The Control of Nature Study Guide

The Control of Nature by John McPhee

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Plot Summary

The Control of Nature is a historical nonfiction novel published in 1989. Events occur on a backdrop of geological time that spans eons. John McPhee tells stories about the lives and happenings of residents, non-residents, scientists, engineers and government bureaucracies in conflict with various forces of nature. He explores each region as an investigative reporter to meet and interview participants, witnesses and experts. Money, power, conflict and accidental death and destruction pervade the work. Nature and acts of God seem to get in the way of man's plans. McPhee sympathetically reveals that man causes his own disorder and destructive actions on nature and a natural order of things.

John McPhee visits Southern Louisiana, Iceland, Hawaii and Los Angeles during the 1980s. Each region he investigates is created by, set within and driven by ongoing major geological events. Natural flows and man's control are common elements of conflict in each area. Mississippi River water both creates and floods southern Louisiana and the Atchafalaya bayou. Volcanic red-hot lava creates and threatens Iceland and Hawaii. San Gabriel mountain debris flows create and threaten Los Angeles. Native residents in each of these regions recognize and accept the natural order. They simply pick up and move or work around the force of nature. As civilizations develop and spread out people begin to like living down by the riverside, on an island or mountain canyon. Inhabitants want to stay where they are. Governments decide nature should pick up and move or work around them instead. Nature is there first but now man wants control. Organized society declares war on nature and calls on the Corps to enforce its control over nature.

The United States Army Corps of Engineers is assigned responsibility to build structures and mechanisms in the war for southern Louisiana. The army is already in charge there since 1812 when they won New Orleans from the British. The Army Air Corps tries to control Hawaii's erupting Mauna Loa volcano by bombing it. Later the Corps considers building a dam to protect Hilo harbor from flowing lava. Los Angeles enlists its own army with the Los Angeles County Flood Control District, also known as Flood, and the Sedimentation Section of the Hydraulic Division of Los Angeles County Department of Public Works. The Civil Defense Council of Iceland does not declare war on nature to control it like the other bureaucracies. The Council observes while Thorbjorn, the native Iceland physicist, works with nature's own forces to protect organized society.

Unlike Thorbjorn and Kim, the Civil Defense director in Hawaii, warring parties keep fighting to control nature's water and debris flows. The bureaucracies of the Corps and Flood continue to pour more taxpayer money into unsuccessful actions. Neither the Corps nor Flood accepts nature as the absolute power. Thorbjorn and Kim accept the absolute power of nature. They work with nature to successfully protect society. Neither makes war on nature to control or change the direction of its natural flows.

Atchafalaya

Atchafalaya Summary and Analysis

The Control of Nature is an historical nonfiction novel published in 1989. Events occur on a backdrop of geological time that spans eons. John McPhee tells stories about the lives and happenings of residents, non-residents, scientists, engineers and government bureaucracies in conflict with various forces of nature. He explores each region as an investigative reporter to meet and interview participants, witnesses and experts. Money, power, conflict and accidental death and destruction pervade the work. Nature and acts of God seem to get in the way of man's plans. McPhee sympathetically reveals that man causes his own disorder and destructive actions on nature and a natural order of things.

A navigation lock on the right bank of the Mississippi River lowers ships thirty-three feet down to the Atchafalaya River. From there ships can sail to the west or south. The lock is located three hundred miles from the mouth of the river past New Orleans and north of Baton Rouge next to Cajun territory. The lock is at the top of a triangular area that forms French Acadia. Its base is the Gulf Coast from the mouth of the Mississippi to Texas and its sides converge near the lock. Residents of French Acadia are called Cajuns. John McPhee recalls wearing a red bandanna in his pocket like a native Cajun when he meets Rabalais six months earlier. Norris F. Rabalais is a Cajun born and raised in Avoyelles Parish, Louisiana. The Corps hires Rabalais initially as a construction inspector at the navigation lock to watch for escaping river water. There are no navigation locks then to lower ships from the Mississippi to Atchafalaya Rivers. By the nineteen-forties the Atchafalaya River widens and deepens to equal one-third the river water volume of the Mississippi. The Atchafalaya water flow is large enough to overtake the Mississippi as master stream. Rabalais remembers being taught in high school that structures would be built someday to control the water flows.

Over many centuries the Mississippi forms Louisiana by overflowing riverbanks. The silt and sand deposits flow back and forth on an arc of two hundred miles like a pianist's fingers playing back and forth over the keys. River water flows to the Gulf by the most direct route. As silt deposits build up river water flows over its banks to lower levels that create new paths. Major shifts occur about every thousand years. Each shift of the river leaves bayous and natural levees behind. The Mississippi River course is advanced so far past New Orleans and into the Gulf by the nineteen-fifties that its next course shift would be into the Atchafalaya River. This next course shift could destroy the economy of Baton Rouge and New Orleans. The Europeans settle and develop the nation with big industries between the two cities. They rely on the river's current course to attract B.F. Goodrich, E.I. du Pont, Union Carbide, Reynolds Metals, Shell, Exxon and others. This natural course shift of the river is treated like an enemy of the state. The U.S. Army Corp of Engineers forms a battle plan to control the natural course shift of the Mississippi River.

They recall the Red River is a tributary of the Mississippi for thousands of years before the Atchafalaya River takes over its water flow. River water flows from higher to lower river levels. The Atchafalaya River has a lower river level and is a distributary of the Mississippi River. The Red River is captured when its river water flow is diverted from the Mississippi and pours directly into the lower Atchafalaya. The Red River capture foreshadows the Mississippi's fate if its river water is diverted to flow directly into the lower Atchafalaya River.

The entangling rivers look like an "H" with the Atchafalaya on the left and Mississippi on the right. The seven-mile crosspiece is Old River. It begins as a meander bend into which Mississippi River water flows to the lower level Atchafalaya. The Old River water flow must be controlled to avoid economic loss of the cities and industries that rely on the Mississippi River's current course. The project is named Old River Control. Rabalais drives McPhee over the project structure to show him that the Mississippi waterside is eighteen feet above sea level. The lower Atchafalaya side is only five feet above sea level. Rabalais explains this site is as likely to breakout as any other. During spring high water years of 1927, 1937 and 1973, more than two million cubic feet of water flow by every second. Close surveillance alone ensures that the Mississippi River does not jump its bank to divert water flows into the Atchafalaya River.

The Corps dams Old River in 1963. The Corps still uses the Atchafalaya to distribute river water to the swamps, bayous, small cities and town of French Acadia. They must maintain a fragile balance between releasing Mississippi water to the Atchafalaya and restraining it from taking over. The Atchafalaya River takes thirty per cent of the water flowing down from the north through Old River. This river water percentage amount is defined in 1950 as the latitude flow. The U.S. Congress mandates that the Corps keep this latitude flow proportion forever. The Corps constructs a dry ground weir ten miles upriver from the navigation lock. The weir is a barrier parallel to the Mississippi and designed to help control the river water flow.

Many consider the Old River Project an arrogant enterprise. Tulane professor Oliver Houck and Water Resources Research Institute of Louisiana State University unite in criticizing its conceit. They consider the Old River Project a conflict between the U.S. Government and the Mississippi River. They award eventual victory to the Mississippi. The Corps reveals their own pride by replying they are charged by Congress to defeat the Mississippi River. The Old River Control Project is essential to stop the Mississippi from following its natural course. LeRoy Dugas manages the apparatus to control the flow upstream from Rabalais' post. He works on the project since 1963 and is called Dugie. Like Rabalais, Dugie is Cajun and recalls when the Mississippi flows freely into the Atchafalaya. When he first hears of the project he is critical. He is near retirement now and worn down from struggling. His current criticism is limited to the ironic saying on his belt buckle "To help control the Mississippi". Dugie watches the diverted Mississippi spill sideways to cause a vacuum that can suck in any size boat. He remembers a man from Wisconsin in the sixties who paddled a canoe-like craft down the Mississippi to the Atchafalaya. The Old River current pulls him off the Mississippi River and shoots him through the Old River Control structure. McPhee calls it an exciting place but Dugie says it's where Murphy lives, meaning if anything can go wrong

it will. McPhee tells about the canoe story to foreshadow the towboat Mississippi's grounding by the Atchafalaya's river current.

In late summer or early fall Major General Thomas Sands makes an annual Low Water Inspection Trip on the Mississippi. He captains the towboat Mississippi. The boat is a regular two hundred seventeen foot long, fifty foot wide modified towboat of four thousand horsepower. General Sands begins at St. Louis and stops at river towns to pick up visitors. He takes note of complaints on his way south to the Atchafalaya. Towboats actually push rather than tow barges. The Mississippi towboat is luxuriously outfitted for important people to push the Army Corps program. It arrives in the morning at Old River for the Atchafalaya Basin Levee Board, East Jefferson and Pontchartrain Levee Boards, Louisiana Office of Public Works, U.S. Fish and Wildlife Service and other dignitaries to board. The towboat enters the lock to be lowered twelve feet to the Atchafalaya. Pilots stand by to navigate the ever-changing shallow areas of the Atchafalaya. The Mississippi River Commission mandates regular trips to inspect flood-control and navigation systems and hold hearings. New Orleans District U.S. Army Corps of Engineers is comprised of ten Army officers and fourteen hundred civilians. The Army is still involved in the area from the War of 1812 when engineered fortifications are necessary. Congress mandates the Corps survey the Mississippi and tributaries to assure and improve inland navigation.

The General conducts his annual journey down the Mississippi like a floating convention. Four more dignitaries arrive by plane to join the towboat. The livelihood of almost three million people is affected by the Old River Control. Before the project begins operating residents accept the natural river water flows. Now that it's operating competing interest groups complain to the Corps. General Sands tries to settle differences while aboard the Mississippi. He worries that the people think the Corps has unlimited power to act. The towboat enters the treacherous Atchafalaya amidst the trees. Pilots steer the Mississippi towboat to port side. McPhee recalls speculation of the lower Atchafalaya River taking over the Mississippi River's water flow. Civilian engineers in the pilothouse discuss the Atchafalaya's capture of the Red River before Old River Control. McPhee asks them what the chance of capture is. The Mississippi towboat sailing between levees and trees symbolizes the river. It lurches and shudders when the Atchafalaya ironically captures the flagship Mississippi of the U.S. Army Corps of Engineers by running it aground.

For ten years after Old River Control begins operating in 1963 the project seems to succeed. From Cairo, Illinois south to the Gulf of Mexico the Corps confines and controls the river water flows. The Corps issues a victory statement. However in the fall and winter of 1972-1973 river levels rise higher, snows are heavier in the North and the South has excessive rains. The Mississippi runs slower and deposits more sediment than during the previous ten years. Spring runoff makes the river run higher. Levees are too low to contain it. Sandbags are added to raise levees for eight hundred miles. Barriers of uncompacted dirt are added. Rains fall up to twenty inches in a day and a half. At Old River Control a slab of water six stories high is seen upriver. The continuing spring high water that drains Middle America to Old River exceeds two million cubits a second for week after week. One fourth of the water flows from the Mississippi to the

Atchafalaya River. Surrounding trees and fields are covered with a brown sea of flooding river water. Only the Corps' narrow dry ground barrier built to control the river flow is visible ten miles upriver from the navigation lock.

Raphael G. Kazmann, professor of civil engineering and author of *Modern Hydrology* drives north from Baton Rouge to Old River in mid-March. He walks out on the five hundred and sixty-six foot structure but leaves quickly when he feels its two hundred thousand tons vibrating. He thinks the Tennessee and Missouri Rivers are responsible for the high water and worries about the Ohio adding to it. Water velocities are highest where the water plunges over the concrete falls into the Atchafalaya. They are designed to disperse waterpower but not the amount this spring's high water flow creates. At the inflow apron turbulent swirling water excavates underlying sediment of the structure itself. At the outflow to the Atchafalaya a hole larger and deeper than a football stadium forms unseen beneath the wild water. The Corps opens all eleven gates to reduce the water's force against the shaking structure. Increased water volume worsens the erosion. Pilings anchor the structure ninety feet down in sand and silt. Solid rock is seven thousand feet further down. Dugie recalls a shaking structure in the '27 high water that forebodes the Corps' fears. A train full of coal is parked on a bridge to weigh it down. Vibrating creates friction that enflames the coal and it all falls burning into the river.

In the April 1973 flood a fisherman walks onto the structure to fish. He foretells what the Corps soon finds. The fisherman sees the guide wall move. He tells Dugie at the north end of the structure but Dugie says he's seeing things. Later Dugie looks for himself and watches it slip into the river's inflow channel. Its foundation is eroded away. The Corps checks the foundation with a camera through a hole in the structure. They find only fish.

Three hundred years of trying to control the Mississippi do not succeed. The Old River Control project symbolizes the failing effort. Ambition drives people in the area to build towns and cities where even campers would not pitch a tent. There is no solid ground but the French settlers establish New Orleans anyway. Floodplains extend for one hundred miles wide. In spite of this for military and commercial purposes in 1718 they position New Orleans while foundations fill with water. The Mississippi River meanders at will over the floodplain and tepees are moved around it until this period. The natural state is no longer accepted by the people of Louisiana in New Orleans. Natural levees rise up higher with sediment close to the river. There is no other higher ground available so they build houses on these natural levees. In the years 1735 and 1785 New Orleans is flooded. Fifty years pass between the floods that allow time to extend and raise the levees. Higher and extended levees bring back a false sense of security from flooding. By 1812 the Mississippi's west bank is levied a couple hundred miles upstream to Old River. The east bank of the Mississippi River is levied all the way to Baton Rouge. Riverbanks are levied by private plantation owners to protect their own land. Levees are not continuous until 1828. When they are connected however they close off Bayou Manchac, which is the only outlet to the east that can release water flow pressure. Ironically the higher and continuous levees increase the risk of loss from flooding.

Henry Shreve changes the Mississippi forever. He introduces the Mississippi steamboat that needs clear river ways to navigate. He is appointed Corps Superintendent of Western Improvements. He is responsible for pulling huge trees, called snags, from the river with the multihulled snag boats he invents. While clearing eighty miles of river in one year he sees a turn or winding of the stream, called a meander, at 31 degrees north latitude. The stream winding forms an eighteen-mile west-bending loop that doubles back on itself. Shreve modifies a snag boat to dredge, or dig out and remove dirt from across the loop's narrow neck. Mississippi River water flows into the neck opening. Within days the river current dredges a main channel where the Red-Atchafalaya conjoins the Mississippi. He plans a smoother shorter way for boats, faster Mississippi current and lower flood crests. Ironically he increases the flow of water from the Mississippi into the Atchafalaya and causes the Old River to act like a drain on the Mississippi River water flow.

Riverfront property owners build levees to protect their own land. The levees protect all the land behind them regardless of ownership. Levee districts and boards form to spread levee costs and local government. By mid-century the United States Congress passes a Swamp and Overflow Land Act. The Act authorizes the Federal Government to deed swampland to individual states. The states sell it to cover costs of levee construction and maintenance. The new absentee owners drain the swamps to use as farmland. They then demand higher levees to protect their more valuable farm property. River levels increase as the outlets for river water decreases. Landowners demand still higher levees. In the eighteen-fifties the Corps is not in control of the area. Individual levees are under local control. The levee system is constantly debated. By 1860 the system is a battlefield that needs army control. River levels in 1870 are higher than ever before. Congress forms the Mississippi River Commission in 1879. The Commission is led by an Army engineer whose decisions are subject to veto of the Corps commandant.

James B. Eads is an important civilian member. Eads invents a submarine to explore the Mississippi River. He also develops a way to maintain navigation at its mouth where the Mississippi flows slowly. The slow-moving river water deposits tightly packed masses of sediment. Deposits at the river's mouth are too thick to dig out or dredge. Ships are unable to navigate. The built up sediment blocks ship entry to the Mississippi River at its mouth. Eads designs two parallel piers or jetties to construct at its mouth. The jetties are engineered to pinch or confine the current between them. Confining the current forces it to dig out and maintain a navigable channel.

The Mississippi River Commission follows a hold by levee policy that refuses to let any water escape the river. Theory behind their policy assumes that holding all river water in the river produces the greatest power. Full river waterpower is the most effective way to scour the riverbed, deepen the channel, increase water velocity, lower stages and prevent destructive floods. The hold by levee policy is practiced by maintaining, reinforcing and building levees. Levees are raised from six to twelve feet high using manual labor. Over twenty years floodwaters average eight feet in Memphis. In 1927, however levees break for a thousand miles. Floodwaters cover twenty-six thousand square miles and stay for three months. Hundreds die but it is not a record hundred-

year flood. New Orleans is saved ironically by blowing up a downstream levee to let the river water escape.

By the nineteen-twenties levees are six times higher but no more effective than earliest ones. The trial and error experiment is tested over fifteen hundred miles. The 1927 flood shows that levees make the problem worse. Laws of nature do not change and attacking them can increase their force. In 1928 Congress enacts the Flood Control Act to start the Mississippi River and Tributaries Project. The Project gets three hundred million dollars to begin but eventually costs seven billion dollars. The coordinated project raises levees, aligns currents and builds dams, gates, spillways and floodways. The Design Flood plan should protect up to twenty-five per cent more than the 1927 velocity high point of three million cubic feet per second passing Old River. Ten years later the Corps succeeds as the 1937 river crest bypasses New Orleans to leave it low and dry. Flood control design of 1928 opens Old River at the Atchafalaya to let it take up to half the Mississippi water. Atchafalaya's water volume by 1950 makes it the third or fourth largest river. Its slope exceeds the Mississippi's by three to one. It is predicted to take over the Mississippi by 1975 and shift the river's mouth a hundred miles away. This prediction invalidates the Mississippi River and Tributaries Project. Acceptance of the prediction would require rebuilding the southern Louisiana levees. Old River Control is authorized in 1954 as an alternative. The Old River Control project proves inadequate for the great flood of 1973.

The Design Flood project is engineered to support a twenty-five per cent increase over the 1927 high point in river water flow velocity. However, the twenty per cent increase in velocity that actually occurs in 1973 almost wipes out the project. Exploratory drilling in the structure reveals the increased water velocity eroded a football stadium-size hole in its foundation. The Old River Control structure is the highest priority project because it is all that protects the Mississippi River from the Atchafalaya River. Gates are left open to minimize pressure on it. The structure is drilled and filled for months with cement and bentonite, but the Corps cannot control its increasing flow. The Atchafalaya digs deeper and diverts more Mississippi River water. Foundation erosion and undermining of 1973 is permanent. The maximum allowable difference between levels of the Mississippi and Atchafalaya decreases from thirty-seven to a still unsafe twenty-two feet. Regular 1974 surveys reveal three holes that need a hundred and eighty-five tons of rock to fill. The Corps reassures a legislative committee it can control the Mississippi with its new model.

A three hundred million dollar new structure called the Old River Control Auxiliary Structure is designed with gates weighing twenty-six hundred tons and sixty-two feet wide. The Old River Control project cost eighty-six million to go on line in 1963. It fails in 1973. Repairs and supplements increase costs to five hundred million before the third greatest twentieth century flood of 1983. Old River Control Auxiliary Structure is still just foundation then. The 1973 flood is a forty-year flood. A one hundred year flood can occur anywhere on the Mississippi. Kazmann confides to McPhee no one knows about a hundred year flood. A fifty-year prediction is unreliable. The Corps does not know what may occur. Kazmann calls it planned chaos, ironically more planning causes more chaos.

The Mississippi hits a sandbar to starboard despite its port side depth of thirty-eight feet. Dignitaries on board the floating conference run to the rail to see what happened but the pilots show no surprise. Dugger cuts the engines and the river current swings the stern wide and off the sandbar. Sands and his colleagues continue discussing land use in lower Mississippi since 1973. Despite seven high-water events the auxiliary structure model reassures them the Old River Control can work. They question whether the Atchafalaya can take the Mississippi near the control structures. They wonder if people can exist in southern Louisiana under natural circumstances. Until 1900 the river brings sediment to the delta to replace compacting, condensing and sinking old sediment. Land building is still net positive through porous banks of the Mississippi. Floodwaters provide nutrients that allow vegetation to grow, decay and form soil. Since then water cannot escape the Mississippi until below New Orleans. The area loses land that floodwaters could build.

Half of New Orleans is fifteen feet below sea level. Rainfall is pumped out of its broad shallow bowl shape to avoid rising city lakes. Houses built on slabs over pilings show the turf sinking. Dwellings seem to rise from the ground. Cemeteries are aboveground and flash floods free coffins to float. The river through New Orleans is like an elevated highway. Boat hulls can be seen above the levees. The waters rise but levees sink. Five feet of new ground nets two feet after sinking. Louisiana loses over fifty square miles of land yearly. A hundred years loses a million acres. Kazmann doubts the coast can be saved but the Corps will not give in. The Corps pompously asserts that society finishes artificially the job that nature does not complete.

The towboat Mississippi breaks free from the sandbar. Conversation and card playing resume on General Sand's floating conference boat. Oliver Houck is the only board member active in the environmental movement. He stands apart on an upper deck to survey the river swamp they work for years to save. General Sands joins Houck to talk. He notices Sand's military uniform. Houck notes its intimidating impact on civilians that respect a military presence. General Sands reminds him the U.S. Army Corps keeps his neighborhood safe from nine feet of water. McPhee says the General is not as military as his title indicates then recalls that Sands parks where he wants in Vicksburg for lunch.

Houck reflects on the old Cajun swamp life of the Atchafalaya Basin. The concentrated floodway and law forbids living inside the levee. He recalls the bayou's beauty. McPhee recollects his first time in Atchafalaya swamp with Charles Fryling in 1980. Atchafalaya reminds him of floating among trees under silently flying birds. Atchafalaya means *long river* in native Choctaw. Since the Corps takes control Atchafalaya means *collision* to McPhee. It is symbolized by Fryling's bumper sticker gift to him. A tug of war between dry land and water is ongoing since then. The Corps keeps a fragile balance of floodway, fish way, oil field and Eden. Conservationists, the Corps, landowners and interest groups turn the seventeen-mile wide and sixty mile long swamp into half what it once is.

Old Cajun bayou life is not lost but much less than it was. McPhee recalls a crawfish trip with Mike Bourque, a craw fisherman in the bayou to check traps. He uses an aluminum

boat and motor to power over fallen logs rather than to canoe around them. Bourque and brother in law Soileau speak in mixed French and English. They recognize where others come from by their accent. Crawfish traps are pulled up by cords. The catch is poured into a trough. Live crawfish crawl down into a bucket and trough remains are discarded. Full buckets are emptied in forty-pound sacks of live crawfish that move when touched. The craw fishermen mark their lines on trees with colored ribbons called flags. Traps are placed carefully so crawfish don't die in the mud. Theft by other fishermen is settled on the spot with fists. Trespassers are arrested and taken to court by the oil companies.

Lunch is ham sandwiches, Royal Crown and pork skins at seven-thirty in the morning. The fishermen have been up since three-thirty. They discuss crawfish recipes and boils that McPhee misunderstands as balls. After lunch they travel the trap line and notice fat beaver, nutria, snakes and birds. They note the Corps' water and mud mix and its effect on craw fishing. McPhee suggests they complain to the Mississippi's floating conference but they don't know about it. McPhee recalls Rabalais saying they don't complain before the Corps because they accept what nature offers. Bourque suspects swamp fishermen are being squeezed out by the Corps for the artificial pond crawfish farmers. Old River structures that control the river flow suggest his suspicions may be on target. Bourque admits levees limit the area that crawfish spread. He sells the day's catch at the landing for three hundred and sixty to a poet who admits there's no market for poetry.

McPhee views vegetation from the Mississippi's rail as it travels down the Atchafalaya in the middle of the swamp. The others speculate that if the Mississippi River shifts into the Atchafalaya the basin would fill with sediment and become bottomland hardwood forest. Houck claims the petroleum industry would adapt and turn Morgan City into a new New Orleans seventeen miles from the Gulf. McPhee walks through the lounge where wagers are bet on the dignitaries' card game. He sees Morgan City behind a twenty-two foot high protective wall through a picture window in the lounge. Morgan City is on an island directly in the path of the Design Flood that the seawall is built to protect. The town is surrounded by water. The seawall is part of the eastern guide levee system. This system controls water that nature previously let flow to the swamp and river. Morgan City relies on the Corps at Old River Control like a space platform depends on Mission Control.

At nine o'clock in the morning hearings begin in the lounge where card games are played the night before. Three generals and two civilians of the Mississippi River Commission sit at the table to hear petitioners. One of the backwater people feels neglected. Another feels relief for the seawall but wants the levee extended south. A third is grateful for the Corps. Doc Brownell, former mayor of Morgan City, says the height of the wall makes them apprehensive. Doc claims Morgan City is like the spout of a funnel where floods last for months.

McPhee's thoughts drift back to Old River where the stories begin. The Corps also runs a smaller towboat, the Kent. This boat is designed to protect Old River Control with its squared bow to catch, hold and assist any vessel in trouble. Kent is a twin-screw eighty-five foot long, steel motor tug. Its two nine-hundred-horse diesels start at the touch of a

button. It has modern radar, multiple computers and a radar beam to detect the speed of a ship from eight miles away. Before the Kent is put in service in 1964, eight unattended ore-laden barges break free and are sucked into the Old River Control structure by the Atchafalaya. Three sink in front of the structure and water piles up to thirty-five feet. Approaching vessels notify the Kent. A sign on the bank warns of the dangerous draw. Dugie claims vessels on the right side are in trouble. The control structure is called the second locks. It is often mistaken for Old River Navigation Lock. Major General Sands says Old River Control Structure is in the wrong place but the Corps keeps it there for economic reasons.

Cooling the Lava

Cooling the Lava Summary and Analysis

Thorbjorn Sigurgeirsson is a native of Iceland. His idea to stop lava flows by cooling is not tried before. He believes it can be done. Thorbjorn is a physicist. Since his father is Sigurgeir, he is named *Thorbjorn Sigurgeirsson*. Many are skeptical of cooling lava in Iceland. McPhee flashes back to February 1973, when a small town and harbor on an offshore island is threatened by red-hot lava. Residents spray the moving lava front with fire hoses. Their televised efforts produce clouds of steam. The Civil Defense Council in the Reykjavik National Emergency Center watches Thorbjorn's experiment with interest.

The Center is established in 1962 as a command-post bomb shelter for nuclear war. Within a year the Council worries about the effects of lava flows on the Atlantic Ocean and the islands of Vestmannaeyjar. The Council broadens its charter to include acts of God. It begins a campaign after January 23, 1973, when a five hundred foot high, mile long lava curtain erupts into the sky above Heimaey's five thousand residents. This is the only populated island of the Vestmannaeyjar. McPhee provides a sense of physical and economic scale by comparing Heimaey's size to Manhattan south of the Empire State Building. The amount of lava spewing out could cover the New York financial district. Vestmannaeyjar has two and a half percent of Iceland's total population but produces one-twelfth its export income. It is proportionately more valuable than downtown New York. Heimaey is the most important fishing center. A wall of lava moves towards the harbor.

They train hoses on the lava front to create a chilled wall of lava. It is not thick enough to stop a flow. Lava must be chilled at the edges and acres of surface. More pumps are used to spray on the lava's surface. McPhee recalls an experience in Hawaii where lava forms new rock. The surface develops a skin of glass that breaks and rebreaks from the hot lava moving underneath. The glass skin clinks and crackles like a campfire. McPhee visits Vestmannaeyjar fifteen years after its eruption when no lava flows. He notices that steam still rises and the ground is hot below a third of an inch. The interior of the 1973 flow is still liquid under insulating ash. During eruption the pumping crews can walk on a two-inch crust. A bulldozer is supported on a foot and a half of crust. A crew of five works with a dozer to operate it through the dense warm fog created by pumped seawater. Dozer tracks turn dark blue from the heat. Workers keep moving so their boots don't flame up. Sigurdur Jonsson is an Iceland resident who works on pumping crews in 1973. He tells McPhee about his experiences. The pumping platoon has seventy-five in a corps of five hundred workers. Hot lava stops glowing red under fifteen hundred degrees. The hose is moved when steam stops rising and water runs down the lava. It can take hours or days for lava to turn black and lose its red glow. Throats get hoarse from its vapors. Doctors dispense *Norwegian chest drops* to soothe them that are a euphemism for shots of whiskey or gin. Workers wear boots and protect their wrists from burning if they fall. Helmets protect them from falling ash and ejected lava

exploding like bombs. Luckily fiery rocks miss them. They work away from big lava bombs unless on crater watch.

Thorbjorn tells McPhee how to avoid volcano bombs on a crater watch. Two walk together in pairs one looking up and the other down. In Surtsey's eruption he records temperatures and measures the magnetic field. Thorbjorn's training is in fission tracks and particle physics. On his return to Iceland he becomes a volcanologist. He recalls watching a hut on Surtsey in the sixties threatened by flowing lava. He sees it follow the coastline and seem to cool by the sea. Thorbjorn wonders if the effect can be man-made. He plans to test his idea. When Heimaey begins to erupt he visits there to measure lava temperatures. He stays in the same building as the fire brigade. Thorbjorn inspects their pumping equipment, hoses and shares his idea. A couple weeks later they test his idea on the coastline. The Iceland television station broadcasts his experiment. Thorbjorn sees water solidify lava but never cool it completely. He calculates that one cubic meter of water can cool seven-tenths of flowing lava to hard rock. Initial observations and testing indicates successful cooling of lava with water but not the amount of water required.

Coordinated pumping operations are run by the fire chief of the American base named Sveinn Eiriksson. Heimaey residents call him Patton. His nickname comes from the famous U.S. Army general that manages a successful military campaign. Patton and Thorbjorn comprise a winning team. Thorbjorn's idea works with Patton's characteristic action and aggressive command. Thorbjorn thinks through and Patton implements his ideas. Thorbjorn and Patton assess conditions, form strategies and decide on their plan. They consider just abandoning Heimaey but worry the island itself might explode from hydrogen emissions. Eruptions continue through February 5. They name the day Black Monday. Lava sprays up a thousand feet and the town is enveloped in pitch-black dark at noon. Ships are warned away from port. Residents believe the battle ends on Monday but it is not yet begun. Black Monday forebodes worse still ahead.

McPhee flashes back to before the eruption in predawn January 23, 1973. There is no warning. Some feel vibrations but think it's from the central heating or settling of earth common to Iceland. A seismometer is a geological instrument used to measure intensity and location of earth vibrations like earthquakes and volcanoes. Mainland seismometers assign the vibrations to other volcanoes or do not indicate an eruption. Two seismometer readings can give an unclear or confusing location of an epicenter. A third seismometer reading would allow scientists to locate the center of activity. Without a third reading the uprising magma is not established under Heimaey. One resident sees the earth crack open and leaves with her sons never to return. Two others begin taking pictures of the lava curtain rising. Others leave for a night or two. Four thousand calm residents depart the island in three hours. McPhee contrasts Heimaey to another erupting volcanic island where residents flee in panic and fearing death cause their own. Heimaeyans are calm.

Heimaey begins erupting in fields of beautiful settings visible on nearby islands and the mainland. Many farmers and fishermen leave Heimaey for the first time. Ships, planes and boats evacuate residents and livestock. Houses in town are left with lights on and

doors open. McPhee recalls Magnus Magnusson taking him to visit an old monument replaced on top of three hundred feet of basalt. They read its inscription and view the landscape. Magnus tells about his fear as a child that Helgafell will erupt again and the Turks will return. He tells of other disasters the Vestmannaeyjar people survive. Three fishermen whose boat capsizes swim to shore in freezing water but only one survives eight hours of struggle. Doctors conclude his fat layer is like that of a seal. Magnus is mayor in 1973, when the lava flows. He tells Thorbjorn they must protect the harbor before the town because without the harbor there is no need for a town. Magnus tells McPhee about a foreboding omen. They believe when the pond Vilpa fills up there will be a disaster. Vilpa fills up in the first days of January 1973.

The author uses the Vilpa omen discussion as a bridge to bring the storyline back to the erupting that continues through mid-February. Lava flows to within a few hundred feet of closing the harbor. Thorbjorn consults with Valdimar Jonsson, Professor of Thermal Fluids who recommends using ten times more water. They pump thirteen thousand gallons daily. Steam makes the cooling more efficient. Thorbjorn flies back and forth to Reykjavik, Iceland's capital city. Patton stays on the island. He worries that nothing may run if he leaves. Sigurdur Steinthorsson is an Iceland native who monitors volcanic gases by smoking cigars. A burning cigar snuffs out if carbon dioxide levels get too high. A filmmaker calls it a war zone and his wife says it sounds like hell. It is very cold but the volcano warms them and foreshadows Heimaey's heating benefits from the hot lava.

The erupting volcano grows to seven hundred feet above sea level. In mid-February small molten lava streams appear near the bottom on its north side. Patton pumps more water on it. The north side of the mountain breaks loose. It begins to move towards the port. Lava flows approach the harbor's breakwater at a rate of one hundred feet a day. It is likely to cross the breakwater and fill the harbor. They relocate water nozzles to more effectively spray the lava surface. The ship *Sandey* from Reykjavnk provides five times more water to pump over eleven and a half million gallons daily. Lava flows stop at the breakwater's edge. The north side of the volcano floats like an iceberg. Its moving outline fills the sky wherever one looks up from town. They euphemistically name the two million ton moving mountain *Flakkarinn the Wanderer*. It floats toward the harbor. Thorbjorn decides to block it with a natural barrier of cooled lava rather than a man-made barrier. He picks a section of lava in the Wanderers path where they can pump seawater. Thorbjorn plans to pump seawater below surface in its molten cracks to cool them. They set up a piping system on a lava field he thinks the Wanderer is moving towards. They pump thirty million gallons of seawater on the lava field to cool it. Wanderer crashes into the cooled lava. The moving mountain section breaks up into nonmoving pieces.

Thorbjorn saves the harbor by cooling lava in the path of the moving mountain. Victory encourages Iceland to find the most powerful and mobile water pumps available. A new lava flow erupts after Wanderer's ruin. The new lava flow heads directly to town. It is named the *City Flow*. The City Flow crushes houses in its path like eggshells. Crews fight to dismantle and save their pipelines, pumps and equipment from molten lava. The loss of houses is secondary. They wonder if successful hardening of lava to destroy the moving mountain makes the City Flow worse. Human meddling may cause worse

effects because results are not natural. Defeating nature may bring about greater loss. Iceland protects its natural harbor and equipment and wonders if its efforts cause more damage.

Historical attempts to control lava do not confirm successful solutions. The Hawaiian Research Association forms in 1911 with a mission to stop any more lava from burying cities. They consider using field artillery to achieve the goal. The U.S. Army Air Corps bombs an insulating vent on the Mauna Loa volcano in 1935. The attempt clogs it with debris and forces lava flows aside. However, Mauna Loa stops erupting before results can be confirmed. Bombing is tried again in 1942 when the port city of Hilo, Hawaii is threatened by another Mauna Loa eruption. Hawaiian natives accept eruptions as acts of God. They pray and make offerings rather than bombing attacks. Mauna Loa erupts on average every three and a half years over two centuries of recorded history. There are five volcanoes in the group that includes Mauna Loa. Kilauea is another volcano in the group that erupts continuously throughout the nineteenth century. The U.S. Geological Survey claims Hawaiians are fatalistic and believe man should let nature take its course.

The National Oceanic and Atmospheric Administration builds small buildings in 1986 to house expensive instruments. They protect them with a barrier from lava flowing down from eleven thousand feet on Mauna Loa. The barrier forms an island, called a *kipuka,* in a river of lava. Barriers are proposed to protect Hilo, which is Hawaii's second-largest city and port. Hilo's loss would devastate the economy in 1958. The Hawaii County Civil Defense Agency issues standing orders that firefighters do not stop or divert lava flows. Hilo is often threatened by lava flows. However, they all stop within a dozen to one mile of the port without using man-made barriers. Iceland's success at cooling lava in 1973 is well known in Hawaii. Patton visits Hawaii in 1984 to meet Harry Kim, the head of Civil Defense. They discuss the Corps' proposed dam and reservoir at Hilo. Patton tells Kim their idea is ridiculous. Kim thinks it comes from the mindset driven by a need to do something. The Corps wants to use their resources regardless of results.

In 1984 the Mauna Loa eruption lasts three weeks. The eruption that occurs at the same time on Kilauea lasts for years. McPhee views the terrain flying in to Hawaii's Keahole Airport. He notices similarities to Iceland with rivers of lava frozen in time. He visits Heimaey to see a volcano inactive and quiet for fifteen years. Kilauea is not quiet for fifteen minutes. They put on fire-resistant flight suits for the helicopter trip to Camp 8. The camp is on a kipuka in a newly hardening river of lava. For over a year Kilauea's magma flows out to a lava lake hundreds of feet across. McPhee is guided by Christina who is a volcanologist. She says the lava field is wide as the Mississippi at New Orleans and lately a forest. Volcanologists test Kilauea's expanding rate before they walk on the solidifying lava's glassy surface. The group walks to a lava lake with sheer crater walls forty feet high. Surface crust forms on the lake and moves from side to side. Fresh lava rises over crusting lava surfaces that slide under. McPhee compares lava lake movement to the earth's crust or plates that move and slide past, over and under one another. Lava lake air is acrid, sulfurous and intense. Hawaii's lava does not explode like Iceland's.

Iceland and Hawaii are the world's most productive geophysical hotspots. The twin formations release core heat plumes that rise two thousand miles. Thrusting heat hits the underside of sixty-mile thick earth crusts. The rising heat repeatedly punches up as plates move. Five thousand miles of Hawaiian Islands are created as the Pacific crust passes the heat source. Hawaii's oldest islands Niihau and Kauai are volcanic peaks for five million years. High peaks are Mauna Kea and Mauna Loa. The Pacific Plate moves as Kilauea builds islands by erupting. Iceland forms in the North American Plate and Eurasian crust. It sits on the Mid-Atlantic Ridge spreading fifteen hundred miles each way. Iceland's west moves with North America and its east moves with Europe. The extreme east and west sides of Iceland are old rock of fourteen million years. Iceland's center is made of young and fluid rock with no significant geological age. The Mid-Atlantic Ridge spreads a forty-mile wide center in the Icelandic mainland. Iceland's center and Vestmannaeyjar are both on a line of maximum action called the volcanic zone.

John McPhee walks the streets and roads the of town years later to see how the residents recover from the 1973 eruption and City Flow. He describes houses that are not repaired and still vacant. Less than two weeks after eruption, the Icelandic parliament increases national sales tax to pay for Patton's crew and damages. The Iceland community owns all land. Heimaey residents own their houses but rent their lot from the community. The current mayor tells McPhee a third of the evacuees do not return. Residents before the eruption number fifty-three hundred but six hundred less after eruption. Many evacuees stay on the mainland to avoid the gray pumice-grit desert that is left after eruption. Newcomers are drawn to the island by cash-paid fishing and construction jobs.

John McPhee climbs to the top of the monument for a panoramic view on a clear day. An arrow and tablet is on the highest part of the crater rim. He moves the arrow to read names of islands and volcanoes. He visits the new volcano to see the heat exchangers that the community uses to convert lava into a central-heating plant. Water is captured as steam for heating that saves Heimaey two million dollars yearly. Ironically, the process used to save Heimaey from disaster now saves it money. Eruption narrows the harbor from half a mile wide to five hundred feet. It becomes less dangerous from eastern wind and waves. Another day McPhee walks along the boats in the harbor and talks with a net man painting a trawler hull. He is new to the area but proud of its fishing record and the natural harbor that the lava makes. On another day McPhee walks out a neck of land on the north side of the harbor. Children, adults and parents visit there to release puffin chicks for their first flight. Adult puffins are caught for food but puffin chicks are freed to fly away. The puffin is a representative bird of Iceland that McPhee calls iced toucan. Cooling lava flows cost one and a half million dollars. It provides thirty million dollars in heating, harbor improvements and paving materials. The disaster now benefits them.

McPhee flashes back to the eruption when nineteen American invasion pumps arrive in the tenth week. They pump gasoline from ships offshore to help invading American troops. Ironically they are used in Heimaey to stop the harbor invasion of lava. The system pumps twenty-three million gallons daily for one hundred and three days. Each

time the lava stops pipes are moved closer to the crater. Five and a half months after eruption, Thorbjorn goes into the crater to proclaim the eruption dead. He recognizes true victory is uncertain because luck is inaccessible. To say they can stop a volcano may be so prideful as to cause a new eruption. Despite success Thorbjorn respects the power of nature. He is not proud or presumptuous that his efforts control the forces of nature.

Los Angeles Against the Mountains

Los Angeles Against the Mountains Summary and Analysis

The struggle between Los Angeles and the San Gabriel Mountains shifts back and forth from winning to losing. Bob and Jackie Genofile can see over Los Angeles to the Pacific Ocean bays on a calm day. Their one-acre home site is high in the mountains. Years ago they wake on a February night from sounds of lightning striking the mountain. The quiet neighborhood usually has only sounds of the creek dropping out of Shields Canyon to the Los Angeles River. River systems across the city from mountains to ocean are modified by man. Riverbanks and beds are concrete-reinforced. When boulders fall down the mountain they sound like rolling freight. The creek is silent despite the rain.

The Genofiles two teenage children are Scott and Kimberlee. Their rooms are on the uphill side of the one-story house. Scott's window opens to Pine Cone Road that is the northern city limit on the ten thousand foot high mountain. The opposite city limit is the Pacific Ocean. Los Angeles communities have no more area to sprawl between the rising San Gabriel range and the ocean. The children are joined by their mother in Scott's room to view Pine Cone Road. Its three-hundred-foot straightaway ends at the Genofiles home after downhill twists and turns for half a mile. The creek that flows under the street is plugged by a boulder. Water spreads over the street. The lightning exposes a massive blackness moving towards their house. Debris flows amass in stream valleys. They are made of water, solid materials and boulders the size of cars. This debris flow carries cars from farther up Pine Cone Road. It crashes into the Genofiles house. Shattering safety glass explodes and mud with boulders pours into the hall and through the house. The house is built by Bob Genofile so its steel reinforced concrete block walls do not move or shake. He is on the opposite side of the house kicking out panels of glass in a bedroom to open an outlet for the water and boulders. They run to the parent's bedroom but the door crashes in and mud, water and rocks pour in after them. Bob is anxious about the roof holding up in the twenty-year-old house built before Pine Cone Road. They jump on the bed as it rises to the ceiling and is pushed to the wall. Each parent holds a child as the debris flow rises and fills the house in minutes. The mudflow rises to the children's chins. Boulders land on the roof and thirteen cars surround the house or lie in the pool.

The Genofiles are fortunate no one is injured or buried by the debris flow. Generally property is the major loss since people can escape. Some flows catch up with or overtake fleeing cars. This flow stops a mile above Foothill Boulevard but many flows spill over it and beyond. Identifiable objects carried along in their path can be used as evidence in lawsuits. Potted nursery plants, tree trunks, boulders, automobiles and coffins can all be relocated by the powerful flows. Deflection walls can be used to redirect the flow when combined with an open outlet. Floods caused by record rainfalls

are so dangerous that even a bulldozer is not safe if a mountain breaks loose and flows downhill like cement.

The semi-desert climate of Los Angeles requires the city import water from hundreds of miles away despite its flash floods. It is located where two tectonic plates grind against each other. The city must organize priorities among the elements it tries to control. In days it can catch twenty-eight million dollars worth of water. In twenty-four hours it can also be hit with twenty-foot ocean waves, tornados, debris flows from San Gabriel and an earthquake. Costs may be forty million plus another twenty million to clear debris. Only the city's strategies in dealing with the mountain keep the cost from running into billions.

A hundred and twenty bowl-shaped excavations, some as large as football stadiums, line the San Gabriel front to catch debris. These debris basins or dams are blocked at the downstream end with earth fill or concrete barriers. They protect properties of the rich and famous living below. The basins are located over fifty miles and seven hundred yards away from each other. They are worth millions. Their names are unknown unless they appear in the headlines. The Los Angeles County Flood Control District, also called Flood Control or by its nickname Flood develops basins. Flood then turns them over to the Sedimentation Section of the Hydraulic Division of Los Angeles County Department of Public Works to manage. Eight million people live below the mountain on the coastal plain. The residents are protected by debris basins. They catch and hold mountain debris or rubble before it reaches populated areas. Other concrete structures are built in canyons above debris basins to slow the plunging mountain streams. The stair step design makes erosion less effective. At the plain where the San Gabriel River, Los Angeles River and Big Tujunga enter three different style and size debris basins keep the rivers open. Cost of the structures is charged to all residents because they all benefit. Boulders and other debris caught at the basin will not block inner city channels and cause floods. The typical basin design has a column in the center with holes. A watery mix of water, mud, sand, rocks and other materials, called slurry flows into the debris basin. As the basin fills with slurry water runs through the column holes for harvesting. Sand-and-gravel contractors can operate quarries in the basin to remove debris from the eroding mountains.

McPhee's storyline flashes back to the Genofiles who are thought dead by would-be rescuers. The house is buried. No signs of life come from the family caught in the dark underground. A neighbor asks if they're alive. The Genofiles call out and are rescued. Before the debris flow begins a crew from Flood drives up Pine Cone Road. The crew is checking a debris basin called Upper Shields. Flood builds it two years earlier to protect Pine Cone Road. When Upper Shields overflows it catches the Flood crew and truck in its debris flow. Bob Genofile surveys damage surrounding their home but finds no walls cracked in the uninsured property he built. The Genofiles and their neighbors are sure debris basins can protect them before this storm. Bob Genofile rebuilds since their house is built like a fort. They win three hundred thirty-seven thousand five hundred dollars in damages from the County's improper design and maintenance of the Upper Shields basin. Ironically, their rebuilt house wins an award for good maintenance and sense of drama.

McPhee does not identify dates of destructive debris flows. The author uses this literary device to suggest continual flows. Geological events over millions of years make every decade or so occurrences seem constant. Residents move frequently and short memories make ten years between flows forgettable. Debris flows do not occur everywhere at the same time. They occur in different places and at different times. Exceptional flows in some years are not frequent enough to stop building houses in their path. Several factors make debris flows possible. Broken-up rock and heavy rainfall are two factors. Unless the factors occur in order however they are not sufficient to cause a flow. Wade Wells is a hydrologist in San Dimas Experimental Forest. His job involves researching erosion and sedimentation. He experiments on plants, rock, water and fire. Wells tells visiting scientists the mountains rise faster than they erode. The San Gabriels are three thousand feet higher than the Rockies and closer to the sea than Mt. Washington.

Wells and his assistant Edwin Harp take mountain soil samples on an eighty-five per cent incline. McPhee watches them do their research. He remains seated taking notes despite the sharp needle grass poking him. Angles of repose vary from sixty-five to seventy per cent inclines. An angle of repose is the steepest angle that soil holds loose rocks before they roll down the mountain. San Gabriel slopes are often considered over steepened. An over steepened slope has an incline greater than its angle of repose. In some areas the slope is so steep that only plants hold the loose rocks. Many types of dense shrubs called chaparral grow on mountainsides. All chaparral, high, low, soft, hard or mixed bursts easily into flame. Chaparral is nourished and rejuvenated by fire. Seeds that fall do not germinate until after a fire. Fire puts nutrients back into the soil so it can support fresh growth. Chaparral leaves glisten with oil and resins that seal in moisture. Oil and resin makes the leaves blaze up explosively in flame. Dry winds that cross the Mojave Desert are called Santa Anas. Winds bring instant critical fire weather to the area. Fires ignite by accident, arson or lightning. The Santa Anas collide with mountain winds and scatter unpredictably. Chaparral burns more intense and powerful there than elsewhere. Plants grow multiple stems that add density and flammable area. Canyons act as chimneys that can set a whole mountain aflame like a volcano in minutes. McPhee uses metaphor and simile to depict the intensity of these huge fires.

Before Los Angeles is settled, high chaparral burns every thirty years or so. Fire is less significant in a natural landscape. Fire now is more concentrated. It burns the chaparral hotter, higher and faster to nothing but ash on the mountainsides. Fine green eroding material regularly tumbles down mountains. After a fire mountain crumbs and other debris increases. Debris piles up in canyons. Rainfall does not clear the piles but may add debris. Fresh-burned chaparral soil is like dry dust when stepped on. Wells keeps waterproof soil in his laboratory to show the burned soil's chemical change. Chaparral's waxy substances make it resist water like oil. Fire vaporizes the waxy substances at the surface but condenses in the soil below. Rain soaks a thin upper layer but not the dust below. Rainfalls liquefy soil streams across the mountain with miniature streambeds. Runoff force and volume can increase to mobilize canyon deposits when a high-intensity storm starts a full-scale debris flow. Los Angeles gets less than half the annual rainfall of other large cities but it can fall ironically in days. Usually a series of five or more days of rain precedes the heaviest rainfall that can start a debris flow.

McPhee recalls other victims of 1973. Beyond the city five miles into the mountains are twenty-five hundred acres that Mill Creek drains to the Big Tujunga. Gun hobbyists with old-fashioned firearms shoot in the area. One shooter put tissue as wadding in his muzzleloader. Firing it burns up over three thousand acres of old chaparral. On top of Hidden Springs almost four hundred thousand cubic yards of debris waits for the right conditions. The storm series that sends a debris flow down Pine Cone Road also drops three million tons of water on the burned out chaparral above Hidden Springs. Debris flow through Hidden Springs is twenty feet high in the front and tapers down in the rear. Thirteen people are carried away and their bodies gone. Despite the Genofiles' successful suit a community church lawsuit for twenty million dollars is dismissed as an act of God. The judge's ruling apparently favors nature's absolute power.

Head-sized rocks wedge in tree branches through the San Gabriel stream valleys. Rocks and boulders of all sizes roll down the mountain. Some end up in town miles away from the mountain. People use them to landscape and build. They believe rocks come from a long-ago process but not recently from the mountain. Streams from the mountains carry free boulders and rocks to residents with no delivery charge to use in walls and buildings. The inconvenience of an unexpected delivery is offset by its lack of cost. McPhee makes an unplanned visit while on vacation in Pasadena. He wants to visit any geologist who is available at Caltech. He meets Leon Silver, a geologist whose studies include the earth's crust, plate structure and formation. Silver takes him up to the flat roof for a panoramic view of the mountains around them. Silver claims the area has many named earth faults that break and batter rock from earthquakes. After a 6.2 Richter scale earthquake in 1971 Silver flies over the San Gabriels to observe an area still exploding with aftershocks. He also notices the unstable mountain debris from ancient landslides. Debris is piled within a hundred meters of the houses below. North American and Pacific Plates slide past each other to form Transverse Ranges with San Bernardino Mountains from the east. Silver sees it within a larger global plate context that helps the mountains rise. He compares plate movements to the wake from a boat crossing calm waters. Cause of the Transverse Ranges is unclear but over millions of years it moves California towards the sea.

Debris basins provide geologists an opportunity to measure and determine erosion rates. An average seven tons per acre every year erodes away from the mountain towards town. The city forms on a long ramp like incline from deposited sediment eroded over millions of years from the mountain. Silver once lives on the mountain to observe the front face of the San Gabes being eroded. He says most of the Caltech geology department lives on the mountain. Silver introduces his colleague Barclay Kamb who studies why humans live near high-risk areas. He lives near the mountain front. Civil engineer professor Vito Vanoni says residents are not safe and protected by debris basins. McPhee asks where he lives. Vito lives below Eaton Basin. Ironically, he lives in denial of his own expertise. Vito says he feels protected since no debris appears in his yard since 1949.

McPhee sees a citrus grove among the residences. Houses spread from the grove in all directions except north where they stop at the mountain. He recalls interviewing Charles Colver from a citrus growing family. Colver recalls seeing debris flows that topple trees

are left in place. Growers plant new trees. Debris flows leave sediment that builds up soil on the floodplain. Native Americans farm the land and adapt. Ranchers run them off and take the water for their cattle. Railroads arrive and the population increase includes farmers. They plant citrus groves that are irrigated by mountain ditches and debris flows. Agricultural towns connect and roadways unite communities. Orange groves separate mountain front from the communities built on a flood plain. Flood is formed in 1915.

A one-street neighborhood named Pasadena Glen fingers up the mountainside in its steep and shaded canyon escape under evergreen oaks. McPhee compares the narrow compact canyon dimensions to a bobsled run. The eroding mountain is at the top of the run and the debris basin lies below. He sees Kamb's high-risk living theory in practice. Pasadena Glen feels free. The stillness of nature provides solace, a city escape and serenity. When it rains however, boulders rumble down the mountainside. After a 1969 rain the Forest Service lines a natural stream to create a concrete trough. It has hundreds of large granite boulders topping the sides of the trough. A twelve-foot stone barrier is built above the home farthest up the canyon to provide a protective barrier.

The nineteen-thirties are critical for Los Angeles. Mountainside slopes are black and bare from chaparral burns followed by rainfall. Debris flows overtake the orange grove. The flows kill people and destroy property in their path to town. The New Year's Day Flood is remembered for its death and destruction. Haines Canyon is a first of its kind debris basin. It is started as a working gravel pit. When the debris flows start it fills with debris and protects the village of Tujunga. It becomes a model for Los Angeles' battle for control of nature. Population increase and industrial growth stimulates the need for more housing. The orange grove that separates mountain foothills and the floodplain city is an attractive site for housing development. Citrus grove maintenance is a nuisance for newcomers. Citrus grove values cannot compete with housing land prices. Eight million people soon inhabit fifty miles of mountain front.

Early debris basins are not designed for record rainfalls. They soon fill up and overflow. Generally debris basins are effective if regularly maintained. However they cannot be placed everywhere. Historical data supports basin design for expected flow levels. The design is only as effective as the age of recorded data. Multiple basins in an area may minimize the danger of overflowing. Some residents consider debris basins to be an assault on nature. They are offended by their gravel pit appearance. Many residents may consider risk an acceptable tradeoff for the view, air quality and environment. Other residents ignore the dangers and live in denial like Vito.

McPhee wonders why people buy homes to live in dangerous areas. He asks several individuals and professionals who offer their opinions. New buyers do not see what happens years earlier. They don't know what changes may enable the next fire. A consulting engineer says they're not aware of the problem. Previously there are no ordinances or now they may not cover the situation. Problems are local. The federal government subsidizes flood insurance. Some private insurers offer insurance as well. The area is rich and eighty per cent of the residents have no insurance. Local officials and neighborhoods offer information that is ignored when nothing bad happens. If a

disaster happens citizens sue the town. Housing is available at all price levels in the fifty miles of the San Gabriel front. Builders search out new sites. Sellers are supposed to disclose debris flows in the transaction. Realtors may not know or claim to not have heard about debris flows. Some property is in a special-study zone where debris may interrupt the study. Often forms say nothing about mudflows or that it happens years before. Developers claim they would not invest if there is danger. A simple response is to plead ignorance or check with Los Angeles. Carl Gunn lives in the area before growth in population. He is retired and lives in a small house at the base of a steep slope. He remembers when rain and runoff enrich business and land. Only a few old-timers recall debris flow damage. Carl lives there because he likes the privacy and a view. Years ago a resident may buy in a dangerous area he can afford. It is now ten times pricier. He feels fortunate that only one major earthquake and major flood and two major fires occur.

Miner Harkness is a native of the area unlike many longtime old-timers from somewhere else. He lives fifty years in the roughest part of the range, against the hard chaparral and an average eighty-five per cent grade. He shows McPhee an eroding mountainside area damaged by truck route. Trucks haul crib parts to build in the nineteen-sixties that reduce canyon debris. He thinks Flood engineers have no perspective. They make mountain erosion likely with roads that only cause more problems at taxpayer expense. Harkness knows the mountains and helps rescue mountain hikers. Sierra Madre residents protect their canyon and refuse Flood recommendations despite threats. Canyon residents band together to soak rooftops when there is a fire. Miner expresses the opinion that people who want the view should cover their own risk. Years earlier Harkness' house is torn in two by a debris flow. It is uninsured also but unlike the Genofiles it is destroyed. He does not consider leaving the area. Instead he builds a new house on steel-reinforced concrete pylons amongst evergreen oaks like a lookout tower. He is warned to evacuate seven times because of fire. He remains because that is a risk he chooses to take.

For the debris basin system to function Flood must clean out basins and reservoirs to make room for more mountain debris. Before Los Angeles began this project, debris naturally flows down the mountainside and canyons. It piles up as sediment on the plains of San Gabriel's alluvial fans. Slope of the plain gradually rises to the mountain front. Billions of cubic yards of material are deposited on its way. Mid-twentieth century Los Angeles assumes responsibility to replace nature. It becomes the material depositor in at least fifty alluvial fans on the San Gabriel mountain front. Although a small fraction may escape, the debris basins trap twenty million tons to date. Mountain debris basins require continuous cleanout often under emergency conditions. Costs can exceed sixty million dollars a year. A burned-out area can fill some basins as fast as they are emptied. This task symbolizes the never-ending bureaucratic role of trying to control nature. Before Flood winter floods carry mountain sand to the ocean where it becomes beach sand. Los Angeles buys mountain sand from basin cleanouts to ship by truck to the beaches. They consider grinding debris to transport by slurry pipeline if they can find water for slurry.

Flood also buys cloud-seeding generators they use in rainy weather to enhance storms. Los Angeles wants water so increasing the volume of rain allows it to mine storms at a hundred dollars an acre-foot. The Pine Cone Road debris flow occurs during an effort at enhancing. A Flood engineer mentions that small debris basins ironically act more like a flip bucket. Debris flows over the spillway before the basin is full. He does admit managing the sediment produced by the San Gabriels is like trying to hold back the storm tides of the ocean. Many million cubic yards of sediment is produced in a season. Colver predicts one day they'll buy housing tracts to put it on. The debris disposal term is replaced with the euphemistic sediment placement sites to minimize any connection to landfill odors. Many environmentalists want to ensure sites accepted by a community are also free of protected or endangered species. The final resolution to the disposal matter is proposed by the simplest of all. Burro Canyon is named a sediment placement site where Flood hauls debris back up the mountain. This fourteen million cubic yard man-made debris mountain in Burro Canyon is built with debris basins.

Characters

John McPhee

John McPhee is the author of *The Control of Nature*. McPhee is an important character in each section of the historical novel. He is an investigative reporter that visits all the geographical regions. McPhee meets and interviews all the other characters. He explores each region with the guidance of another character native to the region. He selects and writes about significant events and characteristics of the regions he explores. McPhee includes himself in the work as another character. The author writes in the first person pronoun to describe his thoughts and action. He is sympathetic to the natural order. He presents a somewhat neutral and objective view of man's attempts to control nature.

McPhee is an historian in Atchafalaya. He describes and discusses the history and development of southern Louisiana. He travels in the Mississippi towboat and talks with the dignitaries on board. McPhee spends a day in Mike Bourque's powerboat checking crawfish trap lines in the Atchafalaya bayou. He speaks with General Sands who is in charge of the Mississippi. McPhee discuss Corps projects with native Acadians who remember when the rivers flow naturally. Rabalais treats him like a native at their first meeting because he wears a red bandanna. McPhee appreciates this insider welcome as much as he does the Atchafalaya bayou. He knows all the characters from being with them in the swamp, on the Corps control structure or in the towboat lounge.

McPhee travels to Heimaey, Iceland in Cooling the Lava fifteen years after the eruption. He visits Hawaii while the Kilauea volcano still spews red-hot lava. He meets Christina and the volcanologist team. McPhee walks the hot lava flows with them. The erupting volcano in Hawaii helps him identify with the volcano crew's experience in Iceland. He meets Thorbjorn and the lava crew workers that help cool the lava in Heimaey. McPhee drinks beer with them and shares the experience. He walks the city streets years after it is saved. He visits the monument with Magnus the former mayor during its eruption. They talk about his decision to save the harbor first. The author learns the lore, omens and folk tales of Iceland from Magnus. McPhee experiences the acrid sulfuric air in Hawaii while walking on just-solidified lava flows before writing about it.

McPhee takes a break from his research in Los Angeles Against the Mountain. While in Pasadena he visits Caltech to talk with any geologist available. He wants to learn about the history of Los Angeles and the surrounding San Gabriel mountain formation. He meets Leon Silver who is a well-known geologist. McPhee learns about crustal settings and global tectonics from him. His visit to the rooftop with Silver brings a sense of being there with them to share their panoramic view. His prickly seat on a steep mountainside with Wade Wells is felt through his description. McPhee visits with area old-timers who recall debris flows before Flood is organized.

U.S. Army Corps of Engineers New Orleans District

The U.S. Army Corps of Engineers New Orleans District in Atchafalaya that is responsible for the Old River Control Project is comprised of ten Army officers and fourteen hundred civilians. This Army division is personified as a key player and named the Corps. Army participation begins in the War of 1812. The apparent reason for the Army Corps' control is another British attack that may require engineered fortifications. West Point is the only school of engineering then. The Corps of Engineers stays involved even though civilian contractors build structures. The Corps is assigned responsibility for the Mississippi River by Congress. The Corps must plan, design, manage, negotiate and administer the Mississippi River environment. The Corps is responsible for building and maintaining structures that control river water flows in southern Louisiana.

Norris F. Rabalais

Norris F. Rabalais is the U.S. Army Corps of Engineers lockmaster at the Old River Control Navigation Lock in Atchafalaya. He is born and raised in Avoyelles Parish before navigation locks lower ships from the Mississippi to the Atchafalaya. From high school days he recalls navigation locks but does not consider being in charge of one. Rabalais is a Louisiana Acadian who the Corps first hires as a construction inspector.

LeRoy Dugas

LeRoy Dugas manages the control apparatus upstream from Rabalais' post. His nickname is Dugie in Atchafalaya. He is assigned to the project from its beginning in 1963. Dugie is an Acadian raised when the Mississippi follows its natural course. He works for the Corps but is critical of attempts to control the river. He is near retirement and feels worn down from fighting the Mississippi. Dugie believes in Murphy's Law that whatever can go wrong will go wrong.

Major General Thomas Sands

Major General Thomas Sands is a U.S. Army Corps of Engineers general who presides over the Mississippi River Commission in Atchafalaya. The General conducts an annual Low Water Inspection Trip in the Mississippi. General Sands takes on board several local and board dignitaries and local petitioners as he travels south down the Mississippi. He meets with his colleagues and holds hearings on the re-outfitted towboat Mississippi. The General considers this annual trip a floating convention.

Raphael G. Kazmann

Raphael G. Kazmann is a professor of civil engineering in Atchafalaya from Louisiana and author of *Modern Hydrology.* He is concerned that the standard measure of risk, a one hundred year flood, is not well defined. He believes planning for floods that occur in shorter time frames is unreliable. He is critical of the Corps and refers to their planning efforts as planned chaos. Kazmann thinks that the more the Corps plans the more chaotic the situation gets. Kazmann doubts the Corps can save the Louisiana coast despite their unwillingness to give up.

Mike Bourque

Mike Bourque is a bayou craw fisherman in Atchafalaya. He speaks in a mix of French and English with other fishermen. Mike takes McPhee on a crawfishing trip with him into the bayou to check his traps. Bourque uses an aluminum boat and motor rather than canoe and paddle. He prefers to power over fallen logs rather than paddle around them. Mike and his brother in law Soileau can recognize where other fishermen come from by their accent. Bourque thinks the levees are good because they limit the area of crawfish spread. He sells the day's catch at the landing for three hundred and sixty dollars.

Thorbjorn Sigurgeirsson

Thorbjorn Sigurgeirsson is a native of Iceland in Cooling the Lava. It is his idea to cool and then stop the flow of lava. There is no record of the idea being tried before but he believes it can be done. The Iceland telephone directory lists people in Iceland by first name regardless of their profession. Thorbjorn is a physicist and his father is Sigurgeir, so he is listed as Thorbjorn Sigurgeirsson. There are many skeptics of his lava cooling idea in Iceland. During another volcanic eruption he records temperatures and measures the magnetic field. His training is in fission tracks and particle physics. When returning to Iceland he studies geophysics and volcanoes. He observes a hut in the sixties being threatened by flowing lava from an eruption. Thorbjorn watches lava follow the coastline and seem to be cooled by the sea. He sees that water solidifies the lava flow but never cools it completely. He wonders if a similar effect could be man-made. He plans an experiment to test his curiosity. Thorbjorn calculates that one cubic meter of water changes seven-tenths of flowing lava to hard rock. His initial experiments have positive results. He does not anticipate the amount of water required. Thorbjorn is a thoughtful scientist. He combines ideas with the practical and decisive Patton to put them in action. Thorbjorn's idea and Patton's crew have both the thought and the action plan to succeed.

Sigurdur Jonsson

Sigurdur Jonsson works with the pumping crews in Cooling the Lava in 1973. He shares his experiences with McPhee. The pumping platoon has seventy-five people in a corps

of five hundred many Iceland natives. McPhee and Sigurdur discuss the experience on a summer evening in his house while they share a Heineken beer. They comment on the doctors dispensing medicine for the hoarseness. The workers wear boots and protect their wrists from burning if they fall down. Helmets protect them from falling ash and ejected molten lava that explodes like volcanic bombs

Sveinn Eiriksson

Sveinn Eiriksson is fire chief of the American base in Cooling the Lava. In Heimaey he is known as Patton. Eiriksson is nicknamed Patton after the successful American military General Patton. Thorbjorn's ideas are put into practice by him. Patton is a man of direct action and aggressive command. Where Thorbjorn is thoughtful Patton is decisive. The two of them meet with others every day to assess conditions, form strategies and make decisions to act on. They consider simply abandoning Heimaey but worry that the island itself might explode from hydrogen emissions

Magnus Magnusson

Magnus Magnusson is a former mayor of Heimaey in Cooling the Lava. He takes McPhee to visit a monument so they can read its inscription and view the surrounding area. Magnus tells him they grow up as children fearing that Helgafell will erupt again and the Turks will return. Magnus recounts other disasters people of Vestmannaeyjar endure that cause them to fight back. Surviving those experiences may be why they battle the lava as well. Magnus remembers his experience at nineteen when a bomb drops on a restaurant where he is eating. He continues to eat because he is hungry. Part of his hearing is gone so he doesn't hear the explosion. Magnus is one of seventy-six listed by that first name in the directory even though he is mayor in 1973. When the lava flows he tells Thorbjorn they must protect the harbor before saving the town. He decides without a harbor there is no need for the town. Magnus shows McPhee sites they can see from the monument. Magnus tells of an omen that if Vilpa, a centuries-dry cistern, ever fills up there will soon be a disaster. Vilpa fills up in the first few days of January 1973.

Harry Kim

Harry Kim is the head of Hawaii's Civil Defense in Cooling the Lava. The Hawaii County Civil Defense Agency issues standing orders that firefighters make no attempt to stop or divert lava flows. Patton visits Hawaii in 1984 to consult with him. Kim asks about the Army Corps of Engineers' proposed dam and reservoir to protect Hilo harbor. Patton advises Kim their idea as ridiculous. Harry Kim considers the Corps' idea to build a dam and reservoir a result of the mentality created by a need to do something.

Los Angeles County Flood Control District

Los Angeles Flood Control District in Los Angeles Against the Mountains is a local government bureaucracy established in 1915. Although an agency, it is personified as a key player under its nickname Flood. Its mission is to develop debris basins. When a debris basin is built, Flood turns it over to the Sedimentation Section of the Hydraulic Division of the Los Angeles County Department of Public Works for administration and maintenance. The power and responsibility of Flood in dealing with the San Gabriels is like the Corps in southern Louisiana. Flood authority is limited to the Los Angeles area.

Bob and Jackie Genofile

Bob and Jackie Genofile are debris flow victims in Los Angeles Against the Mountains. They can overlook Los Angeles to Pacific bays from their acre home site high in the mountains. They live in a quiet neighborhood that usually has only the sound of the creek dropping out of Shields Canyon to the Los Angeles River. The Genofiles have two children Scott and Kimberlee. Bob Genofile is a contractor. He constructs their house so its steel reinforced concrete block walls do not move or shake. Bob worries that the roof may collapse in the twenty-year-old house built before Pine Cone Road. When the debris flow crashes into the house Bob kicks out panels of glass on the opposite side to make an outlet for the water and boulders. The family gathers together in the parent's bedroom. The door crashes in and mud, water and rocks pour in. They jump on the bed as it rises to the ceiling and is pushed to the wall. Each parent holds a child as the debris flow rises and fills the house in six minutes.

Bob Genofile surveys the damage to their home. He finds none of the walls cracked in the uninsured property he built. Scott finds his father's pants in the mud with nineteen fifty-dollar bills Bob plans to give Kimberlee for her nineteenth birthday. Before this storm the Genofiles and their neighbors are confident the debris basins will protect them. After the storm they wake in the night with anxieties. The family decides to stay and rebuild since they are confident the house's structure is built like a fort. The Genofiles five hundred thousand dollar rebuilt house has a designer feel with railings, balconies and Italianate marble. The Genofiles win three hundred thirty-seven thousand five hundred dollars from the county for improper design and maintenance of the Upper Shields Debris Basin. They also win an award for their home's good maintenance and sense of drama.

Wade Wells

Wade Wells is a hydrologist in Los Angeles Against the Mountains. He works in San Dimas Experimental Forest researching erosion and sedimentation. Wells experiments with plants, rock, water and fire. He surveys the Genofiles' neighborhood after the 1978 debris flow. Spanish scientists that visit him express concern for Wells career since the San Gabriels are disintegrating rapidly. He tells them the mountains are rising faster than they are coming down. Wells takes mountain soil samples while McPhee watches.

He asks about the alert that Wells says looks like a first-stage smog alert. Wells and his assistant say it means avoid driving and strenuous activity. Wade Wells demonstrates the waterproof nature of the soil. He explains the burned soil undergoes a chemical change.

Leon Silver

Leon Silver is the first Caltech geologist McPhee meets in Pasadena while on vacation from geology projects. Silver is an isotope geologist in Los Angeles Against the Mountains. He is knowledgeable in crustal settings and global tectonics as well. Silver shows McPhee a panoramic view of the area from the rooftop. He believes the mountain rock is not rotten but shattered from its many earthquakes. After a 6.2 Richter scale earthquake in 1971, Silver flies over the San Gabriels to see an area still exploding with aftershocks. He sees the unstable debris potential of ancient landslides prepared to flow within a hundred meters of the houses below. Silver puts the Transverse Ranges within the larger global plate context that helps the mountains rise. He says plate movements and compression is like the wake of a boat crossing calm waters. Compression at the Transverse Ranges is most intense and compresses the San Gabriels a tenth of an inch every year. The cause is not clear but over millions of years California moves towards the sea. Silver explains these huge tectonic plates come and go and the San Gabes look like a flake kicked around for millions of years. He once lives on the mountain front to observe the San Gabes eroding. He admits many geologists live there now.

Barclay Kamb

Barclay Kamb in Los Angeles Against the Mountains is a Caltech geology department colleague of Silver. He explains that humans often live in high-risk areas. Kamb discusses the absurdity of crib structures above debris basins to prevent sediment from leaving canyons. He says they just store sediment that a flood will eventually scatter.

Vito Vanoni

Vito Vanoni is a Caltech emeritus civil engineer in Los Angeles Against the Mountains. He comments on the costs and residents' lack of understanding about debris basins and their protection. McPhee asks where Vanoni lives. He admits that he lives below Eaton Basin, a hundred yards from the Raymond Fault. He feels protected since he hasn't seen anything cross his yard since 1949.

Charles Colver

Charles Colver is a longtime resident of the area in Los Angeles Against the Mountains. He is raised in a family of citrus growers. He remembers when debris flows that knock down a few trees are left in place. Growers just plant new trees. Many million cubic

yards of sediment is produced in a season. Chuck Colver predicts one day they'll have to buy and tear down tracts of houses to store the mountain debris.

Miner Harkness

Miner Harkness is a fifty year native of the area in Los Angeles Against the Mountains. He is born, raised and lives in the roughest part of the range. He lives where the incline has an average eighty-five per cent grade. Harkness knows the mountains and is on a team that searches and rescues mountain hikers and kids climbing on the decomposing canyon granite. Years ago his own house with his family inside is torn in two by a debris flow. Although it is uninsured and destroyed he does not consider leaving. Instead he builds his new house above grade on steel-reinforced concrete pylons. It is situated in the evergreen oaks like a lookout tower. He is warned to evacuate seven times from danger of fire. He remains because that is a risk he agrees to take. Miner says people who want a mountain view should pay for the risk. He worries Flood engineers lack perspective. They try to stop erosion with methods that just cause more taxpayer expense.

Objects/Places

The Atchafalaya River

The Atchafalaya River is a distributary river of the Mississippi River in Atchafalaya. The word means *long river* in Choctaw. It is an alternative to the Mississippi by threatening to overtake it as the master stream. Atchafalaya's growth in volume makes it the third or fourth largest river. It exceeds Mississippi's slope by three to one. The Corps uses the Atchafalaya to flow water for swamps, bayous and small cities of the surrounding area.

The Mississippi River

The Mississippi River in Atchafalaya forms Louisiana by overflowing its channel. Silt and sand is deposited back and forth across an arc of two hundred miles. The river flows by a most direct route to the Gulf. As silt deposits build up the river flows to lower levels that create a new course. Each time the river relocates it leaves bayous and natural levees in its wake. The predicted natural course of the river will shift it away from New Orleans and Baton Rouge. The Mississippi River's natural course becomes an enemy of the state so the U.S. Army Corp of Engineers forms a battle plan to control this natural adversary.

Old River Control

The Old River Control in Atchafalaya is the keystone to control the Mississippi River from diverting into the Atchafalaya Basin. The Corps structures are two hundred miles north of New Orleans. The seven-mile crosspiece is Old River. Old River begins as a meander bend through which water rushing may cause economic loss of cities and the industrial area.

Mississippi towboat

The Mississippi towboat in Atchafalaya is a regular two hundred seventeen foot long, fifty-foot wide towboat of four thousand horsepower. The boat is luxuriously outfitted to carry important people and promote the Army Corps program on an annual Low Water Inspection Trip down the Mississippi River to Atchafalaya.

Levees

Natural levees rise over time with sediment deposited close to the river in Atchafalaya. Spring runoff makes water run higher and overflow the levees. Sandbags are added for eight hundred miles and barriers of dirt built. River levels rise as their number of outlets is reduced. Levees are six times higher but no more effective than the earliest ones.

Old River Control Auxiliary Structure

The Old River Control Auxiliary Structure in Atchafalaya is a three hundred million dollar new structure designed and built with gates weighing twenty-six hundred tons and sixty-two feet wide. By the third greatest twentieth century flood of 1983, the Old River Control Auxiliary Structure is still just foundation.

Morgan City

Morgan City is a town in Atchafalaya founded by Charles Morgan. He is irritated by New Orleans taxes. He relocates his businesses to Morgan City to avoid paying taxes. The town is surrounded by water on an island in the path of the Corps' Design Flood. Morgan City is protected by a twenty-two foot high seawall.

The Kent

The Kent is a second smaller towboat than the Mississippi in Atchafalaya. This boat is used to protect Old River Control. The Kent has a squared bow designed to catch, hold and assist any vessel in trouble. This towboat is a twin-screw eighty-five foot long, steel motor tug with two nine-hundred-horse diesels and state of the art electronics.

Vestmannaeyjar

The Vestmannaeyjar in Cooling the Lava is a group of islands occupied by two and a half percent of Iceland's population. The islands produce a twelfth of Iceland's export income. The area is proportionately more valuable than downtown New York.

Heimaey

Heimaey is a community of five thousand in Cooling the Lava. Heimaey is the only populated island of the Vestmannaeyjar and is about the size of Manhattan south of the Empire State Building. Heimaey is the most important fishing center.

Iceland

Iceland is one of the two most productive geophysical hotspots in the world in Cooling the Lava. Twin formations provide an outlet for release of deep core heat that travels upward in plumes of two thousand miles. Vibrations from settling earth are common.

Flakkarinn the Wanderer

Flakkarinn the Wanderer is the name given to the north side of the volcano that splits off and floats like an iceberg in Cooling the Lava. Its moving silhouette fills the sky wherever one looks up. The two million ton moving mountain moves toward the harbor.

Hawaiian Islands

The Hawaiian Islands is another of the most productive geophysical hotspots in the world in Cooling the Lava. Five thousand miles of Hawaiian Islands are created while the Pacific lithosphere moves over the heat source. The northernmost and oldest islands are named for Japanese emperors and have eroded back into the sea. Mauna Loa is a volcano that erupts at times. Kilauea spews lava nonstop since 1983. Hilo is the second-largest city and port whose loss would be disastrous to the Hawaiian economy in 1958. Hilo is threatened by lava flows to within one mile in 1881. Barriers are never built to protect it.

Los Angeles

Los Angeles is a metropolitan area of eight million people that live below the mountain on the urban coastal plain. The area is protected by debris basins that stop debris at the cities' mountain front limit rather than filling the plain. Pine Cone Road is the northern city limit on the ten thousand foot high mountain in Los Angeles Against the Mountain. The opposite city limit is the Pacific Ocean. There is no room to expand between limits.

San Gabriel Mountains

The San Gabriel Mountains is the mountain range opposite the Pacific Ocean in Los Angeles Against the Mountain. An average seven tons from each acre disappear each year off the mountain towards town. Despite that rate the San Gabriels rise faster than they erode. Three thousand feet higher than the Rockies they are closer to the sea than Mt. Washington.

Debris flow

Debris flows are comprised of water and solid materials, car-size and bigger boulders in Los Angeles Against the Mountain. Debris flows are not frequent enough to stop people from building in their path. Factors that contribute to debris flows are broken-up rock and heavy rainfall but must occur in the right order to cause flows in an area.

Debris basin

Debris basins are bowl-shaped excavations, some as large as football stadiums, that line the San Gabriel front for fifty miles, seven hundred yards apart to catch debris in Los Angeles Against the Mountain. There are one hundred and twenty debris basins designed and built to protect property of the rich and famous living below.

Chaparral

Chaparral is a term used in Los Angeles Against the Mountain to describe many varied types of dense shrubs that grow down the mountainside. All chaparral plants whether high or low, soft, hard or mixed share unique characteristics. It bursts easily into flame and is nourished and rejuvenated by fire. Seeds do not germinate until after a fire. Plant leaves glisten with oil and resins that seal in moisture but burst explosively in flame. Plants grow multiple stems that make them dense and provide more area to burn. Chaparral has waxy substances that make it resistant to water and act like oil.

Transverse Ranges

The Transverse Ranges is a mountain area in Los Angeles Against the Mountain. The North American and Pacific tectonic plates slide past each other to form a kink with the San Bernardino Mountains from the east illustrated as a tiptoeing h. Compression at the kink is most intense and the San Gabriels are compressed a tenth of an inch every year. Over millions of years California moves towards the sea.

Burro Canyon

Burro Canyon is a mountain canyon where Flood hauls debris back into the mountains. This fourteen million cubic yard man-made debris mountain in Los Angeles Against the Mountain in the mountains is built with its own ready-made debris basins.

Themes

Solid Earth Flows

An irony in the expression *on solid ground* is that forming solid ground requires a liquid. The Mississippi River carries silt and sediment that it deposits in its riverbed. The riverbed builds up over time. The river forms levees and leaves new soil when it overflows its banks. Centuries of depositing this watery residue forms the Louisiana delta and New Orleans land mass. Flooding enables the sedimentation process to add solid land mass to the area. Water that flows downriver from the north begins as solid ice and snow in the far northern Mississippi. Solid ice and snow melts into watery flows that hold sediment. The sediment is carried south where it is deposited to become solid again. This water flow originates in a cold and hard form before melting into liquid. River water can carry the watery sediment south to become solid ground. The Corps' hold by levee policy that keeps all river water in its channel blocks the water flow from forming solid ground.

By contrast a lava flow starts red hot and liquid then becomes solid rock when it cools. An apparently solid volcano erupts into flows of molten rock. Similar to water flows, lava flowing down the mountainside also picks up sediment to deposit away from its source. Hot magma flowing down a volcanic mountain eventually cools to become solid rock again. Thorbjorn observes that contact with the seawater around Iceland seems to speed up the process of cooling lava. His scientific observation of this natural process suggests a method to stop the lava flow from destroying the Heimaey harbor. Another way solid earth relocates is through debris flowing down a mountainside. Debris flows can create alluvial plains like those formed by river water flows. Liquids continually run from higher to lower levels in a natural ebb and flow of water, lava and debris.

Bureaucracies and Self Preservation

Several bureaucracies are portrayed in *The Control of Nature*. These organizations all focus on controlling the path of river water, lava and debris flows. A bureaucracy may form with a specific initial purpose. For example, the Hawaii Research Associates promotes the mission of no more buried towns. The U.S. Army Corps of Engineers is formed to support the army in war by engineering structures for war, initially in New Orleans and the War of 1812. The Civil Defense Council in the Reykjavik National Emergency Center is established in 1962 as a command-post bomb shelter for nuclear war. Finally the Los Angeles Flood Control District is established in 1915 to develop debris basins and turn them over to the Sedimentation Section of the Hydraulic Division of the Los Angeles County Department of Public Works.

As soon as a bureaucracy is set up and operating it has personnel, equipment and other organizational elements to maintain. If its original mission is accomplished or no longer relevant it may disband. Alternatively it may look for other new projects to do that

fit the mission or change the mission. Other organizations may have missions or charters broad enough to be ongoing and never end.

The mission of Hawaii Research Associates is ongoing if towns are at risk of being buried from lava or any other disaster. Other organizations modify their mission. The Council's concern about the effects of lava flows on the Atlantic Ocean and the islands of Vestmannaeyjar leads it to broaden its charter to include acts of God. New missions may require an ongoing state of organizational readiness. The Corps already has skills, know how and equipment but needs a mission. Congress provides a mandate and authorizes projects that please the politicians and the bureaucrats. A perfect example of bureaucratic self-preservation is Flood building its own debris mountain in Burro Canyon. Eventually and inevitably it will become debris flow once again.

Man, Nature and Effective Action

An ongoing struggle exists between man and nature to control conditions of life on earth. The struggle becomes intense when an area is more populated or economically valuable. For example, Kilauea is an erupting volcano for several years and has active lava flows. Six lava research camps are consumed by lava. The volcanologists have no attachment to a specific camp. Consequently they just move camp like any early settler. Mauna Loa has occasional eruptions so the port city of Hilo is developed in the path of a typically dormant Mauna Loa. When an eruption threatens, the Hawaiian Research Association calls the U.S. Army Air Corps to bomb an erupting vent. Similarly citrus growers on the alluvial floodplain of Los Angeles plant new trees in the debris flows that knock down old trees. When trees are replaced by housing developments Flood tries to control debris flows with debris basins at the origin on the San Gabriel mountainside. Mississippi River flows both create and destroy by flooding southern Louisiana and the Atchafalaya Basin.

As civilizations develop residents prefer life on the river, on an island or on the side of a mountain. An individual may not afford a war on nature but a society can spread the cost over millions of citizens. Their combined effort lets them live where they want. They may stop nature in its tracks or at least make it flow around them in the short run.

The Corps and Flood are like Patton the man of direct action and aggressive command without Thorbjorn a man of thought and reflection. The Civil Defense Council of Iceland watches Thorbjorn's crew implement his idea. The Corps watches Sands run his floating conference towboat aground. Flood designs a mountain of debris to put on the mountain it already came down from. The man-made mountain has built-in debris basins to protect the citizens it endangers. Thorbjorn in Iceland and Kim in Hawaii observe nature and work around it. Thorbjorn observes lava cooling from seawater, takes measurements, thinks through and plans, then acquires the men and equipment to do the job. Neither have equipment, crews and money to find a mission. Thorbjorn takes clearly defensive action to protect Heimaey. He is not driven by a need to do something. Most notably, each of them respects nature as the acts of God to appreciate not an enemy to conquer.

Style

Point of View

The Control of Nature is written by John McPhee as an investigative reporter who inserts comments and observations in the first person. McPhee is an objective reviewer who seems to favor natural events. He is not an ideological environmentalist and allows the truth he presents to sell itself. His view ranges from personal interviewer to historian and science reporter. The viewpoint of characters is presented in contrast to one another to make a point. For instance, the dedicated Corpsman in charge, General Sands runs the Mississippi towboat aground. The Arcadian native Corps employee, Dugie sports a belt buckle that says to help control the Mississippi.

John McPhee is himself a character in the stories he tells. This approach offers a more colorful presentation of the historical and technical information although it may also be confusing. McPhee appears to be ever present everywhere through his vivid recollection of actual, vicarious and virtual experiences. The writer makes liberal use of the personal subjective pronoun "I" to describe experiences in the bayou, lava field and mountainside. He is a friend of everybody and participates with other characters in boat rides, lava field exploration, mountainside soil testing and rooftop lectures. McPhee shows a viewpoint of the characters and events that literarily recreates their experience.

Setting

Written and published in 1989, events in *The Control of Nature* take place in Southern Louisiana, Iceland, Hawaii and Los Angeles. The settings described draw upon actual, virtual and historical events. They range from a luxuriously outfitted towboat Mississippi on its annual floating conference trip down the river Mississippi to a hardened but hot surface lava flow from Kilauea in Hawaii, the town of Heimaey and a Caltech rooftop. Many more settings are described by McPhee in his recollection of events that allow one to experience the environment as if it were actual rather than historical or virtual.

McPhee begins *Atchafalaya* by describing the history and geography of the land in Southern Louisiana. He relates what the Corps accomplishes so far. He meets with the Acadians Rabalais and Dugie at their stations by the Old River Control Project on the Mississippi River. McPhee boards the Mississippi towboat for the continuation of its annual trip down the Mississippi River. The towboat railing and upper deck is the setting for McPhee's memories and recollections of the Atchafalaya basin and bayou trips with Fryling, Doc Brownell and the crawfishermen Mike Bourque in his powerboat. As the Mississippi towboat travels through the Atchafalaya River basin, McPhee views the seawall protecting Morgan City just ahead through the lounge's picture window.

McPhee visits Heimaey in the Vestmannaeyjar islands of Iceland. Much of the setting described in *Cooling the Lava* is an historical recollection of the 1973 eruption fifteen

years earlier. He spends an evening at Sigurdur's house drinking beer and reminiscing. McPhee and Magnus visit the Heimaey monument where he points out the panoramic view and stories of various attractions surrounding the town. McPhee takes a research trek by plane and helicopter to Kilauea to investigate an active erupting volcano. The volcanologists and McPhee land at Camp 8 on a kipuka. He walks on the hardening but hot lava flow to a lava lake hundreds of feet across. McPhee walks the streets of the restored Heimaey village. He climbs up to the top of the new volcano to see the heat exchangers the community uses. On another day the author walks along the natural harbor the lava creates. He walks out on an isthmus where young puffins are freed to fly.

Los Angeles Against the Mountains opens with a chilling recollection of the Genofiles house caught in the 1978 debris flow. McPhee visits with Wade Wells and his assistant Edwin Harp collecting soil samples on a mountainside with an eighty-five per cent incline. He remains seated despite the needle grass he sits on. Wells recounts the historical recollection of the twenty-foot high debris flow that destroys Hidden Springs. McPhee vacations in Pasadena where he visits the Caltech geology department. Leon Silver takes him to the flat roof for a panoramic view of the seventy miles of mountains surrounding them. Wells and McPhee visit Burro Canyon where a debris mountain is built by man with debris basins.

Language and Meaning

McPhee is very aware of the power of language. He uses a complicated narrative form to confuse time. He creates a sense of geologic time that occurs in eons rather than months, years, decades and centuries. *The Control of Nature* is about nature more than man and it puts time in nature's terms. The arrogance of man's war with powerful forces of nature is made clear by contrasting human centuries with geologic eons. The author's language is descriptive, colorful and evokes visions of sights, sounds, smells and feelings of the environment and era he presents. For example, doctors dispense *Norwegian chest drops* that are really ninety proof throat-burning shots of whiskey or gin to cure hoarse throats and he calls the representative Iceland puffin an iced toucan.

Symbolic language, simile and metaphor are used to compare and describe situations, events and occurrences. The towboat Mississippi run aground symbolizes the Mississippi River captured by the Atchafalaya. The "H" that describes the Old River meander path reappears as a tiptoeing "h" to describe the Transverse Ridge in the San Gabes. Morgan City relies on the Corps like a space platform depends on Mission Control and sits like the spout of a funnel where floods last months. The swimmer that survives frigid water has a fat layer like that of a seal and the volcano section that breaks off floats like an iceberg. California canyons act as chimneys to enflame a mountain like a volcano. The wake of a boat crossing calm waters describes tectonic plate movement and compression.

McPhee uses wit in his writing by describing a belt buckle that says, "To help control the Mississippi" and an engineered flood called "Design Flood". The Corps plans for events

they don't know may happen. Kazmann calls it planned chaos, ironically the more planning the more chaotic it gets. Rocks and boulders carried by the debris flows are used by Flood to build a debris mountain in California. Those rocks and boulders could be used by the Corps in Old River Control to fill holes with a hundred and eighty-five tons of rock. The two million ton moving mountain is euphemistically named *Flakkarinn the Wanderer* since it floats free in Heimaey harbor.

Structure

The Control of Nature is divided into three parts or sections with no appendix. Each part corresponds to an area of the world that is affected by forms of earth flow. Within each section subsections detail events or stories that occur. Some subsections are technical and scientific such as a discussion of plate tectonics and some are historical such as the development of New Orleans and the southern Louisiana levees. Other subsections describe an experience, for instance McPhee's crawfish trip in the bayou. Each of the three sections that describe a regional area has ten to twelve subsections.

Section titles are named for a major environmental formation or struggle that impacts life in the area. Atchafalaya is a distributary of the Mississippi River in Southern Louisiana. Erupting volcanoes spew forth-hot lava that can destroy Heimaey harbor in Iceland unless it is saved by cooling the lava. Los Angeles develops in the foothills of the San Gabriel Mountain Range against the mountains. Modern civilization in each area is threatened by flows of a river, lava or mountain debris. McPhee tells history, science and struggle of the region in subsections of each appropriate section title. Each section is comprised of approximately ninety pages and the ten to twelve subsections within are evenly divided.

Quotes

"The industries were there because of the river. They had come for its navigational convenience and its fresh water. They would not, and could not, linger beside a tidal creek. For nature to take its course was simply unthinkable. The Sixth World War would do less damage to southern Louisiana. Nature, in this place, had become an enemy of the state." Atchafalaya, pg. 6

"The Unites States Congress, in its deliberations, decided that 'the distribution of flow and sediment in the Mississippi and Atchafalaya Rivers is now in desirable proportions and should be so maintained.' The Corps was thereby ordered to preserve 1950. In perpetuity, at Old River, thirty per cent of the latitude flow was to pass to the Atchafalaya." Atchafalaya, pg. 11

"Among navigable rivers, the Atchafalaya is widely described as one of the most treacherous in the world, but it just lies there quiet and smooth. It lies there like a big alligator in a low slough, with time on its side, waiting - waiting to outwait the Corps of Engineers - and hunkering down ever lower in its bed and presenting a sort of maw to the Mississippi, into which the river could fall." Atchafalaya, pg. 23

"The levees of the nineteen-twenties were about six times as high as their earliest predecessors, but really no more effective. In a sense, they had been an empirical experiment - in aggregate, fifteen hundred miles of trial and error. They could be - and they would be - raised even higher. However, in 1927 the results of the experiment at last came clear. The levees were helping to aggravate the problem they were meant to solve." Atchafalaya, pg. 42

"'The coast is sinking out of sight,' Oliver Houck has said. 'We've reversed Mother Nature.'" Atchafalaya, pg. 63

"Cooling the lava was Thorbjorn's idea. He meant to stop the lava. That such a feat had not been tried, let alone accomplished, in the known history of the world did not burden Thorbjorn, who had reason to believe it could be done." Cooling the Lava, pg. 95

"Pompeii was five miles from Vesuvius. The center of town on Heimaey was less than a mile from the crater of the nascent volcano. Vesuvius, beside the sea, is estimated to have been four thousand feet high before it blew off its summit. Eldfell - as the new, seven-hundred-foot volcano on Heimaey is now called - did not exist before the eruption." Cooling the Lava, pg. 119

"Magnus said instantly, 'We must defend the harbor. There is no use of any town if we don't have a harbor.'" Cooling the Lava, pg. 129

"Like an iceberg that had calved off a glacier, the great bulk of the north side of the volcano remained afloat in a molten sea. It was a mountain in itself, and, moreover, it

moved. It was landscape on the loose, an incongruous itinerant alp, its summit high above the lava plain, its heading north by northwest." Cooling the Lava, pg. 138

"Iceland and Hawaii in a sense are twins. They are geophysical hot spots, the two most productive in the world." Cooling the Lava, pg. 159

"'It was just one big black thing coming at us, rolling, rolling with a lot of water in front of it, pushing the water, this big black thing. It was just one big black hill coming toward us.'" Los Angeles Against the Mountains, pg. 185

"High or low - hard, soft or mixed - all chaparral has in common an always developing, relentless intensifying, and vital necessity to burst into flame. In a sense, chaparral consumes fire no less than fire consumes chaparral. Fire nourishes and rejuvenates the plants." Los Angeles Against the Mountains, pg. 208

"'It's a calculated risk. The higher you build, the cooler it is. There are great views. In addition, at night, up there, the cool air off the mountains flows down and pushes the dirty air masses back. The head of our seismological laboratory lives on the mountain front. In fact, most of the Caltech geology department lives on the mountain front.'" Los Angeles Against the Mountains, pg. 229

"He said, 'They never see the previous event. They move up there five, six, seven and more years, and nothing happens. They don't realize the tremendous change taking place in the watershed as it gets ready for another fire. Eventually, fire threatens them. Then flood. Moreover, they are on the Santa Anita Fault. Everywhere on the mountain front, people say, 'I've lived here x years. I've never seen any flow.' They won't, until there's a fire.'" Los Angeles Against the Mountains, pg. 248

"Wells and I went up there one day to see this epic artifact - in clear dry air and vast silence - eight miles from Arby's. A California quail ran by, sporting its knightlike plume. In the V-shaped mountain valley, the deposit rested like an aircraft carrier in dry dock - a comparison that would be more apt if aircraft carriers were not so small. Debris basins were along its upper flank, there to protect the man-made deposit. Burro Creek passed under it, through a deep culvert a mile long. For twenty million dollars, Los Angeles had returned the rock to the mountains." Los Angeles Against the Mountains, pg. 271

Topics for Discussion

Discuss how McPhee uses historical dates and events to expand and develop a geological sense of time.

Compare and contrast attitudes about danger and survival residents of each area express.

Explain the motivation for well-informed and knowledgeable residents to put themselves and their families in the direct path of danger.

Compare and contrast the geological features of Hawaii and Iceland.

Explain how the water, lava and debris flows in each area affect resident life styles.

Discuss how the aboriginal residents of each area express a greater understanding and respect for nature than their modern counterparts.

Explain and evaluate McPhee's literary method of self-presence in each storyline.

Explain how Thorbjorn and Patton characterize actions of scientists and engineers.