Does Meeting Clean-Up Standards Mean Protection of Public Health and the Environment?

Published in: Superfund XV Conference Proc., Hazardous Materials Control Resources Institute, Rockville, MD, pp. 531-540 (1994).

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1994

ABSTRACT

In establishing clean-up standards for "superfund" sites, Responsible Parties, regulatory agencies, and the public are all interested in defining "How Clean Is Clean?" The word, "clean," in this application rarely means the removal of all materials that could pose a hazard; it typically means "remediation" or "clean-up" to meet current regulatory standards or a negotiated settlement. Responsible Parties typically want to spend as little as possible to meet closure requirements, and make limited effort to provide for long-term obligations for future liabilities associated with residual contaminants left after "clean-up." The regulatory agency is charged with ensuring a high degree of protection of public health and the environment, but has many technical, economic, legal, and political constraints and considerations that affect its implementation of protection provisions, especially with regard to residual contaminants left at a site after "clean-up." While the public, in general, assumes that meeting clean-up standards will provide "protection," there is growing justified skepticism about the ability of regulatory agencies to protect public health and the environment.

The question of whether meeting regulatory clean-up standards ensures protection of public health and the environment is explored through a case study of the Southern Pacific Sacramento Railyard site, a state of California "superfund" site that is proposed to be redeveloped for intense commercial and residential mixed uses. The site contains lead, arsenic, and a wide variety of other contaminants in the soils and/or the waters associated with the site. The "remediation" proposed by the Principal Responsible Party (PRP) is the minimum or near-minimum necessary to just meet current regulatory requirements for site remediation. The appropriateness of that approach is discussed with particular reference to issues of the adequacy of current site remediation standards for lead and arsenic, and of their implementation, for protection of public health and the environment from the residual potentially hazardous chemicals that will be left at the site after remediation by the PRP.

INTRODUCTION

The public and its representatives are led to believe that the "clean-up" or "remediation" of a chemically contaminated site renders it "cleaned up," i.e., "safe" for its future use. However, examination of how the clean-up standards for chemically contaminated sites are established shows that they are often based on negotiated agreements between the Principal Responsible

Party(ies) PRP(s) and the regulatory agencies; many PRP's try to do the least possible clean-up to meet minimum regulatory agency requirements. The required degree of clean-up of contaminated soils and waters can vary significantly from site to site, even within a single political jurisdiction, depending on the regulatory agency staff and administration's approach and the negotiations. While regulatory agencies are charged with protecting public health and the environment, they are often under significant pressure from a variety of sources, in addition to the PRP(s), to minimize the requirements and hence costs and to expedite the "clean-up" of sites to increase the number of "superfund" sites "cleaned up." This has led to significant inconsistencies in approaches being used across the US for establishing clean-up standards for similar kinds of site contamination.

The re-use of many "superfund" sites is limited to industrial use, with restricted opportunity for access by the public, especially children. Such limitation on re-use enables PRP's to leave higher levels of residual potentially hazardous chemicals at the site after "clean-up," chemicals that could represent threats to public health and the environment forever. Many of the regulatory approaches for evaluation and "clean-up" of chemically contaminated sites were developed on the basis of such "re-use." However, some PRP's, with support of planning and development agencies, city councils, and others, are now attempting to recapture costs of site clean-up by redeveloping the property for commercial and/or residential uses that potentially allow members of the public and children to be exposed to residual chemical contaminants left at the site after regulatory agency-approved clean-up.

While federal and state "superfund" programs typically require monitoring of the site and site review every five years to determine the adequacy of site remediation, few PRP's are required to establish the necessary funding mechanisms to ensure that funds will be available *ad infinitum* for monitoring, maintenance of on-site storage facilities for hazardous chemicals, and future site remediation. Future site remediation could be indicated if the monitoring program detects that the protection of public health and the environment being provided by the initial remediation has become inadequate, if the desired use for the site were to change at any time in the future, or if new information is developed that demonstrates that the regulatory agency's initially allowed standards and clean-up would not be adequate to protect public health and the environment for as long as the potentially hazardous chemicals would be present at the site. The contingencies for accommodating future changes in desired use and new information on contaminant hazards are often inadequately addressed in the "remediation" of chemically contaminated sites. The inadequacy of long-term funding to meet possible contingencies that could arise at any time in the future from failing to adequately remediate the site initially could readily result in there not being funds available when needed to address future problems. This, in turn, could readily lead to significant hazards to public health and the environment.

SP RAILYARD SITE SOIL-LEAD ISSUES

Many of the issues of concern in the evaluation and "clean-up" of chemically contaminated sites are illustrated by the example of the Southern Pacific Transportation Company's Sacramento Railyard site (SP site). The Southern Pacific Transportation Company had conducted a variety of locomotive and rail-car maintenance and repair activities and had maintained railroad manufacturing operations at its Sacramento Railyard since the mid-1800's. Those activities

resulted in the contamination of the soils and groundwaters of the current 240-acre site with a variety of potentially hazardous chemicals (1)(2). The site is now designated as a state of California "superfund" site; evaluation and clean-up of the site, formerly under the jurisdiction of the California Department of Health Services (DHS), is now being regulated by the California Department of Toxic Substances Control (DTSC) under the jurisdiction of the California Environmental Protection Agency (Cal/EPA).

The SP site is located at a prime location in downtown Sacramento at the confluence of the American and Sacramento Rivers; if adequately remediated, the site could represent a significant benefit to the city of Sacramento. In conjunction with its obligation to "clean-up" the site, SP has proposed an approximately $1 billion intense, multi-use redevelopment project for the site that would incorporate various types of commercial establishments, cultural facilities, recreational and green-space areas, transportation facilities, and housing (including low-density, low-income housing where children would have contact with the soils of the area). Given that "superfund" sites are commonly evaluated and remediated with the intention of having no redevelopment or limited industrial redevelopment, the evaluation and remediation of the SP site for its desired intense people-oriented re-use plans are of considerable concern.

One of the chemical contaminants of greatest concern at the site is lead. Lead can have neurotoxicological effects on people; children and pregnant women are particularly sensitive to those impacts. The lead-contamination at the site was derived from a variety of railyard activities including removal of leaded paint from locomotives, servicing of lead-sulfate batteries, etc. Lead was also contributed from vehicles used at the site as well as on the major roadways near the site, which used leaded gasoline. Residual lead left at the site after "remediation" will remain a threat to public health in perpetuity.

There is considerable inconsistency in the approaches being used today at various locations in the US and other countries to establish allowable levels of lead residues in soils for situations in which children could have contact with the soil. Lee and Jones-Lee (3) have reviewed the information on the concentrations of lead in soils that are considered by various regulatory agencies to be protective of children's health. They have also provided guidance on approaches that the public may wish to follow for managing lead-paint residues (4) and lead-contaminated soils (5). The Lead in Soil Task Force of the Society for Environmental Geochemistry and Health recently published recommended guidelines for lead in soils (6). A review of the literature on levels of lead in soil that are considered to be "safe" shows that various regulatory agencies have established soil-lead standards ranging from 50 to more than 1000 mgPb/kg soil (dry weight).

For the SP site, DHS/DTSC established a two-standard approach for soil-lead clean-up. In areas of the property to be used for industrial, commercial, or other purposes that would not involve children's contact with the soil, 950 mgPb/kg was allowed. In areas in which it is obvious that child contact could occur, the clean-up objective was set at 174 mg Pb/kg. The 950 mgPb/kg standard evolved from a delimiting level of 1,000 mgPb/kg for the classification of lead-containing materials as hazardous waste, developed by DHS some years ago. It was not based on any finding that concentrations above 950 mgPb/kg necessarily represented a threat to adults' public health. In developing the clean-up standards for the SP site, DHS concluded, based on a

risk assessment evaluation, that adults, such as construction workers in lead-contaminated soils, could be exposed to soil-lead concentrations as high as 3,400 mgPb/kg without adverse effects on their health.

The 174 mgPb/kg standard was developed from a health risk assessment model designed to keep children's blood-lead levels below 5 g/dL. With the modeling assumptions, however, it was accepted that there would be children who would not be protected by that standard. For example, in the establishment of the soil-lead standard, DHS made the decision not to try to protect the "pica" children who consume more that 0.1 g soil per day. Therefore the lead clean-up objective of 174 mg/kg for the parts of the SP site redeveloped for low-income housing could result in some children's being harmed by the residual lead left in the soil by SP. It is important to note, however, that urban soils and soils near major roadways throughout the US and in many other countries typically contain lead concentrations of 500 to 1,500 mg/kg due to the former use of lead as an additive in gasoline (3).

The somewhat arbitrary regulatory decision to not try to protect all children from harm from lead in soil is an example of a situation in which an initially established clean-up standard for a "superfund" site could be judged inadequate at some time in the future. This is especially true in light of the fact that a number of regulatory agencies in other areas of the US and in other countries have established child-"safe" soil-lead residue levels at 50 to 100 mg/kg. Weitzman *et al.* (7) recently questioned the appropriateness of cleaning up soil-lead residues to achieve these values where the purpose is the protection of children's health. In a study of the impact of removing lead from soil on children's blood-lead levels, they found that such removal did not, at least during the study period, significantly reduce the blood-lead levels of children. There were, however, a number of significant problems with that study that affect the reliability of the conclusions pertaining to the 50 to 100 mg/kg soil-lead standard, the most important of which is that the children studied were also exposed to a high-lead environment in their homes from lead-paint residues.

In developing its original soil-lead restrictions for the SP site, DHS allowed that areas of the property that were to be cleaned up to 174 mgPb/kg could be immediately adjacent to areas to be redeveloped for industrial/

commercial purposes (with a soil-lead clean-up objective of 950 mgPb/kg), without any physical barrier (fencing or other structures) between the two types of properties. DHS did require that the areas cleaned up to 950 mgPb/kg have two feet of low-lead soil placed atop the higher-lead-containing soil. It also required that a deed restriction notice be placed on the industrial/commercial property deed notifying owners of the property that they should not conduct any activities on the property, such as digging, construction, etc., that would result in the surface exposure of soil containing 950 mgPb/kg. DHS, however, made no provisions for protection of children and others from contact with excessive lead in soil due to its translocation from the soil through plant roots to the leaves, fruit or berries that may be eaten by children or wildlife.

As discussed by Lee and Jones (1)(2), significant questions were raised about the adequacy of the DHS two-standard approach for mixed-land-use redevelopment without significant isolation

of the industrial/commercial areas from other areas, and about the efficacy of the proposed deed restriction approach. The administration of deed restrictions is carried out by the city of Sacramento. There were significant questions about the City's ability to administer such deed restrictions in perpetuity to ensure that children would not be exposed to soils containing excessive lead through excavation or other activities that could bring high-lead soil to the surface at any time in the future, or owing to changes in land use at the site. As a result of the questions about the adequacy of the DHS/DTSC approach, the city of Sacramento decided to impose its own restrictions on redevelopment of the property in an effort to try to reduce its liability associated with its responsibilities to administer the deed restrictions and to approve redevelopment plans. The City's modifications of the DHS approach included an increase in depth of low-lead soil cover to 5 ft in many areas and the incorporation of a land buffer between residential areas where children live and industrial/commercial properties that have higher-lead soil a few feet below the surface. The required isolation of the industrial/commercial properties, however, did not include structural barriers such as fencing.

There are also significant questions about the ability to accommodate future revisions of standards or information pertaining to acceptable levels of soil-lead that will protect the health of children who may come in contact with the soils at the site. This problem is exacerbated by the two-standard approach for establishing the initial clean-up requirements at the SP site. At some time in the future regulatory agencies and/or the courts could readily decide that the clean-up standards and requirements initially established by DHS/DTSC, (or, for that matter, the approach that has been subsequently proposed by the city of Sacramento) were not adequate to protect public health and the environment. Such a determination, in turn, could require that additional remediation be provided at considerable expense to SP and/or future property owners. Further, as the entity responsible for implementation of the deed restrictions, the City could be determined to have significant liability for real or perceived impacts on children or others exposed to the excessive soil-lead, and be responsible for paying significant awards to those determined to have been harmed.

The soil-lead issue is particularly volatile in the US at this time. The problems of excessive exposure to lead-paint and soil-lead are primarily experienced by low-income, economically disadvantaged populations; substantial amounts of money will be needed to effectively address these issues. In light of the current and future economic constraints that the country, states, and cities face, it appears unlikely that funds will be made available in the foreseeable future to meaningfully address the problems of children's exposure to environmental lead. The fact that existing environmental lead contamination (e.g., along roadways in residential areas) is not being actively remediated to levels considered "safe" for children, should not give license for providing less than adequate remediation for "superfund" sites, such as the SP site, at which there is interest in establishing new residential and commercial areas where children could be exposed to elevated levels of soil-lead.

Another area of concern that is developing at the SP site as attempts are made to redevelop the property is the exposure of construction workers to elevated concentrations of potentially hazardous chemicals, such as lead. While DHS concluded that a soil-lead concentration of 3,400 mgPb/kg would not adversely affect adult public health and SP is cleaning up the soil to 950 mgPb/kg in order to stay under the arbitrary 1,000 mg/kg hazardous waste definition,

construction workers can be exposed to soil containing lead at concentrations above 3,400 mg/kg during site clean-up; future workers could be exposed to soils containing as much as 950 mgPb/kg. Should the acceptable allowed adult soil-lead exposure level be decreased, real and perceived impacts resulting from workers' exposure to the higher concentrations during construction activities could result in successful legal claims' being filed against the contractor, the City, and others for real or perceived injury to workers and others who had contact with the elevated concentrations of lead.

There are many questions about the advisability of trying to redevelop chemically contaminated sites for commercial and especially residential purposes that bring people into areas in which residual contaminants remain after site "remediation." It is evident that current soil clean-up objectives for lead as well as for many other contaminants, are not necessarily founded in good science and do not necessarily provide a high degree of protection of public health and the environment. Since many of the chemicals of concern, including lead, that are being left at remediated "superfund" sites will be a threat to public health and the environment forever, there are significant long-term liability issues associated with changes in the clean-up standards that could evolve from future investigative and regulatory activities. In addition to liabilities for the regulatory authority, such as a city, future property owners could readily find that changes in clean-up standards could require re-remediation of the property. While PRP's may enter into agreements that make them responsible for the costs of re-remediation should the standards change, there is no assurance that the PRP's will, in fact, be willing and/or able to meet such a financial responsibility in perpetuity. Public utilities, cities, and others that are perceived to have "deep pockets" need to be particularly careful about their involvement in redevelopment projects that could carry significant long-term liability for a city especially should changes occur in currently accepted "clean-up" standards.

At this time, so-called "clean closure" of a site, in which specific contaminants in the soils and water are reduced to pre-industrial activity concentrations, is said to relieve the PRP(s) and others of future liabilities associated with the site. However, such an approach is not necessarily technically valid or protective. The real public health and environmental hazard of contaminants at a site is not determined by the total concentrations of residual contaminants, but rather by the concentrations of and exposure to toxic/available forms of contaminants, measured and unmeasured. Many of the potentially hazardous chemicals that exist at "superfund" sites are in a variety of chemical forms, only some of which are toxic/available. At this time little consideration is being given in "superfund" site investigations and remediation to the toxic/available forms of contaminants. The concentrations of the available forms of toxic chemicals at a site will likely be significantly different after the industrial input of the chemical than it had been prior to that activity. Therefore, meeting pre-industrial activity "ambient" levels of a chemical in soil or water could be either over-protective or under-protective.

On-Site Landfills/Repositories

Some PRP's have proposed to use on-site repositories (landfills) accepted by the regulatory agencies for storage of hazardous chemicals. That approach can, at least initially, save the PRP(s) considerable money when the alternative is to excavate and haul the soils contaminated over the standard to a hazardous waste landfill or remove the contaminant(s) by soil treatment.

As part of its remediation of the "superfund" site in downtown Sacramento, SP is proposing to store high-lead soils on-site in the bed for the railroad tracks that will be incorporated into the redevelopment. The storage approach is basically landfilling of the contaminated soils; the soils with elevated lead levels would be diluted with other soils and covered with thin plastic sheeting. As discussed by Lee and Jones-Lee (8), landfilling, as it is typically practiced today with plastic sheeting and compacted soil liners and covers, represents a significant long-term threat to public health and the environment. The lead in the SP proposed railroad bed landfill will be a threat to public health and the environment forever. In order to ensure that conditions do not develop at some time in the future whereby the lead in that on-site landfill is brought to the surface and thereby released to the environment, a highly reliable maintenance and monitoring program for this site will have to be conducted in perpetuity.

Diependaal *et al.* (9) reviewed various on-site storage systems for contaminated soil and concluded,

"Thus it is argued that the current types of isolation techniques in use represent a potential 'time bomb'."

Such a conclusion is justified where inadequate attention has been given to measures to protect public health and environmental quality from the buried materials for as long as the contaminated materials in the storage system will be a threat, which for lead-contaminated soils, will be forever. Exacerbating this threat is the fact that the conventional groundwater monitoring approach, utilizing vertical wells for monitoring groundwater for evidence of pollution, is largely ineffective in protecting groundwater quality from adverse impacts from wastes buried in lined landfills (10).

There are some who assert that monitoring and maintenance of on-site repositories will need to be conducted for only the minimum 30-year period specified in the US EPA RCRA Subtitle C regulations. However, such a position reflects a lack of understanding of the real threat that the lead and many other contaminants buried in such systems represent to public health and the environment, and the capabilities of repository systems for providing perpetual containment. Lee and Jones-Lee (11) suggested that for those sites on which hazardous materials repositories are included, there be a requirement for a dedicated trust fund to ensure that funds will, in fact, be available forever for landfill (repository) monitoring, maintenance, and exhumation and proper disposition of the contaminated materials when the system proves incapable of containment. Without such a trust fund there will almost certainly be inadequate funds available when needed at some time in the future to ensure reliable public health and environmental protection.

ARSENIC AS A "SUPERFUND" SITE CONTAMINANT

Arsenic is becoming recognized as a potentially highly significant contaminant in soils and water, although with the soil and water standards for arsenic in force today, arsenic is rarely a key contaminant influencing site clean-up and redevelopment. It has been known for many years that arsenic is a human carcinogen. However, that property has not, in general, been incorporated into drinking water standards or soil clean-up objectives. In its development of water quality criteria for Priority Pollutants the early 1980's, the US EPA (12) concluded that arsenic in

drinking water in concentrations greater than 2.2 ng/L (nanograms per liter) represented a potential lifetime cancer risk of one additional cancer in one million people who drink 2 L of the water daily over a 70-year lifetime. The current US EPA drinking water standard (maximum contaminant level - MCL) for arsenic remains at 50 ug/L based on toxicity concerns. This means that the current drinking water standard for arsenic is about 25,000 times higher than the level to protect the public from an increased lifetime cancer risk above one in one million.

This finding is significant in that "superfund" site PRP's have been required to clean up chlorinated solvent-contaminated groundwaters to levels associated with cancer risks of one additional cancer in a million people for public health protection. However, as of yet, the US EPA water quality standard for arsenic does not in general incorporate the concern for the carcinogenic potential of this element. It is somewhat inconsistent for regulatory agencies to require PRP's to clean up groundwaters containing chlorinated solvents (which are known only to be "rodent carcinogens" (i.e., at high concentrations cause cancer in rats)) to meet standards based on a cancer risk of one in one million people, but ignore the known human carcinogenic potential of arsenic.

One of the reasons that arsenic receives special attention in its regulation compared with chlorinated solvents is that it is naturally present in many surface waters and groundwaters in concentrations of a few ug/L, i.e., a factor of 1000 above the concentration associated with the cancer risk of one in one million people used to regulate many potential carcinogens in drinking water and to establish "superfund" site clean-up objectives for groundwaters. This is another case where the public is routinely being exposed to excessive concentrations of contaminants in the environment outside of "superfund" sites, which are not now being adequately addressed by regulatory agencies.

While the new drinking water standards that will evolve from the US EPA's and the California DHS's current reviews of the public health threat of arsenic in drinking water are not known, there can be little doubt that the standards will be significantly below the current 50 ug/L value. This means that levels currently considered to be "safe" in drinking waters based on the out-of-date standard, will be considered "unsafe" when the new standards are adopted. Additional waters could require remediation.

Groundwater at the SP site contains concentrations of arsenic above the current drinking water standard of 50 ug/L. While the origin of arsenic that has led to these elevated concentrations is unknown, arsenic has been used as a pesticide and herbicide at many locations. Large amounts of herbicides are used on railroad rights-of-way to control weed growth; the arsenic at the SP site could have arisen from its use as a herbicide on the railyard track beds. As the arsenic standards are decreased in the future, there will surely be ramifications for the groundwater clean-up efforts associated with the SP site. A particularly significant aspect of this situation is that while the recognized elevated levels of VOC's in the groundwater at the SP site (which arose from improper handling of TCE in SP's degreasing operations) can be removed by air-stripping, the removal of arsenic from the groundwaters will require a much more expensive approach. As discussed below, this expense could readily significantly impact the economic viability of the proposed redevelopment project.

RELIABILITY OF CURRENT PUBLIC HEALTH AND ENVIRONMENTAL STANDARDS

The state of the lead and arsenic standards as applied to the SP site exemplifies the high degree of uncertainty about the reliability of the current standards for these and many of the other contaminants, that are used as clean-up objectives for "superfund" sites. It also exemplifies how existing standards are subject to future revision. Those familiar with how drinking water and environmental standards are developed and implemented know that there is often a significant lag time of five to ten years or more between the availability of information on the need to adjust a standard and the implementation of new standards into public policy at the local level by regulatory agencies. Certainly, as part of any "superfund" site investigation and remediation, consideration must be given to the reliability of the current standards based on assessments by those highly familiar with the topic area, rather than presuming that cleaning up to just meet existing standards will provide appropriate protection. If a standard is under review by the regulatory agencies at the state and federal levels, as is the case for the arsenic standard, and it is apparent that a more stringent standard will be adopted, it is inappropriate to plan "superfund" site remediation to just meet the existing standard. Similarly, planning agencies, city councils, and others should carefully consider the consequences of changes in standards that could readily occur as a result of current regulatory efforts.

There are some who argue that "superfund" site remediation should not have to meet standards different from those applied for to the same chemicals at other locations. However, it is well-known that many standards, especially those for drinking water, are set based on factors other than the protection of the health of those who consume the water. An example of this situation is the regulation of trihalomethanes (THM's) in drinking water. THM's are formed by the reaction of chlorine (used for disinfection of water supplies) and natural dissolved and particulate organic matter derived from the decay of terrestrial and aquatic vegetation. The organic matter interacts with chlorine to form principally a number of chloromethyl and chloroethyl species, such as chloroform. Chloroform has been known for many years to be a rodent carcinogen. In the early 1980's, the US EPA established an allowable level of total THM (TTHM) in drinking water of 100 ug/L. Assuming that all of the THM's is chloroform (the principal component of TTHM's), that concentration of TTHM's in drinking water would represent a cancer risk of about one additional cancer in 10,000 people who consume 2 L of the water daily for 70 years. That cancer risk is about two orders of magnitude greater than the one additional cancer in one million people risk level typically applied to "superfund" site clean-ups. For years, regulatory agencies have been allowing chloroform to be present in drinking water in concentrations that have the potential to cause one additional cancer in 10,000 people, yet requiring that chloroform in groundwaters contaminated by "superfund" sites be cleaned up to a level that the cancer risk is no greater than one additional cancer in one million people for waters that could at some time in the future be used for domestic water supply purposes. This is obviously highly inconsistent, but emphasizes the point that standards normally used for protection of public health and the environment may not be determined to be adequate for "superfund" site remediation.

ROLE OF LENDERS IN "SUPERFUND" SITE REDEVELOPMENT

The potential for clean-up objectives to change in the future and the mandatory five-year review of the adequacy of site clean-ups could significantly affect the ability to redevelop "superfund" properties for purposes other than industrial use similar to the previous use. Typical redevelopment projects require considerable capital that must be made available by lending institutions. Lenders are becoming increasingly justifiably wary of lending money for redevelopment projects that carry potentially significant liability for hazardous chemicals on the property. There is concern that the developer may not be able to complete the development and pay off the loan for the development because of financial obligations for additional remediation of the property brought about by the establishment of new, more protective site clean-up objectives or property use restrictions. For example, the Federal National Mortgage Association (FannieMae) has established an allowable soil-lead level of 100 mg/kg. It is not clear at this time that FannieMae would allow any of its funds to be used to cover loans made by banks on residential or commercial properties at the SP site since after remediation those properties could contain soil-lead levels as high as 174 mg/kg, well-above the FannieMae limit. Ultimately, financial interests of lenders may become a dominant factor, if not the dominant factor, controlling the redevelopment of "superfund" properties at which the PRP(s) proposes to leave significant amounts of potentially hazardous chemicals.

The potential liability associated with redeveloping the SP site has apparently already adversely affected redevelopment of that site. A major redeveloper of the site reportedly backed out of acquisition of part of the site property because of concern for adequacy of site remediation and the potential for long-term liability associated with the site. Such financial concerns can affect not only the redevelopment of the SP site, but also the sale of off-site properties that overlie the plume of contaminated groundwater from the SP site. A plume of groundwater containing elevated concentrations of TCE and vinyl chloride derived from the SP site underlies a substantial part of downtown Sacramento that contains major office buildings and other commercial establishments. It has been reported that the sale of one of the office buildings did not take place because the prospective purchaser perceived a potential liability associated with the groundwater plume.

An area of particular concern associated with redeveloping industrial "superfund" site properties for commercial and residential purposes is that the city may have to spend large amounts of money developing the infrastructure for the site (roads, water, sewer, etc.) before private developers will or can become involved in redeveloping the properties for commercial or residential use. When a proper assessment is not made of the willingness of developers, investors, bankers, and others to become involved in such a project, large amounts of public funds could be spent on the site infrastructure without the expected payback from the redeveloped properties. In the case of the SP site, it is acknowledged that the public funding for the redevelopment is tenuous and may not be adequate to achieve the desired redevelopment plan.

PROVIDING THE PUBLIC WITH RELIABLE INFORMATION ON SUPERFUND SITE REDEVELOPMENT

There is growing concern that the pro-redevelopment entities such as PRP's and city or county planning agencies are not providing adequate, reliable information on the significant factors that can influence the future redevelopment of a "superfund" site for commercial or residential purposes. In California, such projects require the development of a California Environmental Quality Act (CEQA) Environmental Impact Report (EIR) that is supposed to provide decision-makers and the public with reliable information on the potential impacts of the redevelopment project on public health and the environment. The CEQA guidelines state in part,

"An EIR should be prepared with a sufficient degree of analysis to provide decision makers with information which enables them to make a decision which intelligently takes account of environmental consequences. An evaluation of the environmental effects of proposed projects need not be exhaustive, but the sufficiency of an EIR is to be reviewed in the light of what is reasonably feasible. Disagreement among experts does not make an EIR inadequate, but the EIR should summarize the main points of disagreement among experts. The courts have looked not for perfection but for adequacy, completeness, and a good faith effort at full disclosure."

As it is being implemented, CEQA is not effective in eliciting full disclosure, especially on controversial hazardous chemical issues such as the redevelopment of the SP "superfund" site in downtown Sacramento. This arises from the fact that those who certify EIR's often directly or indirectly control the content of the EIR, especially as it relates to the near-term and especially long-term hazards of chemical contaminants present at a particular site.

An example of this type of situation occurred with the SP site redevelopment project. The city of Sacramento Planning and Development Department staff was responsible for the development of the EIR, including the selection of the contractor. The Department staff was strongly supportive of the redevelopment as proposed since it had worked closely with SP in formulating the redevelopment project. As discussed by Lee and Jones-Lee (13), the draft EIR, and final EIR that was presented to the Sacramento City Council for certification were significantly deficient in conforming to CEQA guidelines regarding providing full disclosure. This deficiency was particularly prominent in the EIR's discussion of potential problems that could arise from conforming to minimum or near-minimum regulatory standards in redeveloping the property for commercial and residential purposes. Repeatedly in the draft EIR and final EIR, it was boasted that the proposed project would meet current regulatory requirements with the implication that the project would therefore be protective of public health. Touting that current regulatory requirements would be met is hollow since the project would not be allowed to proceed if it did not meet current minimum regulatory requirements. What is of genuine concern in this respect, but was not addressed, is whether the current site clean-up objectives and their proposed implementation are adequate to protect public health and the environment. This issue was not addressed in the final EIR even though in comments on the draft EIR several requests were made for the final EIR to discuss the adequacy of current regulatory standards in providing for public health and environmental protection for as long as the residual chemicals that are being left at the site represent a threat. The authors of the EIR and those who controlled its content chose not to address these issues, but instead reiterated the statement that the project would meet current

regulatory requirements for managing potentially hazardous chemicals that would be left at the site by SP.

It is the authors' position that all environmental impact statements, environmental impact reports, and other documents that are designed to provide decision-makers and the public with reliable, full-disclosure information on the public health and environmental impact of a proposed project such as a redevelopment of a "superfund" site for commercial or residential purposes, be required to present a reliable discussion of plausible worst-case scenarios for the various factors that could influence the redevelopment of the property. Where the issues are associated with potentially hazardous chemicals, those responsible for the development and certification of the EIR should require that the plausible worst-case scenario discussion include consideration of changes in the regulatory standards that could occur at any time in the future. Further, for each plausible change in a standard, a discussion should be presented of how that change could affect the protection of public health and the environment provided by the site remediation approach. The EIR should also address the issue of the magnitude of funding that may be required for further remediation, and the source of that funding. In the case of the SP site redevelopment project, it has not been discussed who would provide the funds for additional remediation, in perpetuity, if it is determined at some time in the future that the current approach for protection of children from adverse impacts of lead in soil has not been adequate and a lower soil-lead standard is adopted for residential areas, or who stands liable for impacts on children who already received exposure to excessive lead concentrations left at the site after "remediation." Similarly, the EIR should also have discussed the potential consequences to the proposed project associated with a significant reduction in the arsenic standard that results in the need to remediate large amounts of groundwater in order to remove arsenic down to the new standard levels.

As noted above, groundwaters at the SP site contain arsenic at concentrations near, or in some cases above, the current 50 ug/L standard. It was somewhat surprising that in December 1993 the Sacramento Department of Planning and Development and City Council certified an Environmental Impact Report for the redevelopment of the Southern Pacific Railyard site that did not address the significant potential threat posed by arsenic in the groundwaters at the SP site when the levels of arsenic already exceed what is known to be a badly out-of-date drinking water standard. This deficiency was not addressed despite its being pointed out to them prior to the certification (13). Allowing that deficiency to remain inadequately addressed reflects the problems in eliciting full disclosure in EIR's to meet the requirements of CEQA when interested parties have significant control over EIR development and certification.

POTENTIAL SIGNIFICANCE OF UNREGULATED CHEMICALS

"Superfund" site investigations typically focus on a suite of about 200 chemical contaminants in water and soil. Since there are about 65,000 chemicals in commerce today, and about a thousand chemicals are being developed each year, there are potentially thousands of chemicals at a "superfund" site that are not assessed or regulated. Of particular concern is a wide variety of organic chemicals of anthropogenic origin, known to be present in "superfund" site soils and waters but not characterized beyond inclusion in the measurement of total organic carbon. Only a small fraction of the components of the organic carbon present in waters and soils is identified in a "superfund" site investigation.

The chemicals that comprise the difference between the total organic carbon content and the sum of those organic compounds specifically identified and quantified are typically referred to as a group as "non-conventional pollutants." Chemicals in that group can readily be highly hazardous, but they are not being regulated today as part of "superfund" site investigations/remediations. No one can be sure that there is not another "dioxin"-like chemical among the unregulated organics which could be highly hazardous to public health and/or the environment at very low concentrations (e.g., on the order of picograms per gram). Many of the chemicals of concern in waters and soils today were not known to be present in the environment at potentially hazardous concentrations a few years ago. As more studies are done on the characteristics of the unidentified organic matter in water and wastes, and their impacts on public health and the environment, "new" hazardous chemicals will be recognized to be present and found to be common constituents associated with certain types of industrial activities.

Even if there were no problems with the regulatory standards that are being used to establish site clean-up requirements, it will never be possible to reliably conclude that a site which contains a complex mixture of unidentified organics in water and/or soils is unquestionably safe for public and especially child contact. In an effort to address the problem with "unknown" or "unrecognized" pollutants, the US EPA and others have been developing biological response testing procedures which provide an opportunity to detect potential carcinogens, mutagens, and teratogens in water and soils. Tests like the Ames test for evaluation of the potential mutagenic properties of chemicals will, in time, become sufficiently well-developed, and most importantly, interpretable, so that they will be widely used to evaluate the potential hazards of residual chemicals, both regulated and unregulated, present in soils and water at "superfund" and other sites that have been previously remediated. Eventually, as appropriate biological response parameters are used, there will likely have to be a new round of clean-up of previously remediated "superfund" sites to address the potential hazards indicated by the biological response testing.

Similarly, the US EPA and others are beginning to develop wildlife criteria which are designed to protect animals from adverse impacts of chemicals. The principal concern is the bioaccumulation of chemicals in the food web to levels that threaten members of the top predator group. In the Great Lakes area, the US EPA has proposed wildlife-based criteria for some chemicals, such as mercury, that are several orders of magnitude below the current water quality criteria. While this effort is now principally focused in the US-Canadian Great Lakes area, in time it will spread throughout the US and will become part of the set of standards used at "superfund" sites to judge the adequacy of "clean-up." There can be little doubt that in the not-too-distant future, contaminant concentrations that are now considered acceptable in runoff water from "superfund" sites based on current water quality criteria/standards, will be judged adverse to wildlife in the vicinity of the site and downstream from it.

PROPOSED NEW SUPERFUND

The Clinton administration (14) has proposed a "new" superfund which it is claimed will,

"protect public health and the environment, more fairly allocate liability among responsible parties and provide equal protection for all communities affected by Superfund sites."

One of the key components of the proposed, revised superfund is consistency in "clean-up standards" and "generic remedies." According to the US EPA (14),

" To ensure consistent protection to all communities, national goals will be applied to all sites. Based on these national goals, national generic cleanup levels for specific hazardous substances will be developed and implemented to reflect reasonably anticipated land uses (based on community input) and certain site-specific variables. The establishment of national cleanup levels and generic remedies will also foster voluntary cleanups by reducing economic and legal uncertainties associated with cleanups."

While this approach may make superfund less costly and may reduce litigation, it may or may not provide adequate protection of public health and the environment. The key to providing adequate protection will be the specific approaches adopted by the Agency for developing the uniform clean-up standards, etc. From the authors' experience it is unlikely that the new "superfund" approach will necessarily lead to higher degrees of protection of public health and the environment.

As discussed by the US EPA, the current superfund extends liability to both past and future owners of contaminated sites. According to the US EPA, the new superfund would protect developers from liability associated with the site. The proposed new superfund would also provide legal protection for lenders for redevelopment of superfund site properties. It is questionable whether such an approach can in fact be implemented in light of the unreliability of any national site clean-up standards that the US EPA may adopt since even "clean closure" for a site will likely at some time in the future be judged inadequate for the protection of public health and the environment from the residual chemicals left at the site.

A basic issue that must be addressed is how the new "superfund" would handle a situation in which a site, such as the SP site, is cleaned up to meet certain minimum standards, yet 5, 10, 50 or 100 years from now the standards for protection of public health and the environment are significantly reduced to reflect new information. Who would pay for the additional clean-up needed? Can developers, purchasers, lenders, land-use regulatory agencies, or users of properties ever be totally exempted from liability? There are many questions about how the proposed new superfund will be implemented and whether it will be effective in resolving many of the problems with the existing approaches. There will likely be substantial litigation arising from the Administration's proposed new superfund approach.

CONCLUSIONS

Remediating "superfund" sites to just meet current minimum regulatory standards does not necessarily provide for a high degree of protection of public health and the environment. There are significant problems in the standards-setting process as well as in keeping standards up-to-date with new information on the hazards that chemicals represent to public health and the environment such that standards are often not protective enough and/or are badly out-of-date. As a result, great caution should be exercised in attempting to redevelop many industrial "superfund" sites for commercial and especially residential purposes when the minimum or near-minimum remediation possible is practiced by the PRP(s).

There can be little doubt that ultimately many sites that are presently being judged to have been adequately "remediated" will require additional remediation as part of the mandatory five-year review of sites and the *ad infinitum* monitoring required of "superfund" sites. This applies not only to those sites at which PRP's have left potentially hazardous chemicals in repositories (landfills), but also to those sites at which the PRP's have practiced "clean closure." It is essential that a funding mechanism, such as a sufficiently funded dedicated trust, be developed as part of "superfund" site "remediation" for perpetual monitoring, maintenance, and future remediation. This is especially important for those sites at which the ownership of the property is transferred to others.

ACKNOWLEDGEMENTS

The authors acknowledge Northern California Legal Services for its support of investigations that provided the basis for many of the comments presented in this paper. Of particular importance was the assistance of and comments made by Imm Ong, Esq. of that organization.

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