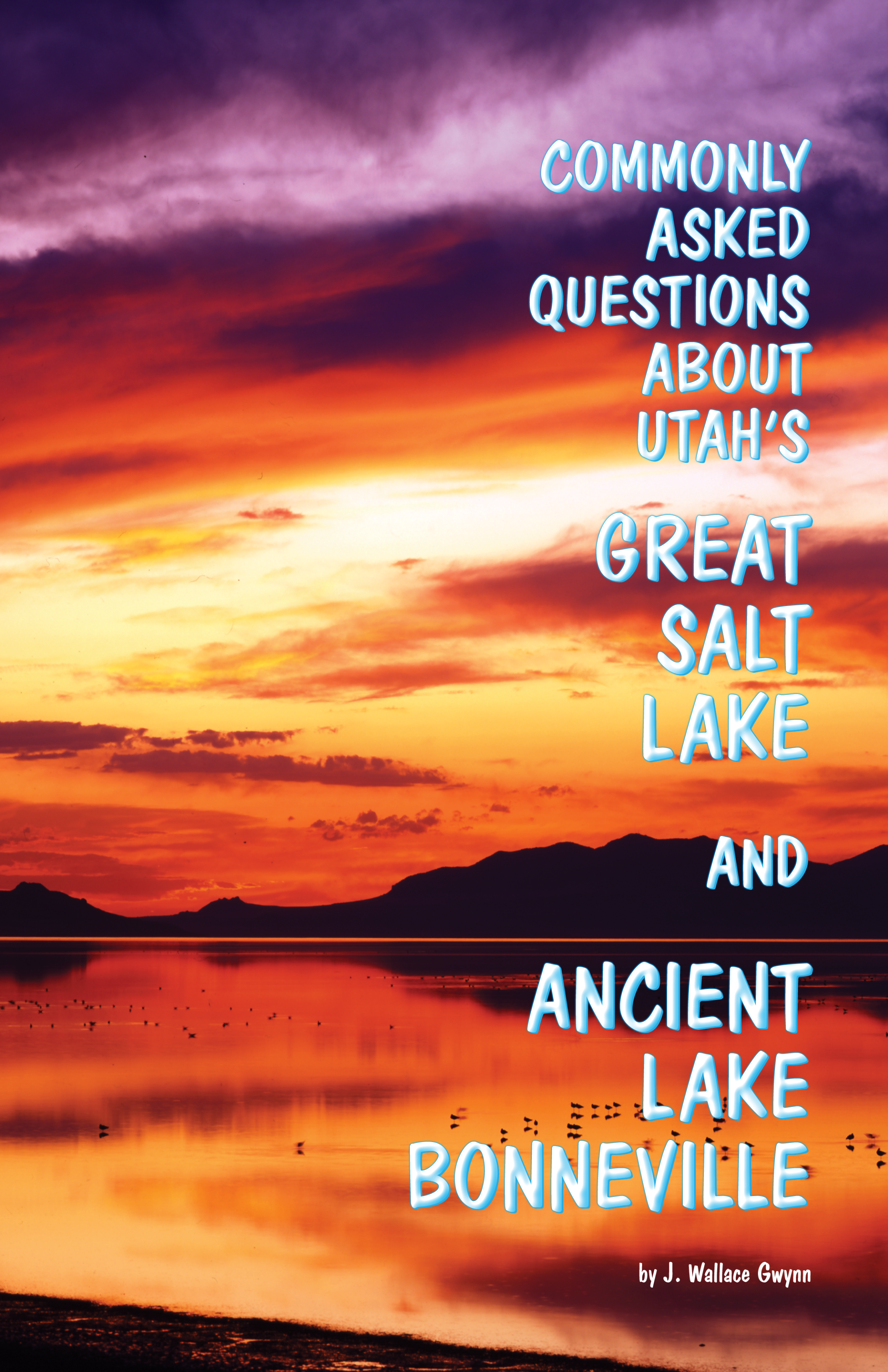


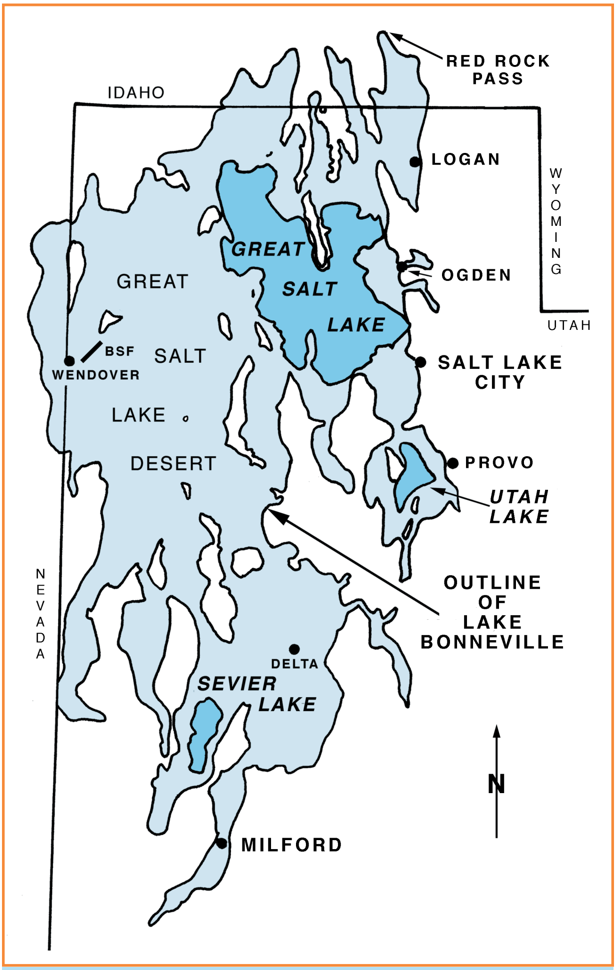
COMMONLY ASKED QUESTIONS ABOUT UTAH'S GREAT SALT LAKE AND ANCIENT LAKE BONNEVILLE

by J. Wallace Gwynn

~LAKE BONNEVILLE~

WHERE WAS LAKE BONNEVILLE, HOW LARGE WAS IT, AND WHEN DID IT EXIST?

Lake Bonneville was a large, ancient lake that existed from about 32 to 14 thousand years ago. It occupied the lowest, closed depression in the eastern Great Basin and at its largest extent covered about 20,000 square miles of western Utah and smaller portions of eastern Nevada and southern Idaho.



*Outline of ancient Lake Bonneville and associated modern features. (**BSF** = Bonneville Salt Flats).*

WHAT WERE LAKE BONNEVILLE'S DIMENSIONS, AND WHAT WAS IT LIKE?

At its largest, Lake Bonneville was about 325 miles long, 135 miles wide, and had a maximum depth of over 1,000 feet. It contained many islands that are the present-day mountain ranges of western Utah. Its relatively fresh water was derived from direct precipitation, rivers, streams, and water from melting glaciers. During the time of Lake Bonneville, the climate was somewhat wetter and colder than now.

WHEN AND AT WHAT ELEVATIONS WERE THE TERRACES ALONG THE MOUNTAINS MADE BY LAKE BONNEVILLE?

Three major shorelines were left by Lake Bonneville, and one by the Great Salt Lake. The Provo and Bonneville shorelines of Lake Bonneville can be seen as terraces or benches along many mountains in western Utah. The Stansbury shoreline of Lake Bonneville and the Gilbert shoreline of the Great Salt Lake are less obvious, and are found lower in the valleys. Each shoreline represents an extended period during which the lake stood at that elevation. The four main terraces, their elevations, and the ages of their formation are given below.

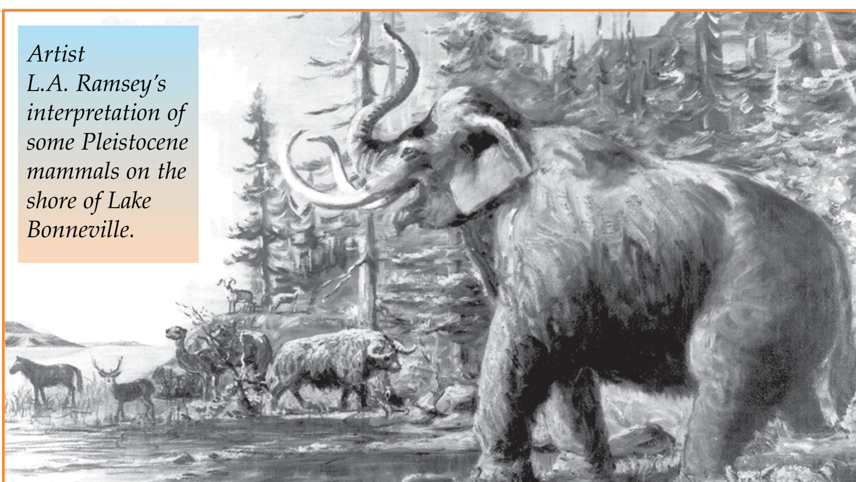
Major shorelines of Lake Bonneville and the early Great Salt Lake

Shoreline Name	Elevation*** at Antelope Island	Approximate Age in Calendar Years before Present
Gilbert*	4,275	12,800 - 11,600
Provo**	4,840	16,800 - 16,200
Bonneville**	5,220	18,000 - 16,800
Stansbury**	4,445	24,400 - 23,200

* *Great Salt Lake shoreline*
** *Lake Bonneville shoreline*
*** *Feet above mean sea level*

WHAT KINDS OF ANIMALS LIVED IN AND AROUND LAKE BONNEVILLE?

Fish lived in Lake Bonneville; amphibians, waterfowl, and other birds inhabited its marshes; and animals such as buffalo, horses, bears, rodents, deer, camels, bighorn sheep, musk oxen, and mammoths roamed its shores. The arrival of humans in the Lake Bonneville Basin has been set by archaeologists at about 10,000 years ago.



Artist L.A. Ramsey's interpretation of some Pleistocene mammals on the shore of Lake Bonneville.

WHERE DID LAKE BONNEVILLE GO?

For a long period of its history, Lake Bonneville was a terminal lake with no rivers draining from it. The lowest outlet for Lake Bonneville, Red Rock Pass in Idaho, had an elevation of about 5,090 feet. Approximately 16,800 years ago, the lake rose to the elevation of Red Rock Pass and began to flow northward into the Snake River drainage. The flow of water through the pass began a rapid downcutting process that caused a catastrophic flood. Researchers believe that the flood probably lasted less than a year. During this year, floodwaters cut through the soil and rocks and lowered the outlet elevation about 375 feet. The lake stabilized and the Provo shoreline formed during the next 600 years.

Artist L.A. Ramsey's interpretation of Lake Bonneville flooding through Red Rock Pass approximately 16,800 years ago.

Lakes

"Nature is said to attain the full height of her romantic skill in the creation of lakes. Moreover, as if to forestall any question of her ingenuity, she produces them in almost endless variety and scatters them to the ends of the earth. Some come to rest in desert places, some in mountains, and some in well-watered lowlands. Not a single extensive region in the world is untouched by their presence. Lakes are among the most attractive features of the physical universe."

Frederick J. Pack

~ GREAT SALT LAKE ~

WHAT IS THE ORIGIN OF THE GREAT SALT LAKE?

After the Lake Bonneville flood, the Great Basin gradually became warmer and drier. Lake Bonneville began to shrink due to increased evaporation. Today's Great Salt Lake is a large remnant of Lake Bonneville, and occupies the lowest depression in the Great Basin. The size, shape, and location of this depression have been controlled by Basin and Range faulting. Subsidence within the depression, caused by downfaulting, has accommodated deposition of as much as 12,000 feet of sediment carried into the lake by its tributaries. It has also allowed the lake to remain in a relatively constant position. Other relics of Lake Bonneville are Utah Lake, Sevier Lake, and the Great Salt Lake Desert containing the famous Bonneville Salt Flats.

WHO DISCOVERED GREAT SALT LAKE?

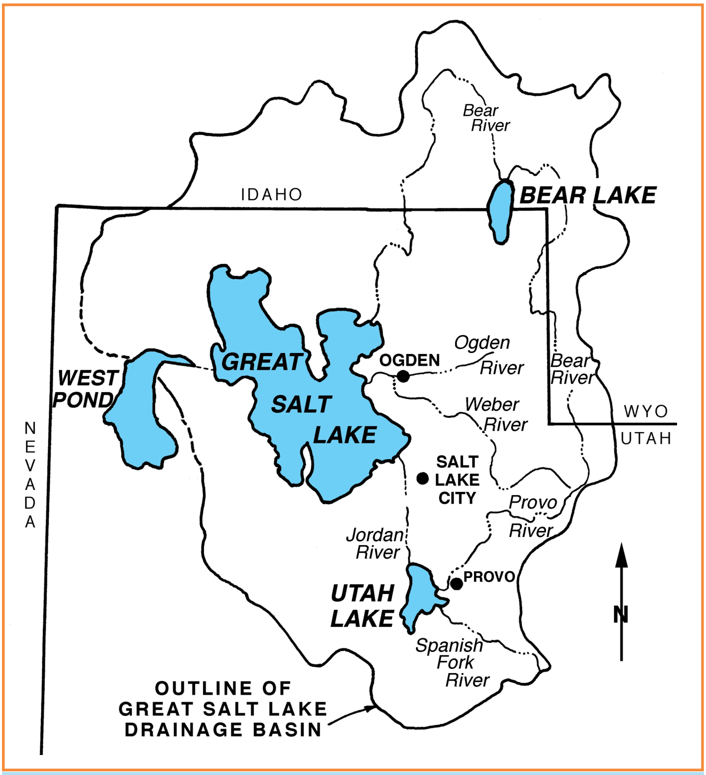
The Spanish missionary explorers Dominguez and Escalante learned of Great Salt Lake from the Native Americans in 1776, but they never actually saw it. The first white person known to have visited the lake was Jim Bridger in 1825. Other fur trappers, such as Etienne Provost, may have beaten Bridger to its shores, but there is no proof of this. The first scientific examination of the lake was undertaken in 1843 by John C. Fremont; this expedition included the legendary Kit Carson. A cross, carved into a rock near the summit of Fremont Island, reportedly by Carson, can still be seen today.

WHY IS THE GREAT SALT LAKE SALTY?

Much of the salt now contained in the Great Salt Lake was originally in the water of Lake Bonneville. Even though Lake Bonneville was fairly fresh, it contained salt that concentrated as its water evaporated. A small amount of dissolved salts, leached from the soil and rocks, is deposited in Great Salt Lake every year by rivers that flow into the lake. About two million tons of dissolved salts enter the lake each year by this means.

WHERE DOES THE GREAT SALT LAKE GET ITS WATER, AND WHERE DOES THE WATER GO?

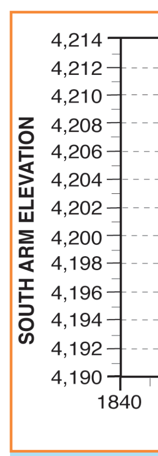
Great Salt Lake receives water from four main rivers and numerous small streams (66 percent), direct precipitation into the lake (31 percent),



Ouline of Great Salt Lake drainage basin, main tributaries to the lake, and major water bodies.

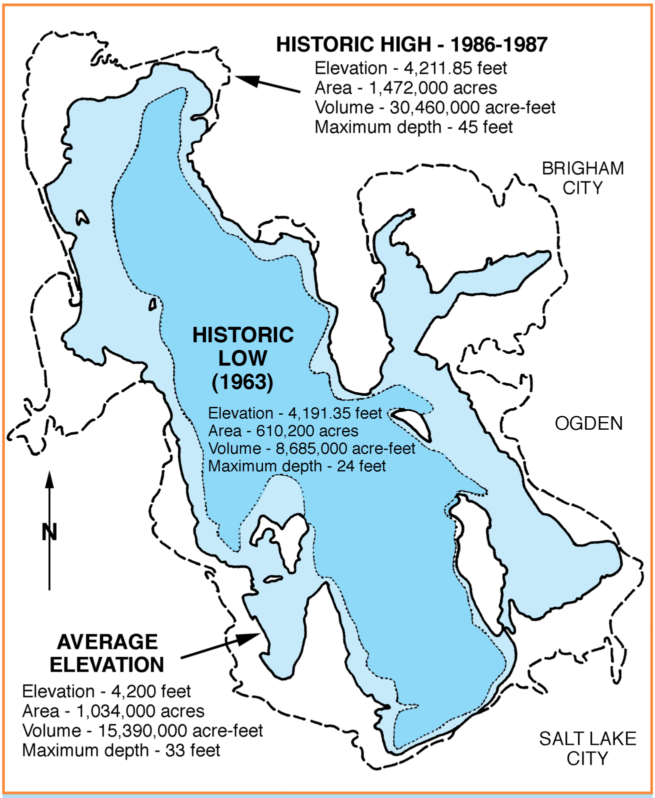
and from ground water (3 percent). The total average annual inflow to the lake is about 2.9 million acre feet of water. The main rivers entering the lake are the Bear River from the north, the Weber and Ogden Rivers from the east, and the Jordan River from the south. The drainage basin of the lake covers an area of about 21,500 square miles.

The Great Salt Lake is a terminal lake because it has no surface outlet (rivers flowing from it). Water is lost from the lake mostly through evaporation. Evaporation rates are highest during the hot summer months and lowest during the winter. An average of about 2.9 million acre feet of water evaporates from the lake annually. When inflow equals evaporation, the level of the lake remains constant. If inflow is greater or less than evaporation, the level of the lake will rise or fall, respectively.

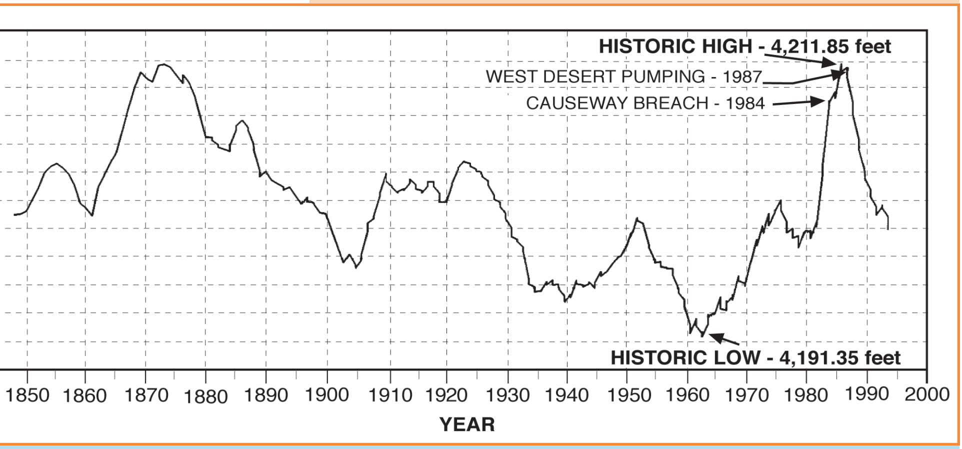


HOW BIG AND HOW DEEP IS THE LAKE, AND WHY DOES IT CHANGE IN SIZE?

Great Salt Lake averages approximately 75 miles long by 35 miles wide at a surface elevation of about 4,200 feet. At this elevation, the lake covers an area of 1,034,000 acres, and has a maximum depth of about 33 feet. It is reported to be the 33rd largest lake in the world, and the largest fresh or saltwater lake in the United States after the Great Lakes. Its size and depth, however, vary both seasonally and over the long term. The magnitude of these changes depends on the balance between the total amount of water that enters the lake and that which leaves. On average, the lake level fluc-



Areal extent, elevation, volume, and maximum depth of Great Salt Lake at historic high, average, and historic low-water levels.

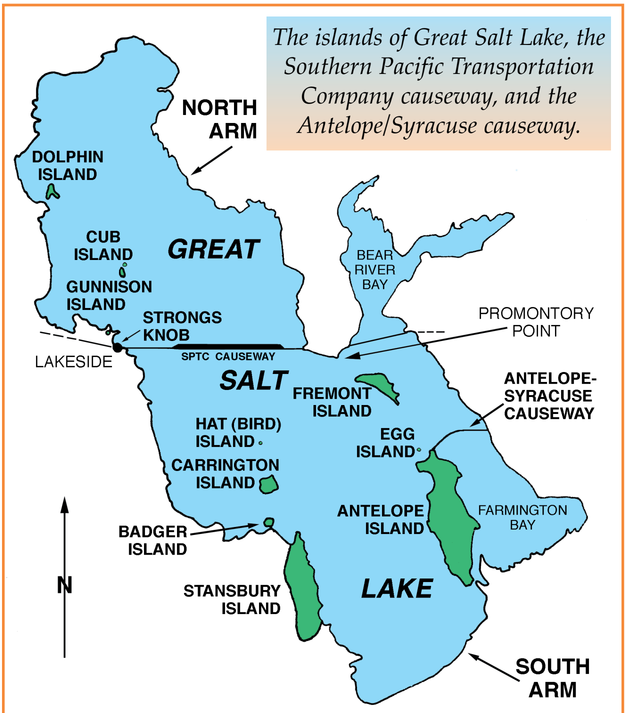


Historical elevations (in feet above mean sea level) of the surface of the southern arm of the Great Salt Lake (at its highest point for the year), 1847-1994 (USGS provisional lake records).

tuates one to two feet annually, rising to its highest level during May through July (following the melting of the mountain snowpack) and dropping to its lowest point during October through November (after the hot summer months). In historical time (1847 to present), fluctuations of the lake level have varied over a range of 20 feet from a low of 4,191.35 feet in 1963 to a high of 4,211.85 feet in 1986-1987. The historical average elevation of the lake is about 4,200 feet. Because of the very shallow nature of the lake, even modest changes in its elevation result in relatively large changes in the lake's area and volume. The accompanying map shows the high, average, and low elevations of the lake and pertinent information for each of these elevations.

HOW MANY ISLANDS ARE IN THE GREAT SALT LAKE, WHERE ARE THEY, AND ARE THEY INHABITED?

The lake contains 11 recognized islands, although this number varies depending on the level of the lake. Seven islands are in the southern portion of the lake and four in the northwestern portion. The large islands in the southern portion are named Antelope, Stansbury, Fremont, and Carrington. The smaller islands are named Badger, Hat (Bird), and Egg. The four small islands in the northwestern portion are Dolphin, Gunnison, Cub, and Strongs Knob.



The islands of Great Salt Lake, the Southern Pacific Transportation Company causeway, and the Antelope/Syracuse causeway.

Antelope Island has been inhabited since pioneer times. A ranch house on Antelope Island is said to be the state's oldest Anglo-built structure on its original foundation and the longest continually inhabited building in Utah. Presently, the Utah Division of Parks and Recreation retains ownership of the ranch house which is open periodically dur-

Aerial view of Antelope Island from the south end. Photo by Grant Willis.

Antelope Island, 23,175 acres of which 2,000 acres are designated as Antelope Island State Park. Photo by Grant Willis.

ing the summer for tours. Fremont Island has also been inhabited, most notably by Judge Werner, a probate judge for Salt Lake County, and his family, from 1884 to 1891. Both Gunnison and Carrington Islands were unsuccessfully homesteaded for short periods of time. Antelope Island has been owned by the State of Utah since 1980. It is home to a large herd of buffalo which is managed by the Utah Division of Parks and Recreation. Antelope, deer, and many other animals also live on the island. The northern 2,000 acres of the 23,175-acre island are designated as Antelope Island State Park. The Antelope Island/Syracuse causeway is the only public-access road connecting the island to the mainland.

WHEN AND WHY WAS A RAILROAD BUILT ACROSS THE GREAT SALT LAKE?

Great Salt Lake is divided into two parts by the Southern Pacific Transportation Co. (SPTC) causeway. That part north of the causeway and west of Promontory Mountains is called the north arm, and that to the south of the causeway is called the south arm. Bear River Bay, although north of the railroad, is considered part of the south arm of the lake. The south arm and Bear River Bay are connected by an opening in the railroad causeway about four miles east of Promontory Point.

Modern rock-fill causeway located parallel to, and 1,500 feet north of, the old trestle; view is westward across the lake toward Lakeside.

In about 1903, the railroad was constructed across the lake as a wooden-trestle structure. The open structure of the trestle allowed for the mixing of water between the north and south arms of the lake. It was built to lessen the distance, degrees of curvature, and time required for trains to travel the previous route around the north end of the lake. By the early 1950s, maintenance costs had become high, and the structure had become unstable under normal operating speeds. Construction of a stable, permanent structure across the lake was needed. By 1953, the SPTC had decided to replace the wooden trestle with a rock-fill causeway to be built parallel to, and about 1,500 feet to the north of, the old trestle. The structure was completed in 1959 at a cost of roughly $50 million (in 1960 dollars). In 1993, the Trestlewood Division of Cannon Structures, Inc. began to dismantle and salvage the timbers and planking of the old wooden trestle. Salvage operations are still active as of 1995.

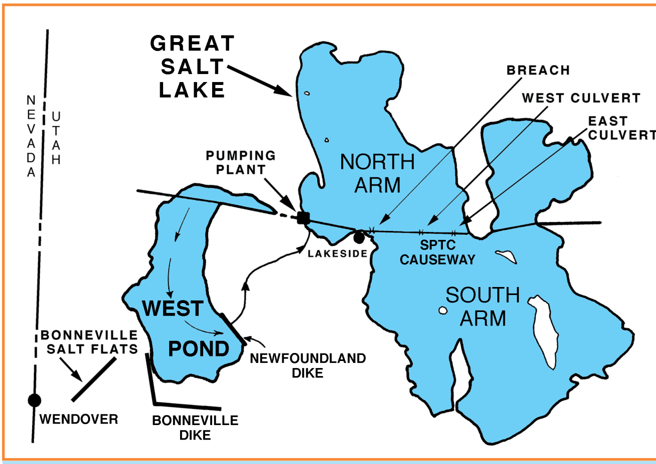
Original wooden trestle railroad that crossed Great Salt Lake, constructed about 1903. Photo by June Cannon, Cannon Structures, Inc.. A salvage operation for the wood started in 1993; some is used in the lobby of the Department of Natural Resources building.

HOW HAS THE RAILROAD CAUSEWAY AFFECTED THE GREAT SALT LAKE?

The rock-fill causeway has had two major effects on the Great Salt Lake, both related to restricted circulation of water between the north and south arms: (1) the south arm has maintained a higher water level than the north, and (2), the north arm has become saltier than the south. These conditions persist despite two 15-foot-wide by 20-foot-deep open culverts that were built into the causeway to facilitate water and boat move-

One of the two 15-foot-wide by 20-foot-deep culverts in the rock-fill portion of the causeway. Photo taken during low lake level (1960-1962).

ment between the two arms, and despite a 300-foot-wide breach (opening) which was cut through the causeway near Lakeside in 1984 as a flood-control measure. The level of the south arm is higher than the north arm because river water enters the south arm at a faster rate than lake water can move northward through the causeway and its openings.



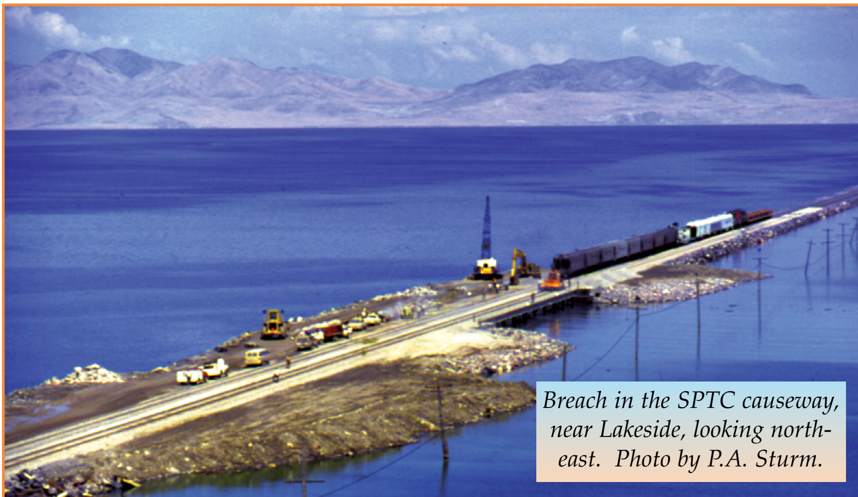
Great Salt Lake, Bonneville Salt Flats, and elements of the state's two flood-control programs: the causeway breach (1984) and the West Desert Pumping Project (1987).

Since the construction of the solid-fill causeway, the salt content (salinity) of the north arm has become greater than the south arm. This is due to the following: (1) the south arm receives nearly all of the freshwater tributary inflow to the lake, and (2) the north arm is fed mainly by south arm salty water seeping through the causeway and flowing through the culverts and the breach opening. Currently, the north arm of the lake is near its salt-saturation point (24-26 percent) and is about twice as salty as the south arm (12-14 percent).

WHAT WAS DONE ABOUT THE FLOODING THAT OCCURRED AROUND GREAT SALT LAKE DURING THE 1980s?

In 1983, the level of Great Salt Lake began to rise, due to above-average annual precipitation. By 1986, the lake rose nearly 12 feet to reach its historic high of 4,211.85 feet. The high lake level caused serious flooding which resulted in millions of dollars in property damage, especially around the south arm of the lake. Flooding disrupted major highway and railroad traffic; inundated mineral-industry solar ponds, roads, beaches, farms, boating facilities and state/federal waterfowl management areas; and threatened water-treatment plants.

In 1984, after studying numerous flood-control alternatives, the State of Utah implemented its first flood-control project by breaching the SPTC causeway. The breach consisted of a 300-foot-long bridge-covered opening in the causeway near Lakeside, which allowed the rapid flow of



Breach in the SPTC causeway, near Lakeside, looking north-east. Photo by P.A. Sturm.

Close-up view of first waters flowing through the breach opening.

south-arm water into the north arm. Prior to the breach, the elevation of the south arm was over 3.5 feet higher than the north arm. Completed at a cost of about 3.5 million dollars, the project lowered the south arm of the lake by nearly one foot and raised the north arm by about 1.5 feet, within about two months.

The lake continued to rise after the causeway breach was completed, forcing the State to implement its second flood-control alternative, pumping water from the lake into the West Desert. Three large pumps installed on the western shore of the lake pumped water via a 4.1-mile-long canal to the West Pond. The pumping project filled the 320,000-acre West Pond with over 800,000 acre-feet of water and greatly increased the net evaporation from the lake. The West Desert Pumping Project was completed at a cost of more than $60 million.

For more than two years, starting in 1987, water was pumped from the north arm of the lake into the West Pond evaporation area in the west desert. During the 26-month life of the project, more than 2.7 million acre-feet of water were pumped, which contained about 695 million tons of salt. The pumps are currently not in use but are maintained in ready condition should the lake rise again.

West Desert pumping plant. Water was pumped from the north arm of the lake through a 4.1-mile-long canal to the 320,000-acre West Pond.

Close-up view of the pumping plant with one of the three 1,000 cubic-feet-per-second pumps in operation (view looking east).

HOW MUCH SALT IS IN GREAT SALT LAKE, AND WHY DOES THE SALINITY VARY?

The total amount of salt dissolved in Great Salt Lake is about 4.5 to 4.9 billion tons. As the lake rises, its salinity drops because the same amount of salt is dissolved in more water. The lower the lake level, the saltier the lake becomes. In historical time, the lake's salinity has ranged from a little less than 5 percent, (just above that of sea water), to nearly 27 percent (beyond which water cannot hold more salt).

CAN I FLOAT IN GREAT SALT LAKE?

You can easily float in Great Salt Lake if the water is salty enough. At the lake's average elevation of 4,200 feet, the south arm of the lake contains about 13 percent salt, which makes it salty enough for most people to float with little effort. When the lake is higher than 4,200 feet, it is less salty and therefore less buoyant. Swimmers float easily in the north arm because it is twice as salty as the south arm.

WHAT IS THE CHEMICAL COMPOSITION OF GREAT SALT LAKE?

The chemical composition of Great Salt Lake is similar to that of typical ocean water. Sodium and chloride are the major ions in the water, followed by sulfate, magnesium, calcium, and potassium. For comparison, the table below shows the concentration of the six major ions in water of Great Salt Lake, a typical ocean, and the Dead Sea.

Chemical compositions (dry weight percents) of Great Salt Lake, typical ocean, and the Dead Sea waters.

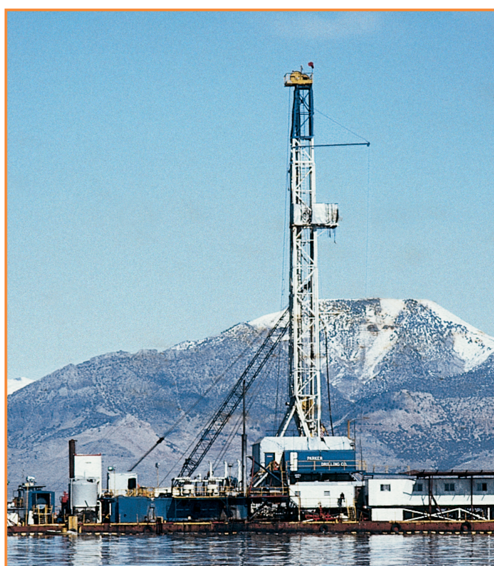
Source	Sodium	Potassium	Magnesium	Calcium	Chloride	Sulfate
Great Salt Lake	32.8	2.0	3.3	0.2	54.5	7.2
Ocean (typical)	30.8	1.1	3.7	1.2	55.5	7.7
Dead Sea	12.3	2.3	12.8	5.3	67.2	0.1

WHAT ACTIVITES/INDUSTRIES EXIST IN AND NEAR GREAT SALT LAKE?

The Great Salt Lake and its environs have been used by swimmers, boaters, bikers, hikers, and hunters for recreational purposes from the mid-1800s to the present. Long-term water-level fluctuations, both high and low, have adversely affected lake recreation over the years, however. Nearly a dozen resorts have either been flooded or left high and dry. The most famous resort, Saltair, was built in 1893 and destroyed by fire in 1971. The lake and and its three state parks, Great Salt Lake Saltair Beach, Antelope Island, and Willard Bay, attracted over a million tourists in 1994.

Famous resort, Saltair, built in 1893 and destroyed by fire in 1971.

The extraction of common salt from the lake started in the mid-1800s and continues to be an important part of the State's economy. Other products, including magnesium metal, chlorine gas, sodium and potassium sulfate, and magnesium chloride, have been extracted since the early 1960s. Oil occurs in natural seeps on the north shore of the lake, and drilling in the late 1970s disclosed additional oil beneath the bed of the lake. The brine-shrimp industry harvests brine-shrimp eggs, for use as fish food, and exports them world wide. Eight state waterfowl management areas and one federal migratory bird refuge dot the southern, northern, and eastern shores of the lake. Established during the early 1900s, these areas serve as important resting, feeding, and nesting areas for millions of ducks, geese, grebes, shorebirds, and other water-dependent birds. Visitors are always welcome, and hunting is generally allowed during the regular waterfowl hunting season.



Oil occurs in natural seeps on the north shore of the lake, and drilling in the late 1970s disclosed additional oil beneath the bed of the lake.

WHAT MINERALS ARE PRODUCED FROM GREAT SALT LAKE? HOW AND BY WHOM ARE THEY RECOVERED?

Five mineral-extraction companies currently operate near the lake. These companies use solar evaporation to concentrate the lake waters to produce either salts or highly concentrated brine (water with high salt content) products. These companies pay a royalty to the State of Utah (owner of the lake), on the salts and other materials produced and sold.

Harvesting potassium-bearing salts from large solar-evaporation pond. Salts will be processed into potassium sulfate, a mineral fertilizer.

Sodium chloride (common salt) is produced by: (1) evaporating the water in shallow ponds that cover many thousands of acres, (2) precipitating the salt, and (3) harvesting it from the bottom of the ponds. The collected salt is rinsed, washed, dried, and screened to produce different product sizes and grades. Common salt is also pressed into pellets for use in water softeners, and formed into salt-lick blocks (some with added minerals) for livestock consumption. Large quantities of bulk salt are shipped out-of-state for use in industry. Much of the salt is used locally for melting ice on roadways. Food-grade, or table salt is not produced from the lake, because its purity cannot be guaranteed without additional, costly processing. The table salt used in Utah comes from salt-processing facilities in New York, Ohio, Kansas, Louisiana, Texas, or California.

Great Salt Lake also yields salt products other than common salt. The salt industry produces potassium sulfate, a commercial fertilizer derived from potassium and magnesium salts. Magnesium-chloride brine is used in the production of magnesium metal and chlorine gas and as a dust suppressant. The production of these salts and highly concentrated brines requires additional evaporation beyond that needed to precipitate common salt. These products also require complex chemical processing. Mirabilite, a hydrated sodium-sulfate salt, commonly used in the production of sodium sulfate or salt cake, precipitates from concentrated lake water only during the cold winter months. The table below lists the names of the five salt companies operating on the Great Salt Lake and the products they produce.

Companies extracting mineral products from the Great Salt Lake, and their products (1995).

COMPANY	PRODUCTS
AKZO Salt of Utah	Sodium chloride
Great Salt Lake Minerals Corp.	Potassium sulfate and magnesium chloride prods.
Magnesium Corporation of America	Magnesium metal, chlorine gas
Morton Salt Company	Sodium chloride
North American Salt Company	Sodium chloride

WHAT LIVES IN AND AROUND GREAT SALT LAKE?

The tiny brine shrimp (*Artemia salina*) is one of the few animals that lives within Great Salt Lake. The brine-shrimp population plays an important part in the lake's ecosystem, especially in keeping the lake waters clean through algae consumption. They are also a major food source for millions of migrating birds.

Other forms of life associated with the lake include brine flies, algae, and bacteria. Brine flies congregate by the millions along the lake's beaches, where they feed on bacteria and algae that grow on rocks or wood. The wind commonly blows the remains of dead brine flies into long, black, odoriferous windrows or piles along the beaches. Numerous species of algae and bacteria, which cause the varied colors of the lake waters, provide food for the brine shrimp.

Magnified view of two brine shrimp (Artemia salina) from Great Salt Lake. The dark spots are their eyes.

Ducks, geese, gulls, pelicans, and hundreds of other types of birds live in the marshes and wetlands surrounding the lake. Great Salt Lake is an important part of the Pacific and Central Flyways for migratory waterfowl and part of the Northern Hemispheric Shorebird Reserve Network.

The shores and nearby wetlands of the lake are also home to a variety of reptiles and mammals. Eight amphibian, two turtle, nine lizard, and eight snake species, as well as total of 64 species or subspecies of mammals have been identified in the Great Salt Lake area.

HOW DOES THE LAKE AFFECT THE WEATHER?

Due to its large size, Great Salt Lake has a significant affect on the weather of nearby cities. During the winter, the lake is warmer than the air above it. This increases the moisture content of the air, creates thermal instability, and causes natural seeding of salt crystals. These factors are believed to cause the fall and winter "lake effect," in which areas adjacent to and usually downwind from the lake receive greater snowfall than those more distant.

WHAT MAKES THE LAKE STINK?

The unpleasant odor (resembling rotten eggs) that comes from the lake is a common complaint from those who live near the lake. The odor results from the decay of plant and animal remains in the shallow waters around its shores, especially in Farmington Bay. This odor is especially noticeable when northwest winds blow across the lake, stir up the shallow waters, and carry the odor landward to populated regions.

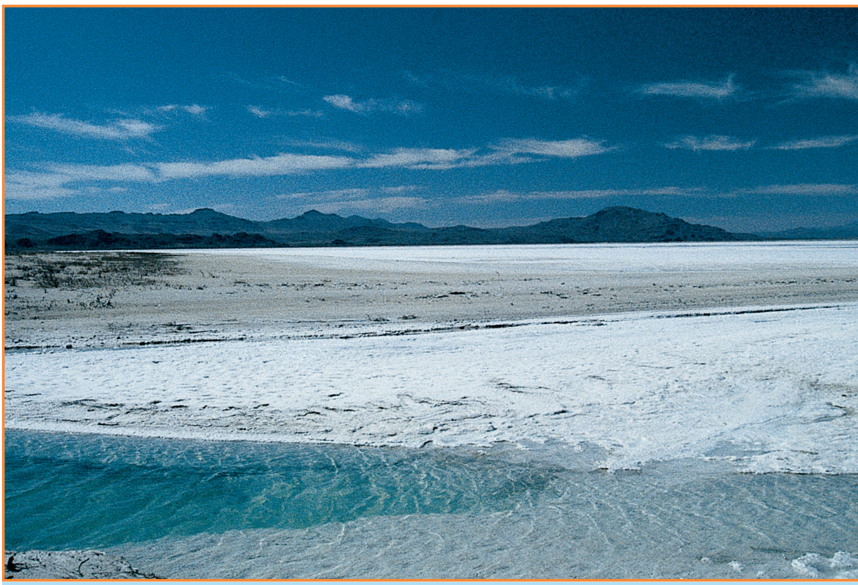
IS THE GREAT SALT LAKE POLLUTED?

The quantities of harmful contaminants in the lake, such as industrial organic wastes, copper, arsenic, mercury, cadmium, and lead are very low. This is contrary to what one might expect since rivers, waste-water treatment plants, and industrial facilities discharge into the lake. The lake ecosystem appears to cleanse itself of certain types of contaminants through chemical and biological processes. More study is needed to understand these cleansing processes, however.

WHERE ARE THE BONNEVILLE SALT FLATS AND HOW DID THEY FORM?

The Bonneville Salt Flats are located west of Great Salt Lake near the town of Wendover on the Utah-Nevada border, about 115 miles west of Salt Lake City. The flats are a broad, salt-covered lake bed, and one of the flattest areas on earth. They were formed during the final evaporative stages of Lake Bonneville. The salt flats are the site of high-speed car-racing events. In 1970, Gary Gabolich of the U.S. piloted the Blue Flame (rocket-powered) racer to a speed of 622.407 miles per hour, a Bonneville Salt Flats speed record which still stands today.

In the past 30 years, there has been an apparent deterioration of the racing surface. This has become a controversial issue involving the U.S. Bureau of Land Management, those who race on the salt flats, and a company that produces potassium chloride salt and magnesium chloride (brine) from salt-flat brine. Studies are underway to determine why the salt is disappearing, if the loss can be stopped, and if the salt can be replaced.



Bonneville Salt Flats located west of the Great Salt Lake.
Photo by Monson W. Shaver III.

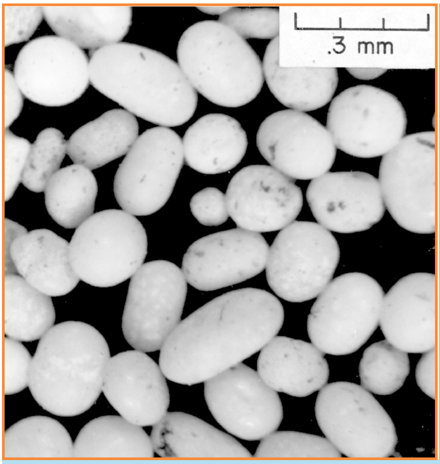
WHAT IS THE TALL SMOKE STACK AT THE SOUTH END OF THE GREAT SALT LAKE?

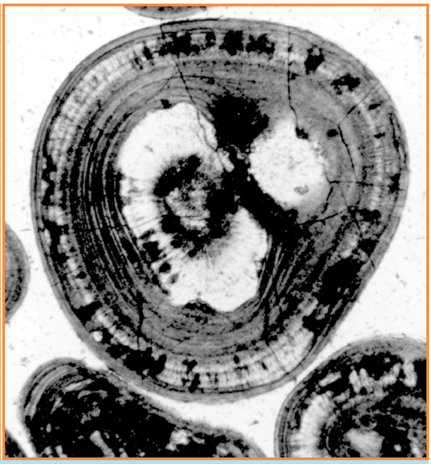
The 1,200-foot-tall smoke stack at the southern end of the lake is part of the Kennecott Copper Company's copper ore-smelting operation. Ore for this smelter comes from the Bingham Canyon copper mine, which is the largest open-pit excavation on earth. The Bingham Canyon mine, started in 1906, is located approximately 15 miles to the south of the lake on the eastern side of the Oquirrh Mountains.

The 1,200-foot-tall smoke stack at the southern end of the lake. This photo also shows Lake Bonneville terraces (levels) and the flooding of 1986.

WHAT ARE THE ROUND, WHITE SAND GRAINS THAT MAKE UP THE BEACHES?

The round, brown-to-white grains that make up many of the beaches around the lake are called oolites. Oolites are small spherical to elongated grains composed of concentric layers of calcium carbonate built up around a central core, much like a pearl. The core material is usually a small mineral grain, or a brine shrimp fecal pellet. Some of the most beautiful beaches around the lake are composed of oolitic sand.





Magnified view of typical oolites (left), and oolite cross section (right) showing concentric layers built up around a central mineral fragment.

ACKNOWLEDGMENTS

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ADDITIONAL INFORMATION ABOUT GREAT SALT LAKE

FOR GEOLOGICAL, WATER SALINITY/CHEMISTRY, AND GENERAL LAKE INFORMATION: *Utah Geological Survey, 1594 W. North Temple, Suite 3410, Salt Lake City, UT, 84114-6100, (801) 537-3326 or (801) 537-3366.*

FOR LAKE ELEVATIONS AND HYDROLOGY INFORMATION: *U.S. Geological Survey, 1745 W. 1700 S., 1016 Administration Building, Salt Lake City, UT 84104, (801) 975-3350.*

FOR RECREATION, BOATING, LAKE-ACCESS, AND SEARCH-AND-RESCUE INFORMATION: *Division of Parks and Recreation, 1594 W. North Temple, Suite 116, Salt Lake City, UT 84114-6001, (801) 538-7220.*

FOR LEASING AND MINERAL EXTRACTION/ROYALTY INFORMATION IN THE GREAT SALT LAKE: *Utah Division of Forestry, Fire and State Lands, 1594 W. North Temple, Suite 3520, Salt Lake City, UT 84114-5703, (801) 538-5555.*

FOR WATER RESOURCES AND LAKE-LEVEL CONTROL PROGRAM INFORMATION: *Utah Division of Water Resources, 1594 W. North Temple, Suite 310, Salt Lake City, UT 84114-6201, (801) 538-7230.*

FOR WATER APPROPRIATIONS, DISTRIBUTIONS, AND ADJUDICATIONS: *Utah Division of Water Rights, 1594 W. North Temple, Suite 220, Salt Lake City, UT 84114-6300, (801) 538-7240.*

FOR WILDLIFE AND BRINE SHRIMP INFORMATION: *Utah Division of Wildlife Resources, 1594 W. North Temple, Suite 2110, Salt Lake City, UT 84114-6301, (801) 538-4700.*

FOR CONSTRUCTION IN AND AROUND THE LAKE (401 PERMIT) INFORMATION: *U.S. Army Corps of Engineers, 1403 S. 600 W., Woods Cross, UT 84087, (801) 295-8380.*

FOR BONNEVILLE SALT FLATS AND FEDERAL LAND-LEASING INFORMATION: *U.S. Bureau of Land Management, Salt Lake City District Office, 2370 S. 2300 W., Salt Lake City, UT 84119, (801) 977-4300.*

FOR BEAR RIVER MIGRATORY BIRD REFUGE INFORMATION: *U.S. Fish and Wildlife, Bear River Migratory Bird Refuge, 866 S. Main, Brigham City, UT 84302, (801) 723-5887.*

OTHER PUBLICATIONS ON THE GREAT SALT LAKE

(available from the Department of Natural Resources Map & Bookstore)

- ***Major Levels of Great Salt Lake and Lake Bonneville*** *by D.R. Curry, G. Atwood, D. Mabey, 1983.*
- ***Great Salt Lake; a Scientific, Historical and Economic Overview****, editor: J.W. Gwynn, 1980.*
- ***The Great Salt Lake, Utah****, by W.L. Stokes, 1984.*
- ***Geologic Resources of Box Elder County, Utah*** *by S.N. Eldredge, M.H. Bugden, and C.M. Wilkerson, 1989.*
- ***Great Salt Lake Information Sheet****, 1990.*
- ***Geology and Antelope Island State Park, Utah*** *by H.H. Doelling and others, 1988.*

- ***Geologic Resources of Box Elder County, Utah*** *by S.N. Eldredge, M.H. Bugden, and C.M. Wilkerson, 1989.*

- ***Antelope Island State Park, Davis County, Utah****, 1995.*
- ***Geologic Map of Antelope Island, Davis County, Utah*** *by H.H. Doelling and others, 1991.*
- ***Engineering Geology of the Salt Lake City Metropolitan Area, Utah*** *by W.R. Lund, 1990.*
- ***Dissolved-Mineral Inflow to Great Salt Lake and Chemical Characteristics of the Salt Lake Brine, Part I, 1963*** *by D.C. Hahl and C.G. Mitchell; and* ***Part II, 1964*** *by D.C. Hahl and R.H. Langford, 1964.*
- ***Great Salt Lake, Utah: Chemical and Physical Variations of the Brine, 1963-1966*** *by D.C. Hahl and A.H. Handy, 1969;* ***1966-1972*** *by J.A. Whelan, 1973;* ***1973*** *by J.A. Whelan and C.A. Peterson, 1975;* ***1974-1975*** *by J.A. Whelan and C.A. Peterson, 1977.*
- ***Effects of a Causeway on the Chemistry of the Brine in Great Salt Lake, Utah*** *by R.J. Madison, 1970.*
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- ***The Effects of Restricted Circulation on the Salt Balance of Great Salt Lake, Utah*** *by K.M. Waddell and E.L. Bolke, 1973.*
- ***Hydrogeology of the Bonneville Salt Flats, Utah*** *by L.J. Turk, 1973.*
- ***Model for Evaluating the Effects of Dikes on the Water and Salt Balance of Great Salt Lake, Utah*** *by K.M. Waddell and F.K. Fields, 1977.*
- ***Effects of Breaching the Southern Pacific Railroad Causeway, Great Salt Lake, Utah - Physical and Chemical Changes, August 1, 1984 - July, 1986*** *by J.W. Gwynn and P.A. Sturm, 1987.*
- ***Geology and Mineral Resources of Box Elder County, Utah*** *by H.H. Doelling, 1980.*
- ***Shallow Ground Water and Related Hazards in Utah*** *by S. Hecker and K.M. Harty, 1988.*
- ***Flood Hazards from Lakes and Failures of Dams in Utah*** *by K.M. Harty and G.E. Christenson, 1988.*
- ***Glauber's Salt Bed West of Promontory Point, Great Salt Lake*** *by A.J. Eardley, 1962.*
- ***Gypsum Dunes and Evaporite History of the Great Salt Lake Desert*** *by A.J. Eardley, 1962.*
- ***Clay Mineralogy at the Brine-Sediment Interface in the South Arm of Great Salt Lake, Utah*** *by L.L. Hedberg and W.T. Parry, 1971.*
- ***Preliminary Report on Possible Solutions to"Fill Effect" causing Dilution of South Arm Brines and Concentration of North Arm Brines, Great Salt Lake, Utah*** *by J.A. Whelan and N. Stauffer, 1972.*
- ***Mineral Occurrences in the Emergency Withdrawal Area and Adjacent Lands in the Great Salt Lake Desert*** *by J.W. Gwynn and others, 1985.*
- ***An Approximation of the Physical and Chemical Characteristics of Farmington Bay and Bear River Bay, Great Salt Lake, Utah*** *by J.W. Gwynn, 1986.*

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Tour Guides, Park Rangers, and Information Specialists hosting visitors to Utah's GREAT SALT LAKE find there are many commonly asked questions about the lake and its ancient predecessor, LAKE BONNEVILLE. This booklet provides brief answers to these questions and serves as an nformational guide to the nature and history of the largest saltwater lake in the United States. This booklet also lists agencies that may be contacted for additional information about the lake.

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