HANFORD SITE CHARACTERIZATION PLAN

CLIMATOLOGY SECTION
Panel Meeting

Seattle, Washington

January 10 & 11, 1985

HANFORD SITE CHARACTERIZATION PLAN -- PALEOCLIMATOLOGY

Agenda of Panel Meeting

Thursday morning

8:30 a.m.	Welcoming - Richard Craig
	Introduction to scope of SCP - Vern Johnson, Rockwell
	The SCP format - Robert Cook, NRC
10:00 a.m.	COFFEE BREAK
10:15 a.m.	Volunteered recommendations
	E. Leopold S. Porter L. Brubaker W. Schell G. Orians
11:30 a.m.	Adjourn for lunch - provided for all participants
Thursday afternoon --	Summary of Evidence
1:00 p.m.	Scope of this session - Richard Craig
1:15 p.m.	The overall hydrologic modelling procedure - Richard Craig
Part I -	The evidence from the continental floral response.
1:45 p.m.	H. Fritts - the last 400 years
2:05 p.m.	P. Mehringer - the last 10,000 years
2:25 p.m.	COFFEE BREAK
2:40 p.m.	G. Spaulding - alternative palynological and macrofossil procedures
3:00 p.m.	P. Bartlein - transfer function methodology

Part II - The Cryosphere-Atmosphere-Ocean System

3:20 p.m.	J. Clague - the Cordilleran Ice Sheet
3:40 p.m.	R. Waitt - paleohydrology of Washington
4:00 p.m.	J. Kutzbach - atmospheric response to global climate change
4:20 p.m.	N. Pisias - oceanic perturbations
5:00 p.m.	Adjourn

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Friday morning -- Recommendations for work items

8:00 a.m.	A member-by-member enumeration of specific work items proposed. Members will describe the needed work, explain why that is required for a defensible analysis of site stability, recommend where the work should be done, when it should begin and be complete, specify milestones to be achieved and recommend particular researchers capable of that work.
8:20 a.m.	J. Kutzbach
8:40 a.m.	R. Waitt
9:00 a.m.	G. Spaulding
9:20 a.m.	P. Mehringer
9:40 a.m.	J. Clague
10:00 a.m.	COFFEE and donuts
10:10 a.m.	N. Pisias
10:30 a.m.	P. Bartlein
10:50 a.m.	H. Fritts
11:10 a.m.	R. Craig
11:30 a.m.	Adjourn for lunch, provided for participants

Friday afternoon - This session will emphasize the development of consensus on work items and the format of the SCP.

1:15 p.m.	Vote on items.
1:45 p.m.	Formulation of minority opinions.
2:00 p.m.	Definition of additional items to be investigated for possible inclusion in the SCP.
2:15 p.m.	Development of justification for each proposed work item.
3:15 p.m.	Recommendations on time schedule.
3:45 p.m.	Arrangement of SCP format.
4:30 p.m.	Definition of SCP time schedule.
5:00 p.m.	Adjourn

SCHEDULE FOR PREPARATION OF THE SITE CHARACTERIZATION PLAN

December 13-31	Begin work. Summarize current information about the climatic stability of the site. Indicate areas where our knowledge is incomplete and how that should be remedied.
January 1	Complete first draft. Forward it to R. Craig. It will be integrated with the other materials and circulated to all members in time for the meeting.
January 10-11	Meet as group in Seattle. Review additional information from other experts. Discuss content of first draft. Reach a consensus on the form of the document.
January 12-31	Telephone and letter discussions to finalize format and content. 'Last minute' changes or additions.
February 1	Receive revised document for peer review. This will be your last opportunity to impact the form and content of the document.
February 15	Complete review. Document returned to Kent State
February 16-28	Telephone discussion of revisions or corrections. Finalizing document.
March 5	SCP presented to Rockwell.

PARTICIPANTS

Dr. Patrick J. Bartlein Department of Geography University of Oregon Eugene, Oregon 97403	503-686-4967
Dr. John J. Clague Geological Survey of Canada 100 West Pender Street Vancouver, British Columbia Canada V6B 1R8	604-666-6565 (his office) 604-666-0529 (secretary)
Dr. Richard G. Craig Department of Geology Kent State University 212 University School Kent, Ohio 44242	216-672-7987 (his office) 216-672-2680 (department) [redacted] (home)
Dr. Harold C. Fritts Tree Ring Laboratory University of Arizona Tucson, Arizona 85731	602-621-2223 (secretary) 602-621-6474 (his office) [redacted] (home)
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Dr. Peter Mehringer Department of Anthropology Washington State University Pullman, Washington 99164	509-335-3855 (his office) [redacted] (home)
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Dr. W. Geoffrey Spaulding Quaternary Research Center AK-60, University of Washington Seattle, Washington 98195	206-543-1166 (QRC) 206-545-2560 (office)
Dr. Richard B. Waitt, Jr. Cascades Volcano Observatory U.S. Geological Survey 5400 MacArthur Blvd. Vancouver, Washington 98661	206-696-7558 (him) 206-696-7693 (office) [redacted] (home)

Paleoclimatology Site Characterization Plan

Additional Attendees at Seattle Meeting

Mr. Robert Cook
Nuclear Regulatory Commission

Charles R. Compstock
Morrison and Knudsen - BWIP

Bruce N. Bjornstad
Rockwell - BWIP

Vernon G. Johnson
Rockwell - EPD

Margaret M. McCarthy
Rockwell - BWIP

Michael G. Foley
Battelle PNL - GR&E

Richard A. Craig
Battelle PNL - GR&E

Richard W. Wallace
Battelle PNL - Rad.Sci.

Gregg M. Petrie
Battelle PNL - GR&E

Paleoclimatology - SCP

Invited discussants - Thursday A.M.

Estella B. Leopold
U.W. - Dept. of Botany

Linda Brubaker
U.W. - College of Forest Resources

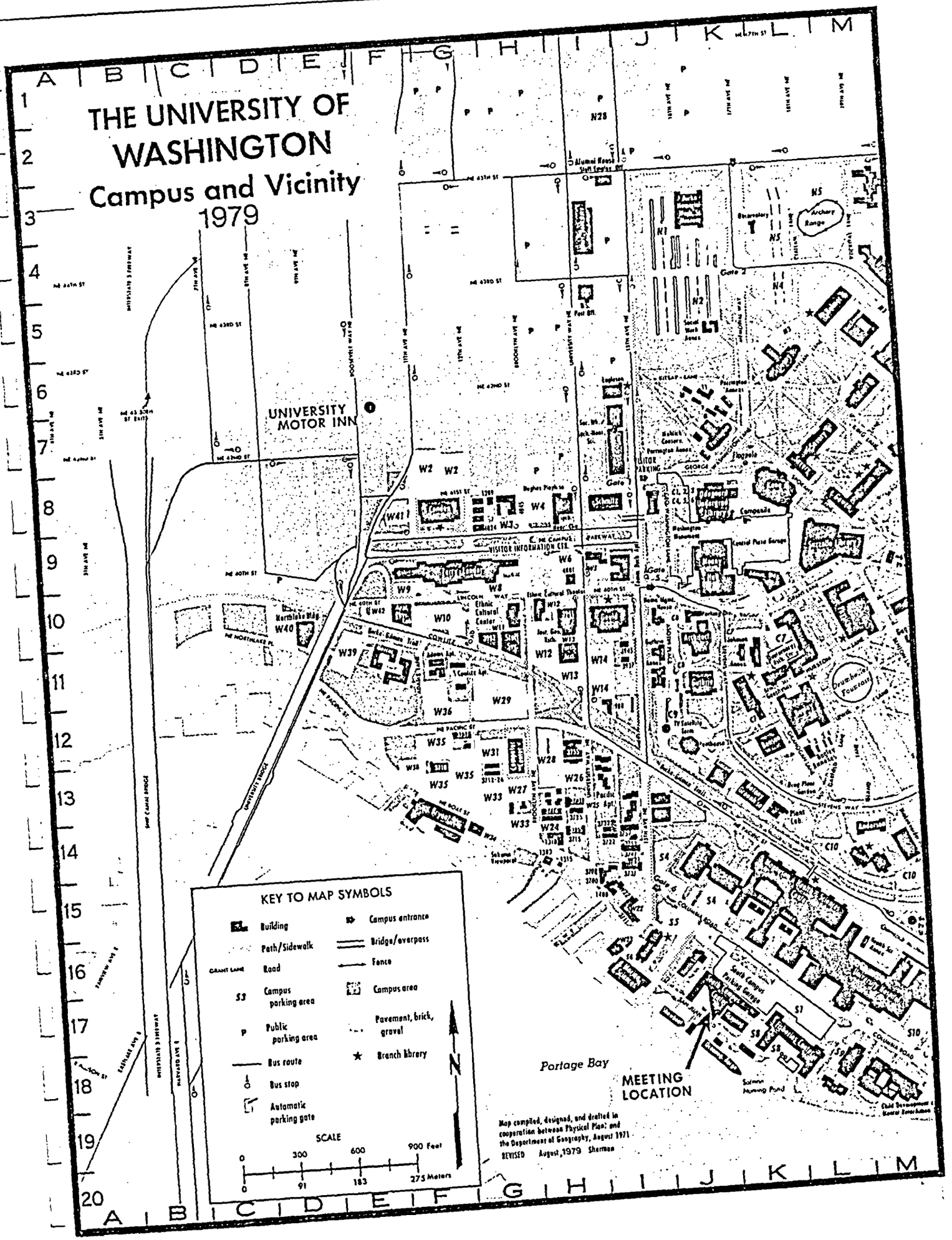
William R. Schell
U.W. - Lab. Rad. Ecol.

Gordon Orians
U.W. - Inst. Env. Studies

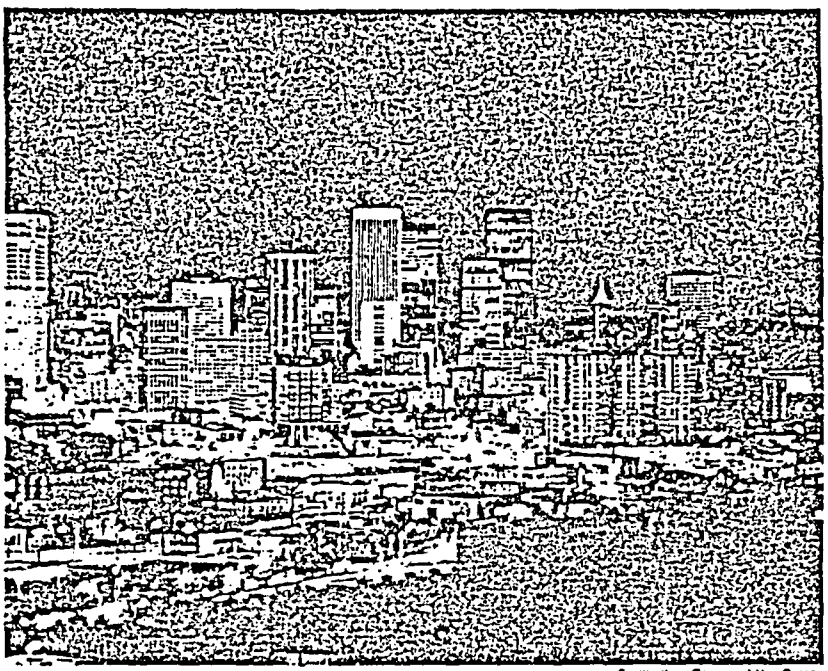
Steven C. Porter
U.W. - Quat. Res. Center

Lisa Graumlich
U.W. - College of Forest Resources

Lisa Croft
U.W. - Dept. of Botany


THE UNIVERSITY OF WASHINGTON
Campus and Vicinity
1979
UNIVERSITY MOTOR INN
VISITOR INFORMATION CTR.
Ethnic Cultural Center
Drumheller Fountain
Portage Bay
MEETING LOCATION
KEY TO MAP SYMBOLS
Building
Path/Sidewalk
Road
Campus parking area
Public parking area
Bus route
Bus stop
Automatic parking gate
Campus entrance
Bridge/overpass
Fence
Campus area
Pavement, brick, gravel
Branch library
SCALE
0 300 600 900 Feet
0 91 183 275 Meters
Map compiled, designed, and drafted in cooperation between Physical Plant and the Department of Geography, August 1971
REVISED August, 1979 Sherman

Seattle



Downtown Seattle — Seattle-King Conv and Vis Bureau

(pop. 493,800, metro. area 1,606,800; alt. to 450 ft.)

Although early maritime expeditions had sighted the Washington area and given names to some of its waterways and landmarks before the close of the 18th century, Seattle itself was settled comparatively late. With an entire continent to cross, overland settlers did not reach what was to be Seattle until the mid-1800's. A few hardy families set up the first colony at Alki Point in 1851.

The settlement was soon moved around the point to a spot near present-day Pioneer Square and was named for Sealth, a friendly Indian chieftain. The expanse of virgin timberland combined with the fine natural harbor to make an ideal setting for the first industry, Henry Yesler's sawmill. The mill cut timber for export, and the "road" down which logs were rolled gave birth to the expression "Skid Road."

The population grew as the forested wilderness areas and their fur-bearing denizens drew lumberjacks, trappers and traders, and the prospect of converting neighboring Indians lured migrant missionaries. Chief Seattle was paid $16,000 in advance for the use of his name on the premise that he would spin in his grave if his name was mentioned after his death. By 1865 Seattle had become a town, but a certain deficiency became painfully noticeable in its populace. An overabundance of bachelors prompted attention to be shifted momentarily from the prospering export business to the matter of attracting a much-needed element—women. Asa Mercer, founder of the Territorial University, went East and recruited 11 brave and eligible young ladies to return with him; the ranks of the bachelors decreased by 11. The success of the initial venture led to the importation of a hundred Civil War widows. As a result, the population leveled out and even Asa Mercer found a wife.

By 1869 Seattle was a good-sized city; although it burned to the ground 20 years later, its industrious citizens soon rebuilt it. Swift growth followed the 1897 Klondike gold rush, for which the city served as jumping-off point. By 1893 the first transcontinental railroad had been extended to Seattle and maritime trade had been established on a regular basis with the Orient and points east.

The restored Pioneer Square area, at 1st and Yesler Aves., retains much of the city's 19th-century flavor. Art galleries, antique shops,

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boutiques and sidewalk cafes surround the heart of old Seattle. Waterfall Park, on the corner of 2nd Ave. S. and Main St., has a central waterfall and a stream along its perimeter. There are flowering plants and shrubs and a strong oriental influence to provide an oasis in the heart of the city.

Modern Seattle, built upon hills between Lake Washington and Puget Sound, is the metropolis of the Pacific Northwest. Within the city are four lakes—Bitter, Green, Haller and Union—which vary in elevation from sea level to 450 feet. From the western side of the city the Olympics are visible across the sound; on the east are the Cascades, to the south looms Mount Rainier and to the north is the intermittently steaming cone of Mount Baker.

Its fine, protected harbor, Elliott Bay, has made Seattle one of the world's great seaports. Ships continually arrive and depart, destined for the Orient, Alaska and practically every maritime nation in the world. Tours of the Port of Seattle terminal facilities on Elliott Bay may be arranged; phone (206) 382-3405. Visitors may also tour the Coast Guard ships; phone (206) 442-7363. The docks accommodate about 75 ocean-going vessels at one time, while a large municipal yacht moorage adds to the bustle of the wharves. Fisherman's Terminal at Salmon Bay is the hub of Seattle's prosperous fishing industry. Visitors may walk out on the docks among the fishing vessels.

The city is important for its shipments of fir, redcedar and canned salmon. The largest and most important industries are aerospace and related fields, including a huge Boeing airplane plant. Other economically significant industries are shipyards, foundries, electronic firms, marine-science research centers, and forest- and food-processing companies.

An important center of education, Seattle is home of the largest university in the Pacific Northwest—the University of Washington, with nearly 35,000 students. Seattle Pacific University and Seattle University are also here.

Approaches

By Car

The major north-south automobile route is I-5 from the Canadian border through Seattle to Portland and California. East-west traffic generally follows I-90, which crosses the Cascade Mountains and approaches Seattle over Lake Washington from Spokane and the east. During rush hours, I-5 and I-90 have reversible lanes in operation.

By Plane, Bus, Boat and Train

Most domestic airlines, as well as some foreign ones, have regularly scheduled flights to Henry M. Jackson International Airport, midway between Seattle and Tacoma on SR 99. Closer to Seattle is Boeing Field, south of the city center on Airport Way; this is a smaller airport generally used by private and charter planes. All scheduled services use Jackson International Airport.

Gray Line operates express buses every 30 minutes between Henry M. Jackson International and the downtown Park Hilton, Sixth and Seneca; the Westin Hotel, Westlake Ave. entrance; Four Seasons Olympic, Seneca St.; and the Sheraton Hotel, 6th Ave. Fare from the airport is $4.75, ages 5-11, $2.75. For pick-up service information, call 343-2000. Suburban Airporter provides service between Henry M. Jackson International Airport and accommodations in surrounding suburbs; fares begin at $6.50; phone 455-2353. Metro Transit buses link Henry M. Jackson International with various points throughout the city; fare is 75c (90c during rush hours). Phone 447-4800.

Major nationwide bus lines in the Seattle area are Greyhound and Trailways. Bus stations are at 8th and Stewart (Greyhound) and at 1936 Westlake Ave. (Trailways).

Washington State Ferries, Colman Dock (Pier 52) at the foot of Marion St. (phone 464-6400, 800-542-7052 or 800-542-0810), link Seattle with the Olympic Peninsula, via Bremerton and Bainbridge Island, daily throughout the year. State ferries leave Fauntleroy Pier in West Seattle for Vashon Island and Southworth. State ferry service is also available from Edmonds to Kingston. From May into Oct., the British Columbia Steamship Co. provides daily round-trip ferry service between Seattle (Pier 69) and Victoria, B.C., via a 332-foot cruise ship. Cars only; reservations advised. For information, write BC Steamship Co., Ltd., Pier 69, 2700 Alaskan Way, Seattle, WA 98121. Phone (206) 623-5560 for information; (206) 682-8200 for reservations.

Amtrak passenger trains arrive and depart the King Street Station at 3rd Ave. S. and S. King St. For information and reservations, call 464-1930.

Getting Around

Street System

Seattle's avenues run north to south; they are designated by both numbers and names. Streets, also both numbered and named, run east to west. Most addresses are further pinpointed by area designations—N., S., E., W., N.E., N.W., S.E. or S.W.—which are important in determining correct locations. Many downtown streets are one way. To facilitate crossing the city, traffic lights are synchronized on 4th Ave. northbound and on 2nd Ave. southbound.

Parking

On-street parking in downtown Seattle is controlled by meter. During rush hours, however, parking is prohibited on certain streets from 7 to 9 a.m. and 4 to 6 p.m. During rush hours, northbound 4th Ave. and southbound 2nd Ave. have a transit-only lane. There are 24-hour garages in the downtown business district at 5th and Seneca, 601 Olive Way, and 1st and Union.

Driving in Seattle

Speed Limit is 30 mph., or as posted.

Minimum age for drivers is 18, 16 with drivers' training.

Rush hours, 7 to 9 a.m. and 4 to 6 p.m., are to be avoided if possible. Parking on heavily trafficked streets downtown is prohibited during these designated hours and offending vehicles will be towed away. By state law, right turns are permitted at red lights after a complete stop at an intersection, unless the intersection is otherwise posted.

Being Prepared

Climate and Clothing

Seattle's summers generally have pleasant temperatures in the 70's, while the winter average is only 45 degrees. Coldest months are January and February, with minimum averages of 37 or 38 degrees; wear woolens, coats and moisture-proof boots.

The city gets 82 percent of its annual rainfall October through April, so be sure to include raingear for visits during these months. For weather forecasts, call 382-7246; for reports on the condition of mountain pass roads, call 464-6010 Nov.-Mar.

Emergencies

For all emergencies from Seattle and Mercer Island, dial 911. However, the following numbers are supplied for reference: Police, 625-2000; Fire, 625-4091; Dental Society, 624-4912; Medical Referral, 622-6900 or 285-0221; Travelers' Aid, 447-3888.

Being Informed

Newspapers

The Seattle area has two daily newspapers, the *Post-Intelligencer* in the morning and the afternoon *Seattle Times*. There is also a daily Japanese paper, the *North American Post*.

Radio and TV

All major networks and many independent stations operate on both AM and FM radio. The major TV channels are 4 (ABC), 5 (NBC), 7 (CBS) and 9 (PBS). Check the daily papers.

Rental Cars

Auto rental agencies in Seattle include: Avis Rent-A-Car, 1919 5th Ave. (622-1000); Airways Rent-A-Car, 801 4th Ave. (623-7755); Budget Rent-A-Car, Westlake and Virginia Aves. (622-1962); Dollar Rent-A-Car, 7th and Stewart Sts. (682-1316); Hertz Corp., 722 Pike St. (682-5050); National Car Rental, 1942 Westlake Ave. (622-3355); and Thrifty Rent-A-Car, 18836 Pacific Hwy. S. (246-7565). Be sure to understand the rental contract thoroughly before signing it. Pay attention to insurance coverage and other items in small print.

Taxis

Taxis must be ordered by telephone or hired while stopped at cab stands. Major companies are: Farwest Cabs (622-1717), Gray Top Cab (622-4949) and Yellow Cabs (622-6500). Check the Yellow Pages for further information.

Public Transportation

Seattle Metropolitan Transit System (Metro) operates a full schedule of bus and trolley service within the city and to the outlying suburbs. Passengers must have the exact fare: 50c in the city, 75c in King County. These fares increase to 60c and 90c, respectively, during rush hours. Free bus service is provided within the downtown area bordered by Battery St. on the north, Jackson St. on the south, 6th Ave. on the east and the waterfront on the west. For route information, call 447-4800.

The transit authority operates streetcars built in the 1920's daily on 1½ miles of track along the waterfront between S. Main St. and Broad St. Fare 60c; cars run every 20-30 minutes. Call the number above for operating times.

The Monorail speeds passengers from its terminal at 4th Ave. and Pine St. to the Seattle Center, covering the 1.2-mile stretch in 95 seconds. The Monorail operates Sun.-Thurs. 10 a.m.-midnight, Fri.-Sat. 10 a.m.-12:30 a.m. Fare 35c.

The Kingdome Shuttle makes trips to the stadium south along 2nd Ave. from Pine St. for football games and major concerts. Service begins 60 to 90 minutes prior to game time; 50c. Phone Metro for details.

What To See

BLAKE ISLAND MARINE STATE PARK, 475 acres 4 mi. w., is accessible only by boat. The park offers clamming and other recreational activities *(see Recreation Chart)*.

◆ *Tillicum Village* features a Northwest coast longhouse where Indian art and artifacts are displayed, interpretive tribal dances are performed and a baked salmon dinner is served. The island is reached by a 45-minute boat cruise on the Pier 56 Harbor Tour. Boats depart Mon.-Sat. at 11:30, 4:30 and 6:30, Sun. at 1:30 and 4:30, July 1-Labor Day; reduced

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schedule, rest of year. Adults $22; ages 5-13, $9; over 65, $20; ages 3-4, $3; boat ride included in admission fee. Discount on adult and ages 5-13 rates. Reservations required; phone (206) 329-5700.

COAST GUARD MUSEUM NORTHWEST, ½ mi. s. at Pier 36 on Alaskan Way S., features nautical artifacts, ship models, Coast Guard memorabilia and photographs. Wed. noon-4, Sat.-Sun. 1-5. Free. Phone (206) 442-5019 for more information.

DISCOVERY PARK, entered at W. Government Way and 36th Ave. W., covers 400 acres, including 2 miles of beach at the base of Magnolia Bluff, deep wooded ravines, tracts of forest and grassy meadows. Nature trails and a fitness course are available. Guided nature walks are offered in the summer; call for schedule. A visitor center is open Tues.-Sun. 8:30-5; phone (206) 625-4636. The U.S. Coast Guard's West Point Light Station is open for tours Sat.-Sun. noon-4, Mon.-Fri. by appointment; phone (206) 282-9130. The Daybreak Star Indian Cultural Center, in the park, features Indian arts, crafts and entertainment. Open daily 9-4:30; gallery open Tues.-Fri. 9-4, Sat.-Sun. noon-4. Free. Phone (206) 285-4425. Discovery Park open daily dawn-11 p.m.

ELLIS PARK, a 5-acre plaza commemorating the Bicentennial, is dotted with greenery and water cascades. The park spans Seattle's eight-lane freeway (I-5) and connects downtown to First Hill. Featured is Naramore Fountain, a towerlike arrangement of bronze by George Tsutakawa.

EVERGREEN POINT FLOATING BRIDGE, 3 mi. n., is the world's longest floating bridge. Consisting of 33 separate pontoon units, it has a total length of 7,578 feet.

FIRE STATION NO. 5, Pier 53, Alaskan Way at foot of Madison St., serves as berth for fire boats *Duwamish*, *Alki* and *Leschi*. Tours of the station are available daily at 1 and 5. Free. Phone (206) 625-4091 for reservations.

FRYE MUSEUM, Terry and Cherry Sts., displays 19th-century European and American paintings and changing exhibits of contemporary art. Mon.-Sat. 10-5, Sun. and holidays noon-5; closed Thanksgiving and Dec. 25. Free. Phone (206) 622-9250.

HENRY ART GALLERY, on the University of Washington campus, has changing exhibits of contemporary and classic American art. Late-19th-century and early-20th-century American and French paintings are also on display. Tues.-Wed. 10-5, Thurs.-Fri. 10-7, Sat.-Sun. noon-6. Closed university holidays. Admission $3, 65 and older and students with I.D. $2, under 12 free. Phone (206) 543-2280 for more information.

KINGDOME, at 2nd Ave. S. and King St., houses sporting events, concerts, trade shows and other activities. Tours, which include viewing the Royal Brougham Sports Museum, are held daily at 1 and 3, Apr. 30-Oct. 1; 11, 1, and 3, rest of year. Handicapped should call in advance. Adults $2.50, ages 6-12 and over 65, $1.25. Phone (206) 628-3331.

KLONDIKE GOLD RUSH NATIONAL HISTORICAL PARK, at 117 S. Main St. in Pioneer Square, commemorates the city's role in the Klondike gold rush of 1897-98. Ignited by the return of the *Portland* in 1897 laden with two tons of solid gold from the Yukon River wilderness, a goldseeking mania swept the United States. Thousands of would-be prospectors, each equipped with a year's supply of goods, crammed aboard any available steamer bound for Alaska from Seattle. Less than a year following the news of the *Portland's* arrival from the Yukon, Seattle merchants had sold about $25 million in merchandise. And to Seattle most goldseekers, either defeated or rich, returned.

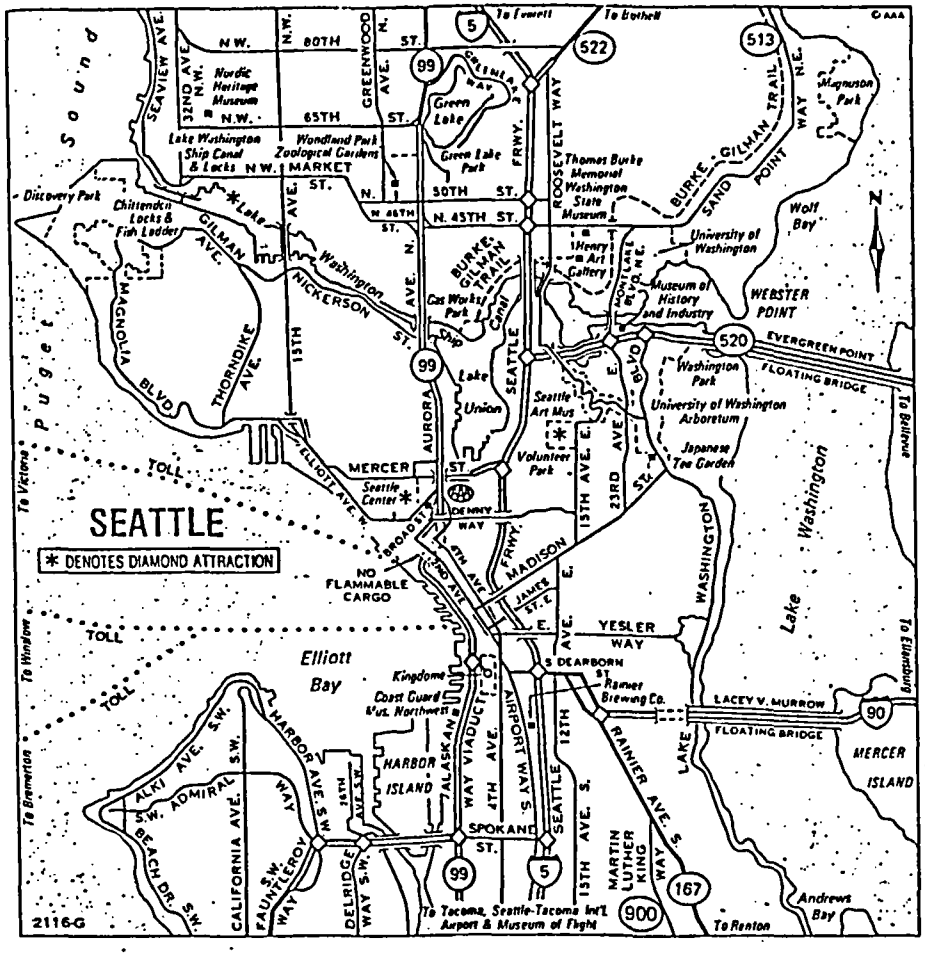
The Union Trust Annex building, housing the visitor center, features photographic murals, a slide show of old-time photographs and displays of hardware, clothing and mining artifacts from the gold rush era. Feature-length films depicting the era are shown upon request. National Park Service personnel provide interpretive services. Charlie Chaplin's classic silent film "The Gold Rush" is shown Sat.-Sun. at 3. Maps outlining historic buildings in the Pioneer Square Historic District are available. The park is open daily 9-7; in summer; 9-5, rest of year. Closed Jan. 1, Thanksgiving and Dec. 25. Phone (206) 442-7720.

LACEY V. MURROW FLOATING BRIDGE, spanning Lake Washington via Mercer Island, is over a mile long. Its 10 standard and 15 special sections are rigidly bolted together and anchored to the lake bottom; a floating draw-span is near the eastern end of the bridge. Free.

◆*LAKE WASHINGTON SHIP CANAL AND LOCKS*, within the city, connect salt-water Puget Sound with the large fresh-water harbor comprising Salmon Bay, Lake Union and Lake Washington. The Hiram M. Chittenden Locks, among the largest in the Americas, are complemented by 7 acres of gardens.

From a viewing window on the south side of the locks trout and salmon may be seen in their runs up the fish ladder. Heaviest salmon runs occur June-Nov.; steelhead trout run Nov.-Mar. and cutthroat trout July-Feb. Locks may be viewed opening for boats 7 a.m.-9 p.m. Visitor center open daily 11-8, June 15-Sept. 15; Thurs.-Mon. 11-5, rest of year. Phone (206) 783-7059.

MUSEUM OF FLIGHT, 9404 E. Marginal Way, S., is designed to showcase the history of aviation technology. The restored Red Barn,



Boeing's first manufacturing plant, features exhibits documenting early flight from the 13th century through 1930. Open daily 10-6. Adults $2.50; ages 13-18 and over 64, $1.50; ages 6-12, $1. Phone (206) 767-7373.

MUSEUM OF HISTORY AND INDUSTRY, in McCurdy Park on Lake Washington, 2161 E. Hamlin St., features exhibits dealing with Seattle, King County and the Pacific Northwest, including a collection of dresses from the late 19th century. Open Mon.-Sat. 10-5, Sun. noon-5; closed Thanksgiving and Dec. 25. Adults $1, ages 6-12 and over 62, 50c. Free admission on Mon. Phone (206) 324-1125.

NORDIC HERITAGE MUSEUM, 3014 N.W. 67th St., focuses on Scandinavian cultural contributions to life in the Pacific Northwest from the 18th century to the present. Displays trace the development of the fishing and lumbering industries; there are also exhibits of handicrafts and personal effects and changing exhibits from Scandinavia. Tues.-Thurs. 11-3, Sat.-Sun. 1-5; closed holidays. Admission $1, under 12 free; free Wed. (206) 789-5707.

PIER 59, on Alaskan Way, at the foot of Pike St., is a highlight of Seattle's waterfront development. From Pike Place Market, the pier may be reached by climbing a terraced walkway. Pier passes, offering reduced admission into the Museum of Sea and Ships, Omnidome Theater and Seattle Aquarium, are available at the pier's ticket booth for $6.95, ages 6-18, $4.95.

Museum of Sea and Ships, mezzanine level, exhibits several ship models, navigation equipment and nautical memorabilia. Daily 9-7, Memorial Day-Labor Day; 10-5, rest of year. Closed Dec. 25. Adults $2; ages 13-18 and over 64, $1.50; ages 6-12, $1. Phone (206) 628-0860 for more information.

Omnidome Theater presents natural history films using a 70-millimeter, "fish-eye" format which virtually surrounds the audience. Differ-

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ent films are shown throughout the year. Daily 10:30-9. Adults $3.95; under age 18 and over 64, $2.95; under 6 free. Phone (206) 622-1868 for information on films and showtimes.

Pacific Marine Institute's Anchor Excursions depart from Pier 59 next to Seattle Aquarium for 2- to 3-hour marine science cruises on Puget Sound aboard the research vessel *Snow Goose*. Programs include an ecology lecture, an explanation of navigation and experience in identifying plankton types and dredging and sorting marine organisms. Tours offered weekdays; phone (206) 282-8368 to confirm day, times and fare.

Seattle Aquarium, Pier 59 at Waterfront Park, features an underwater dome where visitors can view the sea life of Puget Sound, including sea mammals and seashore creatures. A salmon ladder is also featured. Daily 10-9, May 15-Sept. 15; Wed.-Mon. 10-5, Tues. 10-9, rest of year. Adults $3.25; senior citizens and ages 13-18, $1.50; ages 6-12, 75c. Phone (206) 625-5030 for more information.

PUGET SOUND VESSEL TRAFFIC SERVICE, ½ mi. s. at Pier 36 on Alaskan Way S., provides 24-hour traffic and weather information for vessels operating on Puget Sound and the Strait of Juan de Fuca. A slide show and 30-minute guided tour of the command center are featured. Open daily, 24 hours. Free. Phone (206) 442-4124.

RAINIER BREWING CO., 3100 Airport Way S., offers tours Mon.-Fri. 1-6. A wrap is recommended; children must be with an adult and able to walk up seven flights of stairs. Phone (206) 622-2600.

◆*SEATTLE CENTER*, 89 acres, 1 mi. from downtown near Elliott Bay, occupies the former world's fair grounds. Many of the fair buildings now serve civic and cultural purposes; a striking feature is the architectural concept, designed for man in the 21st century. Phone 625-4234. Significant attractions within the center include:

Pacific Science Center includes airy Gothic arches and space age displays, as well as a Northwest Indian house reconstructed from original parts. A film on aviation is shown in the Eames/Imax Theater. Mon.-Fri. 10-5, Sat.-Sun. 10-6; closed Thanksgiving and Dec. 25. Adults $3, ages 6-17 and over 62, $2; on Wed. senior citizens and the handicapped are admitted free. Phone (206) 625-9333.

Seattle Art Museum Pavillion has changing exhibits of historical and general art. The exhibits, which reflect the diversity of art around the world, are well displayed, with rest points for longer viewing. Tues.-Sat. 10-5, Sun. and holidays, noon-5, also Thurs. 5-9 p.m. Adults $2, ages 6-18 and over 61, $1. Phone 447-4729.

Space Needle, 605 feet high, provides panoramic views from its topmost platform. A restaurant atop the needle turns full circle every hour; a second restaurant is on the 100-foot level. Daily 9 a.m.-2 a.m. Elevator $3, ages 6-12, $1.50. Phone 447-3100.

THE SEATTLE CHILDREN'S MUSEUM, 117 Occidental Ave. S., encourages children to participate in hands-on, innovative activities using everyday items. Open Wed.-Sat. 10-3:30. Admission $1.50. Phone (206) 624-6191.

THOMAS BURKE MEMORIAL WASHINGTON STATE MUSEUM, University of Washington campus, 17th Ave. N.E. entrance, exhibits artifacts of the Northwest Indian and peoples of the Pacific Rim, including fossils, rocks, totem poles, scrimshaw, seashells and dinosaur relics. Tues.-Fri. 11-5:30, Sat.-Sun. 9-4:30; closed holidays. Free. (206) 543-5590.

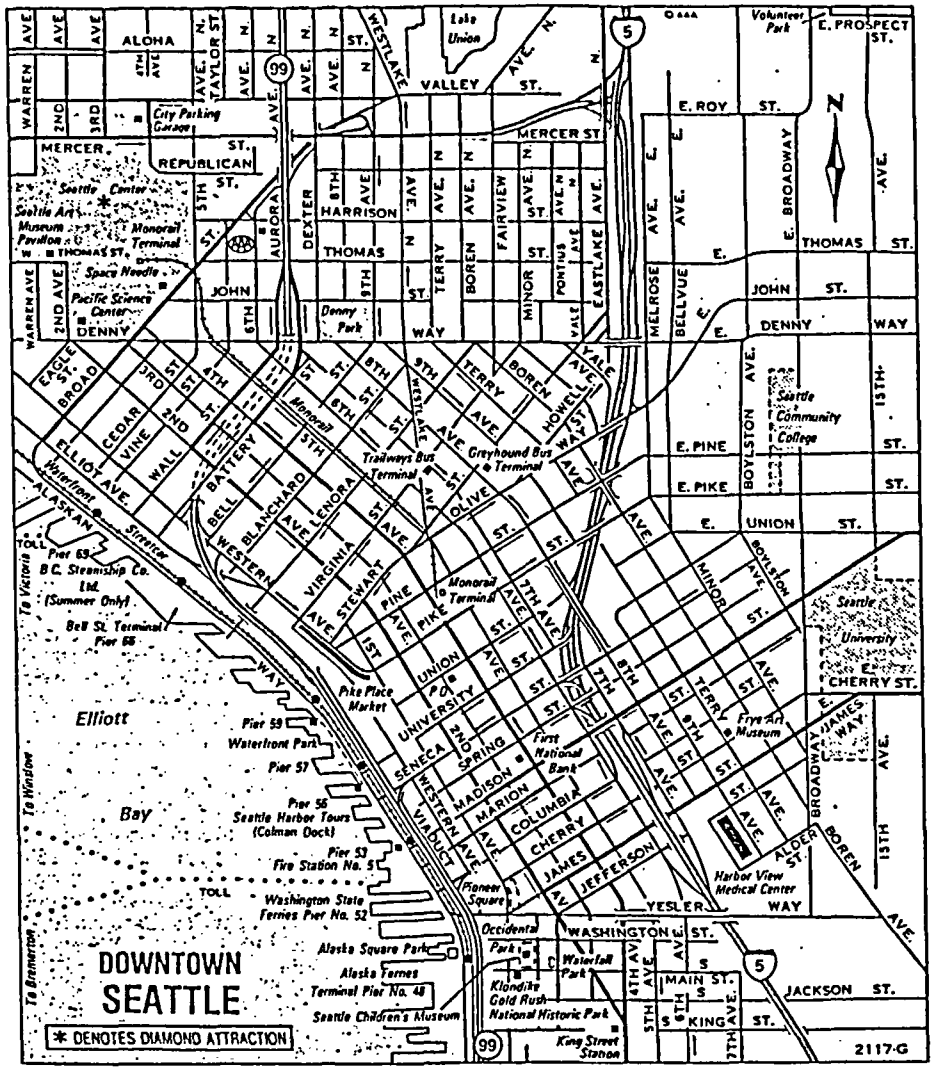
UNIVERSITY OF WASHINGTON ARBORETUM, in Washington Park, contains 200 acres of plants from throughout the world. Lake Washington Boulevard, through the arboretum, is open 24 hours; Arboretum Drive, more scenic, is open daily during daylight hours. Greenhouse open Mon.-Fri. 8-4; office, Mon.-Fri. 8-4:30. Free. Phone (206) 543-8800.

Japanese Tea Garden was designed in Japan and built under the direction of Japanese landscape architects. A tea room, a *machiai* (waiting room), an *azumaya* (resting place), and a pond are integral parts of the Japanese Tea Garden. Daily 11-8, June 1-Aug. 31; 10-7, May 1-31; 10-6, Mar. 1-Apr. 30 and Sept. 1-Nov. 30. Adults $1, over 64, under 19 and the handicapped 50c. Phone (206) 625-2635.

VOLUNTEER PARK, entered at E. Galer and 15th Ave. E. and E. Prospect and 14th Ave. E., features 44½-acres of formal gardens and extensive lawns on Capitol Hill. At its center is the Seattle Art Museum. The Conservatory has a large collection of cactus, orchids and subtropical plants; daily 9-5. Free. Phone (206) 625-4043. Nearby, a statue of former Secretary of State William H. Seward commemorates the 1867 Alaska Purchase. A spiral stairway leads to the top of the 75-foot Water Tower for a excellent view of the city, its lakes and nearby mountains. Park open daily dawn-11 p.m.

◆*Seattle Art Museum* houses a world-famous collection of oriental art and one of the two Tiepolo ceilings in America. Paintings by members of the school known as the Northwest Mystics are here, as well as examples of early European, pre-Columbian, Islamic, African and Persian arts, and an extensive collection of Chinese and Indian jade. Tues.-Sat. 10-5, Sun. and holidays noon-5; also Thurs. 5-9 p.m. Closed Thanksgiving and Christmas. Adults $2; students and over 61, $1; under 6 free. Free on Thurs. Phone (206) 447-4670.

WING LUKE MEMORIAL MUSEUM, 414 8th Ave. S., presents various cultural exhibits contributed by Asian ethnic communities in



the Northwest. Examples of folk art, calligraphy and photography are displayed, as well as historical artifacts and changing exhibits. The museum commemorates a city councilman, active in the city's international district, who was killed in an airplane crash. Tues.-Fri. 11-14:30, Sat. noon-4; closed holidays. Free. Phone (206) 623-5124.

WOODLAND PARK ZOOLOGICAL GARDENS, Phinney Ave. N. between N. 50th and N. 59th Sts., features approximately 1,000 animals and reptiles. Of special interest are the rare Golden Tamarin, the gorilla habitat, the African Savannah and the Nocturnal House. Open daily 8:30-6, May-Sept.; daily 8:30-5, Oct.-Dec.; daily 8:30-4, rest of year. Adults $2.50; ages 13-17, $1; ages 6-12, senior citizens and handicapped 50c. Parking up to 75c. Phone (206) 789-7919.

What To Do

Sightseeing

Gray Line Tours and American Sightseeing International offer conducted trips through Seattle and environs, as well as to the North Cascades, the Olympic Peninsula and Mount Rainier. Other companies conduct tours from Seattle to Canada, Alaska and elsewhere. Consult the Automobile Club of Washington for information.

Chinatown Tours of Seattle's Asian community begin at the Kobe Park Building, at 628 S. Washington St., and include Japanese Hall

(Continued)

SEATTLE *(Continued)*

and Chinatown; check locally for schedule. Fare $3, students with ID and senior citizens $2. Reservations required; phone 624-6342.

Seaplane sightseeing flights over the Seattle area depart daily from the Lake Union waterport. Flights last 30 minutes; call Lake Union Air (284-0300) for reservations. Narrated 2-hour flights to Mount St. Helens *(see description)* depart daily from Boeing Field; phone 485-7544.

BILL SPEIDEL UNDERGROUND TOURS feature five-block walking tours which take in some of the 19th-century storefronts around Pioneer Square. The tour includes subterranean sidewalks and storefronts created when street levels were raised 8 to 35 feet following a fire in 1889. Walking shoes should be worn, and visitors may wish to carry a flashlight. Tours depart from Doc Maynard's Public House, in the Pioneer Building at 1st Ave. and James St., in Pioneer Square Park, Mon.-Sat. 9-7, Sun. 9-5, June 14-Labor Day; daily 11-4, rest of year. Call to verify hours. Adults $3; over 65, $2; ages 6-12, $1.50. Reservations required. Phone 682-4646, 682-1511 or 682-1164 for reservations and information.

SEATTLE HARBOR TOURS, Pier 56 at the foot of Seneca St., offer 1-hour narrated trips along the waterfront and past the shipyards. Daily at 11, 12:15, 1:45, 3:15 and 4:30, June 1-Sept. 30; at 12:15, 1:45 and 3:15, May 1-31 and Oct. 1-31. Adults $3.50; over 65, $3; ages 5-11, $1.50. Discount; all fares except over 65. Phone 623-1445.

Sports and Recreation

Seattle offers every sport from skindiving to mountain climbing; its residents boast that its location and climate make it possible to sail in the morning and ski that afternoon. The extensive city park system includes more than 5,000 acres of park patches and boulevards. The many state parks in the vicinity provide recreational and camping facilities *(see Recreation Chart)*.

Local outdoor recreational books and topographic maps for hiking are sold in the bookstore of the Automobile Club of Washington office.

Spectator sports run the gamut in Seattle. There are three major automobile raceways in the area; schedules for car meets vary. Horseracing with pari-mutuel betting takes place at Renton's Longacres Race Track during the summer racing season. The Kingdome features football by the Seahawks, soccer by the Sounders and baseball by the Mariners during their respective seasons. The Supersonics play basketball and the Seattle Breakers play hockey in the Seattle Center Coliseum. Area college teams participate in all major sports. During the August Seafair, Lake Washington provides a course for hydroplane races.

Boating is available on fresh-water Lake Washington, salt-water Puget Sound or both, thanks to the locks and canal connecting the two. A multitude of marinas provide moorage facilities. Any type of craft may be rented, from small sailboats or canoes to large sea-going yachts.

Golf courses, both municipal and commercial, are plentiful, as are driving ranges and pitch-and-putt courses. Some private clubs extend reciprocal privileges to visitors who are members of certain out-of-town golf clubs. The Seattle Park Department, phone 625-4671, can furnish information on locations and greens fees.

Hiking and horseback riding enthusiasts will find miles of forest trails in nearby areas and mountains. The U.S. Forest Service and Park Service (442-0170) can furnish information on trails; the Yellow Pages contain listings of stables and academies.

Hunting and fishing opportunities are plentiful. Fresh-water fishing is available from piers at Green Lake and Lake Washington, in county parks and in area lakes and streams. The Washington State Game Dept. (464-7764) is the best source for fresh-water license requirements and information. Piers 57 and 86 are public fishing piers on Elliot Bay. Charters may be arranged for Puget Sound or deep sea fishing off the coast; consult the Yellow Pages.

Whitewater rafting, float trips and bald eagle sightseeing tours are offered throughout the state. The season for whitewater rafting is Apr.-Sept., while bald eagle sightseeing tours take place Dec.-Feb. Rates for such trips are commensurate with offerings, but the average fee for a full-day excursion is $40-$65; half-day trips and children's fees are less. Reservations for trips may be made through the following Seattle agencies: Cascade River Runners, P.O. Box 4096, Seattle, WA 98104 (322-3469); Northern Wilderness Co., 7342 15th St. N.W., Seattle, WA 98117 (789-6702); and Orion Expeditions, Inc., 10728 Lake City Way N.E., Seattle, WA 98125 (364-9850). Discount. Offices are open weekdays during working hours.

Mountain climbing and skiing are possible at many challenging spots in the Seattle area. Guided trips to the summit of Mount Rainier as well as instructions in climbing techniques are available *(see Mount Rainier National Park)*. Major ski areas within a short drive of the city are noted under the listings for Mount Baker-Snoqualmie and Wenatchee National Forests *(see descriptions)*. For a ski report, phone 634-0200. Cross-country skiing also may be enjoyed.

Swimming and skindiving are favorite summertime sports. There are salt-water beaches at Alki and Golden Gardens and fresh-water beaches on Lake Washington and Green Lake, as well as several public swimming pools within the city. The Yellow Pages provide information on skindiving instruction and the rental of the equipment required.

Since the 1890's, bicycling has been a popular sport in Seattle. Today the city has an assortment of asphalt and concrete routes for cycling enthusiasts. The 12½-mile Burke-Gilman Trail, designed for biking and hiking, extends from Gas Works Park, at N. Northlake Way and Burke Ave. N., to Logboom Park, at 61st Ave. and SR 522. The trail skirts the University of Washington campus and offers good views of the area. Most routes connect with the city parks; others are along the waterfront. For information, phone 522-BIKE.

Tennis and other sports are also available. The city park department maintains nearly 100 public courts, some of which are lighted for night matches; several private tennis clubs extend reciprocal privileges to travelers. Commercial ranges for rifle and skeet shooting are listed in the Yellow Pages. Jogging and lawn bowling are becoming increasingly popular. Facilities for both are in the city parks. For information, phone 522-7711 and 762-9728 or 782-1515, respectively.

Where To Dine

From seafood stands right on the water's edge to a revolving dining room 500 feet in the sky, Seattle offers dining choices to answer every craving. Seafood, particularly salmon, clams, shrimp, oysters and crabs, is excellent here. Many restaurants along the waterfront specialize in fresh fish and seafood dishes; several delight patrons by serving salmon Indian-style, broiled over open fires. In others, Japanese food is prepared at your table. Rare dining experiences are found where scenery is served with the menu in the revolving restaurant atop Seattle Center's Space Needle and in the mirror-lined walls of the Mirabeau Restaurant in the Seattle-First National Bank Building.

Nightlife

You'll be missing a great opportunity if, when in Seattle, you don't mix your cocktails with a view. Some bars and lounges offer unparalleled views of snowcapped mountains; others overlook the picturesque harbor or sound and permit the diner or drinker to watch the waterfront activity.

Nightclubs downtown and along the waterfront feature big-name entertainment; the daily newspaper can bring you up to date on visiting performers and cover charges. Some larger hotels provide dinner music for dancing, and there is the usual smattering of discotheques.

Note: The mention of any area or establishment in the preceding sections is for information only and does not imply endorsement by AAA.

Theater and Concerts

Seattle Center is the cultural focus of metropolitan Seattle. Its Opera House is headquarters of the Seattle Opera Association, which presents several full-scale operatic productions featuring guest stars during its Sept.-May season. When not the scene of operas, the Opera House plays host to the Pacific Northwest Ballet, artists, theatrical productions, modern dance performances and concerts by the Seattle Symphony. This orchestra schedules concerts regularly on Mon., Tues. and Wed. evenings Sept.-Apr. There are also Sun. matinees and family concerts. The refurbished Paramount Theatre presents well-known entertainers in concert at 907 Pine St.; phone (206) 624-5772 for more information.

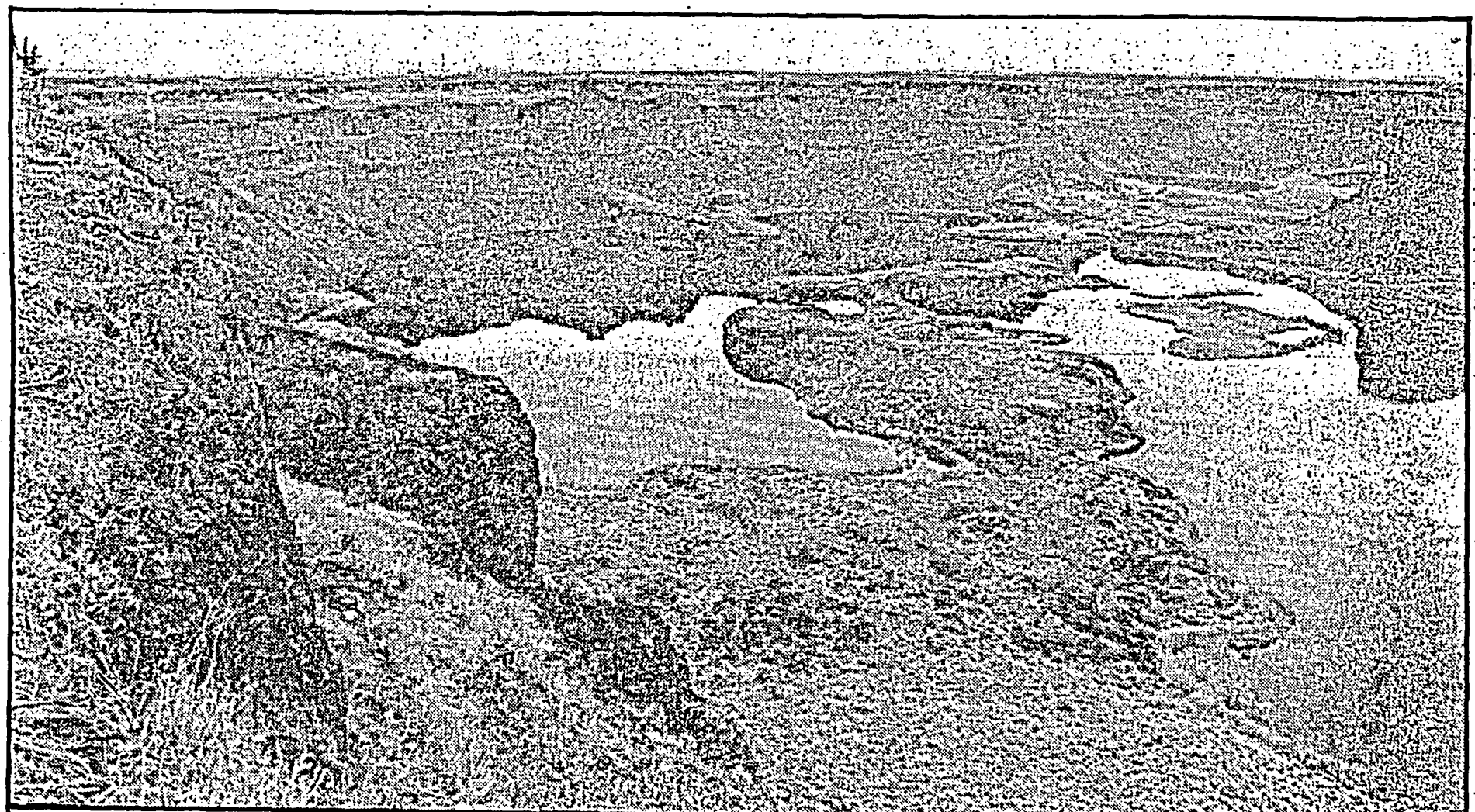
The Bagley Wright Theatre at the Seattle Center houses the nationally acclaimed Seattle Repertory Theatre Company, which presents six plays each year late Oct.-Apr. Check locally for curtain times; tickets range from $5.25 to $8. Phone 447-4764. Broadway shows are the attraction at the 5th Avenue Theatre, 1308 5th Ave.; phone (206) 625-1900. Popular among summer playgoers are A Contemporary Theater (ACT), near Seattle Center at 1st Ave. W. and W. Roy, and Intiman at the Second Stage, 1419 8th Ave. The Indian Dinner Theatre, at Daybreak Star Art Center in Discovery Park, claims to be the only one of its kind in the world; theatrical productions are featured every other Fri. Other performances are given at the University of Washington's Showboat, the Penthouse, Glen Hughes Playhouse and at other little theaters. Check the newspapers for full listings.

Especially for Children

Seattle contains a variety of attractions and experiences to interest even the most travel-weary youngsters. Bathtub sailors enjoy the bustle of dockside activity and tours of the harbor, locks and floating bridges. Budding fishermen are interested in the city's aquarium and Fisherman's Terminal. Seattle's parks provide acres of play space; Gasworks Park has a playbarn and an area with ropes, towers and slides. Woodland Park features a zoo and has children's theatrical productions at Poncho Theater. The totem pole in Pioneer Square Park intrigues most children. Designed exclusively for youngsters, the Children's Museum features interesting hands-on displays. Puppet shows and other amusements for youngsters are part of Seattle Center's children's program. The Seattle Junior Theatre conducts children's performances at the Seattle Center Playhouse Oct.-Apr.; phone 622-7246.

TOURTIME, a guided sightseeing bus service for children, visits several youth-oriented attractions in the Seattle area. Day trips run about 7-5; the bus will pick up participants at designated places in Seattle. Day trips $15; other trips are available. Phone 823-2613 for more information.

The Seattle Times/Seattle Post-Intelligencer Sunday,December 16, 1984
Times Special Report



Peter Liddell / Seattle Times

Layers of basalt rock in the cliffs above Dry Falls in Central Washington are similar to the deeply buried rock layers being studied at Hanford for disposing of radioactive waste. The layers are the result of repeated lava flows millions of years ago.

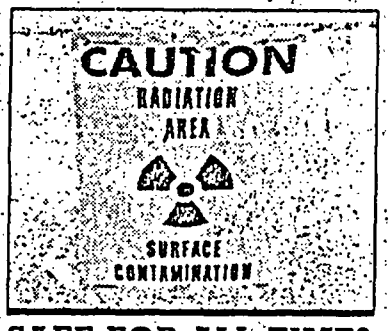
Hunt for nuclear burial spot zeroes in on Hanford

by Hill Williams
Times science reporter

Of the more than $800 million the federal government has spent to study the nine candidates for a nuclear-waste repository, more than a third has been spent in this state.

Hanford in Eastern Washington and Yucca Mountain, a barren ridge in Nevada, are the only two candidate sites with a history of nuclear work and with significant previous radioactive contamination. Together, Hanford and Nevada account for two-thirds of the DOE's total expenditures in the search for the nation's first permanent disposal site.

NUCLEAR WASTE



SAFE FOR ALL TIME?

And work is continuing on the federal land at Hanford and in Nevada while field work has virtually stopped at the other sites.

Hanford and Yucca Mountain are atop volcanic rock that conceivably could qualify in the rigorous search for a waste site. Some of the seven other sites, all in salt formations, have obvious problems:

- Two sites in the Texas Panhandle are below rich, privately owned farm and ranch land and are directly beneath the nation's largest underground fresh-water supply, the Ogallala Aquifer.
- Two in Utah are in spectacular canyon country with heavy recreational use. One is near a campground.
- One in Mississippi is privately owned. The other is beneath national-forest land but has a big National Guard military reservation sitting on top of it.
- The ninth site, in Louisiana, is under privately owned land in a state that believes it has been excused from the search.

The choice of candidates has led to suspicions that some of the salt sites are straw men, set up to fulfill the requirement for a nation-wide search.

Whatever the case, the Department of Energy will recommend three of the sites early next year. The Nuclear Waste Policy Act of 1982 requires that one of the three sites be in a geological formation other than salt. Either Hanford or Yucca Mountain would qualify.

Many observers expect both Hanford and Nevada to be among the final three. Of the salt sites, a Mississippi salt-dome formation known as the Richton Dome appears to be preferred by the investigators.

However, political opposition is heavy in Mississippi, led by Gov. Bill Allain.

Here is a brief description of the sites:

- Hanford — The proposed repository would be in an ancient lava flow about 3,000 feet below the surface. It would be below the water table and, therefore, flooded after the repository was filled with waste, closed and sealed.
- Nevada — A cavern would be mined 1,200 feet below Yucca Mountain in one of the least populated areas in the United States, with an average of less than half a person per square mile. The cavern would be dry, 500 feet above the water table.

The rock is welded tuff, a thick layer of volcanic ash that was so hot when it erupted 13 million years ago that it welded itself into solid rock.

- Utah — The two sites, Davis Canyon and Lavender Canyon, are about 2 miles apart in spectacular recreation country owned by the Bureau of Land Management.

The repository would be 2,900 feet below the surface in a layer of bedded salt more than 250 feet thick laid down by a deep, stagnant sea some 250 million years ago. The salt is relatively free of dirt and other contaminants, making its behavior easier to predict.

Salt is plastic and would be expected to close around the waste after the repository has been closed permanently. The fact that salt has been there millions of years indicates a lack of water.

After some initial drilling, the governor of Utah prohibited the DOE from further work. He did not seek re-election, but the incoming governor has also criticized the program.

- Texas — There are two general areas, in Deaf Smith County and in Swisher County in the Texas Panhandle, but specific sites have not been announced because of fierce local opposition. The area is agricultural land.

The repository would be in bedded salt, the result of another ancient sea, about 2,500 feet below the surface. The salt is less pure and wetter than that in Utah and therefore less desirable.

Many Texans believe that Don Hodel, energy secretary, has promised that Texas will not be considered because of grassroots opposition and the clout of the state's politicians.

- Louisiana — One site is under consideration in a salt dome, a different type of salt structure. The site is Vacherie Dome in the northern part of the state.

Salt domes were formed along the Gulf Coast during millions of years as rivers poured sediment on top of sea-bottom salt layers as much as 5,000 feet thick. The crushing weight of sediment pushed the salt into ridges and then, as time went by, into columns creeping toward the surface, almost like toothpaste squeezing out of a tube.

Louisiana politicians believe that former President Carter promised the state would be exempted from a nuclear-waste site if it accepted the strategic petroleum reserve, which it did. Vacherie Dome is privately owned.

- Mississippi — The Battelle Memorial Institute, which is managing the salt-site investigation for the DOE, believes Richton Dome in Mississippi would be the best salt site. The repository would be about 2,500 feet deep in a column of salt that, at that depth, would be about 4½ miles long and 2¾ miles wide. There would be 5,000 acres available for a repository. Richton Dome is privately owned.

The other Mississippi site is Cypress Creek Dome, which is under national-forest land. However, Camp Shelby, a National Guard military reservation is above the dome.

Oil and gas are not usually found in domes themselves, but sometimes occur on the flanks of the

The Seattle Times / Seattle Post-Intelligencer Sunday, December 16, 1984
Times Special Report

U.S. Picks 3 States In Nuclear Waste Dump Site Study

By ARLEN J. LARGE
Staff Reporter of THE WALL STREET JOURNAL

WASHINGTON—The Energy Department said it wants to pick a final resting place for nuclear waste from among three possible sites in Nevada, Texas and Washington state.

A deep-underground waste dump site is supposed to be picked by the president in 1991, and is to start accepting spent fuel rods from nuclear reactors by 1998. The maze of deep horizontal tunnels will be designed to isolate radioactivity for "several thousand years," said Ben Rusche, the department's civilian nuclear waste chief.

Reluctant Candidates

The agency's three reluctant candidates for a five-year study of their suitability for depositing nuclear waste are:

—Yucca Mountain in Nevada, 100 miles northwest of Las Vegas on the boundary of the government's desert reservation for underground tests of nuclear bombs. The reactor waste would be buried in a thick underlying layer of compacted volcanic ash called "tuff."

—Deaf Smith County in the Texas Panhandle, 30 miles west of Amarillo. Below the surface prairie land is a bed of rock salt from which the burial tunnels would be carved.

—The government's Hanford nuclear reservation in southeastern Washington state, near the city of Richland. The arid landscape covers a formation of volcanic basalt, in which the waste would be buried.

The scientific task of the federal site-searchers will be to pick the geologic formation that can best protect the casks of waste from water seepage or other disturbances for centuries. Tougher yet will be the political task of getting people living near the final site to go along with the government's choice.

"It's fair to say that none of the (three) states are supportive" of their selection as candidates, said Energy Secretary Donald Hodel, who spent yesterday morning on the telephone talking to governors and congressmen from the states. Mr. Hodel said he hopes that after extensive local public hearings and consultations, "the president will be able to select a site that has general support."

Wall Street Journal
12/20/84

Akron Beacon Journal - 12/20/84

ATOMIC WASTE SITE LIST PARED: Following years of preliminary studies, the Department of Energy today was to release its formal assessment ranking the best of nine sites in six states for burying 70,000 metric tons of radioactive nuclear waste.

Although final site will not be chosen until 1990, a source with a copy of the relevant draft chapters in the documents told the Associated Press that the five sites that emerge as the top candidates are:

- Deaf Smith County, Texas, about 30 miles west of Amarillo.
- Yucca Mountain, on the edge of Nellis Air Force Base and the Nuclear Weapons Test Site in southern Nevada.
- The Energy Department's Hanford reservation, just northwest of Richland, Wash.
- Davis Canyon, just outside the boundary of Canyonlands National Park in southeastern Utah.
- Richton Dome, near Richton, Miss.

The draft versions effectively eliminate from consideration four other sites — one each in Utah, Mississippi, Texas and Louisiana.

Thursday, December 20, 1984
The Seattle Times

State isn't convinced Hanford is best waste site

by Hill Williams
Times staff reporter

The ranking of Hanford as one of the top three candidates for a national disposal site for radioactive waste was predictable. So was the reaction.

The mayor of Richland, a city about 25 miles from the proposed site, thought first of jobs. The project would be an economic "shot in the arm" for the Tri-City area, John Poynor said.

But Susan Krala of the University of Washington Public Interest Research Group (WashPIRG) said, "Washington state has lost the first round in a stacked lottery."

Hanford was ranked in a report issued yesterday by the Department of Energy, which is responsible for finding a burial place for high-level waste from the nation's nuclear-power plants. Hanford, Yucca Mountain in southern Nevada and a site beneath farming country in Deaf Smith County in the Texas Panhandle were named as the preferred sites for the repository.

The Department of Energy is scheduled to formally select the top three sites next summer. That action will begin an intensive, five-year study of each finalist. The total cost of the study will exceed $1 billion for each site.

Warren Bishop, chairman of the state's Nuclear Waste Board, which has negotiated but not signed an agreement with the DOE setting out the state's rights in the study of Hanford, said:

"The state is not convinced that the Hanford site is the most suitable. . . . The Nuclear Waste Board has not committed itself in any way to the preliminary decision made by the DOE. . . . The state will exercise every authority it has to make its own determination."

Although the report is in draft form, Energy Secretary Don Hodel said he did not expect the top three sites to change "unless we are surprised (by test results), and we don't expect surprises."

Hanford and the Nevada site were widely expected to be among the top three.

Larry Caldwell of Richland and the Hanford Oversight Committee said, "From the very beginning, the DOE was partial to remote, sparsely populated sites, primarily in the West, with captive and compliant populations."

State officials who will be responsible for judging the DOE's work and investigations at Hanford were cautious.

Al Williams, chairman of the state Senate's Energy and Utilities Committee, said, "A great burden of proof" will rest on the federal government to establish that Hanford is a safe site.

"We have a long way to go," he said.

Dick Nelson, chairman of the corresponding committee in the state House of Representatives, said that even though the state would have a veto if Hanford finally were selected, it could be overridden by Congress unless the state had solid, technical objections to the site.

"We're going to have to be as smart as the Department of Energy is about this, and that's what we're gearing up for," Nelson said.

Gerald Pollett, attorney for WashPIRG, said the investigation of Hanford probably will be "the single largest environmental and public-health issue for this state for the remainder of the century."

Pollett said the DOE, "in its rush to bail out the nuclear industry, has ignored serious doubts" about the safety of the site.

Nelson said, "It is puzzling why they pick Hanford when it is next to the Columbia River, the major Northwest river."

U.S. Sen. Dan Evans said, "There is no question that we have to find a safe place" for radioactive waste, and "it is irresponsible for anyone in any state to say, 'Fine, but not me, not here.'"

Still, Evans said, there are unanswered questions about the safety of the Hanford site and about transportation of the waste.

"We need to pay attention to the burden the state already bears in radioactive waste," Nelson said. "Hanford has about 50 percent of the nation's defense waste. A commercial site there gets 54 percent of the nation's low-level waste. Hanford is targeted as a place to dispose of reactor components from nuclear submarines.

"Add it up and it's a tremendous burden," he said.

Hodel said he hoped the five-year study of the three final candidates would be so convincing of the safety of the project that "I don't think it will be viewed as entailing extra risk."

But Gov.-elect Booth Gardner said much work remains before it can be determined if Hanford will be a suitable site for the waste.

"This study, from what I know of it, may raise more questions than it answers," he said.

The Seattle Times Thursday, December 20, 1984

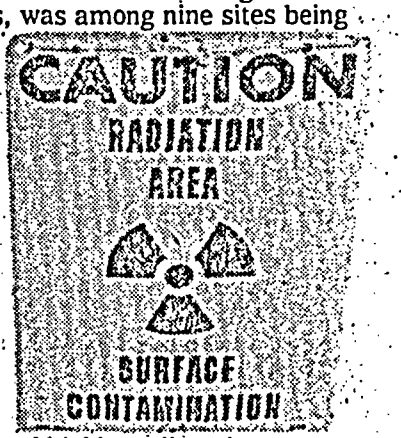
EDITORIALS

THE FINAL THREE

Need for caution at Hanford N-waste site

NO ONE who has been paying the slightest attention to the long debate over what to do with America's radioactive wastes should be surprised that the Hanford Nuclear Reservation in Eastern Washington is one of the three finalists for the nation's first permanent federal nuclear-waste repository.

Hanford, a desolate, 570-square-mile chunk of sagebrush and sand just north of the Tri-Cities, was among nine sites being studied in the last several years by the U.S. Department of Energy. More federal money — $300 million out of more than $800 million — has been spent investigating Hanford than any other site, however.



The DOE's so-called Basalt Waste Isolation Project at Hanford, located in a tunnel inside an ancient lava flow 3,000 feet below the surface, may well prove to be the best geological site in the nation for long-term storage of highly radioactive wastes.

But much more work and study must be done before that case is proved conclusively. Important, unanswered questions have been raised about possible groundwater seepage, cracks in the basalt layers, and earthquake dangers.

The Energy Department hurt its own credibility two years ago when some of its findings about Hanford were challenged by the U.S. Geological Survey and the Nuclear Regulatory Commission. But those agencies now generally approve of the department's efforts. A series of briefings and hearings on the department's draft environmental-impact assessment of Hanford will begin in January.

The state also has its own comprehensive oversight process under way, led by the 15-member Nuclear Waste Board, a citizens' advisory council, and the Department of Ecology. The federal Nuclear Waste Policy Act of 1982 requires a thorough process of "consultation and cooperation" between federal and state governments before a final site is designated.

The state has the right to carefully monitor federal actions and develop its own independent studies of public-health, safety and environmental impacts. A statewide citizen-involvement program is being developed with the help of the League of Women Voters.

In the end, if the president selects Hanford as the preferred site sometime after 1990, but citizens of this state are still not satisfied, the governor or Legislature could veto the federal decision — and a two-thirds vote in both houses of Congress would be required to overturn the veto.

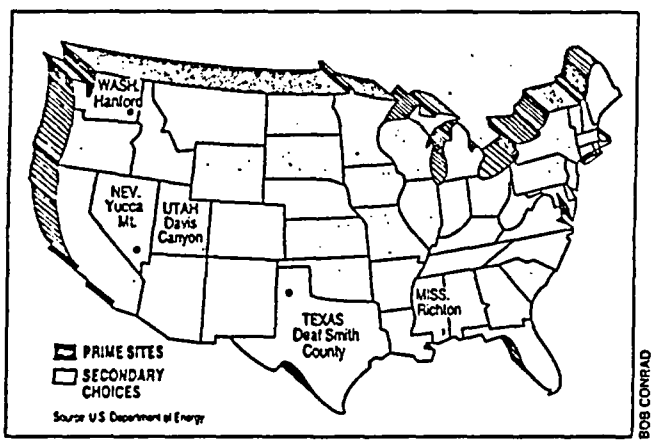
Washington state citizens should not reject the idea of a nuclear-waste repository at Hanford out of hand — but neither should they accept it with open arms.

Too Hot to Handle?

A furor erupts over where to bury nuclear waste.

Energy Secretary Donald Hodel called Texas Gov. Mark White personally to break the news: the Department of Energy had tentatively selected a nine-mile swatch of Texas's Deaf Smith County as one of three areas best suited for the nation's first high-level nuclear-waste burial site. "Do you know who Deaf Smith was?" White thundered. "He was one of Gen. Sam Houston's scouts at the battle of San Jacinto. Deaf Smith will hear me on this issue!" Later the governor vowed that "sparks will fly ... before the people of Deaf Smith County will glow."

Not-in-my-backyard sentiment was almost as virulent at the other sites DOE named last week. Nevada Gov. Richard Bryan said he would veto a waste repository near Nevada's Yucca Mountain. Washington Governor-elect Booth Gardner expressed concern about a site at the government's Hanford nuclear range. Officials in Utah and Mississippi, site of DOE's fourth- and fifth-place choices, also vowed to keep their "powder dry," as outgoing Utah Gov. Scott Matheson put it. Environmentalists fumed that Utah's Davis Canyon, within sight of the Canyonlands National Park, should never have been on the list, and one Richton, Miss., developer figured the government already owed the town $10 million for bad publicity. Meanwhile, three environmental groups filed suit protesting DOE's selection process. Said the Sierra Club's Brooks Yeager, "There isn't a site on this list which isn't hampered by severe technical or environmental problems."



BOB CONRAD

Potential repositories: No town called Some Place Else

DOE's move was aimed at solving a problem that has existed since the first commercial nuclear power plant went on line in 1957: what to do with spent fuel. All along, that was to be a federal responsibility, but solutions have been delayed by on-again, off-again efforts to reprocess the material. Meanwhile, 10,000 metric tons of spent fuel have accumulated at nuclear power plants—a cache that will quadruple by the year 2000. The Nuclear Waste Policy Act of 1982 required DOE to select nine possible disposal sites and rank the top three. After 90 days of comment, the three will be submitted to Ronald Reagan, then each will undergo five years of testing. In 1990 the president will make a final choice, and the site will accept its first shipments in 1998. The state governor may veto the selection, but Congress can override the veto.

JIM MCHUGH—SYGMA

Protective gear: Delayed solutions

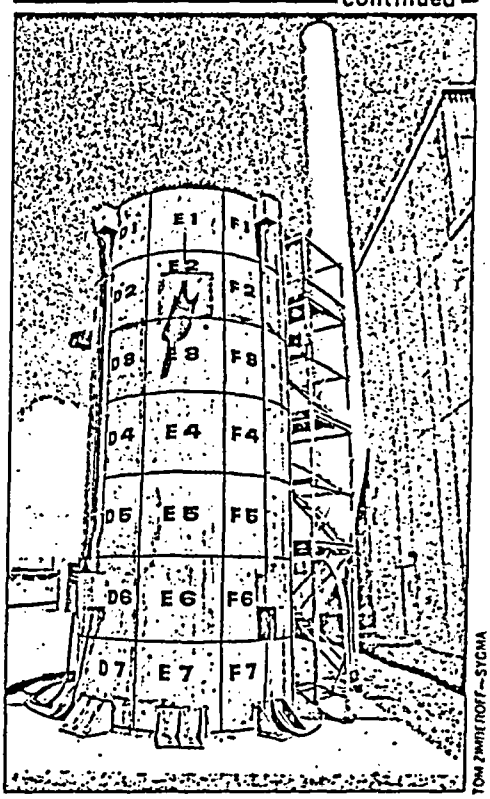
Shafts: DOE officials insist the choice will be based on technical, not political considerations. The site must be geologically equipped to store at least 70,000 metric tons of nuclear waste for 10,000 years, the time it takes for the radioactivity to decay to harmless levels. After burying the waste in steel and concrete casks deep underground (page 36) for 25 to 30 years, the site will be monitored for 50 years. Then the underground shafts will be sealed and markers erected to warn future generations of the danger. Officials say the natural and man-made barriers should prevent waste from reaching underground water for thousands—even millions—of years. "It will be one of the safest endeavors ever undertaken," says Michael Lawrence, a Hanford DOE official and former acting chief of DOE's waste-management office.

Hodel concedes "right now, none of the states is supportive." But he hopes residents will soon see the economic benefits—about 3,000 jobs in Deaf Smith County, for example, during peak years. Panhandle residents, however, fear for their current livelihoods. The surrounding area produces 10 percent of the nation's beef and 85 percent of the world's sorghum seed. The site also lies under the vast Ogallala aquifer that supplies drinking and irrigation water. "People will fight you with the three 'L's'—legislators, lawyers and lead," farmer Dale Kleuskins warned DOE officials. Last week the state sued, charging that DOE had violated the 1982 law by designating the specific site only two weeks earlier. "An Oklahoma card shark will give you a fairer deal," said state Agriculture Commissioner Jim Hightower.

In Hanford, where nuclear activity has dominated the economy for 40 years, local folks are more favorably disposed toward the proposed repository. But authorities are concerned about possible earthquakes and the flow of ground water toward the nearby Columbia River. Even the Tri-City Herald, once boosterish about the potential economic boon, has grown cautious. "As you get older, a lot of things in this world are more important than $1 billion," says editorial-page editor William Bequette. The Yakima Indians, who hold property and fishing rights in the area, are outraged—and will try to veto Hanford's selection. In Nevada, meanwhile, residents say the state has done its part, given the extensive nuclear-weapons tests there. Others say there have been problems transporting waste to a Nevada silo—and they fear for tourism if Yucca, 100 miles from Las Vegas, is chosen. Says Bryan, "We don't want to replace neon with radioactive glow."

Transporting the waste material is likely to be an even bigger issue—affecting virtually every state. Some experts say the spent fuel, shipped in solid form in armored casks, will be far less dangerous than other hazardous cargo, since it cannot explode, catch fire or spread poisonous fumes. Still, critics fear

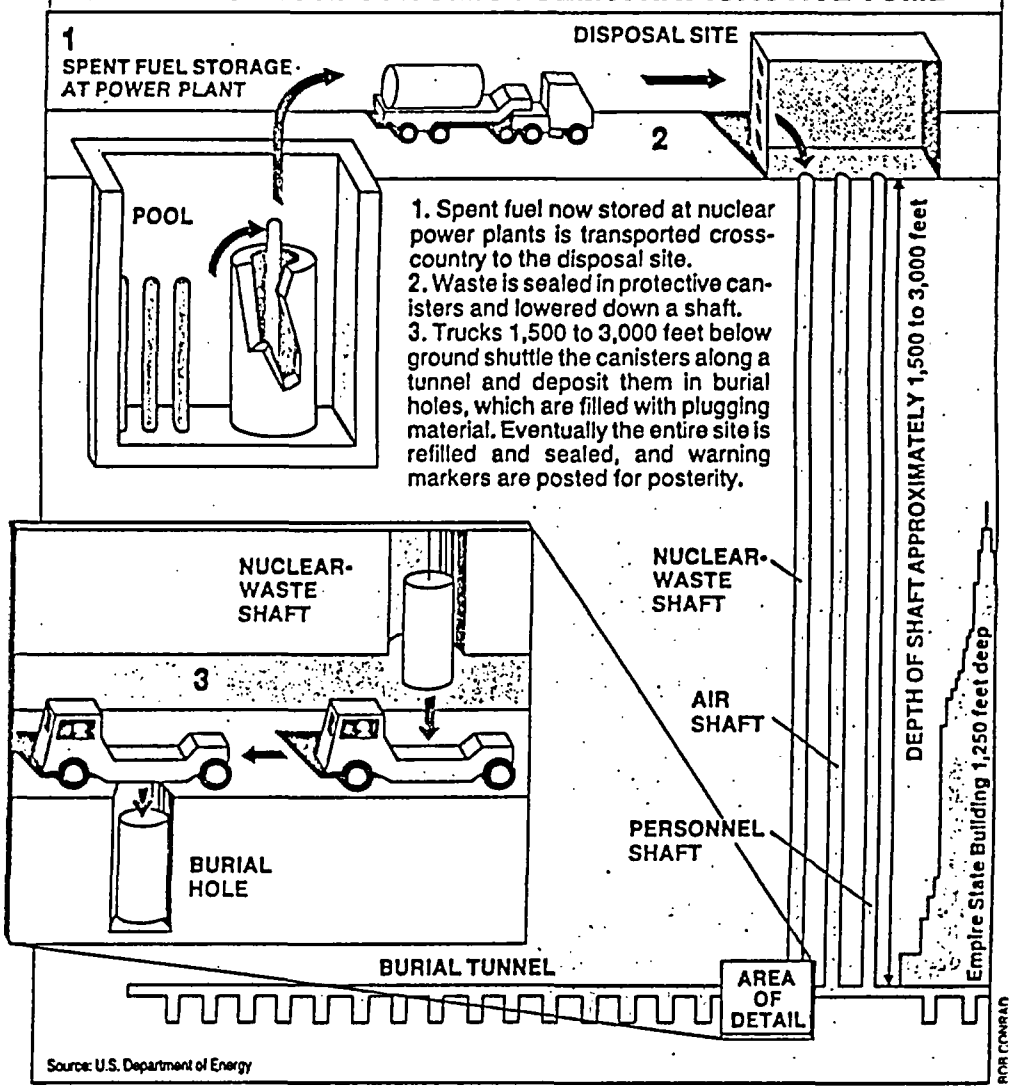
continued



TOM ZIMMERMAN—SYGMA

Storage silo in Nevada: Problems

SEALING UP SPENT ATOMIC FUEL: A RADIOACTIVE TOMB



that an accident could spread lingering radiation for miles. "These shipments often move through small communities protected by volunteer fire departments," says Joseph Strohl, chairman of Wisconsin's Radioactive Waste Review board, who estimates that eight truckloads could pass through his state each day if the Hanford site is selected. Wisconsin officials already worry about waste now carried on trains crossing Mississippi River wetlands—areas that flood frequently. "At one meeting, the Nuclear Regulatory Commission people were concerned about acts of sabotage," says Du Wayne Gebken of the state Department of Natural Resources. "I told them Mother Nature is apt to sabotage the shipments long before any terrorists do."

Colorado officials expect their state to be a major waste route west—and they fear accidents on snowy mountain passes glutted with ski traffic. But states and localities have little say over transit routes. New York officials are still smarting over a federal court ruling that overturned their ban on nuclear-waste shipments through New York City. U.S. Department of Transportation officials, who regulate nuclear and hazardous shipments, say a patchwork of local rules would be more problematic. But critics say the federal rules are lax—and that localities should be better informed. Last week, NEWSWEEK learned EPA regional officials were not notified that a large shipment of dioxin-contaminated materials had begun moving from Dow Chemical in Midland, Mich., to a Texas incinerator. "We should have been informed immediately," said Chicago regional adminstrator Valdas Adamkus. "Everybody's looking for excuses."

For all the controversy, last week's announcement was only round one in the process: the 1982 waste law requires that a second disposal site be selected before more than 70,000 metric tons of waste can be buried at the first site. DOE has released a list of 17 Eastern and Midwestern states with potentially acceptable crystalline rock formations. Opposition there is likely to be even more ferocious. But, says DOE's Lawrence, "waste has to go somewhere." And nowhere on the U.S. map is there a town called Some Place Else.

MELINDA BECK with WILLIAM J. COOK in Washington, GEORGE RAINE in Hanford, JOHN McCORMICK in Chicago, BARBARA BURGOWER in Houston and bureau reports

The Seattle Times/Seattle Post-Intelligencer
Times Special Report
Sunday, December 16, 1984

Is site safe for N-waste?

by Hill Williams
Times science reporter

After eight years and about $300 million, Uncle Sam still faces staggering difficulties in determining whether a site in Eastern Washington is a safe place to dispose of nuclear waste.

The task is complicated beyond precedent because, in human terms, the site at the Hanford Nuclear Reservation must be safe forever.

But the Department of Energy's investigation, which suffered a major setback about two years ago when other government agencies challenged its interpretation of data in a report, now seems back on track.

The severest critics, the Geological Survey and the Nuclear Regulatory Commission, still point to unsolved problems, but generally approve of the new effort.

The job facing the department and its contractor, the Rockwell Hanford Co., involves determining whether a rock layer more than half a mile below the desert surface could be counted on to contain dangerously radioactive wastes from nuclear-power plants for at least 10,000 years.

The investigation is complicated by changes the rock layer has undergone since the hot lava flowed millions of years ago. It cracked as it cooled. It buckled under mountain-building stresses. It broke or even sheared during earthquakes. It was buried under the crushing weight of repeated lava flows. And it was saturated by groundwater under more than 1,000 pounds of pressure.

The question is whether the DOE can find, in a type of rock that is typically cracked and leaky where it occurs elsewhere, a place to dig out a cavern where waste can be expected to remain thousands of years until it is harmless.

The job was tough enough to begin with. The controversy over the flawed report made it even tougher.

Even now, David Squires of the DOE at Richland doesn't know how much of the $300 million worth of past work may have to be discarded or done over.

"I can't say until we can show how good the information is," Squires said. "But I feel it is good. We may not have had a quality-assurance plan in place to suit the Nuclear Regulatory Commission, [illegible] information is good."

Squires said there was an "early overly optimistic approach" that was reflected in the report. He added, "The criticism was positive in that it made us go back and take a look at the planning."

Probably the most complex job facing the DOE's Basalt Waste Isolation Project at Hanford (BWIP for short) is understanding the action of groundwater well enough to predict what it will do to the waste over thousands of years.

The rock layer selected for the study, 3,000 feet down, is below the water table. In contrast to the desert surface, groundwater inevitably would invade the waste repository once it was filled and sealed and workers had left.

The $300 million question: How long will it take, after the steel waste containers corrode, for groundwater to move radioactive material to the Columbia River 10 miles away?

Bill Meyer, hydrologist with the Geological Survey's Tacoma office, says the BWIP people are not even close to understanding the groundwater patterns yet — let alone answering the questions.

Working them out will be complex. Uncracked basalt rock is very dense and water would move through it slowly if at all. But cracks from cooling and earth stresses could provide a faster route.

And water could move even faster in what geologists call the "interflows," sand or rubble sandwiched between layers of solid rock. The interflows formed during thousands of years between flows when soil accumulated and plants grew, only to be covered by the next flow of hot lava.

Some hydrologists believe that water travels so rapidly in the interflows that, once there, it should be considered to have already re-entered the biological environment.

Understanding the flow has been complicated by the Geological Survey's discovery of some sort of barrier a few miles west of the proposed repository site. No one knows yet whether the barrier would be good or bad for the repository.

Chemical composition of the buried rock layers also could influence how suitable the site would be for a repository. There are indications of what is known as a "reducing environment," a chemical condition where metal corrosion would be low. Even more important, such an environment could be expected to slow the spread of any escaping radioactive materials.

Rockwell, criticized two years ago for assuming the presence of a reducing environment, is far from being able to prove its existence. Probes to help measure electrical voltages in the rock, which would indicate such an environment, are still under development.

Earthquakes present a third big problem for the researchers. The Nuclear Regulatory Commission has disagreed with a Rockwell conclusion that a repository at Hanford would be safe from earthquakes, and has demanded more studies of the potential hazard.

Over the years, there have been swarms of tiny earthquakes in the Hanford area, some within 6 miles of the proposed repository site. And the commission believes that a major earthquake near Milton-Freewater, Ore., in 1936 was on a fault that runs within about 9 miles of the proposed disposal site.

The big BWIP program has not yet begun the actual work demanded by the NRC and Geological Survey. But the DOE and Rockwell say it is being included in work now in the planning and funding stage.

The need for outside scientific approval of work was obvious to BWIP. The state — which could veto selection of Hanford (though both houses of Congress could overrule) — let it be known it would lean heavily on independent scientific opinion.

The complexity of the job ahead has, for the first time, caused some BWIP officials to wonder privately if Hanford might not be selected for the nation's first commercial-waste repository.

Even though work at Hanford is far ahead in terms of money spent, another candidate at the DOE's Nevada Test Site appears to have some advantages. It is even more isolated than Hanford. Most important, the Nevada burial site, although 1,500 feet below the surface, would be dry, still 500 feet above the water table.

A dry hole would simplify the process of certifying the safety of a site.

On Thursday, the public may get hints of the DOE's thinking when it releases environmental assessments of all nine sites that are under study as candidates for the repository. continued

IS SITE SAFE FOR N-WASTE?

DOE has provided advance draft copies of most of the Hanford report to the state. But Chapter 7, which is reported to have been written with some secrecy in DOE headquarters, is expected to give some broad hints as to how the nine sites will be ranked. The state has not seen Chapter 7.

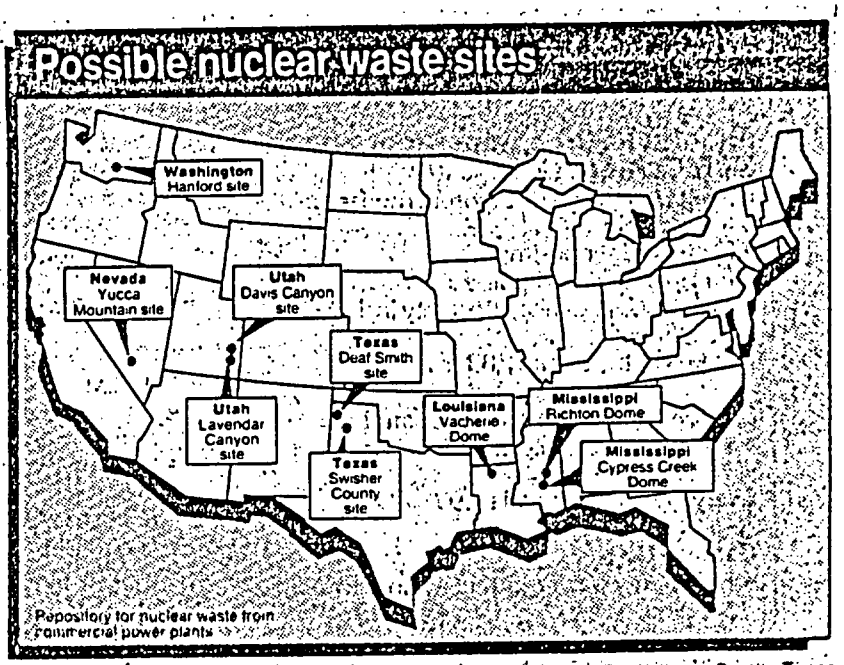
The DOE expects to narrow the field to five sites early next year, and then, within a short time, the top three will be selected by President Reagan.

The Hanford and Nevada sites are expected to be among the top three. The third will be an underground salt formation in either Utah, Texas, Louisiana or Mississippi.

Although work at Hanford is far ahead of that at any other site, the DOE says that by the time the No. 1 site is chosen in the early 1990s, an equal amount of investigation will have been done on all three finalists. The final price tag is expected to total just more than $1 billion for each site.

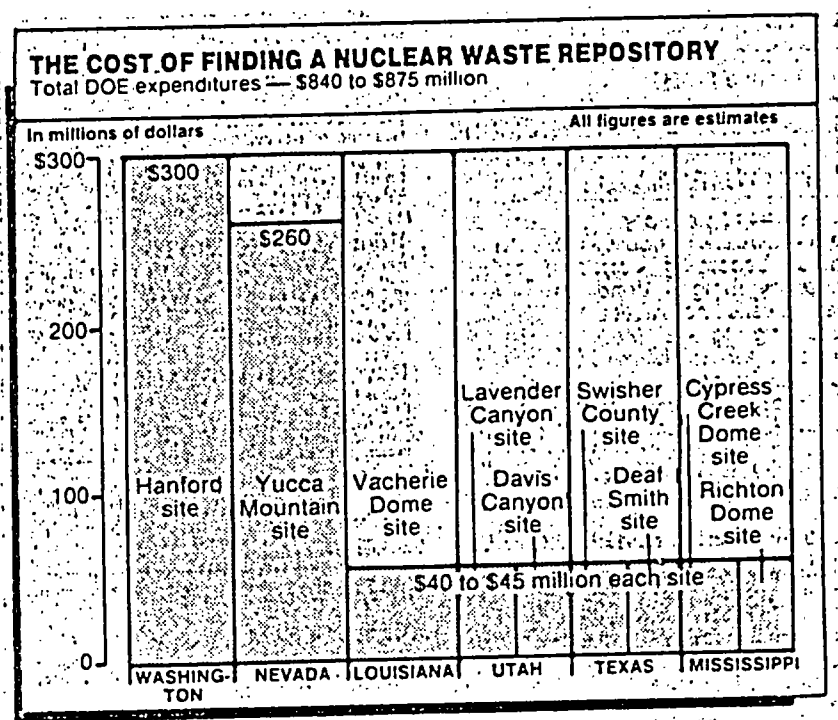
The first repository, wherever it turns out to be, is not expected to start operating until near the turn of the century. It will have about a 20-year operating lifetime. But Congress has ordered that the repository, even after it is full, be kept open and the waste in retrievable form for another 50 years in case anything goes wrong.

So, assuming that the repository opens when expected and nothing goes wrong during the 50-year waiting period, the hole won't be sealed for about a century.



Ed Walker / Seattle Times

Possible nuclear-waste sites across the country.



U.S. NUCLEAR REGULATORY COMMISSION DRAFT REGULATORY GUIDE 4.17

The following is an excerpt from the U.S. Nuclear Regulatory Commission (USNRC) Draft Regulatory Guide 4.17 regarding long-term climatic assessment guidelines.

5.2 Long-Term Climatic Assessment

An analysis of paleoclimatic conditions at the candidate area and the site should be provided. Based on this analysis and on recent climatic characteristics of the candidate area, an assessment of the magnitude and rate of climatic changes that might be expected to occur in the future should be provided. The information should be presented in sufficient detail to indicate impacts on long-term isolation of the waste.

5.2.1 Paleoclimatology

Provide an analysis of the Quaternary paleoclimatology of the candidate area and the site, including atmospheric, and cryospheric aspects of the successive climatic regimes, in the context of determining the magnitude of the climatic changes and the rates at which the changes occurred. Changes in precipitation regimes, locations of potential aquifer recharge areas, glaciated areas, and windflow patterns should be identified. Geological, biological, and ecological evidence to support the analysis should be provided. Information should also be provided on the size (areal extent and thicknesses) of any glaciers and on accumulation and ablation rates. The impacts of any glaciers on precipitation regimes and windflow patterns should be discussed. Relationships between air temperatures and regional precipitation, in relationship to the water balance of the area, should also be discussed.

Sources of all information should be provided. The validity and applicability of the information provided, with respect to the representation of conditions at and near the site, should be substantiated.

5.2.2 Future Climatic Variation

An estimate of the potential impact of climatic change on precipitation patterns, windflow regimes, the cryosphere, and sea levels should be discussed.

Based on the reconstruction of the paleoclimate and the recent climate, long-term estimates of the following should be provided.

1. Potential maximum and minimum changes and rates of change in precipitation and air temperature from the present that could be expected to occur.

2. Potential regional windflow and precipitation patterns that may evolve in the future as a result of climatic and geologic changes.

3. The potential for glaciation, including estimates of times of onset of glaciation and lengths and severity of glacial regimes in the site area, and

4. Future fluctuations in sea levels and cryosphere due to climatic changes.

   All procedures, including models, used in the climatic extrapolation should be identified, as should all assumptions and areas where insufficient data make extrapolations questionable.

5.2.3 Site Paleoclimatic Investigation

Describe how information obtained during the site characterization stage will be used to increase the data base concerning the paleoclimatology of the area. This could include the examination of sediment core samples for fossil pollen, ancient soil types, lake sediment valve sequences and thicknesses, etc. The application of the information thus developed to supplement places where data are spare or lacking in the initial investigation should be emphasized. Any changes in the paleoclimatic assessment that results from this investigation should be reflected by revisions to the future climatic condition extrapolations.

SITE CHARACTERIZATION PLAN -- HANFORD

Paleoclimatology

CLIMATOLOGY

- SUMMARY
- CLIMATIC CHANGES AND GLACIATION
  - APPROACH AND RATIONALE
  - PALEOCLIMATOLOGY CHARACTERIZATION
    - A. Introduction and Work Requirement Formulation
      - 1. Overall Purpose
        - a. Introduction
        - b. Climatic Conceptual Models
          - Past
          - Future
        - c. SRT (Relationship to Systems Requirement Tree)
      - 2. Status
      - 3. Justification for Additional Data
    - B. Paleoclimatology Characterization Requirements
      - 1. Location of Study
        - a. Criteria
        - b. Rationale
      - 2. Key Measurements
      - 3. Basis for Statistical Sampling
      - 4. Criteria for Acceptable Data Base
    - C. Paleoclimatology Characterization Options
      - 1. Alternative Study/Analytical Approaches
      - 2. Approach Selected
        - a. Rationale
        - b. Criteria
    - D. Paleoclimatology Characterization Descriptions
      - 1. Geomorphic Studies
      - 2. Palynological Studies
      - 3. Sediment and Stratigraphy
      - 4. Geochemical Isotope Studies
      - 5. Dendrochronological Studies
    - E. Analytical Techniques
      - 1. Models
      - 2. Climatic Characterization - Long Term Assessment

F. Application of Results

G. Schedule

(Key Milestones)

FACILITIES AND EQUIPMENT

A. Surface Facilities

B. Surface Site Preparation Activities

C. Underground Test Facilities

D. Equipment

QUALITY ASSURANCE

SCHEDULE, MILESTONE, DECISION POINTS, AND DELIVERABLE PRODUCTS

D. Paleoclimatology Characterization Descriptions

Objective 1 *SENTENCE*

A. Purpose

Cyclic climatic patterns occurred during the Quaternary, and are expected to continue into the future. Past climates were wetter and cooler than those of today. Because the expected climatic conditions will increase recharge rates and possibly change patterns of recharge, they also could increase rates and amounts of radionuclides released from the repository and transported to the accessible environment, or could cause flooding of the repository. Satisfaction of the objective is required for resolution of this issue and is called for in 10 CFR 60.122(c) (4 and 7).

B. Objective. *PARAGRAPH(S)* Parameters needed to satisfy *objective addressed* include

a. *SENTENCE*
b. *SENTENCE*
.
.

C. Descriptive Summary

1. Approaches to this investigation include

a. *SENTENCES*
b. *SENTENCES*
c. *SENTENCES*
.
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.

2. Field or laboratory methods for obtaining data. Description of procedures.

a. *PARAGRAPH(S)*
b. *PARAGRAPH(S)*
c. *PARAGRAPH(S)*
.
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3. Alternative procedures, uncertainty, and limitations

PARAGRAPHS

Estimated Schedule of Completion

Date	Item
4/85	Preliminary estimates of --- *Information Need*
6/85	Perform preliminary assessment of impact of --- and determine if further studies are needed.
6/85	Consult with experts on --- and develop plan for further studies.
11/85	Improved preliminary estimates --- for eventual use in performance assessment input for DEIS.
12/85	Provide input to Information Need 2.2.4 for performance assessment input to DEIS.
12/85	Completion of data collection (except for...).
12/85	Technical Report.
12/85	If needed, complete analysis of studies to improve definition of --- Implement studies with completion of data collection and analysis.
3/86	Complete technical reports on performance assessment for a repository at Hanford.
10/86	Complete updated analysis of radionuclide releases from the altered hydrologic system for the DEIS.
3/87	Complete final analysis of radionuclide releases from the altered hydrologic system for PSAR.