COST ESTIMATES OF REMEDIAL TECHNOLOGIES FOR THE HYDE PARK LANDFILL SITE

Report prepared by:

Robert N. Rickles, PhD, P.E.
Executive Director
Institute for Public
Transportation
211 E. 43rd Street
New York, N.Y. 10017
(212) 661-4370

on behalf of:

Ecumenical Task Force
Pollution Probe
Operation Clean-Niagara

Amici Curiae

INTRODUCTION

This report has been prepared at the request of the amici in order to establish the approximate costs of proposed and possible remedial technologies for the Hyde Park landfill site. The purpose of establishing these costs is to ascertain for the Court whether the maximum guarantee that may be sought from Occidental Petroleum Corporation is comparable to the actual anticipated costs of any or all remedial strategies under consideration by the parties. All the cost figures contained within this report are based on factual data and conditions at the site and hypothetical situations as they were presented to me by Grant Anderson, the hydrogeologist for amici.

In order to present an evaluation of the advantages and disadvantages of various remedial strategies for the site from an economic point of view, the first section of this report will review briefly the prescribed and optional strategies proposed for this site.

The second section will deal with cost estimates of four selected scenarios illustrating proposed and possible remedial technologies for the Hyde Park site.

I. AVAILABLE CONTROL AND DISPOSAL TECHNOLOGIES

In general, the types of remedial technologies that can be applied to hazardous landfill sites fall into two broad categories - a) those which leave the waste in the site ("in situ"), then treat contaminated groundwater and/or control the effects; and b) those which remove the wastes, and then store them in a more secure environment or destroy them.

A. IN SITU TREATMENT AND CONTROL

"In situ" treatment and control is the basic approach being proposed in the settlement agreement. In this case, this approach is composed of the following specific elements:

- capping the landfill and perimeter areas (Stipulation and Judgement Approving Settlement Agreement, Addendum I-I);
- installation of a tile drain system to remove chemicals migrating through the overburden (Addendum I-21);
- installation of a barrier-collection system of purge wells to collect contaminated groundwater (Addendum I-22); and
- uses of activated carbon and other wastewater treatment to remove the organics and metals from the wastewater (Addendum I-25).

In addition, Hooker Chemical Company under the conditions of the settlement is required to examine additional control technologies (Requisite Remedial Technologies) such as:

- installation of a grout curtain wall down to the top of the Rochester Shale Formation (Addendum I-17);
- grouting through controlled fractures to contain non-aqueous phase liquids in the bedrock (Addendum I-17);
- extending the depth of the purge wells to the top of the Rochester Shale Formation (Addendum I-18);

(1) CAPPING

Capping involves the installation of clay with a low permeability and/or synthetic material over the landfill and along the perimeter. The cap is intended to reduce the amount of water entering the landfill and eroding the surface. This would slow down the leaching of toxic materials from the landfill into various water bodies such as the Niagara River. The proposed Settlement Agreement in addressing perimeter capping appears to be based on a belief that capping the surface of this landfill site will prevent organic chemicals from being eroded from the surface.

While the clay cap will reduce the amount of rainfall penetrating the site and therefore the amount of contaminated groundwater, it will not eliminate it. Rainwater will continue to reach the subsurface, either directly or after falling on other sites and moving onto the Hyde Park site at or below the surface.

However, based on experience, Hooker's consultants' projection of limiting water infiltration to 2" (see p.13 Evaluation of Remedial Work Hyde Park Bloody Run, February 7, 1980, Conestoga-Rovers) a year is very optimistic because:

1. the cap is subject to cracking and rupture by many kinds of natural phenomena, e.g. freezing and thawing;

2. clay caps tend to lose their barrier character because of gradual hydrolysis of the clay; and

3. differential settlement of the landfill and resultant cracking of the cap.

It is important to note that capping does not reduce the amount of chemicals that will ultimately leach into the site. It merely reduces the amount of water available for leaching. Therefore, capping simply extends the time that other controls such as purge wells must be operated. Thus, capping has only a limited capacity for containing the hazard.

(2) THE TILE DRAIN SYSTEM

The tile drain system is a means of collecting organics and contaminated groundwater which, in the case of Hyde Park, drains from the upper ten (10) feet of the landfill. On the assumption that the tile drain system was expanded as stipulated in the proposed Settlement Agreement, there seems to be no reason to believe that it will not perform its predetermined function.

On the other hand, it is important to recognize that its contribution to overall site control is limited, since most of the contaminated groundwater will be below this level.

(3) PURGE WELLS

Purge wells are simply a series of wells designed to intercept an underground flow in a manner similar to a water well. The contaminated groundwater is then removed to the surface in order to prevent it from moving beyond the well line.

The major questions with regard to purge wells are:

- Are they sufficiently close to each other to intercept the entire flow?
- Are they deep enough?
- Are there adequate treatment facilities available? (This question will be discussed below in the subsection on activated carbon.)
- Are all the water-bearing formations hydraulically connected to the line of wells to intercept the contaminants?

It is critical in the case of Hyde Park, considering the fractured nature of the Lockport Dolomite Formation and the Rochester Shale Formation that:

- the wells be extended through the Rochester Shale Formation in order to make certain that no contaminated water flows under the wells;
- the wells completely surround the site, in light of the Report of Grant Anderson about the direction of subsurface water flow;
- a line of monitoring wells be installed outside the line of purge wells to ensure that all of the contaminated water is being captured by the purge wells. If the monitoring wells indicate bypassing of contaminated water, then additions to the purge well line must be undertaken. In addition, as a further precaution, any springs at the Gorge should be monitored at the same frequency as the monitoring wells.

Given Mr. Anderson's submissions regarding the fractured condition of the Lockport dolomite, it would appear that the purge well system will <u>not</u> effectively prevent the escape of contaminated groundwater from the site.

(4) CONTAMINATED GROUNDWATER

Contaminated groundwater treatment, in the case of Hyde Park, is proposed to be carried out by an <u>activated carbon</u> system or a "performance equivalent" system.

It is assumed that an activated carbon system means pretreatment to remove solids (which would plug the carbon bed) and heavy metals (which would violate the EPA discharge standards), followed by an activated carbon system to remove biologically resistant organic compounds, and ending with biological treatment to remove organics which can be "eaten" by aerobic biological organisms.

An activated carbon system is a bed of carbon granules which have been "activated" (a large adsorbing surface area created by pretreatment, usually by steam and/or air). This large surface area can adsorb and hold organics, particularly those which are hydrophobic (i.e. relatively insoluble in water). The amount of organic material that the carbon will hold depends upon the nature of each organic and its concentration in the water phase. When the carbon is fully loaded with respect to a particular organic, that organic will remain in the water phase and pass out of the system with the water. Thus, careful monitoring of the water phase <u>in the carbon bed</u> must be performed for <u>all</u> hazardous organics to avoid breakthrough and escape of these organics.

When the bed is exhausted, it must be replaced with fresh carbon. The spent carbon (or media) can be regenerated, usually with steam and/or air, but it is important to note that:

- complete restoration of efficiency is usually not possible;
- the adsorbed organics will be collected in a water solution and will have to be stored or incinerated.

Because of the highly toxic nature of these chemicals, a more cautious alternative to regeneration is to store the carbon in a secure chemical landfill. The spent carbon could also be incinerated without regeneration, provided that the incinerator chosen could meet EPA standards while burning this material.

The proposed settlement agreement indicates that an alternative system with removal efficiencies equal to an activated carbon system may be employed. In my judgement, such a system does not exist within the realm of proven technology.

(5) <u>TREATMENT OF RESIDUE MATERIAL</u>

Treatment of residue material in the proposed settlement agreement would be by incineration, disposal (storage), or the performance equivalent. In my judgement, the only two viable alternatives for the residue materials would be incineration and secure chemical landfill. There are now both federal and state standards for both, and any proposal would have to meet these rigorous standards.

Incineration would be used with high strength organic wastes where evidence exists that all of the toxic materials would be destroyed (consistent with EPA standards) in the particular incinerator chosen. It should be noted that EPA in a letter (Walsh to McDonald, June 18, 1981) to the Environmental Protection Service (Ontario Region) casts doubt on the ability of the Hooker incinerator to meet those standards.

The advantage of proper incineration is that it produces final destruction of the organics, thereby removing long term care and cost concerns.

Secure chemical landfill will not destroy the organics but it will handle a mixture of organics, inorganics, water, solids, slurries, etc. in a manner which will keep them, if properly operated and monitored, out of the environment in perpetuity.

(6) OTHER PROPOSED CONTAINMENT PROCEDURES

The proposed Settlement Agreement Addendum I-17-18 speaks of four Requisite Remedial Technologies which should be examined by Hooker. One of these (a system designed to remove non-aqueous phase liquids directly from the landfill) is so non-specific that nothing further can be said about it. Considering the fact that such materials are now well dispersed throughout the landfill and into the bedrock, such technology would appear to be non-existent.

The second of these (deeper purge wells) has been discussed above. The other two (grout curtain wall and grouting through controlled fractures of the bedrock) are similar in purpose, and are both used in the petroleum extraction industry as temporary measures to control subsurface flow. Neither are applicable for long term retention of the chemicals placed in Hyde Park because of their strong solvent structure. As evidence of this, the report of Camp, Dresser and McKee for the New York State Environmental Facilities Corporation and New York State Hazardous Waste Disposal Advisory Committee (March, 1980), on page VII-10, provides a chart of various stabilization/solidification processes. In that chart they list cement-based and lime-based fixation systems as being unsuitable for organic wastes. These materials are similar in chemical nature to grouting material.

B. OFF-SITE REMOVAL AND DISPOSAL

If the contaminated material was to be removed from the site, it would either be stored in a secure chemical landfill, incinerated, or some combination of the two.

There has been some experience with the safe removal of hazardous materials. The evidence is that removal can be carried out successfully without endangering the health of the workers or residents. There are several organizations which possess the requisite experience to carry out such a task in an environmentally safe fashion.

During my administration as Commissioner of Air Research for New York City, we were faced with the problem of protecting workers and residents from dangers produced during the demolition of buildings containing large amounts of asbestos, a highly carcinogenic material. Regulations involving wearing of inhalators, clothing disposal, enclosure, and wetting down the site eliminated the problems when enforced. In my opinion, a similar approach would permit the removal of hazardous waste materials from Hyde Park.

Once the material is removed, there would be two alternative techniques available. The first approach would be to incinerate all, or at least part, of the removed material. That portion which would be highly organic in nature could be incinerated in a well-designed incinerator which would meet EPA destruction standards, and which could handle collection of the associated inert particulate matter by removal from the exhaust gas stream by some particulate control system such as fabric filters. The alternative would be burial in Secure Chemical Landfills (SCL). SCL's are clay and plastic sheet lined vaults especially designed to limit water entry from top, side, and bottom and leachate exit as well. Any leachate which is formed is continuously removed and sent to a wastewater treatment system similar to that previously discussed. Vents remove gases that may form, and these, if present, can be treated by a variety of air pollution control systems.

II. ESTIMATED COSTS

In this section we will estimate the present costs (in 1981 dollars) of four alternative scenarios as potential solutions to the Hyde Park problem. The first scenario provides an estimate of the costs of the specific elements being proposed in the settlement agreement. (See Addendum 21-22) This scenario does not include the cost of any requisite remedial technology that may be employed at the site. The other three scenarios were provided to me by Grant Anderson for costing and evaluation and represent possible remedial strategies that could be applied to the Hyde Park Landfill site.

The second scenario consists of purge wells placed around the perimeter of the site and down through the Rochester Shale Formation. The third scenario provides for removal of contaminated materials, placement in a secure chemical landfill and a supplementary short term purge well system. The fourth scenario provides for excavation of the site and incineration, with a supplementary short term purge well system.

These cost estimates take into account only the most costly components of the possible remedial technologies. They do not include, for example, costs of obtaining permits, or health and safety cost considerations.

It is important to recognize that all four solutions are not equivalent in safeguarding the environment from damage.

A. Scenario Elements

The elements of each scenario are the specific components of remedial strategies either found in the proposed settlement agreement or given to me by Grant Anderson, the hydrogeologist.

The features and assumptions common to all scenarios are as follows:

- All costs calculated to present worth in 1981 dollars.
- Previous years brought to 1981 using 8.0%/year increase in construction costs (Engineering News - Record Construction Index Average yearly increase - 1977-1980).
- Assume Bloody Run capping and drainage dredging at $1,000,000 (1978 cost). (Sources: Fred C. Hart Report to Mead Corporation and Information Dossier 78.13 NYSDEC)
- Real money cost (Interest minus Inflation) - 3%/year (Source: historic data, Bureau of Labour Statistics)
- Number of monitoring wells is 50% of purge wells at the same depth
- Well replacement every five years at 50% of original cost.

(1) Scenario 1

1. Tile drainage, Bloody Run capping and drainage dredging
2. 11 wells - 45' deep pumping (15' below top of Lockport bedrock zone) (See Addendum I-22)

   13,000 gpd (Source: Evaluation of Remedial Work Hyde Park Bloody Run - February 11, 1980, Conestoga-Rovers, p.4)
3. Activated carbon treatment.

(2) Scenario 2

1. 30 purge wells - 90' covering north, south and west side of site
2. 30 purge wells down 175' through the Rochester Shale Formation on same sides
3. 150,000 gpd in perpetuity
4. Activated carbon treatment
5. Tile drainage

(3) Scenario 3

1. Excavate 500,000 cubic yards. Assuming a density of 75 lbs./cubic foot, this amounts to 505,000 tons.
2. Remove to a secure landfill
3. Construct purge wells as in 2 but pump for a considerably shorter period of time because the major source of contamination removed.

(4) Scenario 4

Same as scenario 3 except all excavated material is incinerated in two-step incineration process. (Multiple Hearth followed by ultra-high temperature gas phase incineration to destroy all organics.)

B. Scenario Costs

For each scenario, capital construction costs are itemized, followed by annual operating costs as well as the estimated 5 year costs of well reworking. A summary of these costs is provided for each scenario. A final summary of the relative costs of the four scenarios is set out in Table I below.

1. Scenario 1

a) Capital Construction Costs

i) Bloody Run capping and drainage dredging — $1,260,000

ii) Tile drainage system (costing source: Manual for Remedial Actions at Waste Disposal Sites - Draft Final Report - JRB Associates, McLean Virginia - EPA Contract 68-01-4839, Dw #15 June 20, 1980, Table 4.11) - Length 3300 ft. excluding west side - 15 ft. deep by 3 ft. wide

Trench - 5500 cubic yards x $1/cubic yard

Spread excavated - 5500 cubic yards x $0.66/cubic yard

Well point dewatering - 3300 linear ft. at $75/linear ft.

Sheet piling - 49,500 sq. ft. at $5.70/sq. ft.

Waler - 33 tons at $105/ton

Limestone - 5500 cubic yards at $11/cubic yard

Total cost - $603,000 (1980$)

1981 cost - — $ 650,000

iii) Wells - 11 purge wells (Costing source: Manual for Remedial Actions Table 4.16, 4.14)

	Wells - $2/inch diameter per ft.		
	6" -	$5940	
	Casing - 8" PVC	5198	
	Pumps	12925	
	Total (1980)	$24063	
	Total (1981)		$ 26,000
iv)	Monitoring wells (6) (4" diameter)		$ 7,000
v)	Piping ($3/linear ft. 1.5 miles)		$ 24,000
		TOTAL	$1,967,000

b) Annual Operating Costs

i)	Wastewater Treatment ($0.18/gal. Costing source: Manual for Remedial Actions, Table 5.7)	$ 854,000
ii)	Utilities, monitoring and sampling (RNR estimate - 2¢/kilowatt hr.)	$ 50,000*
	TOTAL	$ 904,000

* These costs do not include exotic sampling or any of the major studies proposed in the Stipulation.

c) Five year Costs

i)	Well Reworking at 50% of original cost of purge wells	$ 13,000

d) Summary

Estimated Capital Construction Costs	$1,967,000
Estimated Annual Operating Costs	$ 904,000
Estimated Five year Costs	$ 13,000

2. Scenario 2

a) Capital Construction Costs

i)	Bloody Run Capping and drainage dredging	$1,260,000
ii)	Tile drainage system	$ 650,000
iii)	Purge wells - 90' deep	$ 142,000
	175' deep	$ 276,000
iv)	Monitoring wells - 90' deep	$ 38,000
	175' deep	$ 74,000

v)	Piping (2.5 miles)	$ 40,000
	TOTAL	$ 2,480,000

b) Annual Operating Costs

i)	Wastewater Treatment	$ 9,850,000
ii)	Utilities, Monitoring, Sampling	$ 220,000
	TOTAL	$10,070,000

c) Five year Costs

i)	Well reworking	$ 209,000

d) Summary

Estimated Capital Construction Costs	$ 2,480,000
Estimated Annual Operating Costs	$10,070,000
Estimated 5 year Costs	$ 209,000

3. Scenario 3

a) Capital Construction Costs

i)	Bloody Run capping and drainage dredging, no cap on landfill, (cap and grading cost - $400,000)	$ 860,000
ii)	Excavation of 500,000 cubic yards (Costing Source: Manual of Remedial Actions) at $2.00/cubic yard	$ 1,000,000
iii)	Transportation ($0.15/ton mile x 50 miles x 505,000 tons)	$ 3,792,000
iv)	Secure Chemical Landfill at $140/ton	$72,000,000
v)	Site Rehabilitation fill at $6/cubic yard	$ 3,000,000
vi)	Grading and compacting at $4/cubic yard	$ 1,940,000
vii)	Vegetation at $2000/acre	$ 30,000
viii)	Wells (see #2)	$ 539,000
ix)	Piping	$ 40,000

b) Annual Operating Costs

i)	Wastewater Treatment	$ 9,850,000

ii) Utilities, Monitoring, Sampling $ 220,000

TOTAL $10,070,000

c) Five year Costs

i) Well reworking $ 209,000

d) Summary

Estimated Construction Costs $83,200,000

Estimated Annual Operating Costs $10,070,000

Estimated 5 year costs $ 209,000

4. Scenario 4

a) Cost items i, ii, iii, v, vi, vii, viii, ix same as Scenario 3 above.

- Capital Construction Cost items

- All Annual Operating Cost items

- All 5 year costs

Change iv to Incineration at $90/ton = (Source: Camp, Dresser and McKee Report to NYS - 1980, pg. VII-11) $45,450,000

Summary

Capital Cost $56,700,100

Annual Cost $10,070,000

5 Year Cost $ 209,000

5. Summary of Costs

In this section we will summarize the costs for 10, 20, 35, 50 and 100 years for the four scenarios. Table 1 summarizes this data.

TABLE 1 - SUMMARY OF COSTS ($$10^6$)

Scenario	Capital Costs	Annual Costs	5 year Costs	10 years	20 years	35 years	50 years	100*** years
1.	1.967	0.940	0.013	---*	15.8 **	22.0 **	25.8	31.6
2.	2.480	10.070	0.209	---*	155.6 **	224.4 **	264.9	324.7
3.	83.2	10.070	0.209	171.7	234.2	---*	---*	---*
4.	56.7	10.070	0.209	144.3	208.2	---*	---*	---*

Table 1 continued

* Not Applicable
** Feasibility not likely due to continued environmental effects.
*** Given the toxicity of the chemicals buried in the Hyde Park Landfill site and the hydrogeology as outlined by Grant Anderson, it appears that the in situ technologies would include monitoring, pumping, and treatment of contaminated groundwater for thousands of years. However, 100 years was chosen as a means of graphically illustrating what the costs could be for the relevant scenarios for a finite period of time (i.e. one century).

III. CONCLUSIONS

A. Available Control and Disposal Technologies

1. Capping the landfill will not limit rainfall intrusion and groundwater flows to the extent indicated by New York State and U.S. EPA. It will tend to extend the length of time that contaminated groundwater will have to be monitored, collected and treated.

2. The Tile Drain System will be of limited value in collecting contaminated groundwater.

3. Purge wells must be spaced close enough and be deep enough to intercept the groundwater flow. Wells at Hyde Park must be placed through the Rochester Shale in order to capture all of the contaminated flow. The purge well line (if this approach is used) should be extended around the perimeter on the north, west and south sides.

4. The only known practical technique for treating contaminated groundwater of the type found at Hyde Park is activated carbon with associated treatment for solids, heavy metals and biologically degradable organics. Careful monitoring for toxic organics in the bed is critical to prevent discharge of such materials. Regeneration of such beds is not likely to be effective and the exhausted beds will likely have to be incinerated or placed in Secure Chemical Landfill.

5. The residue material must be either stored in a Secure Chemical Landfill or incinerated in a properly designed incinerator.

6. Grout curtains and controlled fracture grouting are petroleum extraction techniques that do not appear applicable because these organics are likely to corrode the grout and pass through the grout.

7. Four scenarios were selected for cost evaluation. They were:

   a. Specific elements in proposed Settlement Agreement

   b. Wells around perimeter and down through the Rochester Shale Formation.

c. Removal of contaminated material, secure chemical landfill, and short term deep purge wells

d. Removal of contaminated material, incineration and short term deep purge wells.

8. All scenarios indicated current costs far in excess of the $10,000,000 maximum guarantee that may be sought from Occidental Petroleum.

9. Excavation and reburial or incineration (Scenarios 3 and 4) are cost competitive with the costs of installing deep purge wells as set forth in Scenario 2. However, excavation and reburial or incineration provide a greater degree of protection to the environment than any other scenario.

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Robert N. Rickles, Ph.D., P.E.