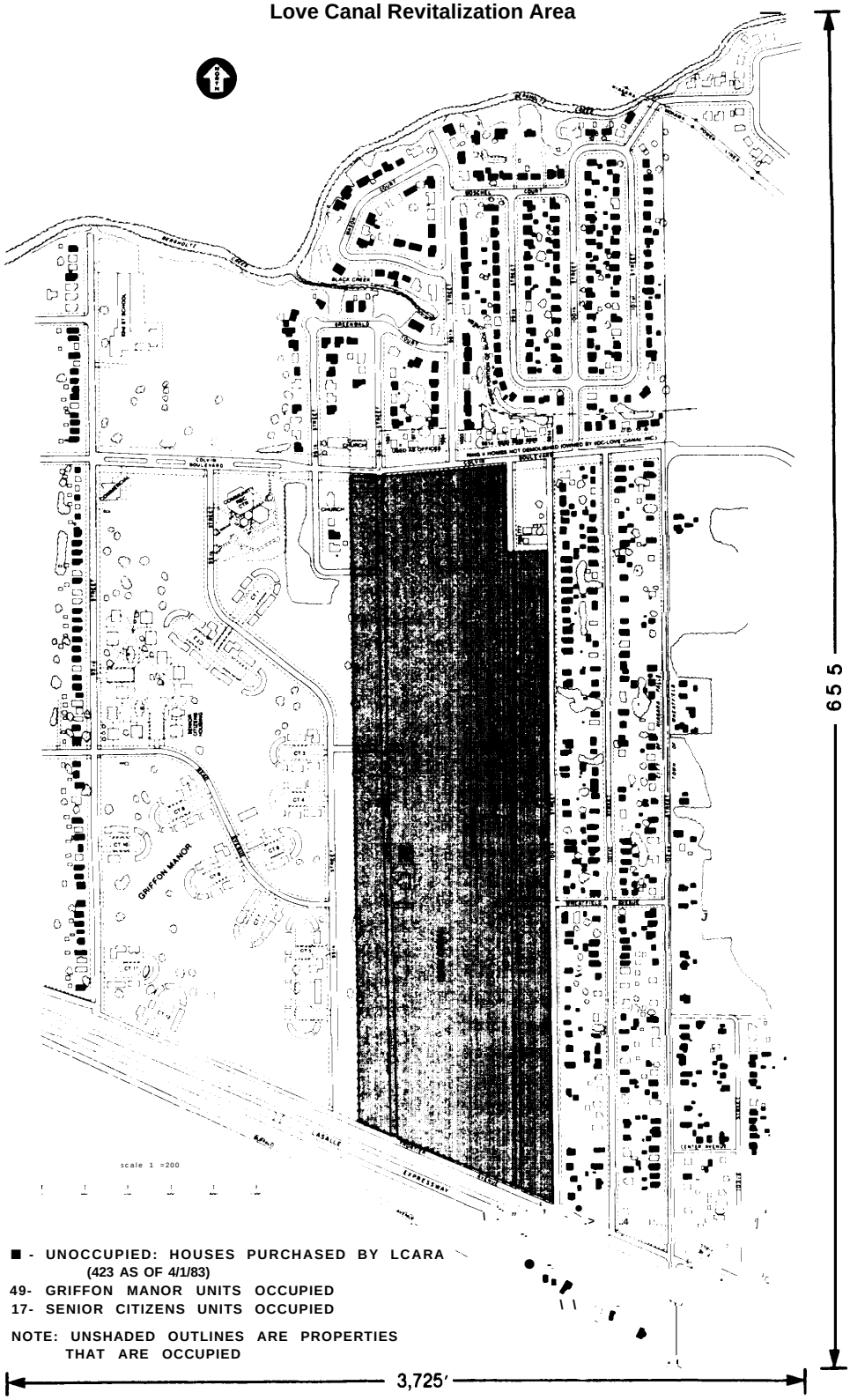
- Examine the "How clean is clean?" question, and to develop standards for unacceptable levels of contamination by toxic chemicals.
- Obtain much more information on the health effects of toxic chemicals, and better define the Federal decisionmaking process concerning habitability of, and relocation of residents from, uncontrolled hazardous waste sites.
- Develop technical guidelines for monitoring studies, particularly for sampling and analytical protocols, and for the way results are presented and documented.
- Compel consideration of more permanent solutions for cleaning up uncontrolled waste sites, and to develop ongoing programs to evaluate technological opportunities for eventual permanent solutions to replace waste containment "interim solutions. " It is also necessary to improve oversight by EPA of State implementation of chosen remedial action programs.
- Explore answers to problems of long-term institutional effectiveness, such as mechanisms to assure indefinite funding for operating and maintaining waste containment systems.

BACKGROUND

In 1980, the Federal Government decided that a potential health threat existed beyond the canal (shaded area on figure) itself. The outer area was termed the emergency declaration area (EDA). See the accompanying figure for a description of the EDA and Love Canal areas. In cooperation with New York State, the Federal Government provided assistance for residents who wished to move out of the area. Not all residents in the EDA decided to relocate. The canal itself and Rings 1 and 2 had been the subject of an earlier Federal state of emergency which included total evacuation and intensive cleanup efforts. As for the EDA, there was no clear evidence at the time of the emergency declaration that substantial and widespread contamination by toxic chemicals existed in the area. The voluntary evacuation was considered a precautionary measure.

Nevertheless, Government actions have raised the issue of habitability of the EDA. These actions included: providing assistance for relocation, implementing monitoring studies to determine if contamination was present (and at what levels and patterns), carrying out studies on possible health effects among residents of the EDA, and implementing the cleanup program to correct the known problems in the canal itself and the adjacent rings. In light of these activities, the hab-

Love Canal Revitalization Area



■ - UNOCCUPIED: HOUSES PURCHASED BY LCARA (423 AS OF 4/1/83)

49- GRIFFON MANOR UNITS OCCUPIED

17- SENIOR CITIZENS UNITS OCCUPIED

NOTE: UNSHADED OUTLINES ARE PROPERTIES THAT ARE OCCUPIED

itability of the EDA became, and still remains, an important issue.

Government agencies anticipated that scientific evidence of no contamination, or of acceptably low levels of contamination, would be necessary before people could be allowed to move back into the evacuated portions of the EDA. From August to October 1980, EPA conducted a monitoring study to provide evidence for determining whether the EDA was contaminated by toxic chemicals from Love Canal, or could become so. The related, difficult task of deciding whether or not the EDA was habitable was undertaken by DHHS. DHHS was to make its decision primarily on the basis of the EPA monitoring study, but was also to consider other data on contamination levels and on health-related problems observed in residents, as well as professional judgments about possible health effects that could result from exposure to chemicals present in the EDA.

EPA asked NBS to examine the analytical chemistry procedures EPA used in its monitoring study. After completion of the initial NBS report in May 1982, DHHS requested NBS to explain the significance of the negative data in the EPA study. Ninety percent of the samples taken by EPA had revealed either no detectable levels or trace amounts of contamination. DHHS wanted to be satisfied that the data were reliable enough to allow the conclusion that, in fact, only very low levels of chemicals were detected. The possibility that EPA's analytic techniques may have missed contamination in the low parts-per-billion range had to be considered. DHHS was satisfied with EPA's responses to the NBS comments on this matter. In July 1982, DHHS affirmed its earlier provisional decision that the EDA "is as habitable as the control areas with which it was compared." However, DHHS made its decision on habitability contingent on the understanding that the canal site itself and Rings 1 and 2 would be "constantly safeguarded against future leakage from the canal and that cleanup is required for existing contamination of local storm sewers and their drainage tracts **[in the EDA]."**[1]

[1] **"DHHS Evaluation of Results of Environmental Chemical Testing By EPA in the Vicinity of Love Canal-Implications for Human Health–Further Considerations Concerning Habitability" (Washington, D. C.: Department of Health and Human Services, July 13, 1982).**

It must be stressed that EPA's monitoring task for a large area possibly contaminated by hundreds of different chemicals was historically unique, technically complex, and very large in scope. EPA had no precedent for a similarly broad and complex monitoring study, targeted toward a decision on whether a site possibly contaminated by toxic wastes was habitable or rehabitable. Time for the study was severely constrained **because of the Government's strong desire to make a policy decision on habitability. The effort was further complicated by other factors:**

1. **Information on the existing or potential migration of chemicals from the canal was lacking.**
2. **Boundaries for the EDA were arbitrary, unrelated to technical considerations of possible routes of transport of chemicals from the canal.**
3. **The time constraints ruled out a pilot study to define the requirements for 'the larger monitoring program (e.g., to identify qualitatively the levels of contamination to be expected, thus influencing sampling design and the choice of analytical procedures).**

The findings of the study, moreover, made a habitability decision difficult. The discovery of high levels of contamination of even a few chemicals can provide a reasonably certain basis for a decision of "nonhabitability," but it is far more difficult to contend with a situation involving low levels of contamination. The latter was the unexpected result of the EPA monitoring study. Did the low levels of contamination in the EDA found by EPA accurately reflect reality? For the general public as well as technical experts, there were concerns about the sampling, analysis, and interpretation of EPA's data. Thus, the goal of reaching a policy decision on habitability quickly was not met. Interpretation of the data collected by EPA was difficult in itself. In addition, a number of parties raised questions about the study which required further analysis.

The problems confronting New York State in the Love Canal cleanup were also unique, difficult, and complex. Love Canal was one of the first

major uncontrolled hazardous waste sites in the Nation where remediation was attempted. There was a paucity of previous experience to offer guidance on the technological problems of short-term cleanup and long-term maintenance. These problems must be solved. Moreover, EPA's Superfund program has not yet reached the stage of providing complete, effective technical and policy guidance on remediation.

THE OTA ANALYSIS

Scope of the OTA Analysis

At the request of the two U.S. Senators from New York, and based on OTA's previous work on hazardous waste,[2] OTA reviewed and analyzed the EPA monitoring study, documents prepared by DHHS and NBS, the plans for remedial action developed by EPA and New York State, and various independent critiques. OTA focused on the technical aspects of sampling design and analytical procedures used to obtain monitoring data, on the statistical methods used to evaluate the data, and on the immediate and long-term remediation plans for the entire Love Canal area. It was not OTA's task to reach a finding concerning habitability of the EDA or to obtain new monitoring data. OTA's primary goal was to examine the technical basis for the decision already reached by DHHS in conjunction with EPA. OTA was also asked to consider possible implications of this case study for the national Superfund program for cleaning up uncontrolled hazardous waste sites.

[2] *Technologies and Management Strategies for Hazardous Waste Control* (Washington, D. C.: U.S. Congress, Office of Technology Assessment, OTA-M-196, March, 1983).

The principal findings:

1. With available information it is not possible to conclude either that unsafe levels of toxic contamination exist or that they do not exist in the EDA.
2. There are also serious concerns and uncertainties about progress in the remedial program to date and plans for the future.

The OTA analysis does not support an interpretation of the DHHS decision that would lead to the immediate and complete rehabitation of the EDA. There remains a need to demonstrate more unequivocally that the EDA is safe for human habitation immediately and over the long term. If that cannot be done, it maybe necessary to accept the original presumption that the area is not habitable.

The three following sections discuss:

1. Four arguments that support the above findings, with the more detailed supporting analyses provided in an appendix to this report.
2. A number of Federal and State actions that might be undertaken for incremental rehabitation of the EDA over time.
3. Implications and issues for the national Superfund program of the Love Canal case.

THE FOUR ARGUMENTS FOR OTA'S PRINCIPAL FINDINGS

1. The current activities and long-term plans for EDA cleanup and operation and maintenance of the Love Canal remedial action program pose difficulties and uncertainties.

Regardless of whether contamination of the EDA by toxic chemicals exists now, rehabitation of the EDA requires assurance about the future. The current activities and long-term plans for cleanup of the entire canal area and for isolation of the wastes remaining in the canal must be effective (see the appendix for a description of these activities and plans). Effective cleanup was a critical contingency in the DHHS decision on habitability, for two main reasons:

1. in several areas of the EDA there are confirmed high concentrations of dioxin which

pose a threat either if the dioxin stays where it was found originally or if it migrates elsewhere; and

2. **there remain in the canal itself very large amounts of toxic wastes and contaminated soil, both of which pose threats unless they are safely isolated from the environment, totally removed, or permanently destroyed or detoxified onsite.**

The remediation approach at Love Canal is containment of the toxic wastes so that there is no migration of toxic chemicals into the surrounding environment. This approach raises the question of what is meant by "long-term" in containing these wastes. *Both technically and institutionally, "long-term" for toxic wastes must be interpreted to mean hundreds or thousands of yearn. Why* **is it necessary to go beyond several decades in assuring the effectiveness of the containment system? Because many of the toxic chemicals present in the canal area are expected to remain stable and hazardous indefinitely. It is difficult to conceive of sanctioning rehabitation in the areas most exposed to leakage of toxic chemicals from the canal area without a high level of confidence that the remediation plan will remain effective beyond the next few decades.**

OTA sees three major reasons for concluding, at present, that further attention must be given to site cleanup and remediation before rehabitation of the EDA can proceed.

First, *the areas in the EDA contaminated with high levels of dioxin have not yet been cleaned up.* **Moreover, until just a few months ago storm sewers leading from the canal area to the EDA and known to contain dioxin remained open. It is possible that during the past few years—after completion of the EPA monitoring study—dioxin may have been transported within or beyond the EDA. A study to determine the full extent of contamination in and near the sewers is not yet completed. When it is completed, it will greatly assist the cleanup effort.**

Second, *there are technical problems with the current activities and plans for the canal itself and the immediate rings.* **These include:**

- *Leak Detection Systems.* **—The long-term integrity of the remedial technology is not certain. Reliable methods are needed to allow early detection of damage (leading to permeability) to the two basic elements of the containment system. These elements, intended to minimize water entering the canal, are the cap over the canal area and the concrete barrier wall to be built around it. There is no dispute about the need for repair and replacement of the cap and leachate collection system over time, Yet, how it will be done is not clear. How structural damage or clogging of the drain system will be detected, and how repair and replacement can be carried out safely remain unanswered.**
- *Monitoring Programs.* **—Assurance of sufficient warning about any potential migration and accumulation of chemicals from the canal is essential. Plans are underway for developing a long-term monitoring plan for ground water in the area immediately adjacent to Love Canal, but not in the EDA. In this same area (adjacent to Love Canal) it is also necessary to design more extensive ambient monitoring of environmental media other than ground water (e.g., air, soil, and biota). Media other than ground water are possible routes of exposure to toxic chemicals. For example, depending on the properties of chemicals disposed in the canal and the soil through which the ground water moves, some chemicals could be filtered out and could accumulate in soil or possibly in biota. Humans might become exposed to either. In addition, damage to the cap could allow release of volatile compounds into the air.**

A third major area of uncertainty concerns the long-term ability of government institutions to remember, fired, and carry out commitments for long-term continued monitoring and maintenance of the site. **The full range of institutional issues surrounding very long-term commitments for managing uncontrolled hazardous waste sites under the Superfund program have nowhere yet been fully addressed. New York State is not alone in facing these questions. But Love Canal is something of a historical first, and may be viewed as a model. Annual cost estimates for routine operation and maintainance, as well as for replacement, of the leachate collection system at Love Canal**

are about $0.4 million now, $4.2 million in the year 2005, and $8.5 million in 2030. These costs could rise if the other leak detection and monitoring needs noted above are found to require attention. Even though the present State administration is committed to providing these funds, there is no guarantee that State officials 20 or 100 years from now will either remember or honor this commitment.

It is reasonable to raise the prospect that even larger funds might be needed at some time to take further corrective action at the Love Canal site if the original containment system were to fail. Furthermore, there are few institutional mechanisms in place to assure continuity in transferring vital information on Love Canal from one generation to the next. Nor does it appear that New York State has taken binding and permanent title to the canal area in a manner that unequivocally rules out future use of the site. * Finally, the idea that the present containment system is no more than an acceptable "interim solution" requires more attention. No specific program has been undertaken to find a more permanent remedy for removing, destroying, or detoxifying the wastes in the canal.

2. The design of the EPA monitoring study, particularly its sampling strategy, was inadequate to detect the true level and pattern of toxic chemical contamination that might exist in the EDA.

The principal finding of the EPA monitoring study was that, except for a few locations with high levels of dioxin and some other chemicals, there were insignificant levels and patterns of contamination in the EDA attributable to wastes in Love Canal. The finding was based on analysis of the samples taken in the EDA. Our concern is that the design of the monitoring study was not adequate to detect all significant contamination that might be present.

The uncertainties which OTA sees as critical involve such aspects of design as how many samples were taken for specific chemicals, in how many locations within the EDA, and in what environmental media. Whether a monitoring study detects contamination depends on how the search is conducted. If the design of a monitoring study is inadequate, then an erroneous false-negative interpretation may result.

The absence of a strong positive finding of contamination does not at all imply that a negative finding (absence of contamination or absence of health effects) follows logically or persuasively. In the case of a monitoring study, particularly one carried out under serious time constraints and without the benefit of a pilot study, sampling inadequacies can lead to a low level of confidence in the results. While there may never be absolute confidence that a study can find what it is looking for, the issue in the case of the EPA monitoring study is that the confidence level is low.

This lack of confidence in negative results (the finding of an absence) presents substantial problems to policymakers who desire a firm, scientific basis for decisionmaking, but it is sometimes an inevitable outcome of scientific studies. Scientists themselves often find it difficult to give an answer of "I can't determine, or I'm not sure" rather than a "yes or no" answer. Low confidence in the design of a study to produce the desired information, it should be noted, is not the same as scientific uncertainty over the results of a study; uncertainty is discussed in a later section.

The following specific problems with the sampling procedures used by EPA led OTA to judge the outcome of the study indeterminate with regard to the extent (or distribution) and level of chemical contamination, and its site and regional variability y:

- The monitoring study sampled unevenly across environmental media and the 12 regions (10 in the EDA, the canal, and the control). The numbers of sampling sites were not in proportion to sizes of the regions, which vary by a factor of 10. One reason for this situation was that EPA assumed that higher levels of contamination existed closer to the canal. Consequently, some regions farther away from the canal had very little sampling;

* This is not to imply that there is any serious consideration being given to reuse of the canal. But some people may raise this prospect for the future. Reuse already took place once, when governmental bodies deemed the canal area safe for community development after it was no longer used for waste disposal.

the distribution of sampling among regions in the EDA was particularly inadequate. Initial beliefs about possible routes of transport of toxic chemicals from the canal to and through the EDA may also have influenced numbers of sampling sites in environmental media. To the extent that these assumptions about patterns remain unproven or unsupported by the results of the study, it can be concluded that the sampling may not have detected contamination present in the EDA which does not correspond to the patterns assumed initially by EPA.

- The numbers of sampling sites used were insufficient to determine accurately the level of contamination within some regions.
- As for environmental media, the extent of sampling was very broad and included air, surface and ground water, soil, sediment, and biota. However, the effort across media was uneven, and there was no examination of yearly seasonal variations. Within the EDA, those media sampled most extensively were soil, air, and sump water. Ground water was sampled less extensively and biota were sampled least often of any of the environmental media. Sampling in some media may have been inadequate to detect contamination.
- Too few replicate samples were collected per site to evaluate site variability; thus, the data on absolute concentrations of chemicals detected within any one region may not be meaningful.
- The study lacked adequate control area data; thus, comparisons among regions are difficult. However, as discussed more fully later, DHHS did not rely entirely on the control area data in its habitability decision.

The considerations outlined above apply to all the chemicals sought in the EPA monitoring study. However, OTA has examined the sampling situation for dioxin in greater detail because:

- dioxin is generally viewed as a very toxic material at very low concentrations,
- very high levels of dioxin were found in some locations within the EDA,
- public sensitivity to dioxin contamination is high, and
- it is possible to make some comparisons between the Love Canal dioxin sampling and that done by EPA recently in Missouri.

Monitoring for dioxin was insufficient with respect to extent (distribution), level, and replication. No conclusions can be drawn from the absence of positive findings for dioxin in most of the EDA. There can be little assurance that the findings accurately describe any contamination that could or could not exist there. Only 6 out of 21 environmental submedia in the EDA were sampled for dioxin; of the 10 regions in the EDA, only two were sampled for sump water contamination and three each for air and soil. In the 10 EDA regions no more than five sites were sampled per region, except for storm sewer sediment. No attempt was made to take replicate samples at all sites; this is particularly important because dioxin binds strongly to organic particles. Some further indication that sampling for dioxin in the EDA was inadequate is that in three Missouri sites the number of samples ranged from about 4 to 37 times more per acre than those used in the EDA.

3. The EPA monitoring study contains important uncertainties over the levels of the toxic chemicals detected, and the possible levels of those not detected. There are also uncertainties over possible synergistic human health effects of multiple toxic chemicals present at low concentrations. These two areas of uncertainty, as well as the lack of documentation by DHHS of its analysis, place the decision on habitability by DHHS in doubt.

The results of the EPA monitoring study were the major basis for the DHHS habitability decision. Two lines of evidence have been offered to support the view that the EDA is not too contaminated for habitation. DHHS has asserted that:

1. the EDA is no more contaminated than "control areas" near the EDA, and
2. the absolute levels of contamination are so low as to present no health threat.

OTA has not emphasized in this discussion a comparison of findings in the EDA with those in

the control areas used in the monitoring study. As discussed in the appendix, OTA's own analysis, analysis in other studies, and, to a degree, even EPA's own analysis disclose critical flaws in the study's use of control areas. As a result, most of the comparisons made between the EDA and control areas lack statistical confidence. In any case, DHHS maintains that its decision on habitability did not solely depend on making comparisons with the control areas.

Therefore, the following discussion focuses on the data which did form the critical basis of the DHHS decision—the levels of contamination detected in the EDA. EPA has presented data to demonstrate that the low levels and the lack of patterns of contamination it found are consistent with levels found in industrialized areas nationwide. However, it is not clear how DHHS used this information.

Like others who have examined the results of the EPA monitoring study, OTA questioned the reliability of the study measurements, which found low values for most chemicals detected in the EDA; moreover 90 percent of all measurements found only trace amounts, or no detectable amounts, of contamination.

For the low values reported, the main issue is the validity of the values and the uncertainty that might exist in such values. EPA reported results as parts per billion (ppb) and did not report results as ppb plus *or* minus some value. The fact that "plus or minus" values are lacking means that the study provides no information on a possible spread in the detected levels. Such a spread could result from single or compounded errors in the entire chain of sampling, and analysis of the samples.

Closely related to this issue is the level of contamination which is judged to be significant to human health. Human health effects are different for different chemicals, and they are also different for the same chemical in different environmental media because of differences in exposure opportunities. For example, suppose that 100 ppb is the value, for a specific combination of chemical and environmental medium, below which health effects are not considered important or likely. In this case, a finding in a sample of 50 ppb plus or minus 10 ppb would be a firm basis for a decision that health is not likely to be affected. But if the result is 50 ppb plus or minus 40 or 50 ppb, then such a decision becomes much less certain. And in fact, it is often difficult to achieve high levels of certainty in associating a health effect with a given contamination level.

Considering the uncertainties in data and estimates of health effects, as well as in detection levels, the combination of the two introduces substantial uncertainty into a decision dependent on both. All technical data have some uncertainties; nevertheless policy decisions can make use of such data. The issue is: How much uncertainty exists? The uncertainties for the EDA monitoring data and with the health effects information used by DHHS are high, and they make policy decisions based on these technical inputs open to continuing debate.

EPA reported that its positive findings reliably indicated contamination in the EDA no higher than the low ppb range. NBS, which examined the EPA monitoring study to assess the adequacy of the analytical methodology, quality control and quality assurance programs, did not support the EPA contention. Based on a review of their analysis, OTA believes the NBS assessment is valid and has not duplicated it. NBS said:

> The methodology selected and used by EPA is appropriate for measuring concentrations in the low parts-per-billion range for air and water samples. However, *using appropriate methodology does not guarantee reliable results.* Thus, the question that remains is the level of performance of the laboratories conducting the analyses. At the low parts-per-billion level, *the contract laboratories displayed wide variability in performance.* Well-documented statements of precision and accuracy are critical since these provide the only valid basis for assessing the meaning of the numerical data to those who wish to draw their own conclusions from the report. Without such documented statements of precision and accuracy, the results of measurements are of limited usefulness for making comparisons within and among sites.[3] [Emphasis added.]

[3] From a letter by Raymond G. Kammer, Deputy Director, National Bureau of Standards, Aug. 30, 1982, sent to Senators Daniel P. Moynihan and Alfonse M. D'Amato and Congressman John J. LaFalce. This letter is the most recent statement from NBS and was written after EPA responded to the earlier comments of NBS, and also followed congressional hearings on the subject.

NBS also noted that the "limitations in the state-of-the-art for measuring biota and soils and sediments resulted in EPA appropriately focusing its study principally on air and water." What all this means is that there remains troubling uncertainty regarding the results of the monitoring study indicating low levels of contamination in the EDA. Some of the positive results said to be in the low ppb range maybe as high as several hundred ppb because of variability and uncertainty. Of even greater uncertainty are the 90 percent of the results termed "not detected" or "trace." For these results, NBS continued, in the letter quoted from above:

> Unless measured values, including "none detected," are accompanied by estimates of uncertainty, they are incomplete and of limited usefulness for further interpretation and for drawing conclusions. For these reasons, performance . . . in the low parts-per-billion range" has not been demonstrated to our satisfaction in the documentation.
>
> Based on knowledge of the analytical methodology used by EPA and the documentation provided by EPA, NBS has no reason to believe that measurements labeled "none detected" or "trace" represent concentrations above one part-per-million. [Emphasis added.]

DHHS has taken the results of the EPA monitoring study, including EPA's reply to NBS concerns, to mean that the chemicals present in the EDA are present in amounts ranging from low ppb to perhaps several hundreds of ppb. Furthermore, except for the locations in which high levels of contamination, primarily dioxin, were found, DHHS has made the judgment that less than 1-part-per-million levels support a positive finding of habitability; i.e., that contamination is for the most part so low and so unexceptional as to rule out possible health effects for those choosing to reside in the EDA.

OTA believes that the persistent concerns of NBS remain valid. EPA has not yet provided all the considerable details of its monitoring study that would permit outside experts to reach EPA's own level of confidence in its data. Thus, levels of contamination may or may not be consistently as low as DHHS concludes, and as EPA assures them to be. Moreover, OTA has had difficulty in assessing the foundation for the DHHS decision, as few details have been released (e.g., what health effects data for specific chemicals and environmental media were considered, and how these were linked to specific results of the EPA monitoring study). DHHS faced problems with EPA's monitoring study because details were absent from the publicly available documentation. Ironically, this is now the case with materials made available by DHHS.

DHHS has not explained how it considered the potential for synergistic health effects from the many toxic chemicals at Love Canal. Synergism means that low levels of contamination for several chemicals may combine to pose health threats, even though the same chemicals present individually at the same low levels of contamination might not be considered threatening. This comment should not be interpreted to mean that much information on possible synergistic effects exists. Unfortunately, there are few data on synergistic effects for the many toxic chemicals which may contaminate the EDA. However, this lack of information contributes to uncertainty for possible health effects. The importance of this uncertainty to DHHS is not clear.

It is also possible that for a few chemicals (e.g., hexachlorobenzene), contamination at levels of only hundreds of parts per billion may pose health threats. Such levels, because of uncertainties, may have been present in samples recorded as having no detectable or trace amounts. Of particular concern is uncertainty about the "no detect" results for some two-thirds of samples tested for dioxin. First, the number of samples tested for dioxin was very small, only four soil samples in the entire EDA of over 200 acres were taken. Moreover, the problems of analyzing for dioxin are well known. They may have been less known and, perhaps, even worse in 1980 than they are today.

Finally, the semantics and logic of the formulation of the habitability issue raise questions. So do the statements by DHHS on its habitability decision. DHHS defined the task for itself and its consultants in this way:

Based on available data, can it be concluded that the area is not habitable?[4]

This formulation of the habitability decision task seems to demand *one* **of two answers: either the EDA is to be demonstrated as unsafe or it is habitable. * In light of this formulation, DHHS summarized its interpretation of the findings of the panel of 11 outside experts who advised DHHS staff, as follows:**

> **. . . a majority of the consultants concluded that based on the data available they could not conclude that the area was not habitable.** [5]

However, as indicated earlier, the inability to conclude that the EDA is not habitable does not necessarily imply that the EDA is habitable. It may be questioned whether the findings of the DHHS panel of consultants, as quoted above, support the statements DHHS ultimately made on habitability.

The most recent statement on habitability, by a senior member of the DHHS team that made the original habitability decision, includes no reference to control areas and is put in unusually positive terms:

> Review of these [monitoring] data by the Department of Health and Human Services, with evaluation of technical methodologies by the National Bureau of Standards, led to federal recommendations in July **1982** that the general area surrounding the Love Canal was safe for human residence outside the canal itself and the two rings of homes surrounding it. It **was** also recommended that the storm sewers and their drainage tracts be cleaned and that special plans be made for perpetual maintenance of the clay cap covering the site.[6]

Relative to our earlier expressed concerns regarding cleanup and maintenance of the site, this statement lacks the strong contingency element of the original DHHS statement on habitability. Instead, it poses cleanup and maintenance needs as separate from the habitability conclusion. It provides less assurance that the site will in fact be cleaned up and the cleanup maintained; a concern which is emphasized in the OTA analysis.

Heath of DHHS notes that "one would hope that this could be done while restoring the surrounding neighborhood to normal activity." This rather general statement not only retreats from the implication that cleanup is a prerequisite to habitability, it fails to address the potential problems of cleaning up the locations contaminated with high dioxin levels without threatening the health of nearby residents.

The results of studies on health effects and chromosomal damage in Love Canal area residents may appear relevant to the DHHS habitability decision. For the most part, these studies have found little positive evidence of health damage. However, the following conclusion and caveat by Heath should be noted:

> **. . .** it can be said from current epidemiologic data available at Love Canal that no striking increases in illness occurrence have thus far appeared in association with living near the canal. This does not mean that such occurrences might not yet appear or that some canal-related illness may not have occurred but at frequency levels not detectable by the studies performed.

The present state of uncertainty about health effects for Love Canal area residents is not unique. It is common. That is why so much public policy in the environmental protection area is precautionary in nature. To wait for conclusive evidence for adverse health effects in people would mean that people could be unnecessarily exposed to toxic chemicals.

4. **OTA'S analysis of some of the data obtained in the EPA monitoring study provides limited, but not conclusive, indication that there may be contamination in the EDA by toxic chemicals from Love Canal.**

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[4] **Statement of Edward N. Brandt, Assistant Secretary for Health, Department of Health and Human Services, hearing of Subcommittee on Commerce, Transportation, and Tourism, House Committee on Energy and Commerce, Aug. 9, 1982.**

* **This formulation of the problem might be interpreted differently; i.e., that it demands a lesser burden of proof than a formulation which begins with the premise that the area is unsafe. Detecting contamination is, at least theoretically, easier than proving that an area is free of contamination. However, this is only the case if there is precise design of the study and use of procedures which yield low levels of uncertainties for experimental results.**

[5] **Brandt, op. cit.**

[6] **Clark W. Heath, "Assessment of Health Risks at Love Canal,"** ***Fourth Annual Symposium on Environmental Epidemiology,*** **May 2-4, 1983, Pittsburgh, Pa. (Dr. Heath was the senior author of the DHHS habitability statement in July 1982.)**

Despite the limits and uncertainties of EPA's monitoring study previously discussed, OTA considered the possibility that the positive detections found might be analyzed so as to better discern whether significant contamination existed in the EDA. Although some interesting, suggestive results were obtained regarding contamination of the EDA, by no means are these results strong enough to support a conclusion of nonhabitability. The results also suggest how future monitoring studies may be designed to produce more certain results.

OTA disaggregated the EPA monitoring data to allow an examination of a small universe of data, what we term "indicator compounds." These are toxic chemicals which are known to have been disposed of in Love Canal and which the monitoring study looked for in the control areas and the EDA. A statistical analysis was performed for OTA to determine whether any observed differences in detections of contaminants in the EDA as compared to the control areas were statistically significant. Four chemicals (1,2- and 1,3-dichlorobenzene and 2- and 4-chlorotoluene) were found to be present in the EDA at significantly greater frequencies than in the control areas. However, the levels found for these chemicals were quite low.

Why was it possible for OTA to find these statistically significant differences between detection of contaminants in the EDA versus the control areas when EPA came to a general conclusion that the EDA was not significantly more contaminated than the control areas? The chief answer is that OTA combined monitoring data for all environmental media tested, thereby enlarging the data base per chemical. EPA analyzed data per chemical for each submedia tested, which meant that there were very few data for the control areas. In this situation there were too few data from the control areas to reveal statistically significant differences with the EDA. However, for several chemicals EPA did find *several* significantly **higher frequencies of detection in the EDA samples as compared to the control areas. Essentially, EPA discounted the few positive findings of significantly more frequent contamination in the EDA because the number of negative findings was far larger. This preponderance of negative findings was based on the large number of chemicals which EPA monitored in the study—about 150** chemicals, including 129 which are considered to be "priority" pollutants for general regulatory purposes but, by and large, have no history of disposal in Love Canal. In *other word, with regard to its analysis and interpretation of data, EPA directed a substantial portion of its efforts toward chemicals that are not necessarily unique and important in the Love Canal situation.*

POSSIBLE STEPS TOWARD REHABITATION

In making decisions on the habitability of the EDA, there are choices other than immediate, complete rehabitation and a continued presumption against people moving back into the area. A number of actions could be taken to move toward incremental rehabitation of the EDA. By incremental rehabitation we mean a paced, cautious approach resting on improvements in the scientific certainty for conclusions about the safety of the EDA, and on increased public confidence in policy decisions based on technically complex data and analyses. Habitability need not be seen "as an all or nothing" issue.

In fact, one of the difficulties in assessing the habitability of the EDA, which the EPA monitoring study unfortunately did not resolve, is that some portions may not be contaminated, while others *may* **be. Over time, portions of the EDA may be found, with a higher degree of confidence, to** be **free of contamination. Depending on their location, they may then be judged habitable. One complexity is that if some areas are found to be contaminated, then it will be necessary to clean them up and to assess the effect of the cleanup actions on uncontaminated and, perhaps, rehabitated areas.**

Four critical actions merit further consideration:

1. **The technical problems and uncertainties in the current cleanup activities and long-term**

plans for operation and maintenance of the containment system should be removed. There must be effective cleanup of areas known to be contaminated with dioxin.

2. **The uncertainties of institutional stability and effectiveness over very long terms (i.e., hundreds of years) should be addressed. There may be ways to assure that the funds necessary for indefinite monitoring, operation and maintenance of the containment system, and for possible corrective actions, will be available over the long term. It may be possible to remove uncertainties related to the ownership, title, and future use of Love Canal. There are probably ways to assure that critical information is retained and made accessible over long periods.**
3. **It should be possible to design well-focused monitoring studies to be conducted for carefully defined areas of the EDA, perhaps for individual homesites. To some extent, the EPA's** 1980 monitoring study can serve a function similar to that of a pilot study. The new studies could monitor for fewer chemicals, sampling can be improved, and analytical results can be presented **in ways that remove uncertainties over their reliability and accuracy. Costs are a concern, but may prove to be a reasonable investment. It appears that additional monitoring for individual homesites (including several samples for dioxin and multiple samples for chemicals known to have been deposited in Love Canal) might have a one-time cost of about $5,000 per site.**
4. **Finding a permanent solution for the large amounts of long-lasting toxic wastes still in Love Canal is highly desirable. The present containment approach may best be viewed as an interim solution. Plans could be made to:**
   - **track technological developments for permanently destroying or detoxifying the wastes, and**
   - **assess the technical feasibility and economic cost effectiveness of applying such developments at Love Canal.**

Finally, EPA should provide considerably greater detail on the results of its monitoring study, which might resolve the uncertainties raised by NBS in its examination of currently available documentation.

IMPLICATIONS FOR THE SUPERFUND PROGRAM

This case study provides insights into several issues involved in the Federal Superfund program for cleaning up uncontrolled hazardous waste sites.

1. The "How Clean Is Clean?" Issue

Technical standards to determine unacceptable levels of contamination by toxic chemicals are, on the whole, lacking. Some standards do exist in various environmental programs, but there is no overall set of standards for the broad range of toxic chemicals associated with hazardous wastes. Having such standards, however, does not rule out the use of site-specific information (e.g., concerning migration routes and potential exposure levels) to arrive at habitability decisions.

Without standards, Government agencies must make ad hoc decisions. Uniform protection nationwide is unlikely, and decisions may not always be technically valid. This Love Canal case study illustrates three uses for standards for acceptable (and unacceptable) levels of contaminants:

- **With such standards, technical information on contamination, even if only from pilot or preliminary monitoring, could provide the basis for decisions on relocation of residents and the nonhabitability of areas.**
- **Standards could be very useful in designing detailed monitoring studies to assess the full extent and level of contamination. The problem could be defined as assuring that stand-**

ards are not exceeded, rather than detecting anything that might be present. Interpretation of the results of monitoring studies would also be improved. Standards would probably make the use of control areas unnecessary.

- The choice of cleanup technologies could be more effective, if based on standards that set targets and goals for the cleanup action.

2. Health Effects Data and Decisions on Habitability

Better understanding of the health effects of toxic chemicals is a critical need, particularly on the various exposure routes for toxic chemicals in hazardous waste sites. Using available data, it is possible to establish some standards for acceptable levels of contamination, but more data are needed to establish more reliable and complete standards. Health effects data can be collected from conventional research, but more effective implementation of the congressional mandate in the Superfund legislation is also needed to expand the epidemiological data base for health effects in people already exposed to toxic chemicals. Moreover, policy decisions on evacuation and relocation of residents, and on (re)habitability, need a firmer underpinning of administrative and analytic procedures. The responsibility given to DHHS for the Love Canal EDA was not very clearly defined in this respect. For example, no detailed analysis supporting the DHHS decision was provided. The role of EPA relative to DHHS in substantiating and reaching habitability decisions, and perhaps the use of consultants and advisory panels by DHHS, needs further examination. In the case of Love Canal, interactions between EPA and DHHS that could have influenced the design and implementation of the monitoring study were not possible because DHHS did not play a role until after the study was completed. If DHHS is to continue to be responsible for decisions on relocation and habitability, then it may be appropriate for it to participate more actively in the design and implementation of monitoring studies, and the analysis of their results.

3. Technical Guidelines for Monitoring Studies

The entire experience in the EDA monitoring program underlines the need to develop appropriate sampling and analytical protocols for a number of toxic chemicals and environmental media. It is also highly desirable to establish requirements for the presentation and documentation of results of monitoring studies, including estimates of error and uncertainty.

4. Selection and Implementation of Remediation Programs

A very important implication of this case study for the Superfund program concerns the statutorily required analysis of alternative cleanup approaches. At Love Canal, and apparently at many other Superfund sites, there has been no detailed consideration of permanent solutions. The cost-effectiveness study of which cleanup methods to use at Love Canal considered alternatives for isolating or containing the hazardous wastes in the canal, but none that would destroy or detoxify the wastes. Methods to accurately evaluate the relative cost effectiveness of containment versus permanent solutions require more study.

The containment method adopted imposes operating and maintenance costs for all time (presumably for which New York State is responsible). It is also subject to technical uncertainties about possible future failures and release of toxic substances into the environment.

This leads to an exceptionally important consequence of the Love Canal experience for the Superfund program: the need to compel consideration of more permanent solutions, albeit with higher capital costs (to be paid mostly by the Superfund program), in analyses of alternative cleanup approaches. Some technical approaches for onsite destruction and detoxification of toxic wastes and contaminated materials are available today, and considerable effort is going into the development of more such techniques. Even if a permanent solution does not appear technically or economically feasible for a specific site at the

outset, there is a need for a formal, continuing program to evaluate relevant scientific research and developing technological opportunities for such permanent solutions, site by site. The growing trend to relocate residents away from critical uncontrolled waste sites, followed by containment of wastes and contaminated materials, means continuing difficulties **in establishing long-term safety for rehabitation.**

Another apparent need is for improved oversight by EPA of State implementation of selected remediation programs. In the case of the EDA, the delay in cleaning up areas known to be highly contaminated with dioxin—still not carried out several years after its discovery-is disturbing. However, New York State has faced a number of critical tasks at Love Canal as well as at other uncontrolled hazardous waste sites that have undoubtedly strained its resources.

5. Long-Term Institutional Capabilities and Issues

Love Canal may have yet another unique and useful historical role. Some Government regulations recognize the long-term hazards of nuclear wastes and, reflecting concern for future generations, impose requirements for assured isolation over thousands of years. Yet there has been very little attention to the long-term hazards of toxic wastes, and the extreme uncertainties of containment approaches for controlling them. This neglect is paradoxical and inconsistent. Many of the most toxic wastes will retain their hazardous characteristics indefinitely. Unlike nuclear wastes, most such toxic wastes (molecules) have no inherent half-lives; i.e., they will remain stable unless they degrade through environmental interactions. Yet Government regulations for new land disposal facilities have well-defined requirements extending only 30 years. In addition, the Superfund program has given no consideration to the capability of institutions to carry out essential tasks of controlling toxic waste sites for hundreds or thousands of years.

In considering the long-term effectiveness of the current remediation plan for the EDA, it became apparent that there are currently no mechanisms to assure indefinite funding for monitoring, for operation and maintenance, and possibly for corrective actions for the waste containment system at Love Canal. Considering the recent failures of many public and private institutions to control toxic wastes adequately, it is unreasonable to expect the public to have confidence in a Superfund program that makes extensive use of long-term waste containment but provides no assurances for the long-term effectiveness of those "solutions."

It is likely that waste containment at Superfund sites will continue to be used until there **are more widely available and low-cost technological alternatives to destroy or detoxify wastes and contaminated materials onsite. The issues of long-term institutional effectiveness cannot be escaped.**