# U. S. DEPARTMENT OF AGRICULTURE
# FOREST SERVICE
# FISHLAKE NATIONAL FOREST

Seismic and Volcanic Hazards

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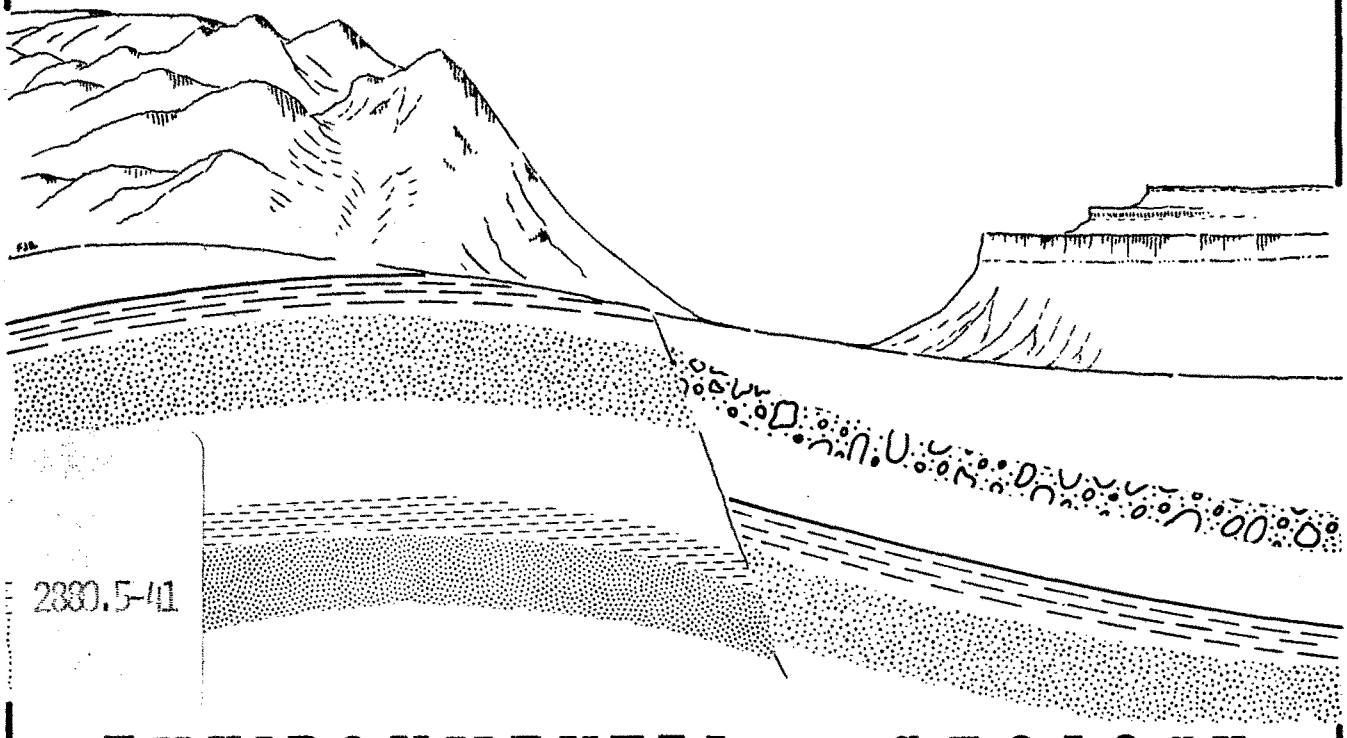

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# ENVIRONMENTAL GEOLOGY

ABSTRACT: This report and map-(see pocket) is intended for use as a guide in determining seismic and volcanic hazard areas on the Fishlake National Forest. The map distinguishes seismic rupture, seismic shaking, and volcanic hazard areas. The map does not distinguish between the specific type or degree of hazards and this should be taken into consideration when planning land use.

This report and map is a compilation of existing data and maps. Four areas were chosen (one on each district) as a random field check and a more detailed study was conducted. The study and field work was conducted in June-July, 1981 by Jerry DeGraff and Alan Gallegos.

REPORT: The Fishlake National Forest lies on the transition zone between the Colorado Plateau and the Basin and Range physiographic provinces
The boundary between the physiographic provinces lies, approximately, parallel with the Sevier River, between Panguitch and Gunnison; The eastern side of this boundary is the western end of the Colorado Plateau physiographic province and is characterized as lava-capped, high block plateaus, that lie between 4000 and 11000 feet elevation (Stokes and Heylmun, 1958). The western side of this boundary is part of the Basin and Range physiographic province and is characterized as isolated ranges (largely dissected block mountains) separated by aggraded desert plains (Fenneman and Johnson, 1946).

## VOLCANIC HAZARDS

The Fishlake National Forest has 102 acres that are considered volcanic hazard areas (see map). These hazards are due to the dangers that exist from the possibility of future eruptions from Black Rock Volcano, northwest of Cove Fort. The area of the Forest considered volcanic hazard area is located on the west end of Clear Creek Canyon, near the Forest boundary. The risk from volcanic hazards in this area is low because volcanic eruptions are so infrequent in the conterminous United States that few occur during any one person's lifetime (Mullineaux, 1976).

Black Rock volcano is considered dormant and is relatively inactive (Mullineaux, 1976). According to Mullineaux (1976), the definition of relatively inactive volcanoes are those volcanoes which have not erupted more than a few times during the last 10,000 years. The volcanic hazards that may be present in the event of an eruption are lava flows, pyroclastic flows, ashfall, mudflows and floods. Refer to Appendix 2 for definition of these hazards . The areas effected by an eruption would be limited to areas within a few tens of miles down-valley or down-wind from a volcano.

The volcanic hazard area on the Fishlake National Forest is based on a preliminary volcanic hazard map issued by the U.S. Geological Survey. By estimating the thickness and direction of lava flows the volcanic hazard area can be determined using topographic maps. Future estimates of lava flows are based on past lava flows, with lava flows up to 150 feet thick. The volcanic hazard area around Black Rock Volcano will include a small part (102 acres) of the Fishlake National Forest. The area that would be affected by ashflows is not included on the map because wind conditions will affect ashfall hazard areas.

Mudflows and floods initiated by volcanic eruptions, are not expected to affect any part of the Fishlake National Forest.

## SEISMIC HAZARDS

The Fishlake National Forest lies in the Intermountain Seismic Belt. The Intermountain Seismic Belt is a zone of pronounced earthquake activity that extends more than 1300 Km from the tri-state junction of Nevada, Utah and Arizona to northwestern Montana. Outside of California and Western Nevada the Intermountain Seismic Belt has one of the highest levels of earthquake risk in the contiguous United States (Arabasz and others, 1979)

Earthquakes are a sudden motion or trembling in the earth that are caused by abrupt release of slowly accumulated strain (Bates and Jackson, 1980). Earthquakes originate near faults and fault zones and are the result of displacement along faults.

The Fishlake National Forest has two major fault zones (Sevier-Tushar and Thousand Lake) that have had five or more earthquakes during 1950 through 1965 (Cook and Smith, 1961). There are several other fault zones on the Fishlake National Forest with 353,122 acres of seismic hazard areas radiating from these faults (see map). Quaternary and pre-Quaternary faults are found on the Fish-Lake National Forest, but only Quaternary faults are mapped because they are considered active and hazardous.

The Quaternary faults on the Fishlake National Forest are based on a Quaternary Fault Map of Utah (Anderson and Miller, 1979). The seismic hazard area was determined using the Quaternary Fault Map of Utah and a method recommended by the procedural guide for inventory of geologic hazards (DeGraff and others, 1979).

The seismic hazard zone consists of a rupture zone and a shaking zone. The rupture zone or scarp zone defines the surface reaction of major earthquakes and consists of the main scarp and 100 feet on either side of the main scarp. The shaking zone defines the area where ground motion will be felt in the event of a major earthquake and is a wider zone than the rupture zone. The shaking zone was established using ground motion response data from the U.S. Geological Survey (Algermissen and Perkins, 1976). It is calculated at 2.5 miles on either side of a fault using the recommended procedural guide approach.

The seismic hazards associated with an earthquake are numerous and depend on three factors (Arabasz, 1979). These three factors are type of geologic deposit, characteristics of earthquake (magnitude, location, area of fault surface), and distance from the fault. The types of seismic hazards are fault displacement, ground subsidence, ground cracking, seismic seiches, liquifaction, and floods. Refer to Appendix 2 for definition of these hazards.

The Fishlake National Forest has approximately six recreation sites, thirteen lakes, and three miscellaneous sites located in seismic hazard areas. Refer to Appendix 1 for a complete list of these sites. Four areas were studied in more detail for seismic hazards. Two areas were found to have seismic hazards of

high risk. Risk is considered high because seismic activity represents likely danger to life or property. This detailed study of existing facilities subject to seismic hazard illustrates the type of problems common in seismic hazard zones.

Maple Grove Campground (Fillmore R.D.) was found to have a high degree of seismic hazard due to rockfall potential. The recreation site is located on a seismic rupture zone (see fig. 1). A field check was conducted and evidence of recent rock falls was evident. Near the amphitheater a big boulder (10 ft. diameter) was found and smaller boulders (3-5 ft. diameter) were found near most of the units. Above the recreation site lies the escarpment of the existing fault. The escarpment or cliff is approximately 1000 feet high and is the source of the boulders found in the campground. The escarpment is highly fractured and not very strong because of the carbonaceous cementing material.

Monrovian Park picnic area (Richfield R.D.) was found to have a high degree of seismic hazard due to rockfall and rockslide potential affecting the site directly and the access road. The recreation site is located in the bottom of a drainage, at the junction of Second Lefthand Creek and Monroe Creek (see Fig. 2). The area is underlain by alluvial deposits and Bullion Canyon volcanics. The Bullion Canyon Volcanics are highly fractured and have three sets of joint patterns. The joint patterns result in wedge shape boulders that have a high potential of instability.

Many boulders, from three to five feet in diameter, were found in the recreation units. The area of the recreation site is surrounded with rock fall and rock slide hazards. Most of the units are vulnerable to these hazards. Rockfall and rock slide would also likely block or impair use of the access road along Monroe Canyon.

City Creek campground (Beaver R.D.) was found to have a moderate to low degree of seismic hazard due to limited landslide and enhanced shaking hazard. The recreation site is located 100 feet away from a rupture zone, near the junction of City Creek and the South Fork of City Creek (see Fig. 3). The area is underlain by alluvial deposits and Mt. Dutton volcanic deposits. The recreation site is in no immediate danger of rockfall hazards because there is no source in the area. The only seismic hazard in the area is possible landsliding hazard.

Fish Lake sewage treatment lagoons (Loa R.D.) were found to have a low degree of seismic hazard risk in the absence of rockfall, landslide, enhanced shaking or rupture zone hazard. The lagoons are located at the south end of Fish Lake (see Fig. 4). Their location coincides with the outer limits of a seismic shaking zone. The lagoons are underlain by clay deposits which limit any enhanced shaking. The water depth is too shallow for damaging seiches to occur. Some leakage is possible with flooding and contamination of the surrounding meadow. This water would drain away from Fish Lake.

RISK ANALYSIS

The degree of hazard depends on two factors: 1) site conditions and 2) frequency. While Maple Grove campground, Monrovian picnic area, City Creek picnic area, and Fish Lake lagoons are in areas of potential seismic hazard, the risk of that hazard depends on the frequency of earthquake occurrence.

In a compilation of earthquake data, "Earthquake Studies in Utah", Walter Arabasz and others provide a method for predicting the frequency of occurrence or probability of earthquakes with a given magnitude or larger (1979, pg. 268-275). The method uses the frequency-magnitude relationship:

$$\text{Log } Nc = a - bM$$

Where, Nc equals the number of earthquakes equal to or greater than a given magnitude per year per 1000 Km, a and b equals values found in "Earthquake Studies in Utah" (Table 15-1, pg. 402), and M equals a earthquake of a given magnitude.

Using this formula and values of a = .63, b = .65, and M = 4.00, the frequency of occurrence of earthquakes equal to or greater than a magnitude 4 on the Modified Mercalli Scale is equal to:

$$\begin{aligned} \text{Log } Nc &= .63 - .65(4) \\ \text{Log } Nc &= -1.97 \\ Nc &= .010715 \\ 1/Nc &= 93 \end{aligned}$$

In summary, the frequency of occurrence of earthquakes equal to or greater than a Richter Scale magnitude 4 (destructive) earthquake is one every ninety-three years. This is not greatly different from the one-percent probability or so-called "100-year" flood event used in flood hazard assessment. This 93 year interval between recurrence of magnitude, 4 or greater earthquakes can be used to establish risk (in %) for different design periods. Calculation employs the following formula (Fohn, 1978):

$$B = 1 - (1 - \frac{1}{T})^n$$

where: B is the probability or risk that a given event will occur in a forthcoming period of n years (design period) when the event has a recurrence interval of T years. Table 1 shows the probability or risk of magnitude 4 or greater earthquakes occurring at the four detailed study areas for several design periods. It shows that while real risk of seismic hazard exists, the probability of that risk being realized is not acute.

RECOMMENDATIONS

With 353,122 acres subject to seismic hazard, management on the Fishlake National Forest must take this geologic factor into account. For some land uses, this hazard will eliminate or restrict suitable locations. To ensure minimizing damage to structures or possible loss of life, a detailed seismic hazard study will be needed for developed recreation sites, administrative sites, summer homes, and similar activities. This will allow location or design mitigation of the hazard to be instituted. Remedial design should be planned for existing facilities within the identified seismic hazard zones. Volcanic hazard is of limited consequence to current Forest management.

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Table 1. Probability or risk of earthquake equaling or exceeding Mag. 4

| | Design Period (Years) | | | | |
|---|---|---|---|---|---|
| | 1 | 5 | 10 | 25 | 50 |
| B (%)* | 1 | 5 | 10 | 24 | 42 |

* for recurrence interval of 93 years

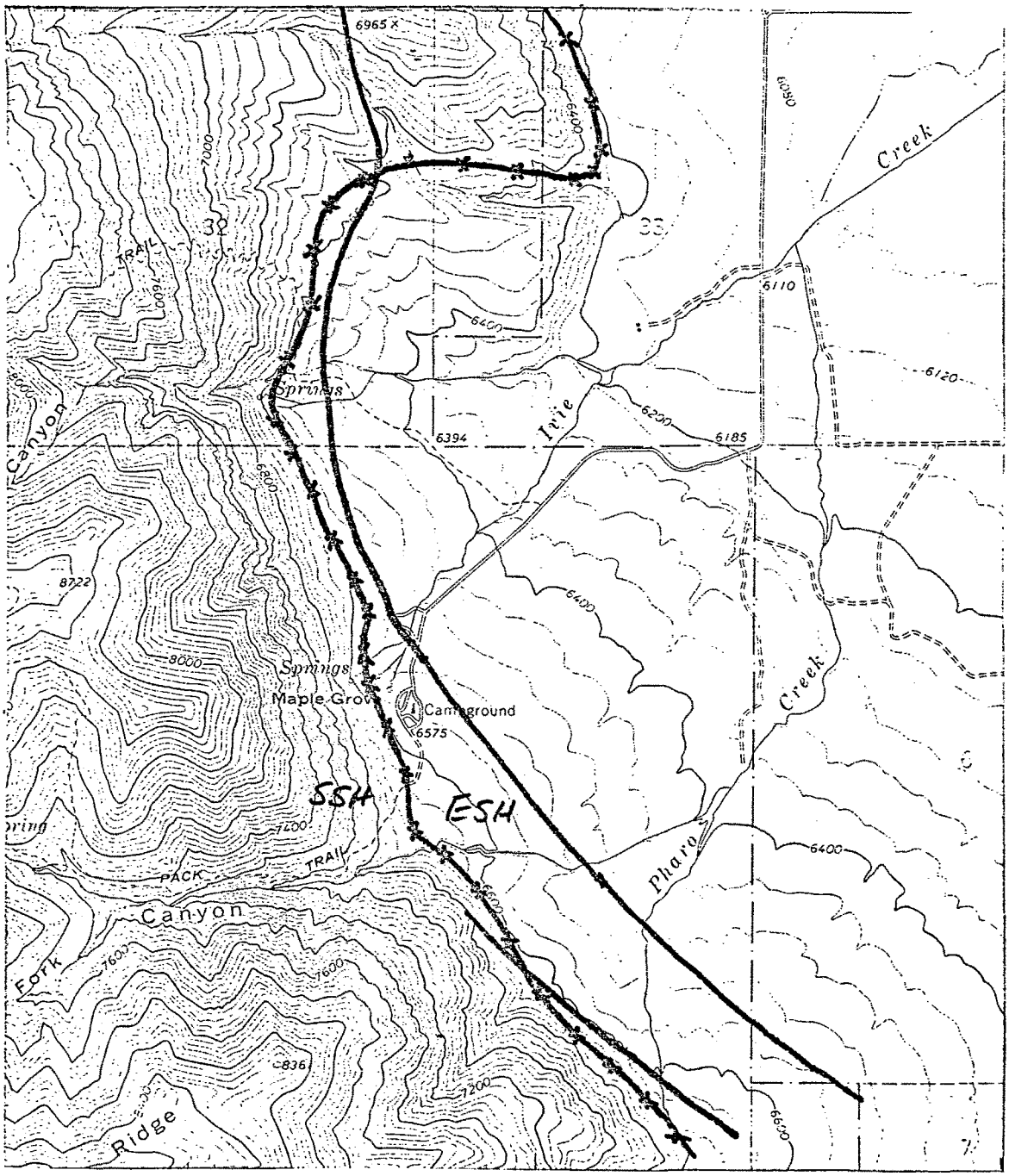


Figure 1. Maple Grove Campground. Solid black line indicates fault line or seismic rupture zone. Line with crosses indicates boundary separating Shaking and Slippage Hazard(SSH) and Enhanced Shaking Hazard (ESH). SSH - areas in shaking hazard zone with slopes greater than 15 percent. ESH - areas in shaking hazard zone with 0-15 percent slopes. Scale 1:24000.

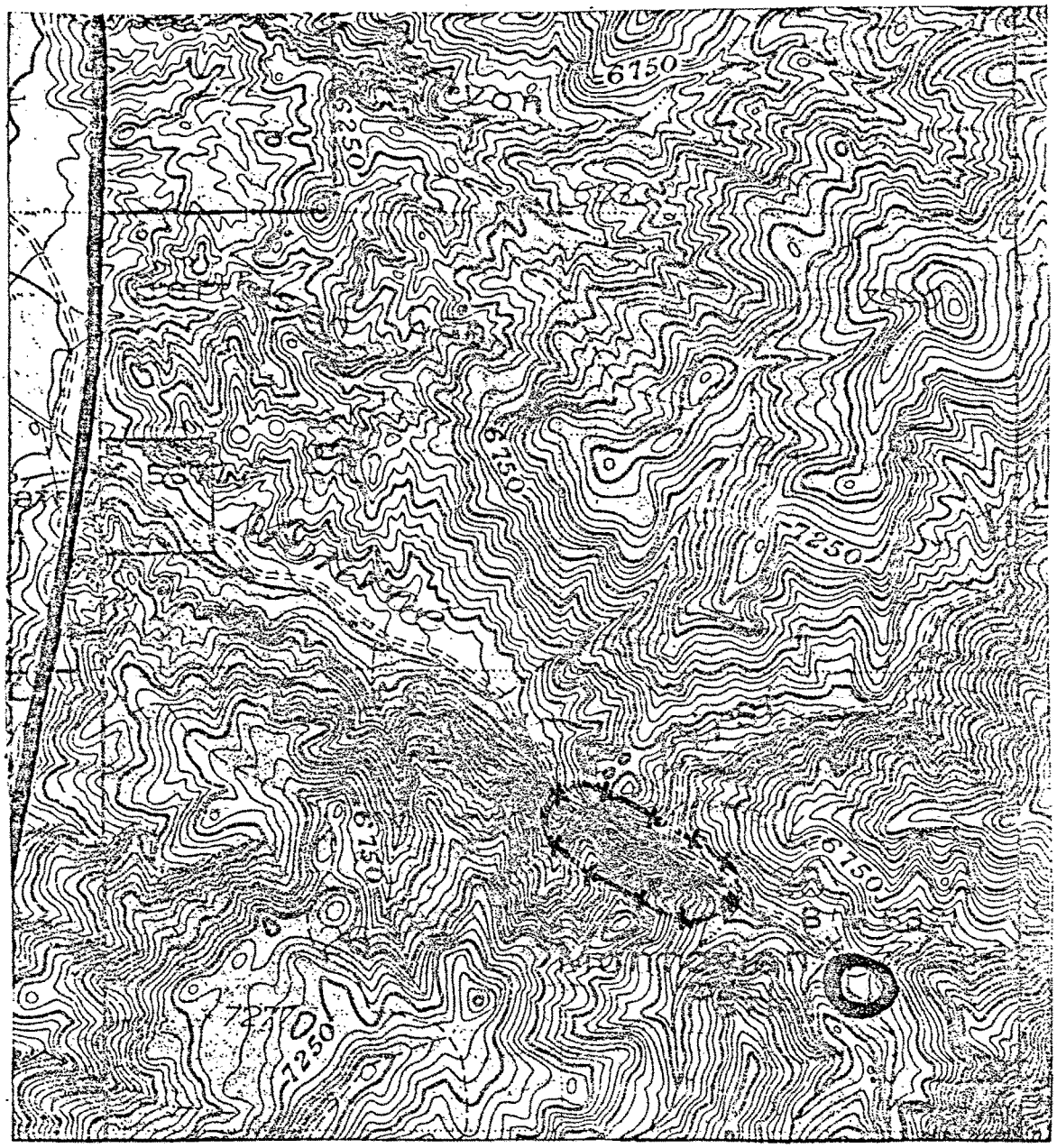


Figure 2. Monrovian Park picnic area. Solid black line indicates fault line or seismic rupture zone. Small circle indicates picnic area. Line with crosses indicates Shaking and Slipping Hazard of access road. Scale 1:24000.

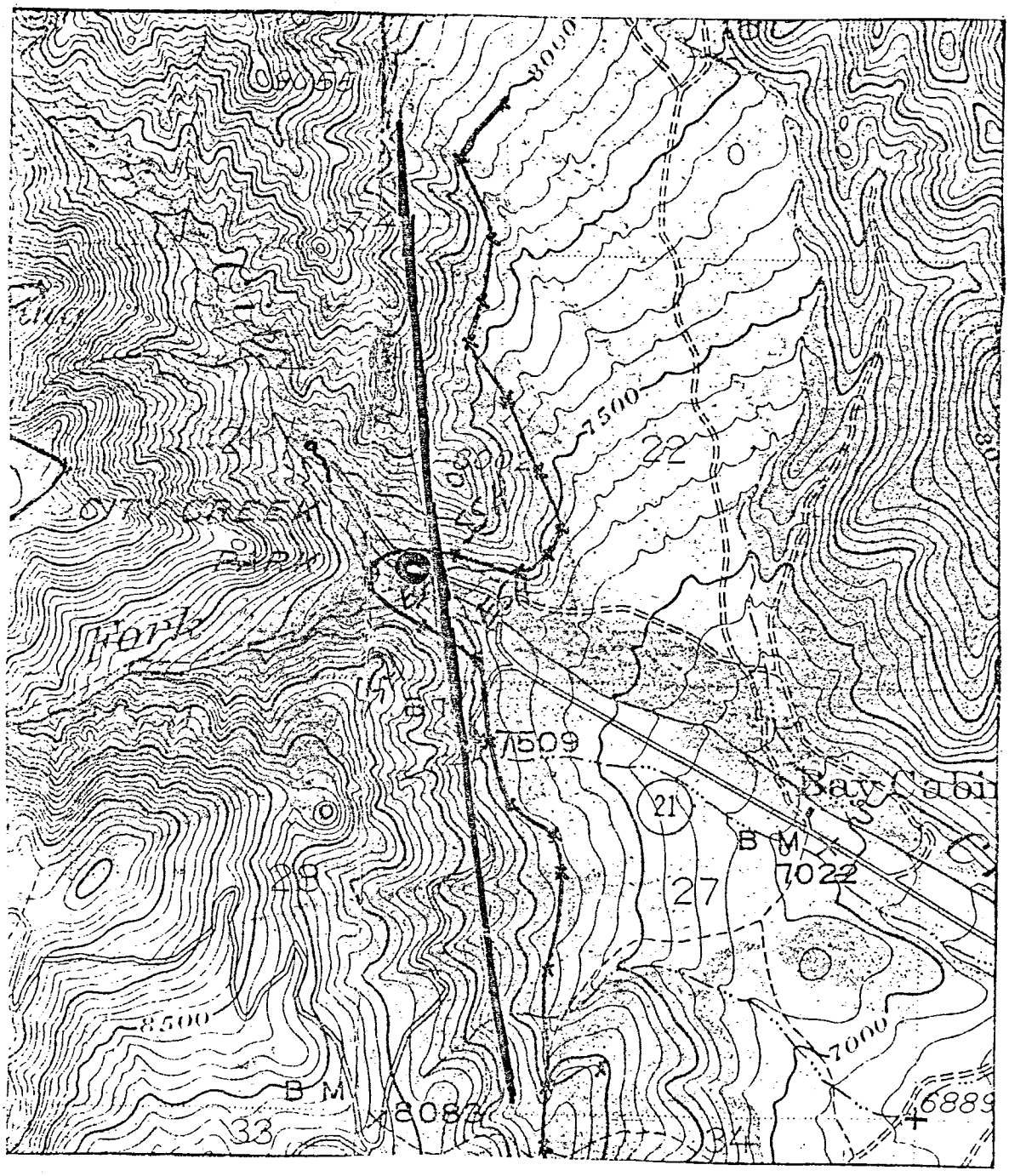


Figure 3. City Creek Campground. Solid black line indicates fault line or seismic rupture zone. Line with crosses indicates boundary separating Shaking and Slippage Hazard (SSH) and Enhanced Shaking Hazard (ESH). Small circle indicates campground area. Scale 1:24000

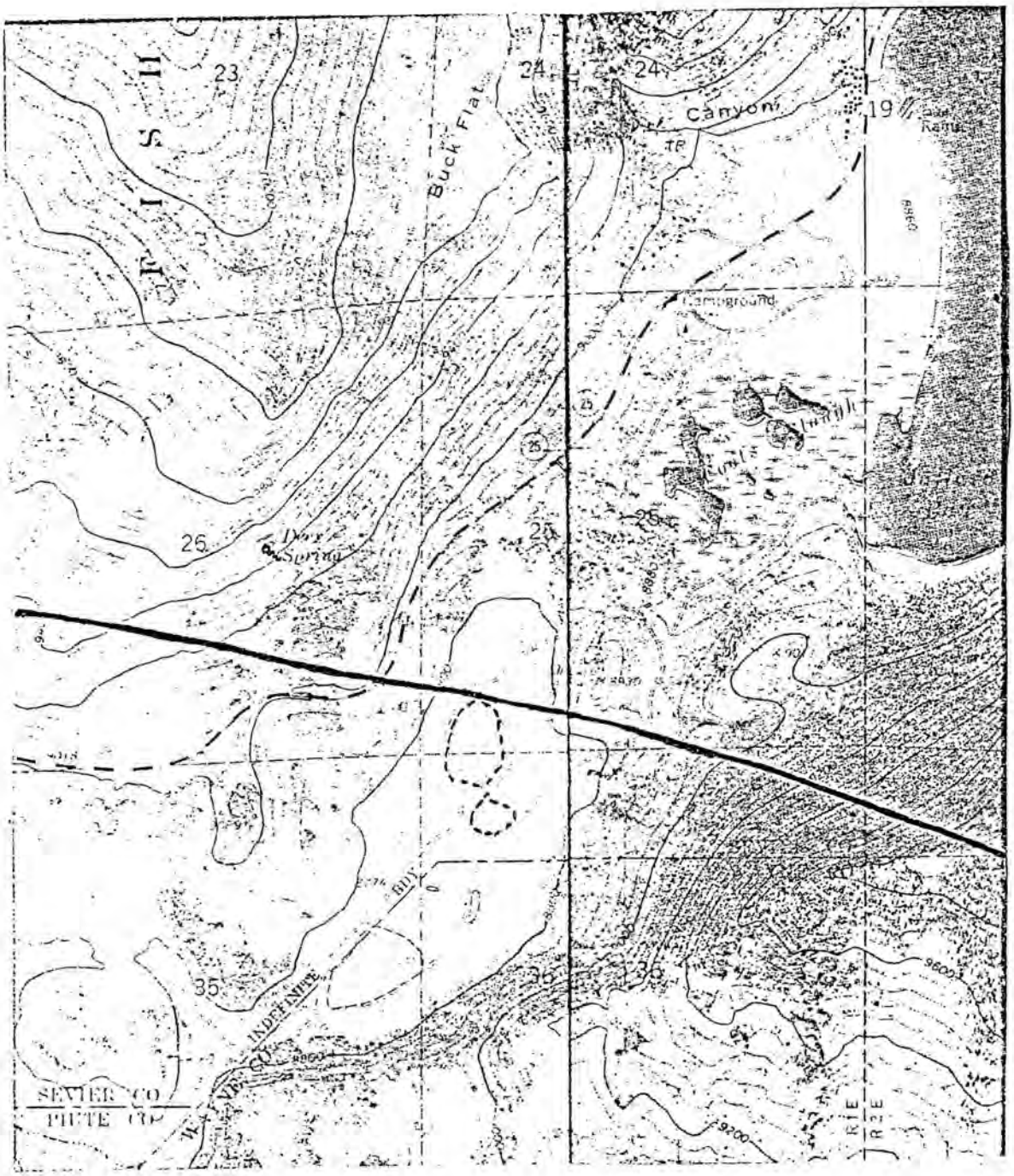


Figure 4. Fishlake sewage lagoons. Solid line indicates shaking hazard boundary. Lagoons are inside shaking hazard zone. Scale 1:24000.

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# FISHLAKE NATIONAL FOREST
# SEISMIC AND VOLCANIC HAZARDS MAP

Scale ½" = 2 Miles

5 0 5 mi

5 0 5 km

Fault Rupture Zone

Fault Shake Zone

Study Area

KEY MAP

1) THIS MAP MAY NOT SHOW ALL POTENTIALLY ACTIVE FAULTS, EITHER WITHIN THE SPECIAL STUDIES ZONES OR OUTSIDE THEIR BOUNDARIES

2) FAULTS SHOWN ARE THE BASIS FOR ESTABLISHING THE BOUNDARIES OF THE SPECIAL STUDIES ZONES.

3) THE IDENTIFICATION OF THESE POTENTIALLY ACTIVE FAULTS AND THE LOCATION OF SUCH FAULT TRACES ARE BASED ON THE BEST AVAILABLE DATA. TRACES HAVE BEEN DRAWN AS ACCURATELY AS POSSIBLE AT THIS MAP SCALE, HOWEVER, THE QUALITY OF DATA USED IS HIGHLY VARIED. THE FAULTS SHOWN HAVE NOT BEEN FIELD CHECKED DURING THIS MAP COMPILATION.

Volcanic Flow Hazard