Chapter Two

Amphibious Assault

New York City was not unusual in shunting quantities of noxious waste to its backyard. Every American city, up until about the middle of the twentieth century, dumped its rejects on nearby scraps of low-value land—usually in swamps. In 1879, a minister described the situation in New Orleans to the American Public Health Association:

> *Thither were brought the dead dogs and cats, the kitchen garbage and the like, and duly dumped. This festering, rotten mess was picked over by ragpickers and wallowed over by pigs, pigs and humans contesting for a living from it, and as the heaps increased, the odors increased also, and the mass lay corrupting under a tropical sun, dispersing the pestilential fumes where the winds carried them.*

When swamps grew scarce, holes were excavated in dry land and garbage was tumbled in. Sometimes the trash was burned to reduce its volume, a process that created billows of black smoke and toxic fumes. In 1937, Jean Vincenz, the commissioner of public works for Fresno, California, after traveling the dumps of the nation, built in his hometown the country's first "sanitary landfill" (England had a sanitary landfill, too, but it never accepted household waste). Every day, Vincenz carefully positioned and compacted the city's waste. Then, to keep down vermin, birds, and odors, he buried it with soil that he'd dug out to make room for the next day's haul. The sanitary landfill idea began to catch on during World War II, when the US military adopted Vincenz's methods. By 1945, according to the Garbage Project's William Rathje, one hundred cities had joined the bandwagon, and by the fifties, the sanitary method was in full flower.

While Vincenz's approach made America's trash heaps look cleaner, their subterranean aspects were anything but. A blanket of dirt didn't protect groundwater from contaminated moisture, called leachate, seeping through the garbage, and it didn't control or capture leaking landfill gases, which are toxic. It wasn't until the 1980s and '90s that the Environmental Protection Agency, through its Resource Conservation and Recovery Act, began to protect human health and the environment against these discharges by requiring leachate- and methane-collection systems. In 1991, the agency gave landfills six years to modernize or close. But complicated liners made of plastic and clay, and gas-collection-and-monitoring systems were expensive, so most dumps shut down. In 1988, there were nearly 8,000 landfills across the country; in 1999, there were 2,314; and by 2002, there were only 1,767.

(A historical footnote: Jean Vincenz's Fresno landfill had, by the time the RCRA rules came out, long been shuttered. But it received a flicker of attention on August 27, 2001, when Secretary of the Interior Gale Norton nominated it as a National Historic Landmark for its importance in the nation's history of civil engineering. The fuss lasted less than twenty-four hours. The very next

day, Norton rescinded her offer: the landfill, she'd just learned, was an EPA Superfund site.)

As illegal dumps closed, fewer but larger regional landfills were inaugurated, usually in rural areas with small populations. Meanwhile, Americans continued to generate more and more trash. The garbage business—concentrated in the hands of a few major corporations—blossomed. By 2001, it was a $57-billion-a-year industry. The economics of megafills covering several hundred acres was irresistible. They were, in relative terms, far cheaper to build than little landfills, even when the millions paid to control pollution and fight community activists were factored in. Because megafills were built in small sections, or cells, with revenue coming in as each section filled, their construction costs could be spread out over many years. In this way, a large landfill could reap gross profits of more than 50 percent.

With urban dumps capped, more and more waste began to cross state borders. Dump owners adopted a "smoke 'em if you got 'em" attitude, working to fill their sites as quickly as possible—before federal regulations could curtail interstate trade in garbage, before recycling could claim an even larger percentage of the waste stream, before environmental regulations tightened up and raised their cost of operations. Just as road builders invited more traffic by adding lanes to highways, so did enormous landfills invite a wanton disregard for waste reduction. If there was plenty of room out there, what was the incentive to conserve space?

In 2002, thirty-two states (reporting to *BioCycle* magazine) imported garbage from other states, while twenty-four states exported garbage to other states (some states did both). Pennsylvania led the importing pack, accepting ten million tons in 2002. In second place came Illinois, followed by Virginia, which shipped its own hazardous waste primarily to dumps in Ohio and New York State. The second-largest exporter was New Jersey and the first was New York, which had contracts to dump its garbage at thirty-seven landfills in New Jersey, New York, and Pennsylvania (with

permits to dump in Ohio, Virginia, and South Carolina if need be), in addition to four incinerators in three states.

Before it closed in 2001, Fresh Kills had been the largest city landfill in the country, indeed, in the entire world. That honor is now held by the Puente Hills Landfill, in Whittier, California, which has a permit to accept twelve thousand tons of trash a day from the surrounding counties. Not to belittle Whittier, but that's just half the daily tonnage that was dumped into Fresh Kills, which sprawled over three thousand acres on the western side of Staten Island.

I'd requested permission from the city's Department of Sanitation to visit Fresh Kills because it played such an important role in New York's garbage history, but my application seemed to be in limbo (much like my request to visit IESI's Bethlehem landfill). I asked Sanitation one more time for a tour of Fresh Kills, then took matters into my own hands. Studying a map of Staten Island, I made out a green-tinged area just north of the dump. In fact, it seemed to be connected to Fresh Kills by a tidal creek. I'd never heard of the William T. Davis Wildlife Refuge, but it seemed like a good place to start.

"Do you have a boat that I might be able to rent?" I asked the receptionist at the refuge. I implied that I was interested in the area's native grasses. No, she said, the refuge didn't keep rental boats, but the resident naturalist, Carl Alderson, knew a lot about the grasses. Without waiting for my response, she patched me through.

I was getting a bit off track, but I liked talking to Alderson. He was refreshingly warm and friendly. A salt marsh ecologist, he had restored wetlands in the Arthur Kill, which separated Staten Island from New Jersey, after a big Exxon oil spill in 1990. (The word *kill* is itself a sort of historical debris. Dutch for *river,* it remains, despite the conquest of the English, scattered throughout the New York area, from Fresh Kills to the upstate towns of Fishkill, Peekskill, and beyond.) Alderson was studying salt grasses on New Jersey's Rahway River, and he'd completed a three-acre marsh

restoration inside Fresh Kills itself. My ears pricked at this news: now we were getting somewhere.

We talked a little about the effect of garbage on the environment, and then Alderson revealed that he had four canoes, a kayak, and a Boston Whaler at his disposal. He asked if I wanted to give him a hand counting spartina grass stems in a week or two at the Raritan site. Sure, I said, trying to temper my enthusiasm. To get to New Jersey, I figured, we'd have to boat right past the landfill.

We set a date for fieldwork, but early that morning it rained. We rescheduled, and once again got rained out. Weeks passed, the weather didn't improve, winter closed in. Alderson's spartina grass had wilted, and I knew he couldn't count his stems until next spring. I was about to give up on seeing Fresh Kills from the water when, one weekend in the middle of December, the telephone rang.

"Come on," said Alderson. "Let's paddle around the landfill."

"Okay," I said, fist raised in silent triumph.

It was 25 degrees and the sky was leaden by the time I met Alderson at the refuge office. With his square chin and snub nose, and in his dark fleece jacket and jeans, he looked a little like George W. Bush, but taller. He had longer hair, too, and a different set of politics.

Together we strapped a three-person kayak onto Alderson's battered Toyota, then drove to our put-in spot, on Travis Road. We manhandled the boat down a rocky grade and into a creek that was just a few inches wider than the kayak. As we adjusted the foot pegs it began to snow, but neither of us mentioned this development. The slate gray mud stretched out for yards on either side of us. I heard the rhythmic *thwack* of a hammer to the north. New houses were going up just outside the refuge, while old ones leaked raw sewage into the creek. "I try to avoid touching this water," Alderson said.

I didn't know what to make of the refuge, which had been the first wildlife sanctuary in New York City. Our put-in, high on Main Creek, lay amid a twelve-square-mile complex of derelict brownfields and thriving industry. There was a paper mill to the

southwest, the landfill to the east, and a checkerboard of oil tanks to the west across the Arthur Kill, which carried more boat traffic annually than the Panama Canal.

Hemmed and hampered by this built environment, the William T. Davis Wildlife Refuge provides shelter for hundreds of native plant and animal species. Founded in 1928 with a land purchase by the Audubon Society and named after a Staten Island naturalist, its 260 acres contain salt meadow, low marsh, forested uplands, rock outcrops, a swamp forest, spring-fed ponds, and alluvial dunes. Those dunes, which protrude like whale backs above the marsh, are composed of sandy deposits that were swept up by strong currents or prevailing westerly winds from the bottom of Lake Hackensack when its water level plummeted some ten thousand years ago. The lake itself, which once covered the western shore of Staten Island and the eastern shore of New Jersey, was formed by the terminal moraine of the retreating Wisconsin glacier. When the lake drained (possibly due to a breach in a natural earthen dam), its rushing waters carved the narrow channel known today as the Arthur Kill, into which Main Creek flows.

We stroked downstream through black water flanked by mudflats and brown grasses. A raft of mallards pivoted in the rising wind. Then suddenly, as we rounded a bend, the mound of Fresh Kills' Section 6/7 rose before us. (The garbage at the landfill was heaped into four enormous mounds, called sections.) I had expected something massive—the size of the dump impresses every visitor, and few media accounts fail to mention that astronauts can see Fresh Kills from low Earth orbit. But from the water, Section 6/7 was just a steep hill jutting maybe a hundred feet above the deck of our bow, its knee-high brown grasses undulating in the breeze. A few dump trucks, burdened not with garbage but with dirt, trundled up switchbacks, black dots on the landscape. The air smelled lightly of sulfides. Crushed plastic bottles and old tires festooned the creek sides.

With our fingers growing numb, we shipped our paddles and shoved our hands inside our jackets. I turned to look north, toward the refuge, and was struck by the beauty of this place, the

alacrity with which the marsh turned into scrub forest—white oak, red maple, sweet gum, and black willow. Before the city began dumping here, this patchwork of marsh, meadow, and forest was the norm. "The landfill supplanted one of the largest tidal areas on the East Coast," Alderson said. "The salt marshes of Fresh Kills, Jamaica Bay, and the Hackensack Meadowlands were unrivaled in their abundance and diversity."

Fifty-three years ago, the writer Joseph Mitchell spent some time in the marshes with Happy Zimmer, a shellfish protector for the Bureau of Marine Fisheries. Zimmer described the marshes and their uplands as a busy and bounteous place. Locals hunted for mushrooms in the autumn, dandelion sprouts in the spring, mud shrimp, herbs, and wildflowers in the summer. Wild berries and grapes went into jams; watercress from freshwater tributaries made salads. In 1929, the Crystal Water Company began bottling and selling springwaters that meandered down toward the sea. Zimmer noted great numbers of pheasants, crows, marsh hawks, black snakes, muskrats, opossums, rabbits, rats, and field mice.

By 1951, when *The New Yorker* published Mitchell's story about Zimmer, the city had already filled in five of the "once lovely" clay pit ponds at Greenridge, on the dump's southern flank. "The marshes are doomed," Mitchell wrote. "The city has begun to dump garbage on them. It has already filled hundreds of acres with garbage. Eventually, it will fill in the whole area, and then the Department of Parks will undoubtedly build some proper parks out there, and put in some concrete highways and scatter some concrete benches about."

The current nudged us toward shore, and Alderson raised his binoculars. "Ring-billed gull," he said. "Canada goose. Great blue heron. Geotextile lining." He aimed his paddle at a scarf of exotic black lying against the brown of Section 6/7. The high-tech tarp was part of Fresh Kills' final closure plan, a barrier that was supposed to keep rain from the garbage and provide footing for future soil and vegetation.

When the EPA began examining landfill impacts in the 1980s, it adopted the "dry tomb" philosophy of landfill construction,

which focused on isolating garbage from its immediate surroundings. New landfills, the agency said, would have liners that protected groundwater from leaking garbage juice; collection pipes to funnel this juice into treatment plants; methane-collection pipes to vacuum the gases created by biodegrading organic material; and, when it was time to close the landfill, some sort of plastic layer that would act like an umbrella and keep rainwater from percolating through the waste. Dry garbage, went the argument, was inert, quiet, and calm. Wet garbage, engineers knew, would generate leachate for thousands of years: the dumps of the Roman Empire, more than two thousand years old, are still leaching today.

But there's one problem with dry-tomb landfills: plastic covers and plastic liners break. It is widely acknowledged, including by the EPA, that even the best plastic will ultimately leak, and well before the waste it contains ceases to threaten the environment. How long does waste pose a threat? According to G. Fred Lee, an environmental engineer who's devoted his entire professional life to the study of landfills, "For as long as the landfill exists."

And so in recent years, a new philosophy of waste has edged its way into civil and biological engineering circles. The so-called bioreactor method is just the opposite of the dry tomb, calling for leachate to be collected and then repeatedly injected back into the garbage. All this moisture accelerates decomposition, so that bacteria feeding off waste produce more gas more quickly. After the fermentation of waste has stopped, the dump contents are rinsed with fresh water, and the toxic runoff is collected and treated before final discharge. Because the garbage shrinks while it decomposes, the landfill settles and stabilizes faster (while monitors are still keeping an eye on things, it is to be hoped). Landfill managers like the idea of this method because they don't have to collect and continually treat their leachate. But because there is a lot more of it cycling through their dump, there is more liquid to potentially leak. Leak-detection liners do exist, but they are very expensive and, said Lee, "No one uses them." While university scientists in biological engineering departments are busily running wet-tomb bioreactor models in bins outfitted with Plexiglas windows, the

EPA is monitoring long-term experiments on four actual bioreactor landfills in California, North Carolina, and Virginia.

"Another problem with bioreactors," said Lee, who actually favors the wet method, "is that most household garbage is sealed inside plastic bags, which get compressed by big machines but not always ripped open." And if the garbage isn't exposed to moisture, it might as well be sitting in a dry tomb. Shredding every bag before it's buried would solve the problem, but this would add about a dollar a ton to tipping fees, said Lee. The job may be too messy even for a dump.

Fresh Kills is neither a dry tomb nor a wet bioreactor. Like any landfill, it produces leachate, a noxious stew of household toxics, such as battery acid, nail polish remover, pesticides, and paint, combined with liquid versions of rotting food, pet feces, medical waste, and diapers. An analysis of free-flowing leachate sampled from landfills of the Hackensack Meadowlands turned up oil and grease, cyanide, arsenic, cadmium, chromium, copper, lead, nickel, silver, mercury, and zinc. To capture the leachate flow at Fresh Kills, which shares this pestilential profile, engineers encircled the uncapped garbage mounds with leachate walls dug seventy feet deeper than the lowest layer of garbage. Comprising perforated pipes, the walls funnel garbage juice to the dump's private water treatment plant, where it runs through an intensive detoxification program before being discharged into the Arthur Kill. The leachate walls, in place only since 1996, capture much of the three million gallons that flowed daily before the landfill was capped, but the laws of hydrogeology will not be denied. Ancient streams and channels still run through the former clay pits (remember, they aren't lined), and twice a day tides still flush escaping leachate into New York Harbor.

Liquefied parsley stems and mucus-filled tissues are gross, but leachate from residential garbage has some far nastier characteristics. In addition to pathogens from organic waste, it also picks up metals and acids, motor oil, and solvents from ordinary compounds used in the home. According to Garbage Project studies, about 1 percent by weight of all household garbage could be considered hazardous by EPA standards. Nail polish, for example, contains several chemicals listed by the EPA as hazardous. According to researchers at Texas A&M University, the leachate produced inside Subtitle D landfills, which contain only municipal solid waste, and Subtitle C landfills, which contain hazardous waste, is chemically identical.

I wasn't throwing out drums of rat poison or anything else that seemed chemically risky, but since recycling had been suspended in New York, I tossed out plenty of plastic containers. I was surprised to learn that most household cleaners and shampoos come in bottles that contain the industrial organic chemical dicyclohexyl phthalate, a plasticizer that's suspected of disrupting the endocrine system and harming the liver.

State-of-the-art landfills have composite liners that conduct leachate to a plant where it is treated, then discharged to a local waterway. But, again, even the most sophisticated liners eventually leak. Geomembranes are eaten away by common household chemicals, stuff like mothballs, vinegar, and ethyl alcohol. (I was guilty of discarding the first two items, but not the third: my booze bottles were always empty when I threw them out.) And then there's human error—seams improperly sealed, holes poked by heavy equipment. Leachate collection pipes become clogged with silt or mud, or are blocked by the growth of microorganisms or the precipitation of minerals. Weakened by chemical attack, pipes are crushed by garbage.

Landfill covers fail, too: freezing and thawing cycles erode them; plant roots try to penetrate them. Woodchucks, mice, moles, voles, snakes, tortoises, ants, and bees innocently attack the cover from above, while buried tires, which have a habit of rising from the dead, threaten from below. If the cover becomes exposed, sunlight dries out clay layers and destroys plastic membranes; subsidence, caused by settling of the waste or organic decay, can result in cracks, too. So fragile are these systems, say landfill opponents, that state-of-the-art landfills merely delay, rather than eliminate, massive pollution to groundwater. The classical dump, at least when it comes to protecting groundwater, may even be preferable

to modern landfills, where monitoring stations are spaced too far apart to detect fingerlike plumes of leachate springing from tiny holes. The unlined dumps leak evenly, said G. Fred Lee, and you know pretty quickly when your off-site groundwater becomes tainted by garbage.

The EPA requires landfill owners to monitor their sites for thirty years postclosure to control leachate and methane buildup, which causes fires and explosions. After this period, there is no funding to monitor water or air, to maintain landfill covers, or to remediate any eventual pollution. Over time, landfills pose more of a threat to the environment, not less.

Our hands were warmed up now, and I asked Alderson what effect the dump had on the nearby plants and animals, most of which had evolved in the absence of leachate. "Nitrogen and phosphorous are essential nutrients, though they can also be contaminants," he said. "But the net effect seems to be beneficial. Our spartina's growth exceeds or is equal to growth in a natural marsh."

I couldn't hide my surprise: after all, raw sewage flushed into creeks and channels upstream, and the tides swept umpteen kinds of poison from the landfill into the water twice a day. And it wasn't as if the Arthur Kill, into which Main and Fresh Kills Creeks flowed, was sluicing the place clean on every flood tide, either: there were twenty-five hundred acres of old and unlined landfills in the Meadowlands, just up the harbor from the Arthur Kill, out of which flowed a little more than a billion gallons of leachate a year.

But Alderson was sanguine about all this. He judged the marsh's health by its productivity, which he measured by colonization of benthic invertebrates, like ribbed mussels, by colonial wading birds, and by fish. He was happy to report the presence of baby bluefish, raptors, and egrets. Such resilience astounded me, though I'd later learn that cadmium and other persistent pollutants from the water were showing up in bird eggs and chicks, possibly jeopardizing their long-term survival.

Today, though, Alderson was showing off a restoration triumph. We continued paddling south, toward an empty barge and a mesh fence that stretched across the channel to a bulkhead. The creek was wider here and the current a little stronger. Alderson had warned me on the phone that debris barriers and booms would separate me from my dream of paddling around mounds of trash. But suddenly, he became animated. "Hey, it's open," he shouted. If we kept to the eastern shore, we could just sneak through the opening in the barrier. "I've never seen this open before," he said, angling us toward the bulkhead and ducking as we glided under a slimy rope. Beyond the bulkhead was exactly what was supposed to be out here—a gently sloped, perfectly functioning tidal marshland.

"We codesigned a three-acre restoration, with a thousand linear feet of shoreline," he said. "The grasses act as erosion control and natural filters. They pull out excess nutrients, metals, pesticides, and herbicides. They also mitigate storms and provide plant and animal habitat." We couldn't see it from sea level, but the sanitation department had also created a surface-water capture basin in there, made of berm and rock. It acted as a secondary means of purifying runoff by capturing surface sediment before it hit the creek.

In Alderson's perfect world, all the waterways around the landfill, where ecologically appropriate, would be planted with salt marsh vegetation. "Landfill engineers didn't have this in their consciousness before," he said. "We brought them square into a new paradigm."

Going north took longer than going south. It wasn't the wind that made it difficult but the water: the tide was going out. The mudflats on either side of us, though I couldn't be sure, looked twice as broad as they had twenty minutes ago. I wondered how we'd get the boat all the way back to the Toyota. We paddled doggedly for ten minutes, until a loud and scolding "Yo!" drew our attention to the western shore.

A sanitation sedan was parked on the lowest contour of Section 3/4. "Shit," Alderson said.

"Paddle over here," shouted a figure in uniform. "What do you think you're doing?"

Alderson bellowed his name and Parks Department affiliation, then said that he'd been checking on his salt marsh. The san man wasn't impressed: "I don't care who you are, I'm giving you a summons."

"I can't get over there!" Alderson shouted. There was fifty feet of leachate-suffused mud between solid ground and the cleat on our bow. Even if we had clear sailing and weren't afraid of running out of tide to reach our takeout point, the idea of presenting ourselves to receive punishment beggared common sense.

"Where are you parked?"

"Travis."

"Get your boat over here! You are trespassing on—"

I didn't hear the rest. Alderson had morphed into an angry beast.

"I built that fucking salt marsh for you!" he shouted without a hint of levity. I could feel his anger coursing through the roto-molded plastic of the boat. "You're telling me I can't paddle in public waters from a wildlife refuge around a landfill owned by the city?" All that shouting interfered with his stroke. I sank a little lower in my seat but continued paddling away from the sanitation cop, in a gesture of moral support. "Talk to Phil Gleason!" he continued. "He'll tell you who I am. If you're gonna give me one summons, you gotta give me a hundred. Give me a hundred and fifty! I've been in your creek a hundred and fifty times!"

We were out of voice-shot now and the cop got into his car. Alderson instantly calmed down. "I'm sorry," he said to me. "I was reverting to the language of the landfill."

Chapter Three

Stalking the Active Face

I drove out to Pennsylvania on the first warm spring day of the year, full of zeal for my quarry and eager to leave the winter-weary city behind. Route 78, known as the garbage interstate, was abuzz with eighteen-wheelers hauling putrescible waste across New Jersey to one of Pennsylvania's fifty-one landfills. Pennsylvania imports ten million tons of waste per year from neighboring states, more than any other state in the union. The garbage traffic fills state coffers with surcharges (in 2002, fees for out-of-state trash added up to $40 million), but it also brings danger. During one eight-day crackdown in the spring of 2001, inspectors found 849 trucks with violations so serious they were ordered off the road. Altogether, 86 percent of the more than 40,000 trucks inspected had safety and environment-related violations, such as leaks or improperly covered loads.

The landscape of rural Pennsylvania bespoke the geography of iron ore—gouged hills and twisting hollows of second-growth hardwoods, the towns depressed and faded. My destination lay a