

# From Confrontation to Collaboration: A Case Study of the Dow Chemical Company Hazardous Waste Site Wayland, Massachusetts

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In Collaboration with the NED/DOW Neighbors Group



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Cover photo by:

Top Left – Ransom Environmental Consultants

Top Right – Ambient Engineering

Bottom Left – Ambient Engineering

Bottom Right – Richard Ames – Town of Wayland, MA GIS Coordinator

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# **From Confrontation to Collaboration: A Case Study of the Dow Chemical Company Hazardous Waste Site Wayland, Massachusetts**

## **Purpose**

This Case Study was written to help others learn from the experiences of a variety of stakeholders, with different goals and expectations, who participated in an environmental cleanup in accordance with the Massachusetts Contingency Plan (MCP), the Massachusetts regulations that govern investigation and remediation of hazardous waste sites. This Case Study focuses on the processes used to resolve issues of contention and analyzes how situations in which goals and expectations of stakeholders converged or diverged were resolved to achieve mutually satisfactory solutions. By examining strategies that worked and did not work, this document can benefit stakeholders facing similar circumstances in the future.

This Case Study focuses on process. It is not a history, and it is not presented as a chronology. In order to provide the reader with background information to assist in understanding site-specific information at the Dow Chemical site and the requirements of the MCP, additional material has been provided in Appendices. Although this Case Study is about a project that had to follow Massachusetts regulations for cleanup of hazardous waste, this document will be useful to residents of other states, who can learn from the process used to achieve the end result.

## **Methodology**

An extensive file of environmental reports and other documents exists in the Public Record for the former Dow Chemical Research laboratory facility in Wayland, Massachusetts. This Public Record establishes the factual basis for the events and circumstances that took place as environmental issues were discovered, reported, disputed, and, in most cases, resolved. In addition, the process was molded and transformed by the interests of key stakeholders that included the Department of Environmental Protection (DEP), Department of Public Health (DPH), Dow Chemical Company (Dow), consultants for Dow (Ransom Environmental Consultants, Inc. and Gradient Corporation), NED/Dow Neighbors, Inc. (Neighbors), the Neighbors' consultants, and various Wayland town boards and committees.

The Public Record is the basis for the factual matter included in this Case Study. Discussions from a Focus Group that met in February 2002 at the JSI Center For Environmental Health Studies in Boston, MA supplemented the Public Record. Representatives of each of the stakeholders attended the Focus Group meeting and provided opinions and insight on the process that led from the initial sale of the Dow property to New England Development Corporation (NED) to the ultimate sale of the property to the Town of Wayland. The Focus Group helped to provide greater insight into the dynamics behind a process that began with a set of divergent and contentious positions and reached a conclusion that was acceptable to virtually all the participants.


Many individuals have been involved in the investigation, cleanup, and public participation at the Dow site. As it is not possible to acknowledge all of them in this document, the Case Study identifies groups, Town of Wayland boards, and consulting firms by their collective identities, and not by the individuals who led them. Although individuals in these groups were instrumental to the success of the program, the learning experience from the Case Study is more effective if it focuses on collective and not individual action. The Appendices identify and acknowledge many of the individuals who were involved with this project.

## **Background**

The Former Dow Chemical Company Research Laboratory facility in Wayland, Massachusetts, a collection of small laboratory buildings on well-manicured grounds consisting of woodlands, wetlands and three small ponds, perhaps did not fit in the neighborhood. The Commonwealth Avenue/Rice Road area, near the boundaries with Natick and Weston, was rural and out-of-the-way in 1962, and when a small R&D operation set up shop there, very few people noticed. But communities change. When the Dow facility began operations, there were only a few homes nearby. There are still some 'old-time' residents who remember when it was in operation, but many of the people who live in the neighborhood now have no recollection of Dow Chemical.

In 1962, there was a farm across Commonwealth Avenue from the two lower ponds, and a farm off Rice Road. The area developed gradually, and then rapidly, as Wayland became one of the most sought-after bedroom communities west of Boston. The fields, farms, and woods became single-family homes and condominiums, and the neighborhood became more and more residential in character.

A detailed site map of the former General Electric Company site. The map shows several key areas: "UPPER SEPTIC SYSTEM" at the top left; "FORMER BURN AREA" at the top right; "NORTH POND" in the upper center; "FORMER LAB BUILDING" in the center; "SHALLOW DISPOSAL/GLASS DISPOSAL AREA" on the right side; "EAST POND" at the bottom right; "WEST POND" at the bottom center; and "UNDERGROUND STORAGE TANKS" on the left side. Other labeled features include "ROAD" along the top and bottom edges, "COMMONWEALTH" along the bottom edge, "U.S. ROUTE 30" near the bottom, "PARKING LOT", "SEWER TANK", "LIFT", "TRANSFORMERS", "GARAGE", "BIED", "DECKE WOOD PILE", "GRASS PLOT 1", "POST PANE", "WALL", and "CIVIL". A scale bar at the bottom indicates distances from 0 to 300 feet, with a note "APPROXIMATE SCALE IN FEET" and "1\"=150'". A north arrow is located in the top left corner.

		Environmental Consultants, Inc.	GENERAL FACILITY LAYOUT
PREPARED FOR:  THE DOW CHEMICAL COMPANY MIDLAND, MICHIGAN	SITE:  FORMER DOW CHEMICAL PROPERTY 412 COMMONWEALTH ROAD WAYLAND, MASSACHUSETTS	DATE: DECEMBER 1997 PROJECT: 94189	



## **Issues and Expectations**

From the time the NED/Dow Neighbors group began its interaction with the owners of the property that created concern in their neighborhood, until Dow and the Town of Wayland signed a purchase and sale agreement for transfer of the remediated parcel to the Town, many issues arose among the numerous stakeholders involved in this project. These stakeholders are identified in Appendix I. Appendix II provides an overview of activities and issues, many of which will be referenced in this narrative. Appendix III explains Risk Characterization, which was the basis for the decisions made regarding cleanup of the former Dow facility.

## **Community Needs and Resources**

Between 1989, when the group that would become NED/Dow Neighbors first learned that the out-of-the-way and almost unnoticed R&D facility in their neighborhood would become a major office park, to May 2000, when the cleaned property was transferred to the Town, the stakeholders learned many lessons about community action and hazardous waste sites. In some ways, Wayland is atypical of communities that find themselves with a Tier 1A site in their midst. Wayland is an upper income community, populated mostly by well-educated professionals. Although Wayland has some industry, it is primarily a residential town. The members of the Neighbors were all college-educated professionals, with the interest and background to do the research necessary to find the information they needed to shadow an MCP cleanup. The Neighbors were able to obtain four Technical Assistance Grants (TAGs) as well as a private grant, and were well disposed to direct their consultants to work for the benefit of the community.

The Neighbors were also able to raise other funds to pay their attorney and consultants and other expenses, and drew from their own funds to supplement what they could not raise. The educational backgrounds, relative financial security, and willingness to spend hours of their own time researching regulations and the technical aspects of hazardous waste site investigation and cleanup helped the Neighbors succeed where residents of other communities may have more difficulties.



In other ways, however, Wayland was similar to other communities with Tier 1A sites next door, regardless of education and income. The Neighbors were faced with the complexities of rules and regulations that govern reporting, investigation, sampling, analysis, evaluation, and government oversight at hazardous waste sites. They initially had to deal with the 'old MCP', under 1988 DEP rules, with its waivers, time frames, and DEP approvals. Midstream in the process, DEP issued new rules, in 1993, and the Neighbors had to learn a new vocabulary, covering Licensed Site Professionals (LSPs), tier classification, Phases, and Remedial Action Outcomes. DEP modified the rules again in 1998, and issued new guidances while this site was being investigated.

When the Neighbors first became concerned about hazardous waste at the Dow property, they turned to the Wayland Board of Health and the Board of Selectmen. Neither body fully understood the issues involved, and provided little assistance. The Board of Selectmen was not prepared for a problem of this magnitude. The Board of Health, possibly concerned about protecting its jurisdiction in matters involving public health, and possibly concerned about litigation, closed off communications with the Neighbors. Later, the Board of Health would apply for a TAG grant for assistance in evaluating the site. The Neighbors applied for a grant at the same time, and were awarded the grant instead of the Town. Some Town officials regarded the Neighbors with suspicion, although the Board of Selectmen later recognized that the residents had become the 'experts' in this matter. In the case of Wayland, the people indeed led, and the leaders followed.

The TAG grants enabled the Neighbors to hire consultants. The Neighbors worked closely with their consultants, and developed a bond of trust with them. During the long investigation and cleanup, the Neighbors also reached out to state agencies, and interacted with other citizens' groups and environmental organizations and activists to share ideas and experiences.

## **Basis for Mistrust**

Most of the active members of the Neighbors group became involved early on, when they learned that the Dow property had been sold to NED. Others became active as a result of specific issues and incidents. One such incident was the matter of the vials, described in Appendix II. When 130 small glass vials, many containing residues of waxy material and other chemicals, were unearthed during investigations at the site, their discovery became a rallying



point for the Neighbors, and a symbol of the growing mistrust between Dow and the community.

Typically, the relationship between a citizens group and a responsible party begins tenuously as they try to communicate their respective goals and expectations about environmental concerns and how to address them. Whether this initial tension evolves into an atmosphere of mistrust or collaboration depends on the extent to which areas of common ground are sought and mutual respect is fostered. The Neighbors participated in the first two public meetings held for this site with a sense that the MCP process would be fair. Although reacting with some skepticism when told by Dow that there were no buried wastes or other cause for concern about hazardous materials at the site, the Neighbors had been told by DEP and others that the process had sufficient safeguards to ensure that the playing field would remain level.



Discovery of buried vials changed this perception of fairness and openness, and the relationship between Dow and the Neighbors suffered its first major setback. However, because of the assurance of continued DEP oversight and technical assistance, dialogue was maintained. Working within the MCP protocols, Dow, the Neighbors, their consultants, and DEP reached agreement on standards for organometallic compounds found in the soils.

The standards agreed upon were more stringent than those initially proposed by Dow's consultant; the Neighbors' consultants were instrumental in providing comments to DEP that led

to revision of the standards, and the Neighbors believed that the process would work in their favor, particularly on an issue as sensitive as buried vials.

From late 1994 through early 1997, Dow and the Neighbors continued their dialogue. At a meeting with a facilitator in March 1997, the Neighbors raised several concerns. Only one, the plans for continued studies, was specifically addressed. Although the vials were not discussed directly, Dow did not refuse to test them. The community held out hope. Then, in July 1997,



while the DEP engineer was on the site, additional vials and broken glassware were discovered on the property. The Neighbors were convinced that DEP would order testing. But DEP agreed with Dow's rationale for not doing additional testing, and the Neighbors' trust in the process suffered a major setback. Dow had successfully argued that there was no need to test the vials because the soil had been tested,

and if any material had leaked from the vials, it would be present in the soils. The Neighbors and their consultants countered that some exotic chemicals could be missed if the laboratory conducted only the standard analysis normally done on soils from hazardous waste sites.

In June 1998 when DEP issued a conditional approval of the plans for additional site characterization (a Phase 2 Scope of Work) and granted Dow permission to destroy the vials, the relationship between Dow and the Neighbors had reached its lowest point. In early 1999, Dow petitioned to have the site reclassified from the highest level Tier 1A to a lower level that did not involve direct DEP oversight. The Neighbors and their consultants continued to comment to Dow on reports and Scopes of Work. Dow continued the investigation at the property. Then, Dow destroyed the vials.

## **Building Trust**

The announcement that the vials had been destroyed was a low point in the relationship between Dow and the Neighbors. Although work continued at the site, and consultants on both sides continued to comment, the channels for collaboration and compromise were damaged.

The turning point in the project was a letter from the Neighbors to the CEO of Dow requesting better communication with the community. Dow took notice, and assigned Jerold Ring, a senior Dow executive, to the project in what was seen by the Neighbors as the first step in restoring trust and reclaiming communication among the stakeholders.

In preparation for a public meeting in September 1999, Dow and its consultants held two poster sessions, provided handouts to interested Wayland residents, and conducted tours of the

property. Mr. Ring began the meeting with an apology from Dow for the miscommunications and misunderstandings between Dow and Wayland, and pledged to make things right. He listened and fielded a number of requests to be more forthcoming and take additional steps to make up for the lost public confidence and outrage caused by Dow's decision to destroy the vials. As the meeting ended, he offered to remove all structures and the two soil stockpiles from the property at Dow's expense in order to restore the site to its natural state so that the property could be transferred to the Town.

Dow later announced that it would clean up the site beyond the levels required by the MCP to establish greater trust and to address any lingering questions about the town's desire to use the property for conservation, open space, and recreation.

During the first quarter of 2000, Dow held a final series of public hearings. At the last public meeting, on March 8, 2000, Dow announced all cleanup activities were complete. Dow had gone beyond what was required by the MCP, and had returned the site to background conditions. This accomplishment was corroborated by the Town's consultant, CDM, and by the Neighbors' consultants.

On May 8, 2000, the Town of Wayland purchased the former R&D facility from Dow Chemical Company for use as conservation and recreational land. The Dow property, which had always blended in with the character of the neighborhood, would remain undeveloped, but most importantly, the residual contamination that was the legacy of years of developing and testing chemicals for use in agriculture and pest control was removed from the property, and risks of harm from the property were reduced to background levels.



The Town is currently working to create a management plan for conservation and recreation uses of the property, thus culminating a decade-long process that demonstrated the benefits of citizens' groups and PRPs working together in a collaborative, rather than adversarial, manner.

## **Health Concerns, the MCP, and the role of DPH**

The Dow site issues were complicated by community fears of health effects, and concerns that illnesses seen in the community were the result of exposures to chemicals on the property. Misunderstandings about the MCP and the requirements for investigation and cleanup of hazardous waste sites led to frustration with two state agencies, the DEP and the DPH.

The DEP has regulatory authority over investigation, assessment, and cleanup of hazardous waste sites through the MCP. This authority includes requiring Risk Characterization to determine if contaminants in the soil, groundwater, and other environmental media will contribute to significant risk if they are not removed or otherwise remediated. The MCP, however, does not provide for evaluating health effects in a community, and also cannot require assessment of actual or potential health effects from contaminants that are no longer present. The purpose of investigations conducted under the MCP is to determine if cleanup of existing conditions is necessary.

There was a problem at the Dow site. Some people who lived near the facility felt that there was an increase in cancer in the area. People asked whether open burning and evaporation of solvents in hoods at the Dow R&D facility, activities that occurred in the 1960's and 1970's, could have contributed to cancer risk among people who lived in the neighborhood when the R&D facility was in operation. The MCP can only require testing of environmental media for chemicals that have been disposed of or released into the environment. The MCP does not regulate industrial activities or air pollution. DEP does regulate discharges to air under other programs, but there is no way to evaluate an air release that occurred in the past seeing there were no records of air testing at the Dow facility during its years of active operation.

Some residents asked if it was possible to model what might have been discharged from hood vents, and others asked that soil and even roofing shingles in the neighborhood be tested for evidence of contamination. None of these was feasible, as it would be difficult to link a contaminant found in soil or on a local roof to an operation that had been closed for ten years.

Some local residents asked the DPH to become involved, and to evaluate community health concerns. DPH conducted a Health Assessment, in which they researched the Massachusetts Cancer Registry for evidence of increased incidence of cancer in Wayland. DPH concluded that

cancer rates in Wayland were within expected levels based on state averages, and no increased risk was seen. DPH's study had some flaws, mostly the result of limitations of the data, and limitations of the science of epidemiology in its ability to evaluate trends among small populations over relatively short periods of time.

Despite the efforts of DEP and DPH to address community concerns, the major problem was the inability to determine what had happened in the past. This was outside the scope of any of the investigations conducted under the MCP, and remained an unresolved issue.

## **Lessons Learned**

The Focus Group that met to discuss the Dow project identified a number of areas where lessons were learned during the process. These lessons are outlined in this section in order to assist other groups facing similar community issues.

## **Communication**

Communication is the key to success in any project, and is particularly important in a project as complex as the Dow investigation and cleanup. Although communication among stakeholders and groups was adequate at first, it began to erode along with trust as a result of a number of incidents, particularly the disposition of the vials.

As long as the vials remained in storage in a laboratory, the Neighbors, and later the Board of Selectmen, held out hope that a compromise could be worked out for testing. The decision to destroy the vials had every appearance of being unilateral on the part of Dow, even though DEP and the Town's own consultant agreed with the decision. Furthermore, it took place at the worst possible time.

At the focus group meeting, participants noted that the vials created a 'fear factor' that contributed to mistrust. The vials were an 'unknown', and some felt that destruction of the vials would leave the community vulnerable to some unknown contaminant that was still lurking in the soils. The Neighbors knew that Dow did research and development with chemicals on the site. Dow's association with chemicals such as Agent Orange spiked interest and concern, even though there was no evidence that chemicals of that nature were ever developed or used in



Wayland. The eventual testing of soils and sediment for dioxins and furans was an outgrowth of those concerns and mistrust. The dioxin and furan testing was inconclusive, with concentrations on the site generally comparable with levels in similar environments.

In September 1999, Dow took a significant step toward improving its relationship with the community by designating Jerold Ring as the liaison between Dow and Wayland. Mr. Ring was assigned to the Wayland community after a letter from the Neighbors reached the CEO of Dow. The letter was sent partially out of frustration and partially out of desperation. At the focus group meeting, Mr. Ring noted that the letter was non-accusatory, and proposed a solution in its request for a liaison. Once Mr. Ring became involved, the catalyst was in place to lead Dow and the community down the path to mutually acceptable goals. There immediately was an improvement in the time it took Dow to respond to questions from the Neighbors' consultants. At public meetings, extra effort was put into displaying information in advance and providing many opportunities for questions to be asked and addressed. As the level of trust improved, the Neighbors and Dow worked cooperatively to keep Town boards informed about the progress of the cleanup.

The Dow case illustrates the value of the responsible party involving its own risk communicator in the process. As distinguished from a public relations person, the risk communicator's job is to inform the public about what the true risks are in an atmosphere of mutual trust. Unless that atmosphere is present, communication of risk will be met with suspicion and disbelief. Fortunately, Dow was able to overcome a low level of trust by making cleanup concessions that went beyond what the MCP required. The goal to turn the property over to the Town for conservation and recreational use became the same for Dow and the Neighbors. Having a risk communicator involved when the site was first designated a high priority site may have ameliorated some of the more contentious issues that followed.

One outcome of the discussions by the Focus Group was the observation that prior to the Neighbors' letter in 1999, no one had ever *asked* the CEO of Dow for assistance. Dow had assigned project managers to the cleanup, but it was clear that their primary responsibilities were to Dow. These project managers were responsible for getting the site through the MCP process, and they were not prepared to participate in negotiation and communication with local residents. Dow, from its offices in Michigan, viewed the Wayland property from the perspective of ensuring that state regulations were followed and timelines were met. Dow wanted to be able

to sell the property, and before it could do so, it had to get through the MCP process. In that sense, Dow's goals were not entirely different from the Neighbors; both wanted the site 'cleaned up'. When cleanup was completed, Dow could sell it and leave the area. The Neighbors, however, would continue to live next door.

The Neighbors' questions about the site were not entirely different from those asked by the MCP:

- What contamination was on the site?
- Where was it?
- How might it affect the neighborhood?
- Was it migrating off the property?
- How could it be best cleaned up?
- Would there be contamination left after cleanup, and how would it affect the neighborhood?

Dow had to answer these questions in order to complete the MCP requirements. Had communication between Dow and the Neighbors been better at the beginning of the program, they would have been able to work together sooner to address many of these questions and concerns.

## **Citizen/Town Cooperation**

Participants at the Focus Group meeting commented that the Town and the Neighbors often viewed each other with distrust, and were often suspicious of each other's motives. In the initial stages of the process, the Town failed to take the initiative in dealing with the site, and the Neighbors stepped into the void. Over the years, they became the de facto experts on the project, and resented attempts by Town boards and officials to take over. The Neighbors wanted to be recognized for their work and initiative. The Town, however, held other competing interests, including potential litigation and concerns over property values and tax revenues. Hazardous waste sites, particularly Tier 1A sites, are not the sort of thing that community officials want to have on the front page of the local weekly newspaper, or in the community information brochures handed out to real estate agents. There was a sense in Wayland, at least early on, that Town Boards and officials would have preferred the site to 'go away', with as little publicity as possible.



Town boards are often ill informed on the MCP and hazardous waste cleanup. Selectmen generally depend on consultants, and occasionally on professional staff to steer them through requirements for addressing hazardous waste sites. Boards of Health traditionally did not deal with hazardous waste; currently, some towns have environmental officers with expertise outside of the traditional roles of Boards of Health that dealt with septic systems, communicable diseases, food service, and housing. Conservation Commissions tend to have members with expertise in wetlands, wildlife habitat, and soil science, but typically do not address hazardous waste.

The lack of expertise, and the early lack of interest in MCP issues in Wayland galvanized the Neighbors to take on the role of a de facto committee addressing the Dow site. The MCP Public Participation process, and the TAG program, encourage this type of effort, and recognize duly incorporated groups of residents as partners in resolving hazardous waste site concerns. The Neighbors were operating in a manner envisioned by DEP when they applied for their first TAG grant and began to fill the role of community representative. DEP awarded that first TAG grant to the Neighbors and not to the Wayland Board of Health, which applied for a grant at the same time as the Neighbors, because the Neighbors' proposal demonstrated a better understanding of the problem and the resolve to work through the program. The Neighbors were awarded additional TAG grants, and as they achieved success with Dow there was inevitable resentment on the part of some in Town government. The Neighbors, once rebuffed when they went to the Town for assistance, took matters into their own hands. They wanted to be recognized for their efforts, and they wanted to be rewarded with some sense of legitimacy from the Town. Instead, they were viewed with growing suspicion.

This project would have been better served by a meeting of the minds early in the process. Town officials need to recognize the contributions that can be made by informed residents. People who live near a hazardous waste site often know things about it that town officials do not know. They may have observed activities, or they may have talked with former workers. They also know more about their neighborhoods, including where children play, where people walk their dogs, and where things are not quite 'right'. Often, residents of a community may bring specific expertise to the table, and may have professional experience that may benefit the Town. Wayland would have been well served by appointing the Neighbors to an ad hoc

committee to work with representatives of Town Boards and with Town employees to follow up on the Dow investigation.

Community residents, on the other hand, need to recognize the concerns that Town officials may have about citizens taking matters into their own hands, and need to understand the limits that future liability place on how much authority a community is willing to vest in a citizens' group. Working together can best address these concerns because the community will know what the community group is doing, and the group can avail itself of legal opinions and other professional services provided by the Town.

### **Department of Environmental Protection Goals and Objectives**

One objective of this Case Study is to provide a vehicle for understanding the role of DEP and the roles of the Responsible Parties under the MCP. Although the vials were among the Neighbors' primary concern, particularly because they were a symbol of mistrust, DEP's major interests at the Dow site were soil and groundwater quality, and potential offsite migration of contaminants. It is not uncommon for the 'experts' to have a perspective much different from that of local residents on what presents the greatest risk of harm at a hazardous waste site. DEP's perspective was based on experience; the Neighbors' perspective was based on fear of the unknown, compounded by growing mistrust.

DEP's opinions on the vials were lost in the noise that resulted from the mistrust between Dow and the Neighbors. A meeting of the stakeholders early on to come to an acceptable decision on the vials likely would have avoided years of conflict. Instead, the matter simmered beneath the surface. If Dow had assigned its liaison earlier in the process, much of the concern over the vials might have been avoided.

At the focus group, DEP indicated that initially many people in the community were requesting that Dow should take actions that were not required by the MCP. DEP is bound by the regulations in the MCP, and cannot push the process beyond what is required. Ultimately, Dow undertook voluntary actions that went beyond the MCP, but that was Dow's decision. DEP cannot require these actions under the regulations.

## Issues for Consideration

The following issues should be considered and discussed by communities, regulatory agencies, and responsible parties involved in hazardous waste site investigation, assessment, and cleanup.

### Community Groups

1. Define goals and expectations early in the process. By establishing a list of goals and their priorities at the beginning, lower priority goals can be identified so that they do not become side issues that distract from the major concerns and potentially compromise negotiations.
2. Get involved as early as possible. By waiting until the process is nearing completion, community groups may find little incentive for collaboration on the part of the decisionmakers. In Massachusetts, the steps toward completion of an investigation and cleanup are established in the MCP. If a community group becomes involved after one or more of the phases have been completed, the responsible party will not go back.
3. After hiring consultants, introduce them to town boards by getting on their agendas. Establishing this contact with the boards will sensitize local officials to the issues at hand and increase the likelihood that they will be supportive rather than antagonistic as the program goes forward. Knowing that the community group has professional consultants may help them gain legitimacy among municipal boards and officials.
4. Identify key community leaders who can be advocates for group goals and engage them early in the process.
5. Because there is often turnover of personnel at small town newspapers, compile and update a factual chronology of events at the site and make it available to new reporters and editors. This practice will help them to understand community issues, and also to avoid committing factual errors.

6. Make use of technology to educate the community. Newsletters and websites can and should be used to reach people who are not members of the group. If the group has a newsletter, make sure a copy gets to each local board and official.
7. A consultant will help meet the responsible party and its consultant on a level playing ground. Having an outside expert to validate community concerns and to focus them using science and fact is critical to achieving goals. It is important to listen to what the consultant is saying, particularly when the consultant challenges the group's perception of what is happening. Ask questions, and make sure the consultant explains things in a way that makes sense to the group.
8. Educate the consultant. He or she may be an expert, but does not live in the community. Make sure that the consultant understands the group's primary concerns and goals, and if the consultant does not agree that these are the most critical issues at the site, make sure that he or she explains why.

#### Department of Environmental Protection

1. Because of the sensitivity surrounding human health concerns at hazardous waste sites, and because of potential jurisdictional overlap between the DEP and the DPH in assessing the risk posed by hazardous waste sites to people, a memorandum of understanding between the two agencies that clearly defines their respective roles in safeguarding public health at hazardous waste sites will help avoid some of the pitfalls that created confusion and concern in Wayland. DEP should communicate clearly to citizens what it can and cannot do with regard to health concerns early in the process.
2. Because many citizens groups and municipal officials are unfamiliar with the MCP process and the roles of LSP's and the DEP, DEP or a consultant should conduct an informational workshop for communities that are monitoring an MCP cleanup. A workshop or seminar will be useful in addressing misconceptions about what the MCP does and does not do, and in defining more realistic expectations at the beginning of the process, so that the limited resources can be spent more effectively and efficiently. Possible partners for these workshops or seminars are the Massachusetts Municipal Association, the Massachusetts Health Officers

Association, the Massachusetts Association of Health Boards, and the Massachusetts Association of Conservation Commissions. Similar organizations exist in other states.

3. Although the TAG grants are currently suspended in Massachusetts because of budget constraints, if TAG grants resume, DEP should consider a mandatory workshop for recipients.

### Responsible Parties

1. Dedicate a risk communication liaison to interact positively with the community. Note that risk communication is not public relations. The person who fills this roll must be willing to work with representatives of the community to achieve mutually agreeable solutions.
2. Encourage a timely flow of information between your consultant(s) and the community consultant(s).
3. Recognize that the local citizens live in the community. They know the community better than anyone, and they generally care about the community. Community activists are also the only people involved in the process who are not getting paid, and who do not have unlimited time and resources to expend on the process.

### Municipal Officials

1. Work with citizen groups early, before the groups become frustrated with perceived lack of interest or concern on the part of local government. Working together enhances the ability of communities to work toward common goals.
2. Consider appointing citizen groups to ad hoc committees that can work with municipal officials toward mutually agreeable solutions to problems like this one. In this way, the community groups can have the benefit of professional guidance from the community, including opinions from legal counsel. If municipal officials take the time to explain

why local government must take a specific action, there will be less mistrust and suspicion about those actions.

### **Concluding Remarks: From Confrontation to Collaboration**

NED/Dow Neighbors had won a victory, but there were many other winners. The Neighbors had shepherded a complex process, with assistance from consultants hired with Technical Assistance Grant money from the Department of Environmental Protection (DEP) and other grant money. In May 2000, they had achieved their goal; the property that was the source of concern and anxiety in the middle of their neighborhood was cleaned up. The Town had scored a victory as well, because Wayland gained valuable recreation and conservation land. Dow Chemical, which had begun the process in an adversarial role, had won the respect of the Neighbors and the community, and left Wayland with the knowledge that the final cleanup was successful and accepted by the Town. The DEP was another winner, because the ultimate cooperation among the other parties resulted in a cleanup that exceeded the requirements of the MCP.

## About the Authors

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**Irwin Silverstein, Ph.D., P.E., LSP**, has more than thirty years experience as an environmental engineer – managing assessment/remedial investigations and remedial action at electric power utility sites, former manufactured gas plants, landfills, and petroleum/hazardous waste storage facilities. His specific areas of expertise include estimating environmental clean-up risk and costs for insurance purposes, wastewater treatment system design, underground storage tank management, evaluation of remediation alternatives, and familiarity with state super lien laws. Dr. Silverstein has taught environmental and structural engineering courses and currently teaches a review session for the Principles and Practice (PE) License Exam in Environmental Engineering – Design and Analysis of Solid/Hazardous Waste Systems.



## **APPENDIX I**

### **Key Stakeholder Roles, Responsibilities, Goals, and Expectations**

Several groups and corporate entities were involved in the investigation and ultimate remediation of the Dow Chemical site. These stakeholders participated in varied aspects of the cleanup over a period of several years as they became aware of the site and the various issues that arose out of the investigation and subsequent remedial activities. Although a number of individuals expressed an interest in the site activities while the investigations were taking place, this Case Study focuses on those groups who participated in the Public Information Plan (PIP) process mandated by Massachusetts hazardous waste cleanup regulations. In order to protect their privacy, this Case Study does not identify residents of Wayland and surrounding towns who participated as individuals. The only individuals identified in this and the other Appendices are employees of corporations and public agencies, as well as paid consultants of Dow, the Town of Wayland, and NED/Dow Neighbors Inc.

#### **Dow Chemical Company**

The Massachusetts Contingency Plan (MCP) identified Dow as one of two Responsible Parties (RPs) at the site (the other RP was New England Development, hereafter NED); as an RP, Dow was legally and financially responsible for the environmental contamination, and therefore for the site investigation and cleanup. Dow was required to conduct investigations at the Wayland site to determine the extent of contamination and to clean up all contamination to a level that would present “No Significant Risk” to public health, safety, and the environment. This goal is the defining concept in the MCP and provides the standard for whether remediation is conducted at hazardous waste sites and provides a performance standard for the extent of remediation. Dow’s primary goal was to comply with the MCP and to meet the MCP criteria for “No Significant Risk” in the most cost-effective manner. Because the Neighbors requested that the site be treated as a PIP Site under the MCP, Dow was also required to comply with PIP requirements, to ensure that the public received access to documents, to conduct public meetings, and to respond to public comments. Although the MCP holds the RP responsible, the actual technical work at the site must be under the direction of a Licensed Site Professional (LSP), who is responsible for ensuring compliance with the MCP. In Massachusetts, investigation and remediation of hazardous waste sites are conducted by the private sector. The

LSPs who direct this work, and who determine when the site meets the requirements of the MCP, are licensed and subject to the oversight of the Massachusetts Department of Environmental Protection (DEP), the agency that has ultimate responsibility for ensuring compliance with the MCP, and with the Board of Registration for Licensed Site Professionals.

### **NED/Dow Neighbors, Inc.**

As a watchdog group comprised of residents who lived near the site, the Neighbors formed in 1990 and incorporated in 1994. The officers and directors of the new organization lived near the Dow facility, in the vicinity of Rice Road, and, as individuals, had been following developments in the neighborhood beginning with NED's proposal to develop the land. Five individuals were the first directors of the new group, and they remained active throughout the process in varying ways. The Neighbors' articles of incorporation note that the group's purpose is to engage in public interest research and education on environmental and health issues in Wayland and to participate in oversight regarding the Dow investigation and cleanup. When the Neighbors learned that the site was contaminated, and that Dow was going to be involved in the investigation and cleanup, they became a major role player in the MCP process, and they also took a lead role in the Town. Members of the Neighbors educated themselves about the MCP and hazardous waste assessment and cleanup, learning a new 'language' and a new set of skills in the process, with help from the Toxics Action Center (TAC), a coalition of citizens' environmental groups with headquarters in Boston, and TAC's Executive Director, Matt Wilson. Mr. Wilson assisted the Neighbors in understanding the intricacies of the MCP, and provided early support as they negotiated their way through the regulations and jargon.

The Neighbors applied for and were awarded four Technical Assistance Grants (TAG) from DEP. As the point group for the PIP process, the Neighbors served as liaisons between residents and Town officials. They hired their own consultants, and interacted with State officials from DEP and the Department of Public Health (DPH). The Neighbors' role was to ensure that response actions at the site were conducted in accordance with DEP's regulations, as spelled out in the MCP. The Neighbors' primary goal in this case study was to ensure that the property was cleaned up in a manner that was in accordance with the MCP, and that public health and the environment were protected.

Initially, the individual members of NED/Dow Neighbors had various concerns about development in the neighborhood. When the property was sold to NED in 1989, prior to incorporation of the group, and plans to build an office park surfaced, some residents of the Rice Road area expressed concerns about possible drastic change in the character of the neighborhood. The Dow facility had operated quietly, set back from the road, and most people did not know it was there. The property had been well maintained, and, until the facility closed, it had been used as a quasi neighborhood park. Even when the R&D facility was operating, local children played on the property, as it was inviting, with its ponds, lawns, and woods.

The Dow facility was built before comprehensive zoning in Wayland, so while the rest of the neighborhood developed as residential, and the newer construction trended toward luxury homes and condominiums, the Dow property, by virtue of its use, became a limited commercial zone island in a residential area. The sale of the property to NED, and the subsequent plans to build a large commercial complex, galvanized many of the Neighbors to express their concerns to Town officials. To their dismay, they discovered that the proposed development was possible under the zoning by-law. One initial focus of the Neighbors was to identify ways to stop or scale down the development. The discovery of contamination on the property refocused the Neighbors' energies.

Over time, members of Neighbors achieved an understanding of the MCP, and what it governs. The MCP does not venture into issues of zoning or land use, but sets standards for cleanup based on use. Recognizing the limits to DEP's powers in areas not covered by the MCP was a major hurdle for some members of the community, but the leadership of Neighbors helped to educate people and to steer them to the proper agencies that could regulate or manage other issues that arose at the site.

One of these issues was concern over health effects. Although the MCP requires cleanup of contaminants to levels that will not contribute to risk of harm, neither the MCP, nor DEP itself, has jurisdiction in dealing with complaints of or concerns about actual illness. DEP does not investigate cases of illness or suspect illness associated with hazardous waste sites, and does not have the appropriate professional staff to answer questions about individual health concerns. The perception that DEP was not able to answer specific questions about health initially caused frustration in the community. The Neighbors consulted with the DPH, the state agency that has epidemiologists and toxicologists on its staff to investigate health concerns. The

inability of DPH to reach specific conclusions about possible relationships between illnesses reported by individuals in the neighborhood and the site led to additional frustration.

## **Department of Environmental Protection**

Once the Dow site was classified as a priority disposal site by the State, DEP assumed an oversight role for all MCP activities at the site. The LSP hired by Dow was still responsible for doing the studies, but DEP was responsible for review of proposed sampling plans, as well as the data and reports that were produced from those activities. DEP was also responsible for holding public meetings as various MCP milestone events were reached. DEP's primary role was to ensure that all requirements of the MCP were met and that the remedial actions proposed by the LSP after the studies were completed would clean the site to a level where there would be No Significant Risk to human health and the environment. The MCP provides a technical definition of No Significant Risk based on the use of the property, and the LSP must demonstrate that No Significant Risk is achieved using both human health and ecological risk assessments and an engineering evaluation of the proposed cleanup actions.

DEP assigned Scott Greene as the project manager for the Dow site. The Neighbors reported that Mr. Greene was helpful and considerate of their concerns during the investigations at the site. The Neighbors also worked closely with Karen Stromberg, the PIP coordinator at DEP. She provided guidance while the Neighbors were applying for their TAG grants, and during the public meetings.

## **Department of Public Health**

The DPH became involved with the Dow site at the request of the Neighbors because of the perception that there were increased rates of some cancers in the neighborhood. At least one person diagnosed with cancer had played on the site as a child, and the Neighbors were aware of other people who grew up or had lived in the neighborhood and who had cancer.

DPH conducted an epidemiological study using cancer registry data and concluded that there was no increased incidence of cancer in the portion of Wayland where the Dow facility was located. The study had limitations, however. The data set used by DPH only included people who lived in Wayland when they received their cancer diagnoses, and the study did not include

any cancers with fewer than five reported cases. Several local residents expressed concern that the study did not include all cases of cancer in the area. DPH defended its methods, but admitted that the most recent incidence data were not yet available.

DPH's role in the investigation and cleanup of the Dow property was adjunct, at best. DPH has no role in the MCP, and in this case, DPH participated in the overall study of the Dow site at the request of the neighbors.

The MCP has no provisions for studies of ongoing health effects; instead, the MCP focuses on preventing future health effects through risk assessments, and requires cleanup of any contamination that may endanger human or environmental health. The MCP cannot be used to evaluate exposure to pollution in the past, particularly if there are no laboratory data available to characterize what was present on a site in the past. In this case, no one knew what contaminants could have been present at the site in the past, either in the soil, the water, or the air.

DPH's goal was to determine if there was an association between the site and an increased risk of cancer. Their study was, at best, inconclusive.

## **Consultants to Dow**

Dow's primary consultants were Ransom Environmental and Gradient Corporation. The LSP of Record was a Ransom employee. The consultants' roles were to develop and carry out response actions and prepare reports necessary to address the oil and hazardous materials detected at the property. Their primary responsibilities were to serve the needs of their client and to conduct studies and perform remedial actions in a manner consistent with the LSP professional standard of care. The LSP of Record has a responsibility to follow the MCP and, as stated in the MCP, to "hold paramount" the protection of human health, human welfare, and the environment. Under the MCP, the LSP of Record has the dual responsibilities of serving his or her client and upholding the integrity of the MCP.

Ransom's goal was to conduct the site investigation and to develop cleanup plans. Gradient's goal was to develop cleanup standards, and then to demonstrate remedial actions and site conditions met the MCP standard of "No Significant Risk".

## **Consultants to NED/Dow Neighbors**

The Neighbors' consultants were Dr. Irwin Silverstein, formerly of META Environmental and Anne Marie Desmarais of Environmental Insight, the authors of this Case Study. Their role was to advise the Neighbors on the quality and efficacy of response actions and reports being conducted by Dow's consultants. Their primary responsibility was to serve the professional needs of the Neighbors, and to do so in a way that was consistent with the requirements of the MCP. Their goal was to provide technical assistance to the Neighbors, to review documents prepared for Dow by its consultants, and to provide technical comments on Dow's reports. Their approach was to help ensure that the work conducted at the site was done in a scientifically acceptable way and in accordance with the MCP. As consultants hired under DEP's TAG program, they also served to inform and educate the community regarding the requirements of the MCP and how they affected activities at the Dow site. This type of advice became an important objective of the TAG consultants' role because the Dow investigation occasionally resulted in activities that were 'outside' the MCP, including health studies and supplemental sampling.

## **Wayland Board of Selectmen**

As the executive branch of Wayland's government, this Board had a leadership role in safeguarding the best interests of the town. Because the Town expressed an interest in purchasing the Dow site, partially as a response to the Neighbors' concerns about commercial development at this site, the Board was concerned that the Town could potentially acquire property that would need further remediation, or that would present a future financial or other legal liability. The primary goal of the Selectmen was to ensure that the Town made the right decision regarding purchase of the Dow property.

## **Wayland Board of Health**

The Board of Health did not become involved with this project until the later stages of the cleanup, and initially did not respond to community concerns. The Board's initial unwillingness to address issues raised by residents provided an impetus for the Neighbors to incorporate and apply for TAG grants.

## **Camp Dresser & McKee (CDM)**

As the Board of Selectmen's consultant, CDM's role was to conduct a due diligence investigation to ensure that the goals of the Board of Selectmen were being met. Their responsibility was to serve the Board and conduct a thorough review of documents for the work conducted at the site since being designated as a priority disposal site. Their goal was to conclude their investigation with a recommendation to the Board of Selectmen regarding purchase of the property.



## **APPENDIX II**

### **Overview of Site Description, Investigation, and Remediation Activities, and Discussion of Major Areas of Disagreement**

#### **Background**

In 1962, Dow Chemical Company purchased approximately 30 acres of farmland in a residential neighborhood in southern Wayland near the intersection of Rice Road and Route 30 (Commonwealth Avenue) and near the Natick and Weston borders. From 1962 to 1989, Dow operated a small research and development laboratory on the property. The research involved identifying, developing, and testing a variety of chemicals, including organometallic compounds used to control marine pests. In 1989, New England Development Corporation (NED), a major developer of shopping malls in the Northeast, purchased the property with intentions to build an office park that would include its corporate headquarters. While NED was going through the public permitting process in the fall of 1991, a local resident discovered site assessment reports prepared in the late 1980s that indicated Dow employees disposed of small quantities of chemical waste products on the property. One disposal method had been burning these wastes in the open air, while another was burying vials containing waste chemicals in a shallow disposal area on the property. This information was shared with the Massachusetts Department of Environmental Protection (DEP), and the Dow property was designated a priority disposal site, and, in accordance with the version of the Massachusetts Contingency Plan (MCP) in effect at that time, it received a Waiver to allow an environmental investigation leading to cleanup of the property to proceed.

The MCP provides that ten citizens can petition the Potentially Responsible Party (PRP) or Responsible Party (RP) at a contaminated site to have the DEP designate the property as a Public Involvement Plan (PIP) site. Once a PIP site is designated, the RP must follow a set of procedures aimed at keeping the public informed of the status of environmental investigations and cleanup activities. In March 1993, a group of Wayland residents filed a PIP petition, and approximately 18 months later, they incorporated the NED/Dow Neighbors citizens group.

In October 1993, DEP had announced new regulations governing assessment and cleanup of hazardous waste sites with the promulgation of the revised MCP (310 CMR40.0000) and a first-

in-the-nation privatized waste site cleanup program. The new MCP created the profession of Licensed Site Professional (LSP) to provide personnel to conduct studies and cleanups.

The revised MCP classifies hazardous waste sites based on the threat they pose to human health and the environment and the degree of oversight required by DEP to ensure that the site is properly managed and remediated. The site classifications are as follows: **Tier 1A** (requiring direct DEP oversight), Tier 1B, Tier 1C, and Tier II (sites managed by LSPs). DEP classified the Dow site as Tier 1A in February 1994. Tier Classification is based on a 'scoresheet' that gives differing values to several factors present at the site. The primary reasons for Dow being classified in the highest category were the uncertainties about the types of wastes present at the site, the methods used to dispose of the wastes, and possible threats to groundwater used for drinking water if wastes migrated away from the property. DEP named Dow and NED as RPs, making them financially and legally required to investigate, assess, and remediate contamination at the site and to ensure that it did not present an unacceptable risk to human health, human welfare, and the environment.

The first of a series of PIP meetings took place in Wayland in May 1994. NED presented the first plan to investigate potential contamination in limited areas where NED planned to build on the property. A second PIP meeting took place the following October; by this time, Dow was leading the investigation, and provided more detail on what would be done to investigate the property. The proposed work was considered to be a Release Abatement Measure (RAM) by the MCP. A RAM is usually undertaken to address limited contamination, or to keep larger areas of contamination from spreading.

In November 1994, as the RAM activities began, Dow's consultant, Ransom, found 130 vials and five tons of soil that contained broken laboratory glassware while excavating on the property in one of the shallow disposal areas. In status reports, Dow identified some, but not all, of the toxic substances found in the soil and groundwater. Among these unidentified substances were organometallic tin and mercury compounds for which neither DEP nor the U.S. Environmental Protection Agency (EPA) had established toxicity or cleanup standards. The vials were inventoried by DEP and initially stored on the property until they were moved to temporary storage at a laboratory in Narragansett, Rhode Island. These vials were later to become a center of controversy in Wayland.

Meanwhile, on February 10, 1995, NED sold the property back to Dow, and Dow became solely responsible for the cleanup. The plans to build an office park were abandoned, and Dow and its consultants conducted all subsequent work at the site.

## **Waste Disposal at the Dow Property**

Dow and DEP interviewed former Dow employees and reviewed company records to obtain information about how waste materials from the former R&D operation were disposed of at the site. This information led to identification of a number of locations on the property likely to be contaminated. Subsequent investigations identified four areas on the property that were likely to be contaminated and/or to be a source of migrating contamination:

- 1) shallow disposal area (SDA)
- 2) burn area
- 3) upper septic field
- 4) underground storage tank area

These areas were discovered during Dow's first RAM in October and November 1994 using geophysical techniques, soil borings with monitoring wells, and excavation to investigate the subsurface environment. After these areas were identified, Dow conducted a second RAM between November 1996 and July 1997 to develop site-specific standards for the organometallic compounds found in the shallow disposal area soils. During this second RAM, Dow's consultants also excavated more contaminated soils, collected soil samples, and determined site background concentrations for various contaminants.

The following discussion summarizes actions and final resolutions at each of the waste areas investigated at the Dow property.

**Shallow Disposal Area:** Information from interviews with former Dow employees guided a November 1994 investigation that led to the discovery of 130 vials, laboratory glassware, and contaminated soil in several scattered areas near a former laboratory building on the property. The total covered about 750 square feet and was several feet deep. Soil analysis showed that the soil contained volatile organic compounds, semivolatile organic compounds, metals, and

organotin compounds. The laboratory report indicated that there were other compounds in the soils, but the laboratory could not identify them. During the investigations, Dow's consultants collected groundwater samples in areas downgradient from the shallow disposal area, and did not find any contaminants at concentrations above the MCP limits.

Following discovery of the vials and contaminated soils, Dow's consultants removed approximately 160 cubic yards of soil from the property. They tested the soils that remained after the excavation, and confirmed that these soils did not contain chemicals above the standards established by DEP. However, there were no standards for the organotin compounds, and without standards, it would not be possible to determine when the cleanup had reached acceptable limits. Dow's consultant, Ransom, hired a risk assessment consultant, Gradient, to develop specific standards for the organotin compounds in order to complete work in the shallow disposal area. Completion was achieved in July 1997; the site soils were not cleaned to background levels, but Dow's consultants were able to use risk assessment to demonstrate that the soils remaining in the shallow disposal area did not pose a threat to human health or to the environment.

**Burn Area:** When the R&D facility was operating, Dow occasionally burned waste chemicals on a concrete pad and in burn buckets. Dow's consultants detected chemical residues in soils in the area where the waste had been burned. Ransom removed some of the contaminated soils, but some contaminants, called polycyclic aromatic hydrocarbons (PAH), were still above the MCP limits. PAH compounds can form during combustion of chemicals that contain carbon. The subsequent risk assessment showed that the residual PAH contamination in the burn area soils did not present a significant risk to human health and the environment. However, in the spirit of trying to return the site to the town at as close to background conditions as possible, Dow authorized Ransom to remove additional soils, beyond what was required by the MCP. This activity is called a "voluntary soil removal action" in the MCP. When the property was transferred to the Town, the levels of all chemicals in soils at the burn area were below the Method 1 limits, which are the generic risk standards set by the MCP. The MCP does not regulate or require voluntary actions; Dow and its consultants ultimately cleaned up the site soils to a level beyond which would have been required by the MCP.

**Upper Septic Field:** When the Dow facility was operating, wastewater was discharged to a septic tank and leaching area on the property because there were no sewers servicing the site.

Septic fields can be sources of contamination if chemicals are disposed down the drain because they can infiltrate into the soils and groundwater. Dow's consultants tested soils in the septic field because there was evidence that Dow had disposed solvents down the drain (a common occurrence in the 1960's and 1970's). The consultant did not find contaminants in the soils, but the Neighbors' consultant suggested that testing be done to see if the contaminants migrated from the septic field to the groundwater. There was shallow bedrock under the septic field along with a bedrock valley that could provide a pathway for migration. The Neighbors' consultants noted that the solvents were water-soluble, and might not be present in the soils because they could have been carried to the groundwater when rain filtered through the soils. Dow's consultants collected groundwater along the bedrock valley, and demonstrated that contaminants were not currently leaving the site by this pathway, although it could not be established whether this had happened in the past, when the septic area was being used.

Dow's consultants later removed additional soils from the upper septic field as part of the voluntary actions.

**Underground Storage Tanks:** Two underground oil storage tanks were present on the property, and removed in November 1996 in the presence of the Neighbors' consultant. The soils around the tanks were tested, and did not contain oil. The tanks were eliminated as a possible source of contamination at the site.

## **Risk Reduction Measures and Site Reclassification**

The paramount objective of the MCP for any hazardous waste site is to achieve a condition of no significant risk to human health and the environment. The MCP is structured to provide opportunities for risk reduction measures, including excavation and removal of soil, to be taken throughout the process in the course of achieving that objective. By doing so, some exposure pathways are eliminated and the overall site risk is immediately reduced, even though other exposure pathways may still exist in the short term. In some cases, the extent of contamination is such that these measures are sufficient to achieve the goal. In other cases, risk reduction measures can change the numerical ranking score for the site and possibly the site classification, as well.

At this site, Dow undertook activities that lowered the overall site risk and resulted in a site score that downgraded the classification from Tier IA to Tier IC by removing the vials, excavating contaminated soil from the shallow disposal area, and removing the underground storage tanks, the concrete pad and contaminated soils from the burn area, and the dredge spoil piles. After completing these activities, Dow requested that the site be reclassified Tier II. Although DEP did not agree that the site could be downgraded to Tier II, the agency approved a Tier IC reclassification, which removed the requirement for direct DEP oversight of all activities.

### **Tier 1A Classification and DEP's Oversight Role**

The Massachusetts DEP oversees all investigations and remediation at all sites classified in the highest priority designation of Tier 1A. DEP's oversight includes reviewing and approving all plans and reports and being present on the site during field investigation and cleanup activities. DEP also observes all field work and participates in the public meetings held to explain activities and progress. Although an LSP must conduct all investigations, nothing can be done at a Tier 1A site until the plans are submitted to DEP in writing and are approved by DEP's project manager. After DEP classified the site Tier 1A in February 1994, the agency assigned Scott Greene as the DEP project manager.

Before the site was reclassified as Tier IC in February 1999, DEP held four public meetings (May 1994, October 1994, June 1995, and December 1997), and oversaw implementation of a number of response actions from 1994 until May 1999. After reclassification, Dow continued the PIP process and held additional public meetings in September 1999, October 1999, and January 2000. In an effort to maintain a dialogue with the community as the cleanup process was nearing completion, Dow conducted question and answer sessions in February and March 2000, and invited the public to a post-facility closure site visit on April 1, 2000.

## **Technical Assistance Grants (TAGs)**

In 1993, DEP began the Technical Assistance Grant (TAG) program to award grants of up to \$10,000 to communities and citizens' groups that demonstrated a compelling need for technical assistance to help them address and understand MCP issues in their neighborhoods. NED/Dow Neighbors received four successive grants between 1995 and 1999, and their applications were generally ranked among the best of those submitted. The TAGs were instrumental in providing lay people with expertise to help them understand and comment on actions undertaken by the PRP or RP. TAGs were to be used primarily for public comment, monitoring of field activities, and review of deliverables. TAGs were often effective in providing the necessary leverage citizens groups need to continue a mutually beneficial dialogue with the PRP or RP. TAG Grants were eliminated from the DEP budget in 2002 by the Legislature in a cost-saving move.

The Neighbors used their TAG grants to hire consultants who commented on Dow's reports, explained the technical aspects of the reports to people in the community, advocated for the Neighbors and requested additional studies, and participated in the public meetings.

## **Phase 2 Studies and Areas of Disagreement**

The MCP requires RP's at Tier Classified sites to conduct tests and studies after the initial RAM work is completed. These Phase 2 studies constitute the Site Characterization phase at an MCP site. During the Phase 2 work at the Dow site, several areas of disagreement arose between Dow and the Neighbors and their consultants. These issues were resolved over the course of the MCP process. The major areas of disagreement, and their ultimate resolution, will be summarized here.

### **1. Disposition of the Vials**

Since their discovery in November 1994 within the shallow disposal area, the vials represented one of the most contentious issues between Dow and the Neighbors. The primary disagreement between Dow and the Neighbors involved testing of the contents of the vials. This was never done. Dow and its consultants had conducted extensive testing of the soils from the shallow disposal area and from areas where broken vials had been found. Dow's position was that the soil testing would have found anything that leaked from the vials. Dow contended that because



the vials were mostly intact, and because the soils in the burial area had been tested, no additional value would be gained from testing their contents. The vials remained in storage in Rhode Island, and other activities continued at the site while the matter was debated.

From the time the vials were discovered, the Neighbors wanted Dow to analyze their contents to determine what was in them. The Neighbors, concerned that there may have been exotic research chemicals in the vials, and that the laboratory tests conducted on the soils would not detect these chemicals, wanted Dow to test the vials. The Neighbors petitioned DEP to require Dow to analyze the vial contents, but DEP had no authority to require this type of testing as the MCP governs the ambient environment. The waste material in the vials was considered solid hazardous waste, which must be disposed of according to state and federal regulations, but there was no regulatory requirement for testing. DEP's position was that the agency would not object to testing of the vials, but agreed with Dow that the soil testing was sufficient to characterize the environment. Analysis of soil in close proximity to the vials did identify organometallic compounds containing tin and mercury, but the laboratory report did not indicate any other highly toxic or unusual substances.

This issue became one of the more important rallying points for the Neighbors, however, and they considered analysis of the contents of the vials to be one of their highest priorities. Their position was that in order to know whether surrounding soil had been sufficiently remediated, it was necessary to know first what was in the vials so that the soil could be tested for the same substances.

At a public meeting in December 1997, the Neighbors' consultants proposed testing the vials for mutagenic activity as a surrogate for chemical analysis. The consultants proposed using a rapid screening test to identify vials that contained substances that could initiate mutations in bacteria, and then doing further chemical tests only on vials that showed mutagenic activity. Dow did not want to conduct testing, and relied on the DEP's opinion. In June 1998, DEP issued a conditional approval of the Phase 2 Scope of Work, and included permission to destroy the vials, but recommended that Dow screen the vials for toxicity and mutagenicity to provide comfort for the public. Dow declined to follow DEP's recommendation, which was advisory only and not a condition for approval of the Scope of Work.

Toward the end of 1998, Dow completed the Phase 2 activities and filed a major permit modification to reclassify the site to Tier 1C. At the same time, the Town of Wayland and Dow were nearing completion of an agreement for the Town to purchase the land. During the negotiations, when many of the stakeholders were converging toward a common goal of a remediated site to be used by the Town for conservation and recreation, Dow announced its intention to destroy the vials in a letter sent to DEP on February 5, 1999. The Wayland Board of Selectmen sent a letter to Dow asking that the vials not be destroyed. In their request, the Selectmen stated, “for the sake of allowing us and other Town boards to address the public’s concerns, we ask that you not destroy the vials until there has been a fair opportunity for us and our community to understand what risks, if any, have been posed by these vials.” Dow responded the next day stating, “The Dow Chemical Company, Ransom Engineering (Dow’s Licensed Site Professional), and the MADEP all agree that there is no valid reason to analyze the vials.” However, in this response, Dow agreed to delay destruction of the vials until March 15, 1999 to allow the Town time to develop a plan for further testing of the vials at the Town’s expense. Dow reserved the right to approve the testing laboratory and the testing methodology.

By asking the Town to develop a testing plan, Dow was forcing the Town to resolve in one month’s time what could not be accomplished in the years since the vials were first discovered in 1994, and to find the financial resources to do so. The Wayland Board of Selectmen and Board of Health, and private citizens considered options, potential costs, the differences between screening and testing, the differences between toxicity and mutagenicity testing, the need to reinventory the vials, and to be sure that the testing protocol was well thought out and scientifically defensible. On March 10, 1999, the Board of Selectmen requested more time and was granted a one-month extension. On April 14, 1999 the Board sent a letter to Dow saying that the Town did not have the time, funds, or employees with the necessary technical expertise to create a complete, comprehensive, and scientifically valid rationale and plan to screen or test the vials. Instead, they repeated the Town’s wish that Dow maintain a status quo position regarding the vials and offered to help pay for the vials’ continued storage. The Board also requested that storage continue at least until a Response Action Outcome of no significant risk as defined by the MCP was achieved at the site.

In addition to the Board of Selectmen, other parties including the Wayland Board of Health, the Massachusetts Department of Public Health, the Natick Cancer Study Task Force, Massachusetts Senator Susan Fargo, former Massachusetts State Representative Hasty

Evans, U.S. Representative Marty Meehan, U.S. Senators John Kerry and Edward Kennedy, and several private citizens requested that Dow not destroy the vials. Despite these appeals, Dow notified the Board of Selectmen on July 2, 1999 that the vials had been destroyed (the Phase 2 Report indicates the vials were destroyed between June 9 and June 13, 1999) citing consensus among Dow, Ransom, Camp Dresser & McKee (the town's environmental consultant), and the DEP that there was no valid reason to analyze the vials and that continued storage was not warranted. The relationship between Dow and the community of Wayland had now reached its lowest level of trust and confidence. The Board of Selectmen received the information about destruction of the vials at about the same time that Dow obtained DEP approval to reclassify the site to Tier IC, which meant the end of the official responsibilities for the site by long time DEP project manager Scott Greene, who had won the confidence and trust of the Neighbors and the Town. On May 20, 1999, the Dow cleanup became totally privatized, without DEP oversight. Dow was free to finish the cleanup constrained only by the MCP regulations.

Dow's decision to destroy the vials coincided with negotiations with the Town regarding the property transfer. Dow's actions concerning the vials jeopardized communications with the Neighbors, and trust among the parties continued to erode. Meanwhile, Dow and its consultants continued to work toward completion of the cleanup. With very little new information made available to the Neighbors and to the Town, the community viewed final stages of the cleanup with suspicion.

The impasse was broken in September 1999, when, after several requests from the Neighbors, Dow assigned Jerold Ring as the liaison between Dow and the community. A letter from the president of the Neighbors group to the Chairman of Dow got his attention, and officials at Dow soon recognized that the people of Wayland deserved answers to their questions and concerns. Under Mr. Ring's direction, Dow began confidence-building measures including small group meetings with the Neighbors, tours of the Dow property for Town officials and residents, and public information sessions prior to public meetings. Mr. Ring worked with the Neighbors to ensure that both parties would be satisfied with the cleanup. The Neighbors and other residents met with Mr. Ring and with Dow's consultant and toured the property. The community members pointed out areas where they wanted additional soil tests, and Dow's consultant tested those areas. During the meetings with Mr. Ring, Dow agreed to conduct the voluntary actions that went beyond the MCP requirements. These actions included demolishing structures that

remained on the property, and removing additional soil, even though it did not meet the MCP definition of contaminated. The property was finally transferred to the Town in May 2000.

## **2. Dioxins and Furans in Pond Sediments**

Determining the health and environmental risks posed by polychlorinated dibenzo-p-dioxins and polychlorinated dibenzo-furans, commonly called dioxins and furans, in sediment is challenging because these substances are ubiquitous in the environment. Also challenging are the very low analytical detection limits necessary to establish whether these contaminants are present.

In June 1997, the Neighbors' consultants submitted comments to Dow expressing concern that the analysis done on sediment from three ponds on the site used detection limits that were too high to determine if the contaminant were present. If the laboratory has high detection limits, very small quantities of these contaminants will not be 'seen' by the analytical instruments, and the samples will be reported 'not detected'. The analogy would be to try to use a bathroom scale to weigh a postage stamp. It would weigh 'nothing'! If weighed on a sensitive balance, however, the postage stamp would weigh a few grams.

DEP agreed with the Neighbors' consultants, and Dow conducted additional testing in October 1998. Dow released the new data in March 1999, and because of additional laboratory problems, resampled the pond sediments in April 1999.

Laboratory problems are not uncommon with this type of testing, but the timing of Dow's laboratory woes could not have been worse, as the pond sediment concerns coincided with Dow's announcement that the Rhode Island laboratory that was storing the vials would destroy them. The Neighbors and others were concerned about the validity of the testing, and were concerned that Dow's consultant had not noticed that the detection limits were inappropriate.

Dow released the new dioxin and furan data in July 1999. DEP and Dow concluded that these results were not substantially different from dioxin and furan sediment data collected in ponds in other locations in Wayland.

Dioxins and furans can form when some types of plastics are burned. They also form during combustion of fuel oils, and they are produced as by-products of some chemical syntheses. The

underlying concern was that Dow may have done research with chemicals that are linked to dioxins and furans, particularly seeing that during the 1960's Dow had manufactured defoliants that were contaminated by dioxins, although not in Wayland. There was no evidence that these types of materials were used at the Wayland R&D facility, but the Neighbors and others wanted to know if dioxins or furans, which are linked to human immune dysfunction and are suspected of causing some cancers, were at the site.

There were very low levels of dioxins and furans in the sediments from the ponds on the property, but these levels were not significantly different from levels in sediment collected from another pond off the site. Dioxins and furans are present in road runoff. They are in the air, from combustion of oil in power plants and from incinerators, and they are washed out in rain. They collect in sediments because they bind to organic matter and to fine soil particles.

The final resolution was the agreement among the parties that the risk assessment indicated that dioxins and furans did not threaten human health. Without the additional testing, the consultants would not have been able to reach this finding, because the data would have been inconclusive.

### **3. Possible Bedrock Pathway**

A June 1992 DEP memorandum had reported that Dow had used solvents at the Wayland facility. One report that DEP referenced indicated that Dow had used 200 gallons of non-flammable chlorinated solvent per year at the facility. Most of the solvent had been used under fume hoods and had been evaporated and discharged to the atmosphere; some of the solvent, characterized in the memo as 'small amounts', was dumped down the drain, into the septic system.

Testing of soil and groundwater samples from the upper and lower septic areas did not indicate contamination by chlorinated solvents. A geophysical study of the site, in 1994, found evidence of a bedrock valley that extended to the north and south of the site. The Neighbors and their consultants raised the possibility that this valley was providing a pathway for contaminated groundwater to migrate off the site, but Dow disagreed. DEP concurred with Dow, and did not require the consultant to drill a well into the bedrock. However, to address the Neighbors' concerns, Dow agreed to test existing monitoring wells on property across Commonwealth

Avenue from the site. These wells were downgradient from the Dow property, and if contamination was leaving the site in groundwater, these wells would be a reasonable location to find that contamination.

There was a valid reason for concern about offsite migration of contaminants in the groundwater. There are drinking water wells nearby in the Town of Natick, south of the Dow property. No contaminants were detected in the monitoring wells south of Commonwealth Avenue, and Dow's consultants concluded that there was no offsite migration of contaminants. However, the question of whether contaminants may be migrating in the deeper groundwater, in the bedrock, has never been resolved.

#### **4. Burn Areas and Dredge Spoils Piles**

The burn areas contained soils that contained residues from open-air incineration of chemicals from the R&D operation. Runoff from the burn areas, and from other potentially-contaminated areas of the site, flowed into the three ponds located on the property. NED had dredged the ponds during its ownership of the site, and had stockpiled the dredged sediments on the property.

During the Phase 2 activities at the site, multiple soil samples were collected from the burn area and from the piles, and soils were excavated, but the goal of reaching background could not be achieved. The risk characterization demonstrated that the levels that remained did not pose a risk to human health or to the environment. Lead and PAH compounds were above background at the burn area, and metals, dioxins, and furans were above background in the piles. The Neighbors expressed concerns about the residual contaminants, and, after several rounds of iterative testing, Dow agreed to excavate and remove all soils above the MCP standards from the burn area, and to remove both dredge spoils piles, consisting of 13,000 tons of soil, from the site. Removal of these soils increased the confidence in the cleanup for the Neighbors, particularly because the property was going to be used for recreation.

#### **5. Organotin and Organomercury Compounds**

There were no MCP standards for organomercury and organotin compounds, two groups of chemicals found at the shallow disposal area. These compounds had been used by Dow in

R&D operations, and were not common environmental contaminants. DEP required Dow to develop cleanup standards for several different organometallic compounds as part of the Phase 2 work at the site. This work was done by Gradient, working with Ransom. The Neighbors, through their consultants, commented on the draft standards, and Gradient made revisions that resulted in values acceptable to the Neighbors and DEP.

## **6. Other Phase 2 Issues**

During public meetings and in private discussions with Dow, the Neighbors raised two other issues of lesser magnitude. The Neighbors, DEP, Dow and the consultants easily resolved these issues as soon as Dow provided the proper data. One issue concerned a sump located outside the eastern side of the building that discharged to the North Pond, and the other concerned the absence of an identifiable source of chlorinated solvents in groundwater south of the soil disposal area. The sump was of concern because it was seen as a possible source of dioxins and other contaminants in the pond. Dow agreed to collect sediment samples at the discharge point, and these samples did not contain contaminants at levels that would contribute to risk.

During the investigations at the site, the source of groundwater contamination south of the shallow disposal area could not be determined. Dow agreed to collect additional groundwater samples downgradient of the disposal area, and demonstrated that concentrations of volatile organic compounds in the site groundwater met all applicable standards, and that contaminated groundwater was not migrating off the site.



## 7. Ecological Issues

As more information became available about the Dow site, the various stakeholders raised concerns about ecological risk. The MCP requires that risk to environmental receptors, including terrestrial and aquatic organisms and ecosystems, be evaluated independently of risk to human health. The MCP considers ecological risk to be equal to human health risk at hazardous waste sites, and therefore unacceptable ecological risk is a reason to require remedial action even if a site does not pose an unacceptable risk to human health.

Metals, PAHs, dioxins, and furans are potentially toxic to environmental receptors, particularly aquatic organisms. These substances are all relatively long-lived in the environment; they bind to sediments, and bioaccumulate in aquatic organisms, thereby exposing other organisms through food webs. The organotin compounds present at the site, in particular, were of concern because they were developed as pesticides, specifically to kill marine crustaceans, particularly barnacles, that attach to ships. Dioxins and furans are toxic to fish as well as to simpler organisms that live in aquatic sediments. These benthic (or bottom-dwelling) organisms also bioaccumulate dioxins and furans, and transfer them to fish, reptiles, amphibians, and to terrestrial animals that eat fish and other aquatic organisms. PAHs are toxic to aquatic animals as well.

The Dow site presented a concern for ecological impacts because the ponds were downgradient of the contaminated soil areas, and there was evidence that runoff from the site had collected in the pond sediment. Several sequences of dredging and storage of spoils on the site had the potential to reintroduce environmentally stable contaminants to the pond and to the organisms living in the pond. Although the Dow ponds were not used for swimming or fishing during the time that the study was conducted, these were clearly potential uses, especially if the Dow site were to be purchased by the Town of Wayland for recreation and conservation use. The Neighbors' consultants were instrumental in designing studies to evaluate the overall impact of the Dow site on the ecological health of the ponds.

## APPENDIX III

### Human Health and Environmental Risk Characterization and Health Concerns at the Dow Site

Method 3 Human Health Risk Assessment under the Massachusetts Contingency Plan (MCP) must be conducted according to specific rules and procedures, and must follow guidance presented in *Guidance for Disposal Site Risk Characterization* (Massachusetts DEP, July 1995, and supplemental guidance). Risk Assessment is possibly the most misunderstood aspect of hazardous waste site management - and one challenge faced by consultants to community groups is helping them to understand the role of Risk Assessment in the MCP process. Maybe more importantly, the consultant must also help community groups to understand what Risk Assessment does not do.

#### Human Health Risk Assessment

Risk Assessment consists of four components: 1) Hazard Identification; 2) Dose-Response Assessment; 3) Exposure Assessment; and 4) Risk Characterization.

In the Hazard Identification step, the risk assessor identifies Contaminants of Concern (COCs) that will be used throughout the Risk Assessment based upon review of analytical data from soils, groundwater, surface water, sediment, and other media, such as waste. The COCs are substances that, based on rules set forth in the *Guidance*, are most likely associated with activities that took place at the site, and are not the result of natural background, laboratory contamination, or laboratory error.

For each COC determined to be related to site activities, the risk assessor selects appropriate risk parameters to evaluate carcinogenic and noncarcinogenic effects. These values, called the Dose-Response values, are used to estimate the likelihood of health effects from COCs found on the site. The Dose-Response values are taken from several databases, EPA's *Integrated Risk Information System (IRIS)* and the *Health Effects Summary Tables (HEAST)*. These are the standard references for dose-response information used in risk assessment under the MCP and under similar U.S. Environmental Protection Agency (EPA) guidance. If a dose-response

value is not available from these databases, there are other sources, including values published by the Massachusetts Department of Environmental Protection (DEP), EPA, and other agencies.

For noncarcinogenic effects, the risk estimate for oral and dermal exposure is the Reference Dose (RfD), and is an estimate of the threshold dose below which no adverse response is expected. The RfD's are normally derived from animal studies to which several safety factors are applied to ensure that the values used for humans are conservative. Both chronic and subchronic RfDs are available. The chronic RfD is used for long-term exposures, usually for 7 years or more. The subchronic RfD is used to evaluate exposures that occur over less than 7 years.

For carcinogenic effects, the risk estimate used is the Slope Factor (SF), also called the Carcinogenic Potency Factor (CPF). The SF is also derived from animal studies, and from a mathematical model that represents the slope of the upper 95 percent confidence interval of the dose-response curve derived from a linearized model that extrapolates low dose estimates of carcinogenic risk from higher dose experimental exposures that caused cancer in laboratory animals.

In the Exposure Assessment, the risk assessor identifies potential receptors, exposure routes, exposure pathways, and exposure point concentrations of chemicals specific for the site.

In the Exposure Assessment, the following are determined:

<u>Routes of Exposure</u>	How exposure can occur, in this case through ingestion and/or dermal contact and absorption.
<u>Pathways</u>	The environmental media and mechanisms through which exposure can occur.
<u>Exposure Scenarios</u>	The circumstances under which exposure can reasonably occur given conditions at the site.

## Exposure Assumptions

The characteristics of the people who are exposed, and the conditions under which they are exposed.

The exposure scenarios used in risk assessments must make assumptions on how the site will be used in the future as well as on how it is currently used. The first step in the Exposure Assessment is identifying groups of people called receptors who may potentially be exposed to COCs given the current and foreseeable uses of the site.

Exposure Point Concentrations (EPC) and Average Daily Doses (ADD) are then calculated for each chemical and each exposure pathway. Lifetime Average Daily Doses (LADD) are calculated for those COCs classified as carcinogens.

The EPC is the estimated concentration of a COC that the receptor contacts under the site-specific exposure scenarios. Pursuant to the MCP Risk Assessment Guidance, the EPC is normally the arithmetic mean (or simple average) of all the data for each chemical at a given exposure point. It is used to calculate the Average Daily Dose (ADD) or Lifetime Average Daily Dose (LADD), which are the estimated daily exposures to the COC that are evaluated for the probability that they will result in toxic and cancer effects, respectively.

Following estimation of the EPC, the ADD, and the LADD for carcinogens, are calculated using the following general relationship:

$$\text{(L)ADD} = \frac{\text{EPC} \times \text{Intake} \times \text{Relative Absorption Factor} \times \text{Frequency} \times \text{Duration}}{\text{Body Weight} \times \text{Averaging Time}}$$

where:

(L)ADD	the (Lifetime) Average Daily Dose (mg/kg/day)
EPC	the Exposure Point Concentration, which is the arithmetic mean of the data for each COC
Intake	the amount of and/or rate at which a receptor comes into contact with the environmental media that contain the COCs
Relative	a value derived from experimental data that
Absorption Factor	Estimates the amount of the COC that is absorbed by the human body after contact with the environmental media at the site that contain the substances

Frequency	The number of times that the receptor comes into contact with the media containing the COCs
Duration	The time span over which exposure occurs
Body Weight	The receptor's weight;
Averaging Time	The time over which the exposure is averaged. For carcinogenic effects, lifetime (75 years) is used and an LADD is determined; for noncarcinogenic effects, the time period covered by the duration of exposure is used.

The risk characterization step of a Risk Assessment involves comparing the average daily doses of chemicals calculated under the exposure scenarios to the dose corresponding to the appropriate risk estimate, either the RfD (for noncarcinogenic effects) or the SF (for carcinogens). These risk estimates are then compared to the MCP risk limits, a total site Hazard Index (HI) of less than 1.0 for noncarcinogenic effects and a total site Excess Lifetime Cancer Risk (ELCR) of less than 1.0E-5 (one in one hundred thousand) for carcinogenic effects.

The risk of noncarcinogenic effects is estimated by dividing the ADD by the RfD. This yields a HI for each COC:

$$HI = ADD/RfD$$

The sum of the HIs for each COC is the site HI.

Cancer risk is estimated by multiplying the LADD by the SF:

$$ELCR = LADD \times SF$$

The sum of the carcinogenic risks for each COC is the total site ELCR.

## How Risk Assessment is Used

Risk Assessment is a tool used in management of hazardous waste sites. Its primary purpose is to allow decision-makers to evaluate the risks associated with contamination present at the site without any remedial action. The Risk Assessment allows responsible parties and regulators to evaluate the site conditions and how they would affect people and the environment by evaluating possible exposures to contaminants in site soils, groundwater, surface water, sediment, and other environmental media by hypothetical people who could live or work on or near the site. Risk Assessment evaluates these exposures by comparing them to exposure levels that would not be expected to cause harm. If the hypothetical 'receptor' is exposed to contaminants at a level lower than the exposure that should not cause harm, the outcome of the Risk Assessment is a condition of 'no significant risk'. If the exposure is higher, there is 'significant risk' as defined by the MCP.

Significant risk does not mean that people who live near a site are at risk of immediate or certain adverse health effects. Significant risk does imply that if the site is not cleaned up there is a chance that some people will be affected, particularly after being exposed to the contaminants in the environment for several years. Because Risk Assessments evaluate exposures under 'reasonable worst case' conditions, the probability that any one individual will be affected by living near or at a hazardous waste site is low. Worst case assumptions consider that some people will have extensive and repeated contact with contaminated environmental media; MCP guidelines recommend 'reasonable' worst case assumptions, which are not absolute worst case, but reflect activities that a 'reasonable' person could be expected to engage in at the site. For example, a worst case scenario considers that a person who lives at a contaminated site will be in contact with soils in his/her yard five days per week during the spring, summer, and early fall. This type of activity could be expected from someone who is a dedicated gardener or landscaper. A more likely scenario is that a person who lives at a contaminated site will be in contact with soils in his/her yard only one or two days per week. Worst case is used in Risk Assessment because regulators want to ensure that cleanup decisions protect people who engage in activities that are reasonable, although not necessarily typical or 'average'.

The outcome of the Risk Assessment is used to determine if remediation is necessary to ensure no significant risk at the site, both in the present and the future. However, Risk Assessment can evaluate only those contaminants present in site media at the time that the investigation is

conducted. Risk Assessments evaluate the existing site conditions, and assume that these existing conditions are the basis for site conditions over the next 20 to 30 years. The basis for the baseline existing conditions in Risk Assessment is the monitoring results developed in the site investigation. These results are used to establish the “Exposure Point Concentrations” to which people who live or work at or near the site are exposed. Risk Assessment can also use modeling to evaluate how site conditions and exposure point concentrations may change in the future. For example, contaminants in groundwater can be expected to migrate, and therefore to spread to new areas of the site. Monitoring data can provide information about migration trends, but modeling is needed to predict the extent of a groundwater plume in the future. Modeling is also useful in predicting the impact of groundwater or soil contamination on indoor air quality, as well as bioaccumulation potential in fish or other organisms. Modeling to predict behavior of contaminants at a site requires information about contaminant concentrations in the environment, as well as detailed information about environmental conditions that will affect fate and transport of the contaminant.

Risk Assessment cannot evaluate conditions that cannot be demonstrated at a site either through monitoring or predictive modeling. Therefore, Risk Assessment can evaluate past conditions if monitoring data are available, but if there are no historic monitoring data, Risk Assessment cannot estimate exposures that could have occurred in the past. This limitation is particularly true if suspected past exposures involved chemicals present in environmental media different from the media that are contaminated at the present time.

### **Risk Assessment Concerns at the Dow Site**

The primary media of concern at the Dow site – based on extensive environmental monitoring - are soils, surface water, and sediment. Although some groundwater contamination was detected, there is limited opportunity for exposure to groundwater at the site. However, residents living near the site expressed concerns about past exposure to contaminants in air. This is a rational concern given the reported past waste disposal practices at the Dow site – particularly incineration of wastes in the burn area. There were also concerns about chemical vapors and particulates discharged through the laboratory hoods while the facility was operating. Because monitoring was not done when these activities were taking place, it was not possible for the Risk Assessment to evaluate their impact on human health or the environment.



Some of the local residents expected that the Risk Assessment would evaluate the impact of these past exposures. This concern was heightened because one former resident of the area adjacent to the Dow site was diagnosed with cancer and was convinced that exposure to site-related contaminants during her childhood was the cause of her illness. The Neighbors' consultants faced the challenge of explaining the role – and the limits - of Risk Assessment and how it would be used at this site.

## **Developing New Standards for Organotins**

The MCP provides options for evaluating risk to human health. Risk Characterizations conducted as part of hazardous waste site investigations can use one of three methods, the most common of which is Method 1, which makes use of standards established by the DEP for maximum concentrations of contaminants that can be present in soil and groundwater in order to ensure protection of human health. These 'Method 1 Standards' are reasonably conservative. The DEP set the Method 1 levels using a reasonable and rational approach that follows acceptable risk assessment practice. There are three levels of Method 1 soil standards that account for use of the property. The most stringent standards are called S-1, and represent concentrations of contaminants in soils that would not result in unacceptable health risks if they were present on residential property. These standards are indicative of what DEP refers to as a 'level of no significant risk' for the most sensitive uses of soil, which include children playing in it, eating it, and eating vegetables grown in it.

## **Method 1 Standards and the MCP**

Use of the Method 1 S-1 standards to determine if there is significant risk at a disposal site is not without some controversy and disagreement among various stakeholders in almost every disposal site situation. The most common arguments arise over what is 'conservative enough'. Very often, people who live near disposal sites, and who are most affected—actually or perceptually—by contaminated soil, argue that any amount of contaminant in soil is too high. The argument for 'zero' as an effective measure of no significant risk is common, and explaining the meaning of significant risk is a challenge for a technical advisor to community stakeholders. Of course, Potentially Responsible Parties (PRPs) have been known to argue that the S-1 standards are too low, that they are not realistic, and that they do not adequately reflect site-

specific background levels of some contaminants, particularly metals and fuel-related contaminants.

The MCP has similar Method 1 standards for groundwater, with the most stringent GW-1 Standards applying to sites where groundwater is used for human consumption or in an area where it could be used for human consumption in the future. Other Method 1 groundwater standards protect against migration of contaminant vapors into buildings and also protect wildlife in surface water that serves as a receiving body for groundwater. The MCP rules for groundwater are more complex than those for soils, and groundwater at a site often has to meet more than one of the standards, depending on the use of groundwater, its depth below the surface, and the physical properties of the contaminants.

The MCP allows the PRP to perform a risk assessment at a number of stages in an investigation at a disposal site, but most risk assessments are done after initial remedial actions are completed. Under the 'rules' that govern MCP investigations, no further remedial work is required if the site meets the definition of no significant risk at any stage in the assessment and cleanup process. Therefore, the goal of many PRP-initiated initial cleanup actions is to 'meet the Method 1 Standards'. If the site soils meets the S-1 standards, and the site groundwater meets the applicable standards, the site is considered to be 'clean' under the MCP and no legal restrictions are placed on any current or future activities on the property. If the site does not meet the S-1 standards, the PRP has a few options. He/she can show that the site meets less stringent Method 1 soil standards (S-2 or S-3), but this finding would require an Activity and Use Limitation (AUL), which is a deed restriction that constrains some activities on the property in order to protect public health. The PRP can also use Method 3, which involves a more complex evaluation of exposure and risk, and take into account site-specific information about the types of activities present or likely in the future. Another option is to continue remediation until the appropriate Method 1 standards are achieved in soil and groundwater.

## Method 1 Standards at Dow

The Dow site ran into difficulty when, as part of the initial investigations of site soil, a number of contaminants were discovered for which there were no Method 1 standards. The MCP includes Method 1 standards for over 100 metals and organic compounds. These substances were selected because they are the most common contaminants at hazardous waste sites, but there are sites where contaminants that are not included in the Method 1 list are found. The Dow site is one of these sites. This circumstance was not unexpected because this site was a research facility where chemicals were synthesized and tested. Some of Dow's research in Wayland included producing and testing small amounts of organotin compounds. These were considered 'hot' new compounds in the 1970's, and Dow experimented with them in search of new chemicals that could prevent marine organisms such as barnacles and other marine crustaceans from attaching to boats and ships. These organisms damage paint, resulting in economic loss to owners of watercraft. The organotin compounds are toxic to barnacles, and by mixing these compounds with marine paints, the paints kill the organisms before they can cause damage to boats.

## Organotin Properties and Toxicity

Organotins are relatively simple compounds, with one or more methyl, ethyl, and other short-chain carbon groups attached to a tin molecule. The resulting compound interferes with cell function at the molecular level. Although there is no direct evidence of toxicity in humans, laboratory studies using mice and rats have demonstrated that organotin compounds can affect the immune system. Tributyl tin appears to be the most toxic organotin compound; it has been shown to be more toxic than dibutyl tin in laboratory studies. Researchers suspect that the organotin compounds affect the life span of cells. Each cell in an organism's body is programmed to die after a specific number of cell divisions, and cells exposed to organotins appear to die early. Some research indicates that this effect may be the result of an affect on the basic energy-producing reactions that occur in the cell.

In the years since the 1970s, organotins became implicated in toxicity to nontarget marine organisms. The overall ecological effects of use of these materials in paints is not fully known, and their potential health effects on humans are also not well understood. Organotins in paints have been suggested as a reason for death of coral, the marine animal whose spiny

exoskeleton forms coral reefs. Some scientists suspect that organotins leach from marine paints in shallow, warm water, and kill the living reefs. Research on the ecological impact of these compounds is continuing.

That organotins are toxic to marine animals other than the so-called 'target organisms' is not surprising given the current state of knowledge in toxicology. A lot has been learned about adverse responses on the cellular and molecular level in the twenty plus years since organotins were first marketed as miracle additives to marine paints. An underlying principle accepted by most toxicologists is that effects on cells and on sub-parts of cells are often noted across species, particularly when those effects are related to basic cellular function. For example, a chemical that affects the way a cell uses oxygen can be expected to have that effect on all cells that use oxygen - therefore on all animal cells. When chemical effects are evaluated on the cellular level, rather than on the organism level as they were in the not too distant past, it is easier to see similarities rather than differences in the way the organisms that are made up of those cells respond.

The effects of organotins on people, however, are still unknown, or more correctly, uncertain. Uncertainty is a technical term used by risk assessors to describe the statistical likelihood that the calculated results or outcome are reflective of the true or real risk. Uncertainty is always part of risk assessment, and part of risk management. Uncertainty is introduced into risk assessment because of scientific judgments and assumptions that are necessary to evaluate the inherent toxicity, potential for exposure, and potential for harm associated with chemical contaminants. One of the most difficult tasks in the public participation part of a hazardous waste site investigation is dealing with this uncertainty. Current society likes definite answers, and very little in risk assessment is definite. Risk assessment practice incorporates safety factors and conservative assumptions to account for uncertainty, and to increase the likelihood that if errors are made as a result of uncertainty, those errors reflect increased risk, rather than decreased risk from a given situation.

## **Uncertainty**

One area of uncertainty that is difficult to account for by conservative assumptions is uncertainty in whether a specific chemical causes an effect (i.e., uncertainty about inherent toxicity). Most people are aware at least anecdotally of substances that were previously thought of as safe,

and turn out to be potentially harmful, and, conversely, of substances thought to be harmful that are found to be essentially safe.

All people have to do to be caught in this conundrum is to read the popular press. Is red wine good for you? Is it harmful? What is 'moderate consumption'? What about saccharin and cyclamates? Do they cause cancer? Didn't thalidomide cause terrible birth defects back in the sixties? Why is it coming back as an anti-cancer drug? Can it be 'safe'? With all the confusion about drugs and food and food additives, it is not surprising that people are confused about chemicals, especially about chemicals with exotic-sounding names, and particularly about chemicals that have known detrimental effects on other organisms, even if those organisms are marine invertebrates that cling to the bottoms of boats. There are many reasons for this - not least among them a basic fear of concern about objects that are not natural, somewhat mysterious, and totally out of the average person's control.

The organotins in the soils at the Dow site created and reinforced concerns that result from uncertainty. DEP did not set Method 1 standards for these compounds because very little is known about their effects on people, and because they are not common environmental contaminants. Combined with the limited flow of information on what was happening at the site and the knowledge of the vials, this uncertainty associated with what were perceived to be exotic toxic compounds produced at a secret research and development laboratory resulted in enhanced community concern.

## **Developing New Standards**

DEP's MCP guidance does provide for situations such as this, with uncommon contaminants. In this circumstance, the PRP has two options, 1) conduct the entire risk assessment using Method 3, or 2) use an alternative approach to Method 1, in which the risk assessor develops surrogate Method 1 standards, using the same procedure that DEP used in the guidance, and apply these standards to the concentrations in soils or groundwater as if they were Method 1 standards. This approach is called Method 2. Both the Method 2 and Method 3 approaches require that appropriate information can be found in the literature to describe and quantify toxic effects of the contaminant on living organisms.

Dow's risk assessment consultant, Gradient, elected to use Method 2 at this stage of the investigation to show that a level of no significant risk was achieved after the initial cleanup and removal of the soil piles. In order to do this, Gradient had to develop Method 2 standards for several organotin compounds, in addition to several organomercury compounds that were also found in the soils. These compounds were not found in site groundwater. The source of the organo-metallic compounds was most likely disposal of waste chemicals from research projects that took place at the facility in the 1960s and 1970s. It is likely that these same substances were present in the vials; it is also likely that they contaminated soils when several vials broke, possibly while they were being buried. Because the vials have not been tested, how the organotins and organomercurials got into the soils will never be known.

Gradient used an acceptable procedure to develop Method 2 standards, but inherent uncertainties in the basic scientific data needed to calculate the standards resulted in additional uncertainties - and concerns - in the recommended standards.

In order to establish a Method 2 standard, an RfD is needed. The RfD is a dose rate - which means it is a mass (weight) of chemical that a person can take into his/her body on a per kilogram body mass basis per day. The RfD is expressed in units of mg/kg/day. The RfD represents the dose rate that will not result in adverse health effects; therefore, the smaller the dose rate, the more toxic the substance. For example, if a substance has an RfD 1 mg/kg/day, a 154-pound (70 kg) person can take in by ingestion or other means 70 milligrams (mg) (about 25 ounces or 0.15 pound) per day over a long term exposure period without adverse effects. However, if the RfD 0.1 mg/kg/day, the acceptable dose would be 7 mg, or less than 0.3 ounce per day. (An analogy to the RfD is the recommended daily dose set by the U.S. Food and Drug Administration for vitamins and nutrients in the diet. In this case, however, the recommended levels are not based on toxicity, but on beneficial effects). The EPA and other federal and international agencies calculate RfDs using data from toxicological studies to determine the dose rate that will not result in toxic effects. Some of these data are from human health effects studies, but most are from animal research. For most of the organotins and organomercury compounds found at the Dow site, however, there were no RfDs. Gradient calculated RfDs from the toxicity studies that were reported in the scientific literature. Gradient followed standard procedures to do this, but made assumptions that were not applied consistently for all the compounds. The procedure for calculating an RfD requires a No Observable Effect Level (NOEL) from the literature, and enough information to determine the uncertainties in the study

that produced the NOEL. The NOEL is a measure of threshold, which is the dose rate that will not cause adverse effects in the test species. Several uncertainty factors, including the number of species used, the variability in the results, the time frame over which the test animals were exposed to the chemical, and the method used to administer the chemical, are evaluated in developing the RfD, which is the NOEL divided by the product of the uncertainty factors.

The uncertainty factors that Gradient used to develop the RfDs were applied in a somewhat arbitrary and inconsistent manner. An example was Gradient's use of a factor of 3 (a relatively low value) for uncertainty associated with an incomplete database available for each contaminant, even though, tables provided in the Gradient report showed relatively wide variability in the quality, age, and types of studies performed. The TAG review expressed concern that the same value was used for all of the compounds, despite the demonstrated wide variability in data quality for many of the compounds. The TAG review recommended that different values be used to account for differing data quality.

Another example of inconsistent use of uncertainty factors in developing the RfDs was the treatment of subchronic studies, which are studies conducted in animals for less than six months. Subchronic studies are of concern because they may not be long enough to show several types of toxic effects that are linked to long-term exposure in humans. (Cancer was not considered in these studies because there is no evidence that organotin and organomercury compounds cause cancer). The accepted practice is to assign an uncertainty factor of 10 whenever subchronic data are used to develop an RfD for chronic exposure. Gradient did not do this for several compounds: trimethyltin, dimethyltin, monomethyl tin, tricyclohexyltin, and dicyclohexyl tin, even though only subchronic studies were available.

For example, for dimethyl tin, three studies were referenced; two were single exposures and the third was a four-week developmental study in the neonatal rat. The NOEL from the developmental study was used to develop the RfD, and only three uncertainty factors were used, 10 for extrapolating from animals to humans, 10 to reflect variability among humans, and 10 for database uncertainties. The fact that this was a subchronic study was not accounted for. If this fourth factor were used, the resulting reference dose, and therefore the resulting standard, would be one order of magnitude, or ten times, lower than that derived by Gradient.



Gradient responded to the comments, and revised some of the standards based on TAG and DEP input. The resulting Method 2 standards were used to evaluate cleanup in the first phase.

The soils remaining after excavation met the definition of no significant risk based on the Method 1 and Method 2 standards. However, it was necessary to evaluate the final, complete site assessment using Method 3. DEP and the Neighbors' consultants agreed that the final Risk Assessment was adequate to evaluate risk at the site.