Kates, R. W., and B. Braine, 1983. "Locus, Equity, and the West Valley Nuclear Wastes", Roger E. Kasperson, ed., Equity Issues in Radioactive Waste Management, Oelgeschlager, Gunn and Hain, pp. 94-117.

Chapter 4

Locus, Equity, and the West Valley Nuclear Wastes

Robert W. Kates and Bonnie Braine***

The first commercially produced high-level nuclear wastes in the United States are stored in two tanks at the Western New York Nuclear Service Center in West Valley, New York. Some years hence, perhaps in ten years, these wastes will be removed to the first or second permanent high-level nuclear waste repository. That repository will be in a rural area, one perhaps not unlike West Valley. Much will have been learned by then about waste processing and storage. Nonetheless, the distribution pattern of benefits and risks will not have been changed substantially from that which prevails at West Valley.

The benefits and risks, even in a small community and for a limited facility, are many and complex and surely are distributed unequally. This case study attempts to unravel that complexity, to identify the benefits and risks, to place them where they accrue, and to consider the equity of the distribution—the fairness of it all. The plant at West Valley, now shut down for almost a decade, still can serve as a guide to the equity issues of a future first-of-a kind facility.

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WESTERN NEW YORK NUCLEAR SERVICE CENTER

The Western New York Nuclear Service Center was planned at a time when the prospects for nuclear energy seemed bright and the commercial reprocessing of spent fuel was a logical step in the nuclear fuel cycle. In 1961, New York State, seeking to establish preeminence in the field, purchased 3,345 acres of farmland in Cattaraugus County (Ashford Town) as a site for nuclear fuel reprocessing and radioactive waste storage (see Figure 4.1). State officials enthusiastically projected increased employment–up to 2,000 jobs–and industrial growth in the rural and economically underdeveloped area. Local newspapers, impressed with the prospects, hailed the development as the means for transforming the region into the "Detroit of the Atomic Age" (*Buffalo Courier Express:* 1962).

In 1963, Nuclear Fuel Services, Inc. (NFS), then a subsidiary of W. R. Grace Company and later Getty Oil Company, leased the site from the state and, with additional state and utility funding of $10 million, contracted to construct and operate a reprocessing and waste storage facility. This facility, a major component in what popularly is known as the "back end of the nuclear fuel cycle," was to receive spent-fuel rods from reactors. These would contain plutonium, uranium, and radioactive fission products in varying amounts. The rods, which were to be handled remotely and shielded by ten to twelve feet of water in storage, would be processed in the plant and, after chemical treatment, would result in three types of product:

1. separated uranium, to be recycled in uranium enrichment facilities and eventually made into new fuel for current reactors;
2. separated plutonium, to be recycled as fuel for future plutonium-burning reactors, such as the breeder; and
3. radioactive wastes, including fission products and transuranics, to be stored and prevented from contaminating the environment for a period of 1,000 to 1 million years.

Of these three products, only the uranium poses little hazard. The plutonium is highly toxic and, if illegally diverted, can be manufactured into nuclear weapons. The wastes involve a staggering amount of radioactivity: one reactor operating for one year produces 500 to 1,000 times the amount of radioactivity released at Hiroshima.

NFS plans called for burial of "low-level" solid wastes on-site; the highly toxic "high-level" liquid wastes were to be stored in tanks which would be replaced every forty years. Although no specific plans were drawn up for the permanent disposition of the wastes, a $4.4 million

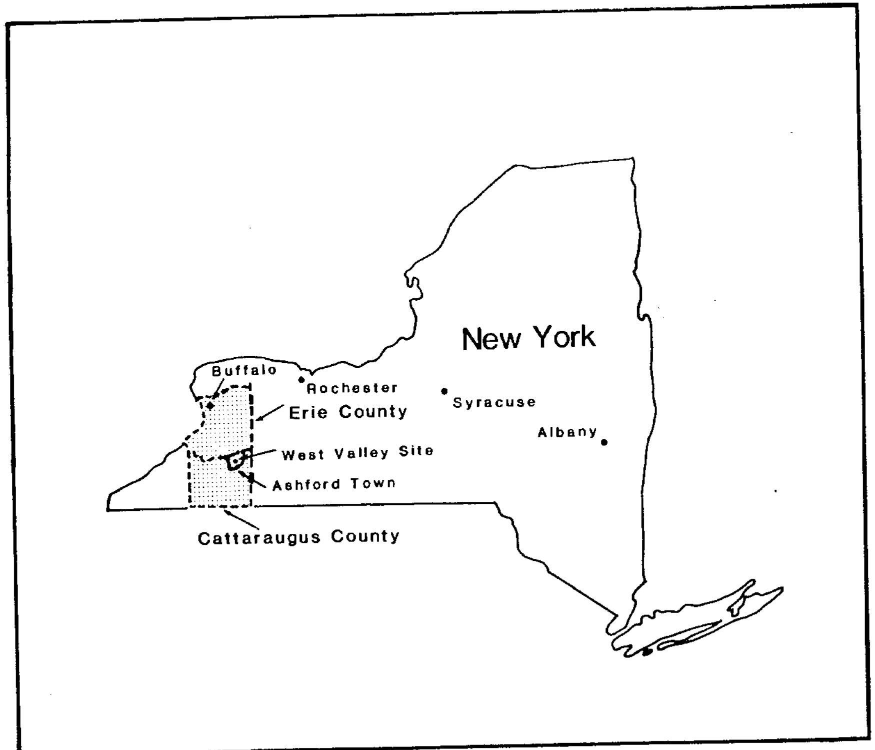

Figure 4.1. Location of West Valley site and surrounding political jurisdictions.

fund (paid for by customers of reprocessing services) was established to finance a program of "perpetual care." Tank storage of such long-lived radioactive materials (which pose a hazard for at least 1,000 years) was clearly a "temporizing" measure. It was assumed that future technical developments would solve the long-term storage problem (Lester and Rose: 1977). The Atomic Energy Commission (AEC) maintained that the private processor, not the federal government, should be responsible for the long-term care of the wastes, but NFS was reluctant to assume such an awesome managerial burden. Faced with a totally uneconomic venture if it accepted such responsibility, NFS exerted sufficient pressure to have the state take over the title to the wastes when the lease expired in 1980 (New York State Atomic Research and Development Authority and Nuclear Fuel Services: 1963).

Between 1966 and 1971, the Nuclear Fuel Services plant reprocessed only 640 metric tons of reactor fuel. At that time, commercial nuclear power was in its infancy and produced only a small quantity of fuel requiring reprocessing; 60 percent of NFS-reprocessed fuel came from the government's "N" reactor which produces plutonium for weapons fabrication. By 1972, when the company shut down the plant for modifications and enlargement, government regulations for nuclear fuel reprocessing had changed dramatically. Standards for the release of radioactivity from nuclear facilities and for the exposure of personnel were stricter. A new Atomic Energy Commission policy required all high-level liquid wastes to be solidified within five years after reprocessing and shipped to a federal repository (Code of Federal Regulations, 10: 1970). Although an exception had been made for the high-level liquid waste already in storage at the NFS facility, any future production would have to be solidified in conformity with the federal rule. Unable to meet the more stringent regulatory and safety standards, NFS announced in 1976 that it was abandoning the reprocessing business.

The site, as depicted in Figure 4.2, presently holds the radioactive heritage of the abortive reprocessing and waste storage venture (see Table 4.1). Neutralized high-level liquid wastes (2.1 million liters) from the reprocessing of the unrecovered fission products are contained in a carbon steel tank that will eventually corrode and leak. The tanks, although currently showing little sign of corrosion, were planned for a forty-year replacement, but they cannot easily be replaced because of their poor design and the condition of the wastes they contain. One hundred and sixty-five metric tons of spent fuel remain stored on-site, awaiting future federal decisions on ultimate spent-fuel disposition. (Since reprocessing has been deferred indefinitely, spent fuel has been piling up at reactor sites all over the nation.) Solid waste contaminated with high-level transuranic elements lies buried in holes fifty feet deep.

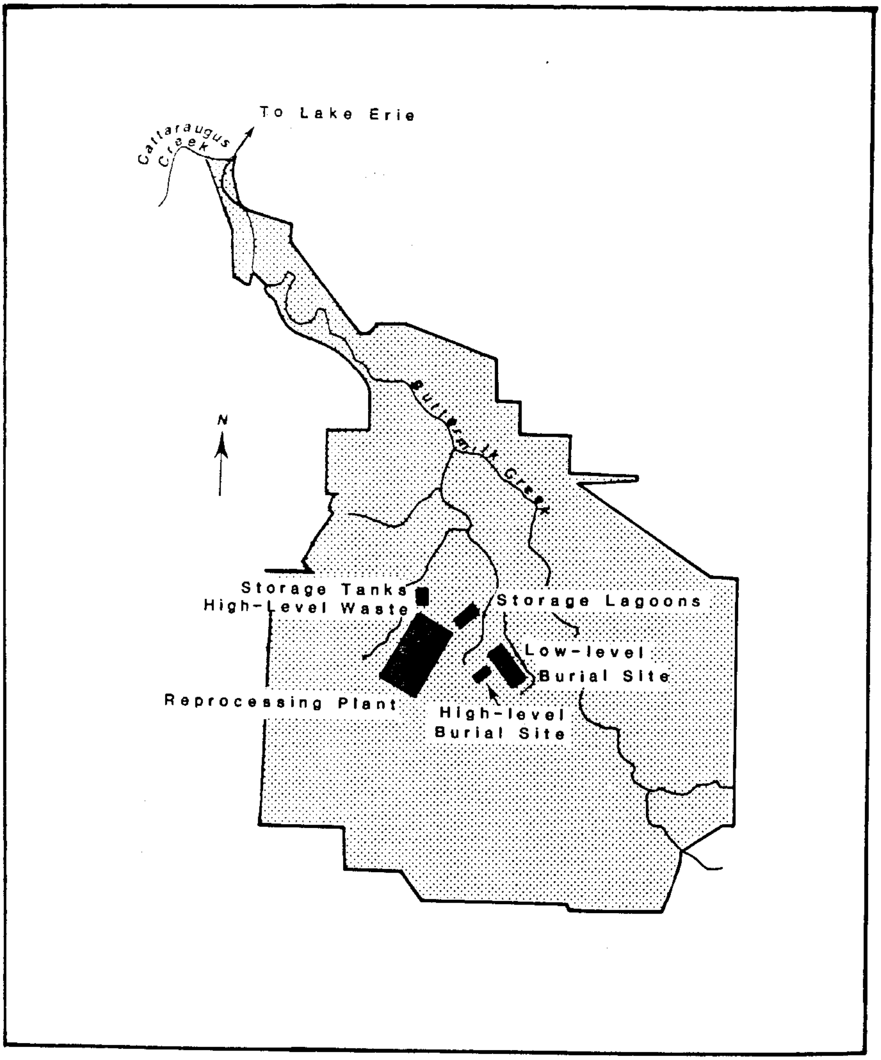

Figure 4.2. West Valley, site of Western New York Nuclear Service Center.

Table 4.1. Western New York Nuclear Service Center: Waste Inventories

Waste type and present storage	Volume	Curies (1978)[a]
High-level liquid wastes (hllw)		
produced in reprocessing 640 MT of spent fuel		
neutralized hllw in one carbon steel tank	2.1 million liters	39,000,000
acidic hllw (from thorium based fuel) in one stainless steel tank	45,000 liters	2,400,000
Spent fuel		
756 spent fuel assemblies in storage pool	165 metric tons	82,500,000[b]
High-level solid wastes		
spent fuel hulls and cladding from reprocessing operations (also 42 ruptured fuel elements that could not be reprocessed)	3,900 m^3	550,000
encased in concrete		
burial in holes fifty feet deep		
Low-level solid wastes		
radioactive trash shipped from hospitals, industrial researchers, utilities, nuclear materials manufacturers, and federal government		
radioactive trash from reprocessing operations (generated on-site)	68,000 m^3	710,000
buried in trenches 20 feet deep		

[a]Radioactivity in Waste inventories are estimated for 1978, and unless otherwise noted are taken from U.S. Department of Energy: 1978b, Table 3.21, 3-62.
[b]Assumes approximately 5-8 year cooling period after receipt from reactor ($.50 \times 10^6$ Ci/MT) estimated, from U.S. Nuclear Regulatory Commission: 1978, G-11.

Lightly contaminated radioactive trash from many sources is buried in a low-level waste burial ground which was closed in 1975. Remedial action is necessary to correct the off-site migration of tritium, and possible future erosion – problems already encountered at similar burial sites in the eastern United States. The reprocessing building, closed and guarded, contains an estimated additional 12,000 curies of radioactive material and has yet to be decontaminated and decommissioned.

In a 1978 study, estimates of the cost of waste management and disposal ranged from $41 million to over $1 billion (U.S. Department of Energy: 1978a) depending on the options chosen for management and storage. Reviewing that study, the U.S. General Accounting Office (1980) concluded that $180 million was a more probable figure, based on the options likely to be chosen. This relatively modest estimate has already been surpassed. In the current draft environmental impact statement (U.S. Department of Energy: 1981), just the management of the high-level liquid wastes (removal from tanks, solidification, transport and burial in a repository) is estimated to cost between $500-700 million and will take at least 20 years of effort. A staggering price of $238-$333 a liter for waste from a product whose value is a twentieth of this cost!

Faced with such estimates, it is not surprising that responsibility–legal, technical and financial–for the wastes has been in sharp dispute among three parties: Nuclear Fuel Services, New York State, and the Federal government through the Department of Energy. Contractually, NFS had control and responsibility until the end of its lease in 1980, then the responsibility was to pass to New York State, although some issues relating to the condition of the waste and waste facilities were uncertain. The federal government, in this narrow legal sense, had responsibility only through its Nuclear Regulatory Commission to license and oversee the facility. Nonetheless, an apparently effective case has been made by New York State, which maintains that:

1. the plant processed mainly government reactor fuel,
2. all other high-level waste is the responsibility of the federal government,
3. new federal regulations required solidification of waste and also led to a shut-down of the plant,
4. the state of New York lacks expertise and resources to cope with high-level waste, and
5. precedents exist for favorable cost-sharing between states and the federal government for projects with substantial federal benefit or responsibility.

It was further argued that solidification of the high-level wastes would provide a demonstration of vitrification technology which would be of great value to the developing waste management program (U.S. Congress: 1980). Emphasizing the demonstration role as well as the needed remedial action, the West Valley Demonstration Project Act (P.L. 96-368) passed Congress in October 1980. This law encompassed the solidification of high-level waste, its transportation to an "appropriate Federal repository for permanent disposal," and the decontamination and decommissioning of the tanks and all facilities employed under the project. The cost-sharing proportions of federal and state shares were established at 90 percent and 10 percent respectively.

Issues such as the future reopening of the low-level waste burial ground or the use of the storage pool for the interim storage of fuel assemblies were sidestepped in the legislation, as were issues of legal responsibility. Moreover, the peculiarities of the tank construction and the uncertainties of solidification technology promise major, continuing technical, as well as social-political, uncertainty. The fate of the low-level waste burial facility is still in dispute, with the state of New York in early 1981 refusing to assume responsibility for the facility after the lapse of the NFS lease. Thus, the future of the waste products of America's first commercial reprocessing plant still is clouded by a number of problems unanticipated at the time the project was initiated.

Although some of these problems are specific to this case (federal-state-corporate contractual arrangements and design of tanks, for example), the types of issues they represent are not atypical. Indeed, as the United States gropes its way among the technical and social-political complexities of waste storage and management, "unanticipated" problems will be the norm. At the heart of many of these problems will be issues of equity, the nature of which clearly can be discerned at West Valley.

ASSESSING THE IMPACTS

The impacts of the West Valley experience are diverse. Six hundred and forty metric tons of fuel from weapons and power reactors were reprocessed, their reusable products scheduled for recycling into bombs or electricity. For a decade, jobs and taxes accrued to the rural township thirty miles southeast of Buffalo where the plant was located. Today, the legacy is a closed and guarded plant; two tanks of high-level liquid wastes; two burial grounds of solid waste; workers who share among them the increased likelihood of one or more additional cancer deaths; and the shattered ambitions of a rural town, a state, and a corporation.

These and the other complex impacts of West Valley can be sorted into five groups: (1) the nuclear reprocessing and waste storage services to the industry; (2) the resulting managerial burden for the perpetual care of the plant and its wastes; (3) the risk of incidental exposure to radioactivity; (4) the local expenditures for taxes, employment, and services; and (5) the local burden imposed by growth and change. Detailed definitions of these impacts are shown in Table 4.2.

In order to collect and compile the data necessary to evaluate these impacts, available documents and reports were reviewed. We visited West Valley in February and April of 1978, conducting interviews with Nuclear Fuel Services officials, former plant employees, local and county

Table 4.2. Description of Impacts

Type	Description
Nuclear services to industry	
reprocessing	reclamation of uranium and plutonium
waste storage	storage of high-level liquid wastes, high-level solid wastes, and low-level wastes
spent fuel storage	spent fuel currently in pool
knowledge and experience (for future reprocessing operations)	first and only U.S. commercial reprocessing plant
Managerial Burden	
collection and treatment	all costs associated with collection and treatment of spent fuel (reprocessing): planning, licensing, construction, and operation of reprocessing facilities
exposure reduction	all costs associated with three types of exposure reduction activities: 1. waste storage, packaging, and burial, 2. plant modification to reduce employee and public exposure, 3. federal and state research activities to promote technical solutions to waste storage problems.
monitoring and surveillance	on- and off-site environmental monitoring by NFS, county, state, and federal agencies
consequence mitigation	NFS expenditures for accidental overexposure remedial action and health and safety program
Radiation exposure	
public	beyond the plant boundary
occupational	past and present employees
environmental	land, water, and biota
Local facility expenditures	
taxes	township, county, school, and fire district levies
employment	in planning, construction, operation, and maintenance of facility
use of local utilities	NFS purchase of phone and electricity
improvements in local facilities and services	road and hospital
Local Facility Burdens	
in-migration and growth	local inflation and housing shortage
burden on local services	increased demand for services
community change and social/psychological disruption	loss of farmland and anxiety

residents, and community and county officials and leaders as well as with representatives of state and federal agencies and the Erie and Cattaraugus County planning and tax departments. The "West Valley files" of local newspapers provided additional sources of background information and historical perspective. In addition, we participated in public hearings held in the area in March of 1978 and January of 1979.

Quantifying these impacts, however, was a difficult process: original data had to be pieced together from fragmentary recollections of officials and other participants. Nuclear Fuel Services still is unwilling to share certain data concerning its operations and some impacts must be inferred. Nonetheless, we have some confidence in the magnitudes we assess for most impacts; where we are uncertain, we specifically make note of that fact.

EVALUATING LOCATIONAL EQUITY

Once the impacts of West Valley have been defined, assessed, and inventoried, they must be allocated among people, institutions, places, and even generations in order to assess their equity or fairness. In this chapter we focus solely on locational equity, however.

In allocating impacts to places and institutions, we employ a simple division by locality, groups, and institutions (see Table 4.3). We consider impacts as occurring either in the immediate locality (distinguishing between Ashford Township, and Cattaraugus and Erie Counties), in New York State, or in the rest of the nation. And we seek to categorize impacts as occurring to workers within the plant, to the surrounding public, to Nuclear Fuel Services and the utilities serviced, and to local, state, and federal governments.

LOCAL IMPACTS

None of the benefits of the nuclear services of the West Valley facility accrued directly to the local area, but all of the benefits from the plant's local expenditures for goods and services as well as the costs of additional services and the risks of exposure were incurred locally. In 1960, the Township of Ashford was a sparsely populated agricultural community (population 1,490; area 32,204 acres); there is little indication that other industries would have located in this section of Cattaraugus County. The West Valley facility paid taxes of over $1.5 million by 1978, providing about 20 percent of the town and county taxes. A "boomtown" never materialized in the local area, although there was an

Table 4.3. Distribution of Impacts by Locus and Institutions or Groups

Impacted Groups and Institutions	*Locus: Local (township)*	*Locus: Local (county)*	*N.Y. State (outside two counties)*	*U.S. (outside N.Y. State)*
Public	×			
Workers	×	×		
Nuclear Fuel Services				×
Utilities			×	×
Local government	×	×		
N.Y. State government			×	
U.S. government				×

influx of about 200 "imported" laborers during the construction period. The facility attracted less than 100 new residents to the Erie-Cattaraugus region (the total regular operating staff was 170). In West Valley itself, the new families added no more than 10 to 15 pupils to an existing school population of about 500. Yet in 1977 NFS paid 16.8 percent of all West Valley Central School District taxes (in contrast with the 2.8 percent share provided by the NFS site in 1961, prior to development).

With site construction, 10.2 miles of local roads were realigned and upgraded at state and federal expense. Other contributions to the area included special emergency training for the local fire department, and the upgrading of the postal service to handle the increased volume of mail.

The major adverse impacts for the locality are intangibles – the disappointed expectation for development and growth and the continuing public concern over safety. Local people clearly expected the facility to inaugurate a period of increasing employment opportunities and economic growth – a scenario that was outlined in 1964 in *Town Plan Ashford:*

> For the Town of Ashford the future has changed. Now instead of job loss, out-migration and assessment reduction, the Ashford community can anticipate increased employment, population growth and new development....
>
> ...In the Town the atomic reprocessing plant will initially employ 150 and by 1970 around 250. Conservative estimates of industrial growth in the area, related to the reprocessing facility, indicate a probable increase in ad-

> ditional basic industrial employment of 750 by 1975 which. . .should generate 1,350 new jobs in service industries. . .a projection of 7,500–8,500 as the 1975 resultant population. . .50 percent (of whom) will locate in the Town of Ashford (Ashford Town Board: 1964, i, 4).

The rosy picture presented by federal, state, and company officials certainly encouraged these expectations. Local employment peaked during the construction phase, providing by our estimate 1,038 person-years of employment in a year and a half. This figure is in sharp contrast with our estimate of only 1,391 person-years of work at the plant over the next thirteen years. The population of Ashford, which was 1,490 in 1960, increased only to 1,882 by 1980.

The decline in expectations is registered in the pages of the local newspaper, the *Olean Times-Herald* (see Figure 4.3). The realization that future plans for the facility might not provide a source of jobs and that the tax revenues might be lost when the state (or federal) government took over the site added to the growing sentiment that the community had been "sold a bill of goods" by the state at the outset. Finally, some concern arose over the potential depression of real estate values and possible ill effects on local businesses, as the village of West Valley unwittingly had become a symbol to the nation of dangerous nuclear mismanagement. This concern was heightened as the region south of Erie County, its industrial future unrealized, developed into a valuable recreational area.

Despite fears to the contrary, public exposure to radiation in the local area has remained low. The maximum annual average whole-body dose to an individual living within twenty-five miles of the facility in 1971 was less than 3 percent of the annual external dose from all other sources (Table 4.4). Since the maximum dose calculations assumed daily consumption of meat and fish taken at the NFS site boundary, the actual average exposure was undoubtably much lower – about one-hundreth of 1 percent of the whole-body radiation dose to the public for that year. This fortunately low figure results partly because of the large site area allowed to NFS in order to dilute radioactive effluents through environmental media (Berg: 1973). The federal government increasingly has prohibited this practice of intentional dispersion of radionuclides in air and water. In 1971, NFS added a required liquid-effluent treatment plant to hold back some of the liquid effluents.

Despite low exposure to the public, local concern over safety persists, as demonstrated in our interviews, in public statements at hearings, and in newspaper articles. An analysis of public statements at a March 1978 DOE public meeting held in West Valley confirms the recognition of local benefits as well as considerable fear over radiation hazards.

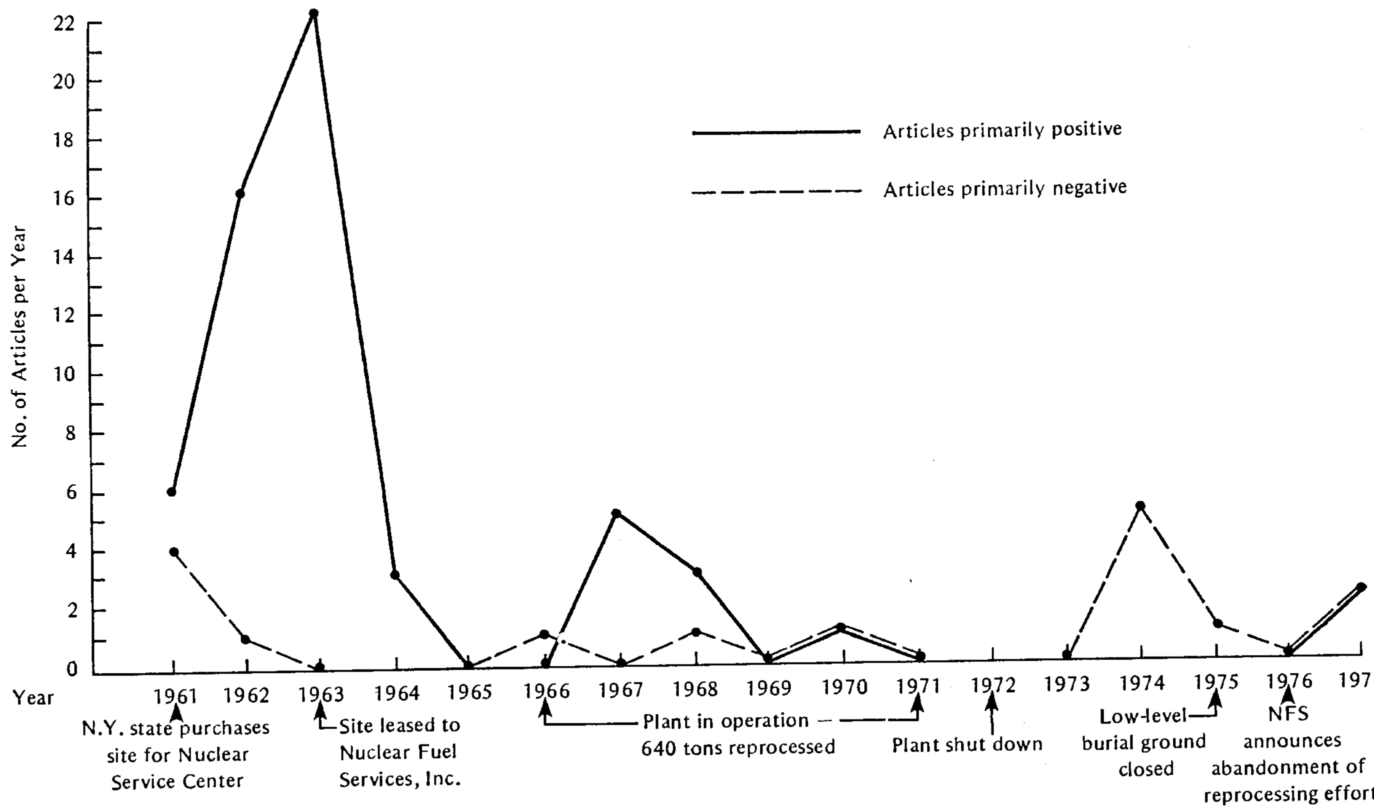

Figure 4.3. Western New York Nuclear Service Center press reports, *Olean Times Herald,* 1960–1977.

Table 4.4. Estimated Radiation Exposure Within Twenty-Five Miles of NFS Facility, 1971

Source of Radiation	*Annual Wholebody Dose*
Cosmic radiation: average external dose to individual in New York State, 1970[a]	45.0 mrem/yr
Terrestrial radiation: average external gamma dose to individual in New York State, 1970[b]	65.0 mrem/yr
—average internal whole body dose to individual in the United States, 1970[c]	25.0 mrem/yr
Fallout: average dose from global fallout to individual in the United States, 1969[d]	4.0 mrem/yr
Medical and dental radiation: average abdominal dose to individual in the United States, 1970[e]	72.0 mrem/yr
Consumer products: average external dose to individual in the United States, 1970 (digital watches and TV viewing)[f]	0.5 mrem/yr
Total	211.5 mrem/yr
Average whole body dose from NFS effluents to individual in the maximally exposed group, 1971[g]	5.83 mrem/yr
Average whole body dose from NFS effluents, (excluding dose from deer meat, fish, and creek exposure)	0.03 mrem/yr

[a]U.S. Environmental Protection Agency, Office of Radiation Programs: 1977, Table 2-2, 17.

[b]U.S. Environmental Protection Agency, Office of Radiation Programs: 1977, Table 2-13, 36.

[c]Klement et al.: 1972, Tables II-3, II-4, 12–13.

[d]U.S. Environmental Protection Agency, Office of Radiation Programs: 1977, Table 4-10, 31.

[e]U.S. Environmental Protection Agency, Office of Radiation programs: 1977, 210.

[f]U.S. Environmental Protection Agency, Office of Radiation Programs: 1977, Table 1-1, 7.

[g]Martin: 1973, 60. "Maximally exposed" individual consumes 125 g fish/day (from Cattaraugus Creek at NFS boundary), 4.8 kg deer meat/day (captured within exclusion area) and 40 hours exposure/year to Cattaraugus Creek "hot spots" (2.8 mrem/yr).

Ashford town leaders tended to discount radiation fears or emphasize positive benefits, but speakers from outside the town boundaries expressed negative sentiments in which the concern for safety was dominant. There also has been an increase in recent years of negative newspaper articles on the facility, most of which stress risk issues (Figure 4.3). Although any authoritative statements on the extent of perceived risk require careful survey research in the area (particularly since the opposition seems to increase with the distance away from the plant), it appears likely to us that public concern greatly exceeds the expert assessment of the risk.

In contrast to the public, workers at the plant did not fare very well. Whole-body radiation exposure to full-time NFS employees was higher than the nuclear industry average and increased as the plant aged – from 2.75 rems per year in 1968 to 7.23 rems per year in 1971 (Table 4.5). The latter figure is 40 percent more than the permissible occupational exposure of 5 rems per year and ten times the average exposure for the industry as a whole.

Contributing to this high occupational dose was an intentional tradeoff designed to improve the economics of fuel reprocessing. In order to lower costs in plant design and operation, some maintenance by direct contact rather than by more expensive remote systems had been planned from the beginning. Nevertheless, the relatively poor performance in occupational safety must be put into perspective. Total whole-body doses to regular and temporary workers, 5,737 rems during the operation of the reprocessing plant, represent enough external exposure to cause one cancer death (5,000 rems) or two cancer cases (2,500 rems per cancer), based on the average of risk models employed at the time (National Academy of Sciences: 1972). Although these models are undergoing reevaluation and debate, it is not expected that the interpretation based on them will change by more than a factor of two. On the other hand, it must be further qualified because of the fact that plutonium exposure through airborne dust undoubtedly was involved in some of the work in the plant. For this exposure, reliable risk calculations based on measured whole-body external doses cannot be made. They must be based on indirect estimates and uncertain dose-response theories instead.

A more difficult issue surrounds the use of temporary workers at NFS. Permanent workers receive the benefits associated with continuing employment and presumably have some understanding of radiation risks and training in radiation protection. By contrast, temporary workers at NFS usually worked for brief periods in high radiation environments. Such employees could often receive a *full quarterly dose* with perhaps only one day of salary. The West Valley facility relied heavily on the presence of such labor. While temporary workers received wages for less than one percent of the total person-hours generated by the plant's operation, they received 30 percent of the total external radiation dose measured during the six-year operation of the plant. A complicating factor is that most of these temporary workers were drawn from a captive labor force. Some were seasonally unemployed workers recruited from the greater Buffalo area; the majority were probably local Ashford residents – high school students (ostensibly over eighteen) or unem-

Table 4.5. Occupational Exposure: Routine Whole-body Exposure to NFS Employees

Year	Regular			Temporary			1968–1971		
	Number of Workers	*Rems*	*Mean Exposure per Individual*	*Number of Workers*	*Rems*	*Mean Exposure*	*Total Rems*	*Regular Workers (% of Total Rems)*	*Temporary Workers (% of Total Rems)*
1968[a]	292	803	2.75	48	47	0.98	850	95%	5%
1969[b]	180	685	3.80	240	230	0.96	915	75%	25%
1970	163	1098	6.74	472	433	0.92	1531	72%	28%
1971	162	1172	7.23	991	1194	1.20	2366	49%	51%
1968–71	797	3758	4.71	1751	1904	1.08	5662	66%	34%

Sources: Whole-body exposure information for 1969–1970 and 1971 obtained from AEC inspection reports (August 4, 5, 1969; April 19–22, 1971; May 16–19, 1972 (U.S. AEC Docket 50-201); 1968 temporary worker dose estimated from average dose to temporary workers in 1970 and 1971.

[a]Includes exposure data from 1967.

[b]Data for 1969 estimated from total number exposed in 1969, as given in NRC Summary of Whole body Exposures, 1969–1972, assuming regular staff of 180 and mean annual dose of 1 rem per temporary worker.

ployed persons who could meet minimum skill requirements and who were eager for work at reasonable pay. When skilled workers were needed on a temporary basis, their pay scale remained the same as that of non-nuclear skilled workers.

STATE AND NATIONAL IMPACTS

During its short operating life, the Nuclear Fuel Services plant at West Valley reprocessed 640 metric tons of spent fuel (60 percent from weapons products, 40 percent from electric power production), yielding an estimated 1,920 kilos of plutonium and the remaining uranium in the spent fuel. The plant provides temporary storage for 165 tons of spent fuel, 2.1 million liters of high-level liquid waste and 3,900 cubic meters of solid waste. Storage for 68,000 cubic meters of radioactive trash currently is provided (see Table 4.1). In addition to these services, valuable experience was gained both in reprocessing technology and waste storage.

To calculate the value of these services in any consistent way is extremely difficult. A precise dollar value of the benefits of the reprocessing operation to the producers of spent fuel would require extensive accounting procedures and research that is beyond the scope of this case study. Nevertheless, we estimate that the value of the plutonium recovered from reprocessing was well over $20 million, and the uranium (if it were reused) would be valued at $6.8 million at the prevailing rates.

Permanent disposal of low-level waste generated off-site is valued at $240,000, based on the fees actually paid for that service. The value of all other waste storage (generated on site from reprocessing activities) can be measured by calculating the costs of spent fuel storage without reprocessing – in other words, the cost to the utilities and the AEC had the NFS facility not been operating. The value of storing 640 tons of unprocessed spent fuel on a temporary basis for ten years is $9.6 million, based on 1976 costs of expanding space in reactor pools (U.S. Congress: 1976, 731). On a permanent storage basis, these costs are included in the $200,000 per metric ton figure then used as an average "one-time" fee for interim storage, transportation, and ultimate disposal of nuclear waste. Thus the value to West Valley customers of the future, ultimate disposal of spent fuel is over $129 million, a modest estimate compared with the $500 million to $1 billion cost expected in 1981.

A rough estimate of the total value of all services (reprocessing, product value, and waste storage) is, under the temporary storage assumption, $36.6 million, or $156 million under the permanent storage assumption. These nuclear services are shared proportionately according to the locus of fuel origin and are shown in Table 4.6 by source: the AEC at Hanford, Washington; commercial utilities at U.S. sites other than New York State; and New York State utilities.

Omitted from Table 4.6 and, indeed, from any calculations is the intangible value of the experience gained through the development of the facility. West Valley demonstrated that commercial reprocessing was technically, if not financially and environmentally, feasible at prevailing prices and amidst changing environmental and safety standards. West Valley as a prototype, however, has not led to the development of fuel reprocessing; indeed, no commercial facility is currently in operation. Initially this situation was due to technical problems at other plants, financial constraints, and, more accurately, to the federal decision to forego reprocessing for the time being in order to discourage nuclear proliferation. Thus it is not clear what the lasting value of the West Valley experience actually will be, nor whether any of that value actually will accrue to NFS and New York State as well as to the nation's nuclear program as a whole.

By comparison with the estimated monetary value of services, the costs are extraordinarily high. The total managerial expenditures for the eighteen years of reprocessing and storage activity are approximately 296 million, compared with $36.6 million for the short-term value of services. Future costs of decommissioning and permanent storage currently are estimated at between $500 million and $1 billion, several times

Table 4.6. Value of Nuclear Services

Services	*AEC-Hanford*	*Non-N.Y. State Utilities*	*N.Y. State Utilities*
Reprocessed plutonium[a]	$ 6,910,773	$11,836,720	$1,344,940
Reprocessed uranium[b]	4,173,400	2,440,900	225,200
Low-level solid waste disposal[c]	—	120,000	120,000
High-level liquid and solid waste disposal[d]	75,880,000	48,818,000	4,640,000
Total	$86,964,173	$63,215,620	$6,330,140
Less fees paid to NSF	18,000,000	3,860,000	3,400,000
Net value of services	$68,964,173	$59,355,620	$2,930,140

[a]Based on average received price of $10,665 per kilo.
[b]Based on a U_3O_8 price of $11,000 per MT.
[c]Based on fees charged for disposal.
[d]Based on 1976 estimate of one-time disposal fee of $200,000 MT spent fuel.

greater than the permanent storage estimated cost of $129 million (1976). If we further break down the overall managerial burden of $96 million according to who bears the expense – the reprocessors and the waste storage operators (58 percent), the customers for nuclear services (26 percent), and the oversight governmental agencies (16 percent) – the difference between costs and benefits emerges clearly.

Nuclear Fuel Services' pioneering role in commercial fuel reprocessing has cost the company up to $56 million to date in capital investment and estimated operating losses. This lion's share of the expenses should be put in perspective, however. Since NFS was able to terminate its contractual responsibilities, it no longer will be financially, or operationally, responsible for the site and the wastes contained there.

The customers of NFS (utilities, laboratories, hospitals, and the U.S. Atomic Energy Commission) paid for over one-fourth of the managerial expenses (in reprocessing and waste storage fees) in return for a very reasonable price for reprocessing, long-term waste storage, and the recovery of valuable materials from spent fuel. Based on government records of plutonium purchases through 1971, our estimates indicate that U.S. utilities made a modest profit of about $8 million on plutonium sales alone (deducting utility reprocessing and waste storage fees). New York State utilities, however, only broke even selling their reprocessed plutonium. Records of specific uranium sales were not available as of this writing, but we value them at $6.8 million.

Profits from the sale of recovered products are also a function of the level of reprocessing charges to the utilities. NFS customers were charged a relatively low price for the reprocessing service, given the escalating costs of operations: fees ranged from $23,500 to $35,000 per metric ton over the period of plant operations. In 1972 (after shutdown), NFS quoted a final reprocessing charge of $1,062,000 per metric ton, a price that incorporated the costs of upgrading the facility to meet new federal standards. Recent estimates of recycling costs are more conservative – for example, a 1976 ERDA estimate of $343,000 per metric ton (also including capital expenditures necessary to meet more stringent regulations) – but they still indicate that reprocessing at West Valley was a bargain by today's standards.

The bill for long-term waste storage was an even bigger bargain. According to our calculation, NFS reprocessing customers paid a surcharge of $6,500 for perpetual storage of high-level liquid wastes for each metric ton of fuel reprocessed. The actual costs of disposing of these wastes depends on the technical options selected – a topic presently being investigated by the Department of Energy. But using the average figure of $200,000 per metric ton, which was estimated in 1976 as the "one time" isolation cost, and inflating the NFS surcharge to comparable prices ($10,000 per metric ton), we see that customers received a twenty-fold subsidy amounting to $46.5 million for the U.S. utilities, $4.4 million for the New York utilities, and $72 million for the AEC. In light of the three- to five-fold escalation in storage and disposal cost estimates, the subsidy is even greater.

New York State, and not the federal government, has borne the brunt of much of the managerial burden for developing and monitoring the site. If funds involved in the initial site selection/development and legal/administrative expenses are included, state expenditures conservatively amount to at least $12 million. Federal expenditures, by contrast, probably total less than $3 million.

Moreover, most of the research conducted on site by state and federal agencies is applicable to national waste management programs. The extensive environmental monitoring program established by the state in [illegible] has provided a wealth of information on the environmental impacts of fuel reprocessing. One of the largest single benefits of the plant was the technical experience gained in reprocessing. Knowledge gained from NFS operations has contributed to improved design and more stringent standards for future reprocessing facilities.

These impacts are mapped by locus in Figure 4.4. The AEC at Hanford, Washington, and the scattered U.S. utilities at ten sites are the big gainers, disposing of waste at bargain prices and receiving, at a cost of $[illegible] million, services valued at $149 million. The construction interests (represented by Bechtel, the designer and prime contractor) received [illegible] and profits. The net losers to date clearly are Nuclear Fuel Services, with an estimated $25 million operating loss, and New York State, where only 6 percent of the reprocessed fuel originated but which bore [illegible] percent of the (non-NFS) managerial costs. The locality also lost because of reduced rates of economic growth and nagging fears of overexposure of workers and of possible environmental contamination.

Not shown on the map at all is the distribution of future costs: the upwards of $1 billion to solidify, transport, and inter the wastes, and the several thousand rems of exposure to workers and the public in West Valley, along the transportation route, and at the permanent repository (U.S. Department of Energy: 1981).

CONCLUSION

To document the immediate gainers and losers is easier than to [illegible] the full locational impact of the NFS experience. To a limited extent the dollar flows can be traced, but even a major loser such as Nuclear Fuel Services may have had much of its loss erased by its parent

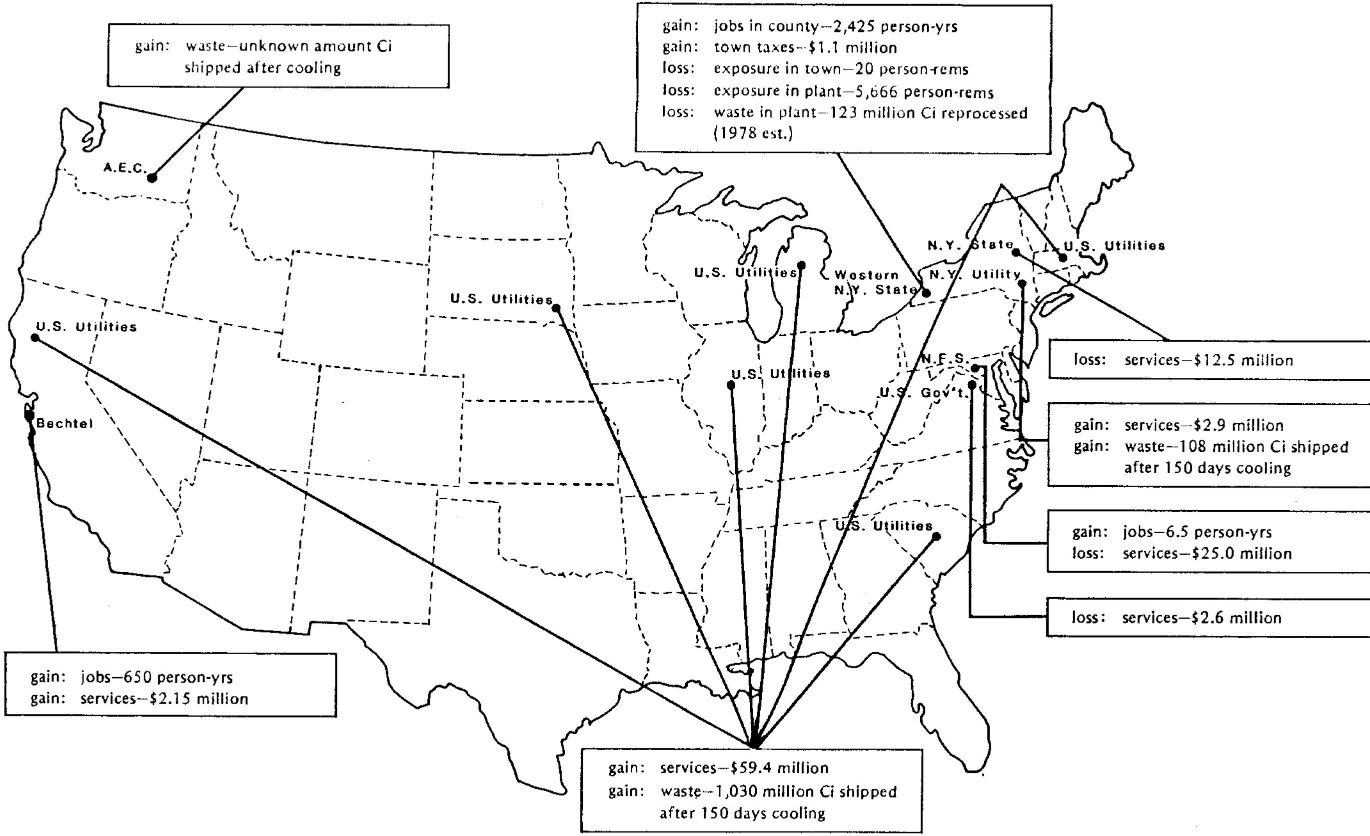

Figure 4.4. Western New York Nuclear Service Center impacts balance, 1960–1978.

corporation's tax juggling. And the coin of comparison may be very different: there is no universal coinage for learning about reprocessing, for rems of exposure, or for grieving a lost home. Nevertheless, we can summarize the gainers and the losers at West Valley during the plant's twenty-year history as follows. At West Valley commercial nuclear fuel reprocessing was demonstrated, and spent fuel assemblies were disposed of at bargain prices. This situation made the nuclear industry in general, the Atomic Energy Commission, and some related utilities slightly richer and much wiser at the expense of a corporate aspirant, Nuclear Fuel Services, and the state government of New York, both now poorer and wiser. A local community traded a brief flurry of jobs and taxes for an uncertain future and unwanted notoriety. Meanwhile, a farmer who lost his home by eminent domain and a worker over-exposed to radiation ponder the nature of their compensation.

Finally, there is the waste, a legacy of what is at best a footnote to the postwar nuclear history of the United States. All the major waste forms are at West Valley, with the exception of uranium mill tailings. All require some form of further disposal or monitoring; none are for anyone's comfort.

Slowly, very slowly, the various parties involved inch toward resolution of the complex legal, political, social, and technical issues. Over the next twenty or more years, solidification of the high-level wastes for eventual disposal in an off-site permanent repository, extended care for the low-level wastes, and partial decommissioning of the plant will take place, with both the responsibility and the bulk of the costs to be borne by the federal government. Some portions of the plant may well be used for interim fuel storage; indeed, the processing of the high-level liquid wastes will require a considerable nuclear industrial activity on-site. Economically, this activity for long-term disposal will be many times larger in cost than the building and operating of the original plant and the entire monetary value of its product.

As a case study in locational equity, the West Valley story, while still incomplete, illustrates well some major dimensions of the radioactive waste problem. There are diverse interested parties in radioactive waste management, and their interrelationships are complex. Even a small-scale operation like West Valley involved gains and losses distributed over more than a dozen locations stretching across the entire United States and Puerto Rico. The institutional gains and losses are complex, with some corporations, some institutions of government, and some local residents benefiting, with others losing, and yet others with mixed balance sheets.

Nonetheless, despite the number of locations and the complexity of interest, the waste eventually ends up in someone's back yard. Defining the back yard, however, is also difficult. At West Valley we described it variously (depending on impact) as the plant site, Ashford town, or the surrounding two counties. Other important backyard definitions might well be based on watershed or aquifer. And the final backyard is still unknown. Thus, there is almost surely a mismatch between the diverse locational interests and those institutions that purport to represent or speak for them. The legal, social, and political complexities surely rival the significant technical problems. Time, in radioactive waste management, seems to move by decades, mirroring, perhaps, the half-lives of the radionuclides we purport to manage.

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