GEOLOGIC AND GEOPHYSICAL STUDIES RELATED TO CONSTRUCTION OF THE TRANSMOUNTAIN PIPELINE IN CLALLAM COUNTY, WASHINGTON

by

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ABSTRACT

Geologic and Geophysical Studies Related to Construction of the TransMountain Pipeline in Clallam County, Washington.

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This report presents the results of a review and analysis of geologic and geophysical information submitted to Clallam County by the TransMountain Pipeline Company as part of their proposal for construction of a marine pipeline facility and pipeline which passes through the county. This report addresses the seismicity of the area, reviews the groundwater problem, evaluates the Low Point off-loading and tank farm sites, evaluates proposed anchor penetration standards, and analyzes the slope stability and sediment liquefaction potential for the submarine crossings. The primary conclusion that may be drawn from this review is that Trans Mountain Pipeline has not provided sufficient information to adequately assess their construction proposal.

TABLE OF CONTENTS

APPENDICES

SECTION I: GROUNDWATER

Introduction

The TransMountain Pipeline Company (TMPC) has applied for site certification to build an oil pipeline through the eastern part of Clallam County, Washington. The pipeline would begin at a dock and tank farm at Low Point, extend east along the Olympic Mountain front, pass south of the towns of Port Angeles and Sequim, around Sequim Bay, and leave the county on the Miller Peninsula (Fig. I-1).

The purposes of this study were to review TMPC's assessment of possible impacts on groundwater resources in Clallam County, and to provide the county government with an independent opinion on potential impacts, and what might be done to avoid or ameliorate them. The present work is intended to act as a review of the subject, and is not intended to serve as a complete groundwater study or environmental impact assessment (the former is being prepared by the U.S. Geological Survey; the latter is the responsibility of the applicant). Rather, this report contains a general description of the geologic and hydrogeologic conditions, and provides a summary of the kinds of information that will be necessary to assess impacts and make design decisions.

TMPC's certification application contains several references to geological conditions (Section 3), groundwater (Section 4), effects of oil spills (Section 4), and mitigation of adverse environmental impacts (Section 7). Most of this information is very general in nature, and inadequate for local design or decision-making.

The only published report dealing with groundwater in the county is Noble's (1960) report on the Sequim-Dungeness area. Unfortunately, the pipeline corridor passes south of his study area.

The major data source for our study was a print-out of water well data (depth, depth to static water level, location, etc.), compiled by the U.S. Geological Survey (Johnson & Rasmussen, 1980). These data were used to estimate depth to the water table at wells within about a mile of the pipeline corridor. The logs for most of these wells are on file with the Water Resources Division of the U.S.G.S. (Tacoma),

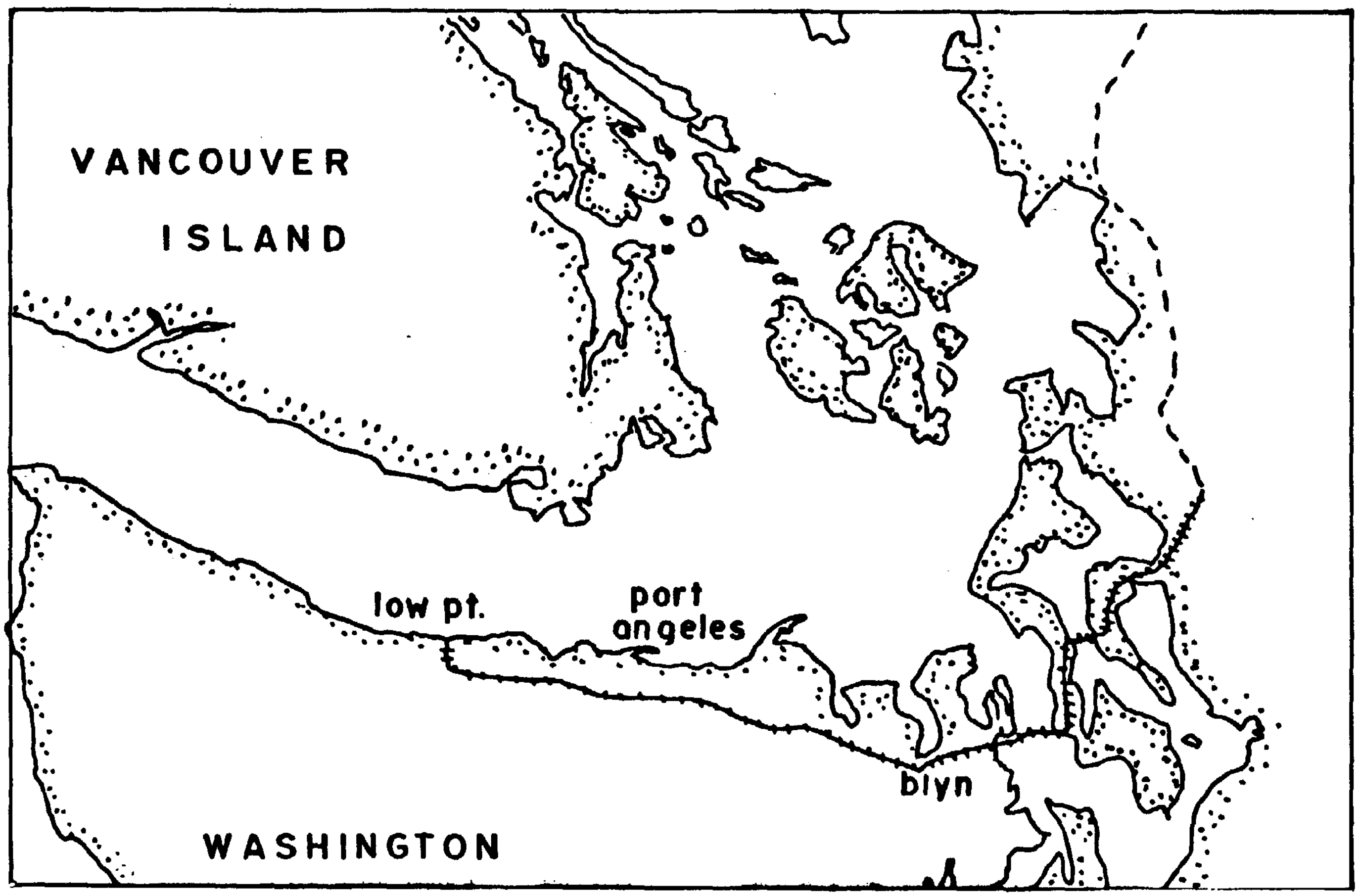


Figure I-1. Proposed pipeline route through Clallam County.

and with the Washington Department of Ecology (Redmond?). The logs were not consulted in this study.

Information on oil spills, oil migration, and groundwater contamination can be found in Freeze and Cherry's (1978) text, and in an article by Dietz (1971) on water pollution by oil. Other references are contained in these works.

Discussion

Hydrogeology of Eastern Clallam County

A. Geology

The area of interest extends from the front of the Olympic Mountains to the Strait of Juan de Fuca, and from Low Point to the Miller Peninsula (Fig. I-1). The northern edge of the Olympics are made of volcanic and sedimentary rocks (~25 to 65 million years old). Bedrock crops out in the hills, in river bottoms, and along parts of the coast. Most of the layers dip northward in the vicinity of the pipeline corridor [though a syncline (concave-upward fold) underlies unconsolidated sediments near the Strait; see the map of Tabor and Cady, 1978].

Overlying the bedrock in most of the study area is a layer of unconsolidated material, variable in thickness, lithology, and texture. These deposits include soils, glacial till, glacial outwash (loose sand and gravel deposited by meltwaters), lake sediments, bog deposits, and old weathered alluvium and slopewash materials. Young, loose alluvium is deposited on the bottoms of larger stream valleys. Because of the irregular nature of the bedrock surface and the processes that formed them, the unconsolidated deposits range in thickness from a thin mantle over bedrock hills to thick fills in the Sequim area.

B. Hydrogeology

Most of the groundwater tapped by wells in Clallam County is derived from the unconsolidated materials, especially gravel and sand units. These loose, permeable materials are irregular in shape and size (small lenses to larger layers). They are interbedded and interfingered with less permeable materials, which may partially perch or confine the aquifers. The hydraulic conductivities of these materials probably vary over ten orders of magnitude (i.e.,

10^{-11} to 10^{-1} ft/sec), so flow rates are equally variable. Because of this irregularity, it is impossible to completely define the flow system, especially given the small number of wells in and near the pipeline corridor.

However, it is possible to draw some inferences about the flow patterns in larger scale. We may consider the groundwater system to be limited to the unconsolidated deposits, since groundwater in the bedrock is limited in volume, slow in movement, and (so far) insignificant in exploitation. Bedrock serves as the deepest surface over which most of the descending groundwater probably accumulates.

The flow system is also controlled by surface topography. Highlands, especially the Olympics, are recharge areas where water percolates predominantly downward. Lowlands, such as river valleys and the coast, are discharge areas, where water flows upward and out toward the surface. The water table is usually a subdued image of the ground surface: higher (but deeper) under hills, lower (but shallow) under the valleys (Fig. I-2). Depending on the details of local topography and stratigraphy, there may be small local flow systems, as well as a regional system (see Freeze and Cherry, 1978, Chap. 6).

In northern Clallam County, the dip of the bedrock and the general northward slope of the land combine to cause northward flow in the regional system, and a general northward decline in water table elevations (Noble, 1960). However, local flow may be in any direction if it is controlled by a stream valley or a hill. In general, shallow (saturated) flow follows the surface topography, and deeper flow is predominantly northward.

C. The Pipeline Corridor

The TMPC corridor is shown on Figure I-1, and on the topographic maps accompanying this report (see the Appendix). Along most of its length, the pipeline would be very near the contact between bedrock and unconsolidated deposits (as mapped by Tabor and Cady, 1978). The covering of soil, till, etc., is extremely variable in the hills, so the depth to groundwater also varies significantly.

Data from the U.S.G.S. print-out were used to plot depths to static water levels (SWL) for wells near the corridor. The SWL is not necessarily the water table--in wells that are closed except near the bottom, the SWL may only

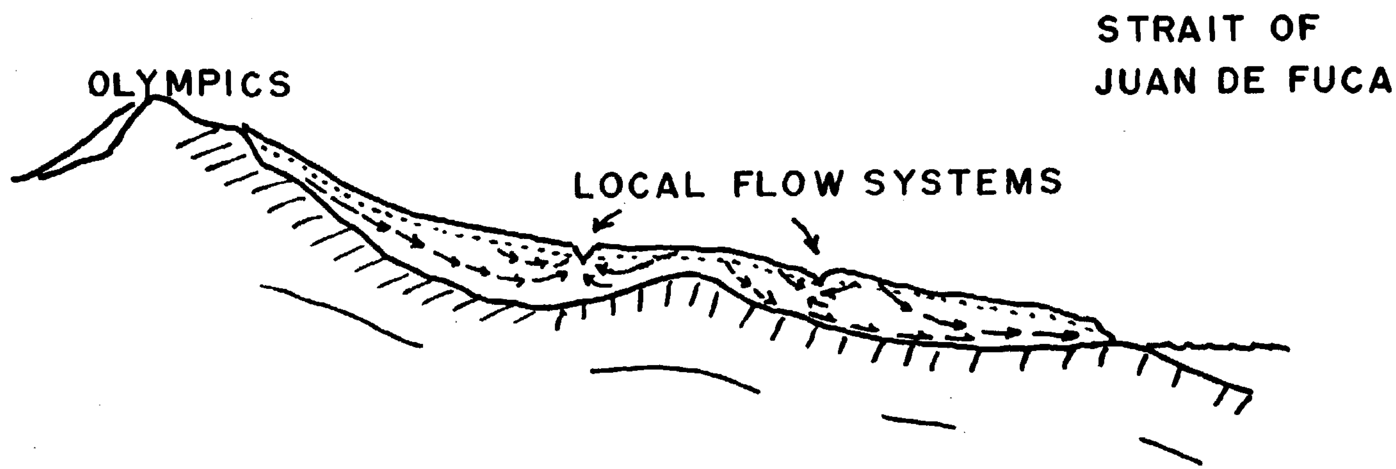


Figure I-2 Schematic diagram of local and regional flow systems in northeastern Clallam County. The water table (dotted line) is a subdued image of the surface. Hypothetical flow lines are shown by arrows.

reflect the pressure in the aquifer being tapped (the piezometric head), and have nothing to do with the water levels nearer the surface. Therefore, water levels that are probably indicative of water table depth (in shallow or open wells) are plotted on the topographic maps in blue, others (which may or may not indicate water table depths) are plotted in red. There are not enough points to define a water table surface, but some general comments can be made based upon these data.

From Low Point, the pipeline corridor trends southeast to State Highway 112, and then parallels the highway on the south. For the first 4 miles it crosses flat to gently-rolling topography. There are no wells in this stretch. However, bedrock is exposed in the valleys of Field Creek and Whiskey Creek, suggesting that the deposits are 50 to 150 feet thick. Water levels are probably less than 50 feet deep.

In the 2 miles between Joyce and Ramapo, the corridor crosses slightly steeper terrain (about 10% slope gradient), underlain by sandstone and siltstone. Groundwater is probably present at shallow depths (10 to 20 feet ??), but there are no wells in this area.

From Ramapo to the Elwha River (5 miles), the pipeline would cross flat unconsolidated deposits between bedrock hills, then over a bedrock saddle and into the Elwha Valley. Again, groundwater depths should be shallow on and near bedrock. West of the Elwha, SWL's in wells near the corridor are mostly 25 to 45 feet, though two wells have SWL's of 4 and 5 feet.

From the Elwha, the corridor crosses U.S. 101, then hugs the mountain front for 2 miles, all on colluvium, alluvium, and glacial deposits. Slope gradients are commonly up to 20%. The water level is very shallow (1 to 5 feet) in some wells, deeper (10 to 60 feet) in others. The corridor then leaves the hills, and crosses rolling plains through the southern outskirts of Port Angeles. Here the deposits are up to about 300 feet thick, and SWL's are 30 to 120 feet deep. The pipeline would have to cross five perennial streams in the vicinity of Port Angeles, and would therefore be buried at or below the water table in those valleys.

From the east end of town, the corridor crosses a thick fill of unconsolidated material for about 8 miles. The terrain is gently rolling, and incised by several streams which have cut channels 100 to 120 feet deep, creating local flow systems near themselves. There are some springs, shallow marshes, and ponds, suggesting that groundwater is reaching the surface on the plains as well as in the valleys. SWL's that represent the water table are 13 to 33 feet deep; piezometric levels are somewhat deeper, 28 to 70 feet.

On the north edge of Lost Mountain, the corridor nears the mountain front, then crosses alluvial fill of the Dungeness valley. Water levels are fairly shallow in the low hills (mostly 6 to 30 feet), but deeper on the edge of the Dungeness Valley (60 to 80 feet), presumably because the water table is depressed along the incised valley.

From the Dungeness River, the pipeline corridor stays in the foothills around Burnt Hill (made of basalt, as are Lost Mountain and Bell Hill), south of Sequim Bay and eastward to the Jefferson County line. The mountain front deposits (colluvium and till?) are moderately steep (5 to 50% slopes) and crossed by many forest streams. The stratigraphy of these materials is extremely variable, so the water levels are as well (2 to 400 feet deep).

D. Information Needed

The generality of the above discussion suggests that further study and information are necessary. Specifically, examination of the logs of wells along the corridor would provide a more detailed picture of the stratigraphy of deposits in the area. Soils data (Clallam County soil survey?) might provide the infiltration capacities of surface materials. With these data and with reasonable estimates of the hydraulic conductivities of subsurface materials, it should be possible to do a better analysis of flow paths and water table configuration, at least in the areas with wells.

At greater expense, it might be necessary to dig new wells in some areas to get the required information. Tracer studies, computer models, or other techniques might also be employed. A hydrogeologic consulting firm with experience in these areas would be required in order to plan these studies.

Hydrogeologic Effects of an Oil Spill

If a pipeline leak should occur, the amount of oil that would get into the ground would depend upon the rate of leakage, the viscosity of the oil, and the permeability of the trench fill and the ground around the trench. If it entered the soil, the oil would percolate vertically through the unsaturated zone, leaving a cylinder of residual oil held in the soil pores by capillary tension, and adsorbed onto the grains (Dietz, 1971). The oil would spread out laterally on reaching layers of lower permeability. This downward percolation process may totally exhaust the oil before it reaches the water table, depending on the depth of the latter.

If the oil reaches the water table, it will spread out in the capillary zone, since the oil is lighter than and immiscible with water (Fig. I-3). This oil will "pancake" until enough of the oil is adsorbed or held by tension to make the oil immobile.

Van Dam (1967) provided a simple method of calculating the depth of oil penetration, and the size of the pancake that will form if it reaches the water table. The method is based upon the volume of oil spilled, the area over which it spreads, and the physical characteristics of the oil and the soil. In order to apply this model, specific data for different sites and estimates of leakage rates are necessary. A general conclusion that can be drawn from this model is that a given volume of oil will spread through 10 to 20 times that volume of soil.

The environmental impact assessment should include reasonable estimates of depth of penetration for conditions along the corridor, based upon Van Dam's method or some other model. In addition, rates of percolation should be estimated for local conditions. These kinds of information will be necessary to determine whether a given water table depth is really safe from quick contamination.

Even though a slug of leaked oil becomes immobile, the effects of the spill may extend much further. Rainwater percolating through the residual oil will take into solution the lighter fractions of the oil, and carry them into the groundwater system (Fig. I-4). Eventually the lighter components will all be washed out, leaving an immobile glob of inoffensive paraffinic oil. However, because the solubility of the lighter components (20 to 80 mg/l) is so much greater

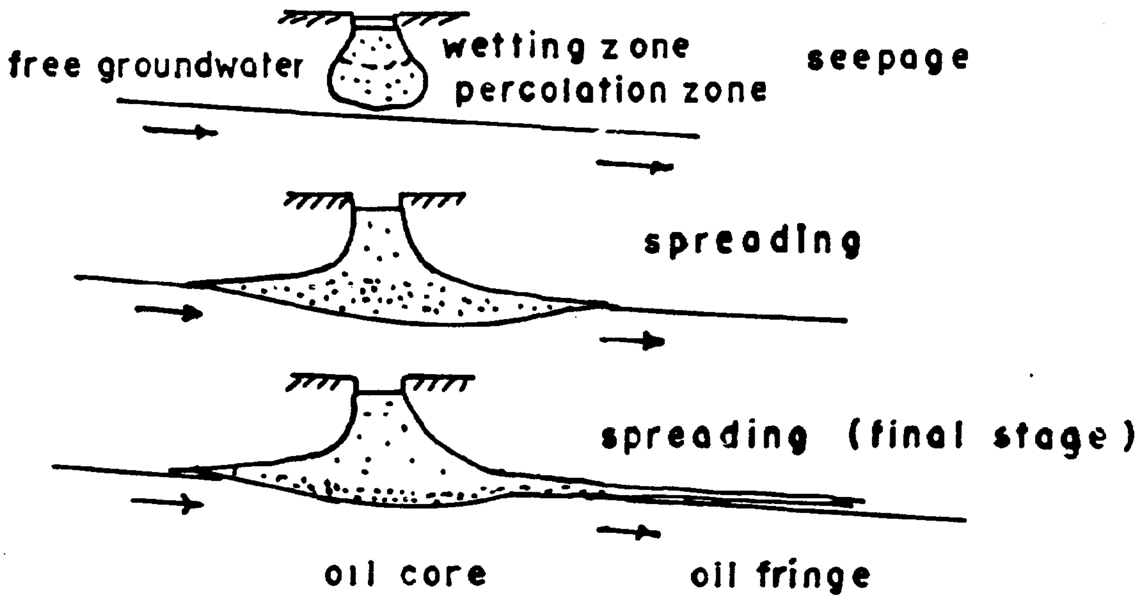


Figure I-3 Stages of migration of oil seeping from a surface source (Freeze and Cherry, 1978).

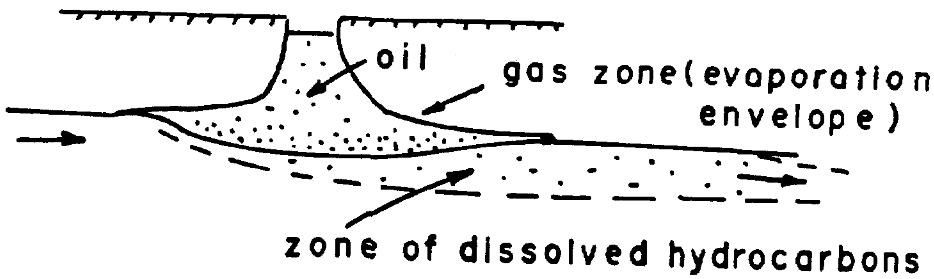


Figure I-4 Migration of dissolved and gaseous hydrocarbons from a zone of oil above the water table (Freeze and Cherry, 1978).

than the amount necessary to affect the quality of water (0.005 mg/l gasoline in water can be tasted), the contamination can spread over a large volume of groundwater, and last for a long time. Processes of dilution, dispersion, adsorption, oxidation, and anaerobic reactions will lower the concentration of contaminants in time, but the "time" may be measured in years (Dietz, 1971).

Once in the groundwater flow system, the oil components will move in the same direction as the water (Fig. I-5). If it is in a local flow system, it may move at shallow depth toward a small stream or spring, and emerge at the surface. If it gets into the regional flow system, it may move through deep aquifers to a large river or emerge at the coast. Like the groundwater movement itself, the migration of oil-contaminated water depends on the details of local stratigraphy, permeability, and flow. Impermeable layers may protect underlying aquifers, or cause concentration of the polluted water near the surface, or both.

According to the TMPC application, a rupture of the pipeline could cause up to 11,320 bbl (1800 m^3) of oil to leak, at an initial rate of 56 ft^3 /sec (Section 4.3.3). This amount could not all percolate into the ground if the rupture is in a buried section, but could spill onto the ground in an above-ground section, and then percolate through the surface.

Surface oil could be contained and salvaged. If preservation of the soil is important, the containment area should be small, however, this will cause deeper penetration of the oil. If the water table is shallow and protection of the groundwater is important, the containment area should be large, so the depth of penetration can be minimized (Dietz, 1971).

Contaminated soil, especially in the pipeline trench, can be dug out and cleaned or replaced. Shallow wells might be used to pump out part of the oil that is still mobile, but this is not a realistic solution.

It may be better, especially in sensitive areas, to prevent any infiltration by lining the trench with impermeable materials (applicant has acknowledged this idea in Section 7.1.1.1). The trench might be provided with some kind of drainage system to collect and remove oil leaked from the pipe.

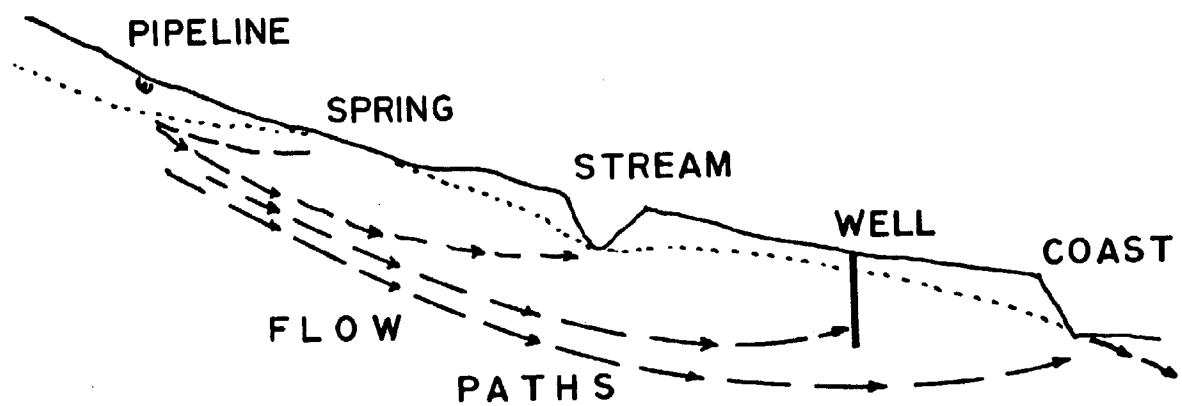


Figure I-5 Possible flow paths of soluble oil components. Could reach springs, streams, wells, or the coast, depending upon the local flow system.

If spilled oil does cause contamination of groundwater, it may be necessary to install wells downstream of the ruptured section. One set of wells could capture contaminated water for treatment, and another set could recharge the aquifer with clean water (if economically or environmentally necessary)(Fig. I-6).

Conclusions

If the pipeline is built so that leakage of oil into the ground is possible, it may be necessary to designate areas in which more stringent (and expensive) design measures should be taken to protect the groundwater resource. Such "sensitive areas" might include:

1. Areas in which a spill would reach the water table in a short time (i.e. too short to be dug out);

2. Areas in which the oil or its soluble components could return to the surface to pollute surface waters important to man, agriculture, or fisheries;

3. Areas in which the light components of spilled oil are likely to pollute aquifers important to water wells.

Obviously the decisions on sensitive areas and design criteria in them must be based on information on the conditions of the flow system, the likelihood of pollution of aquifers, and the costs of prevention and/or amelioration of spill effects. TMPC's application gives no usable information on these factors.

Recommendations

The groundwater geology and hydrology of the TMPC corridor in Clallam County is very poorly known despite the importance of the resource in the eastern part of the county. Much more information is needed to adequately evaluate the potential impacts of pipeline construction or an oil leak on the groundwater system. If TMPC reactivates its application, it should be required to provide specific data on flow paths, water table depths, and flow rates of leaked oil.

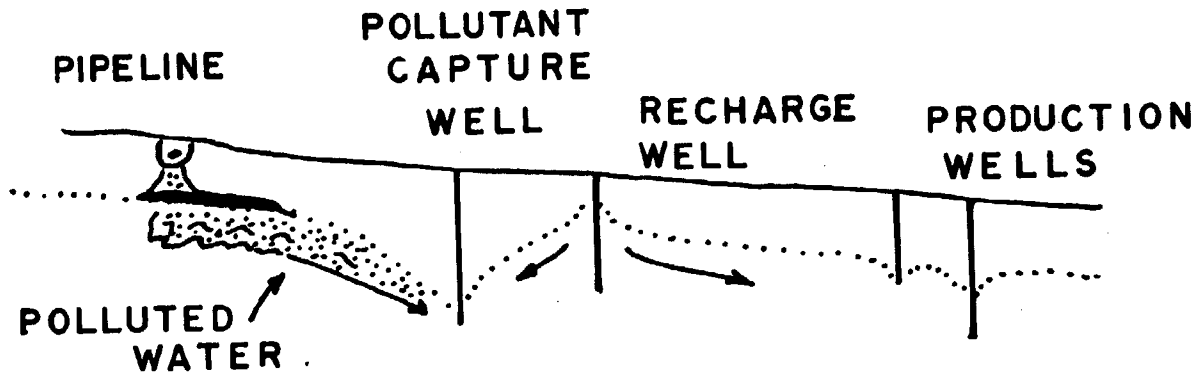


Figure I-6 Possible arrangement of wells to capture oil-polluted groundwater, and recharge the system with clean water.

SECTION II: SEISMICITY

Introduction

This section provides epicentral maps for Western Washington and for the Puget-Vancouver tectonic province. Two sets of maps are provided, the first of which displays all known historic events through 1980 for these two regions (Figures II-1 and II-2), and the second of which shows all events recorded during 1980 (Figures II-3 and II-4). The data plotted include events from magnitude 0 to 7, and represent the most complete available compilation of earthquake data for Western Washington. A detail map showing the epicenters of the February 14, 1981 Elk Lake swarm is also provided. The applicant's seismic design analysis is discussed in light of the seismicity maps.

Discussion

A. Seismicity

Figure II-1, the historic epicentral map for Western Washington, shows a high degree of seismicity from throughout the Puget Sound Trough and north through Vancouver Island. The distribution of these earthquakes, in a spatial and temporal sense, appears to be random in the Puget-Vancouver Island region. The spatial density of earthquakes does decrease in a westward direction along the Washington-Juan de Fuca coastline from just west of Port Angeles to Pillar Point, where seismicity again increases. The significance of this "quiet zone" is only marginal, since there is moderate seismicity to the north and south of the coastline just 20 km away on either side. The proposed TransMountain Pipeline route passes along this zone and then into a zone of high seismicity east of Port Angeles.

Figure II-2 provides an expanded view of the seismicity in the Puget-Vancouver region, using the same data base (included as Appendix II-1) as is mapped in Figure II-1. This figure demonstrates that the seismicity in the region around Clallam County cannot be unequivocally segmented into zones of high and low seismic risk, since earthquakes have clearly occurred over the entire area. Arbitrary demarcation of two zones within Clallam County, which the applicant

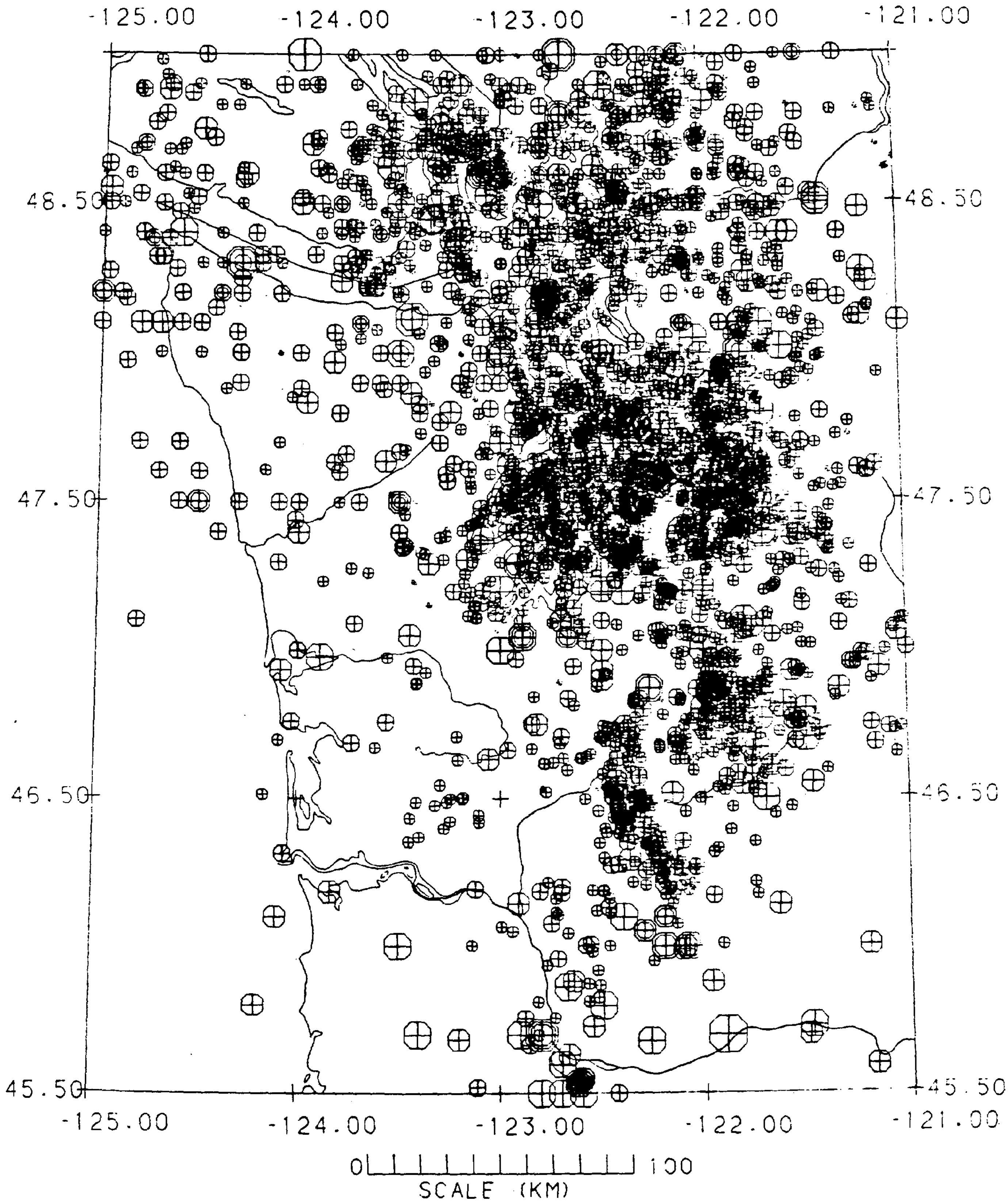


Figure II-1 Historical seismicity in Western Washington. Increasing symbol size indicates greater magnitude. Largest event 7.2 M_r, smallest 1.5 M.

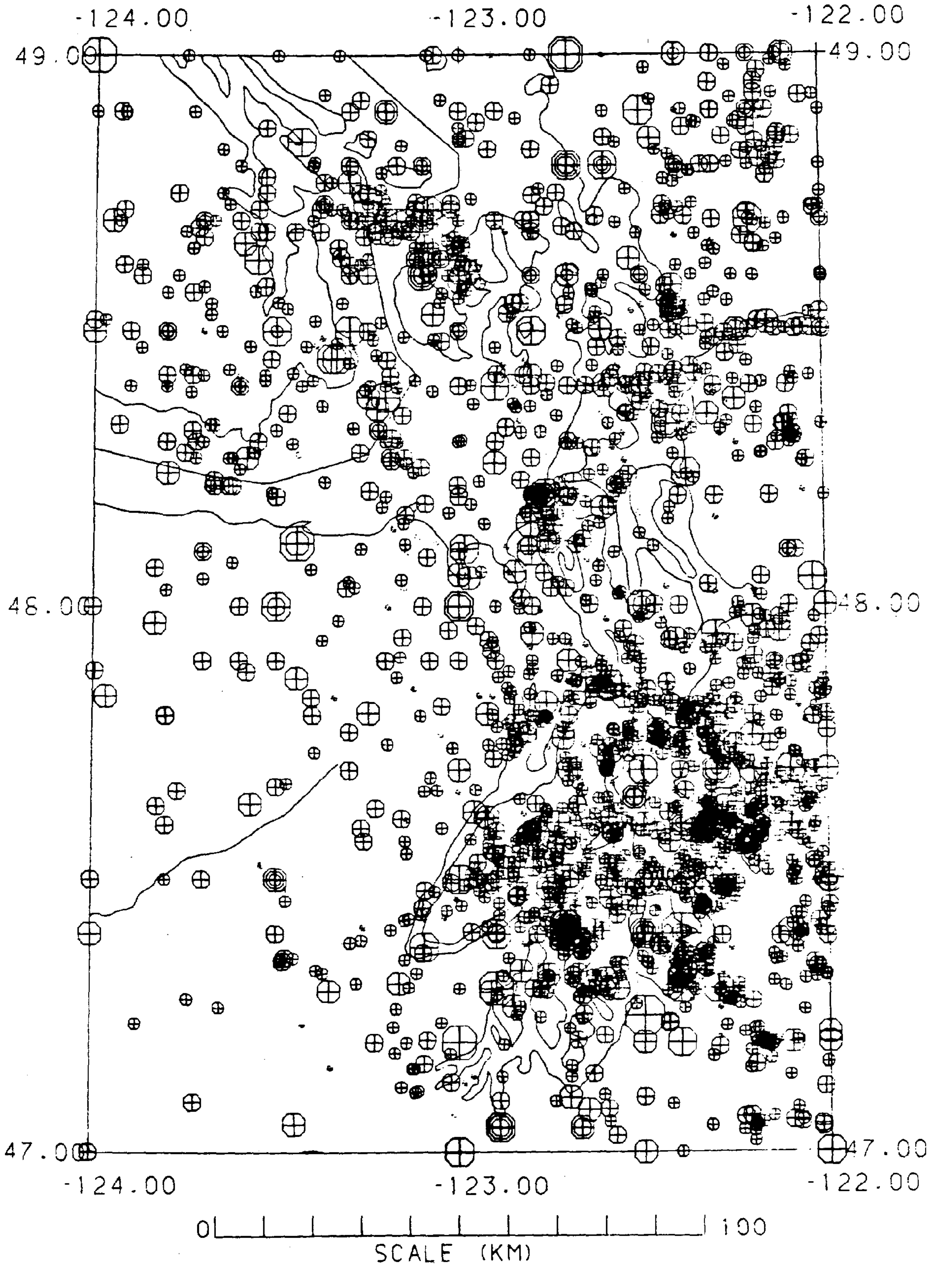


Figure II-2 Historical seismicity of the Puget Sound-Vancouver Island region.

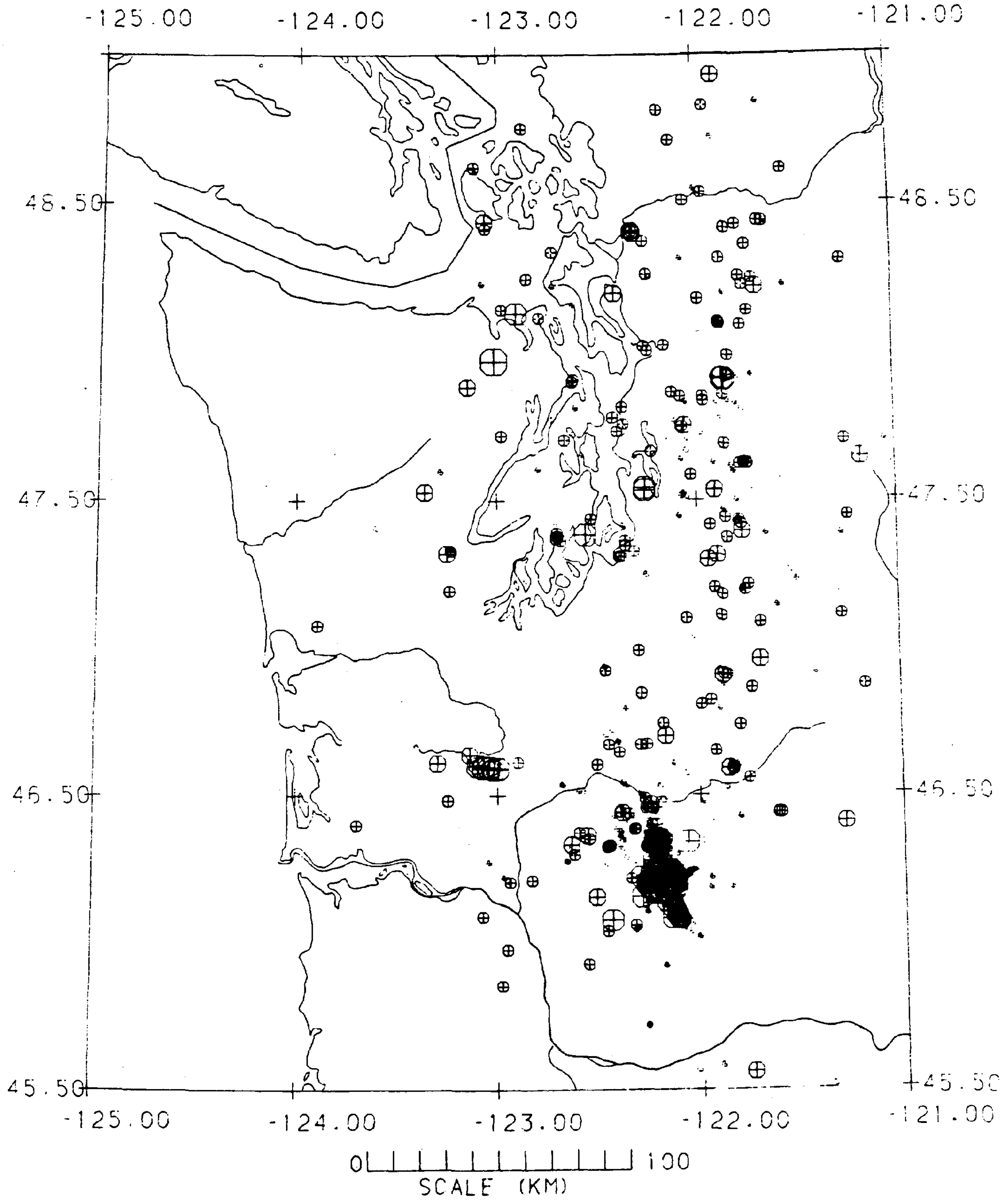


Figure II-3 Seismicity of Western Washington for 1980.

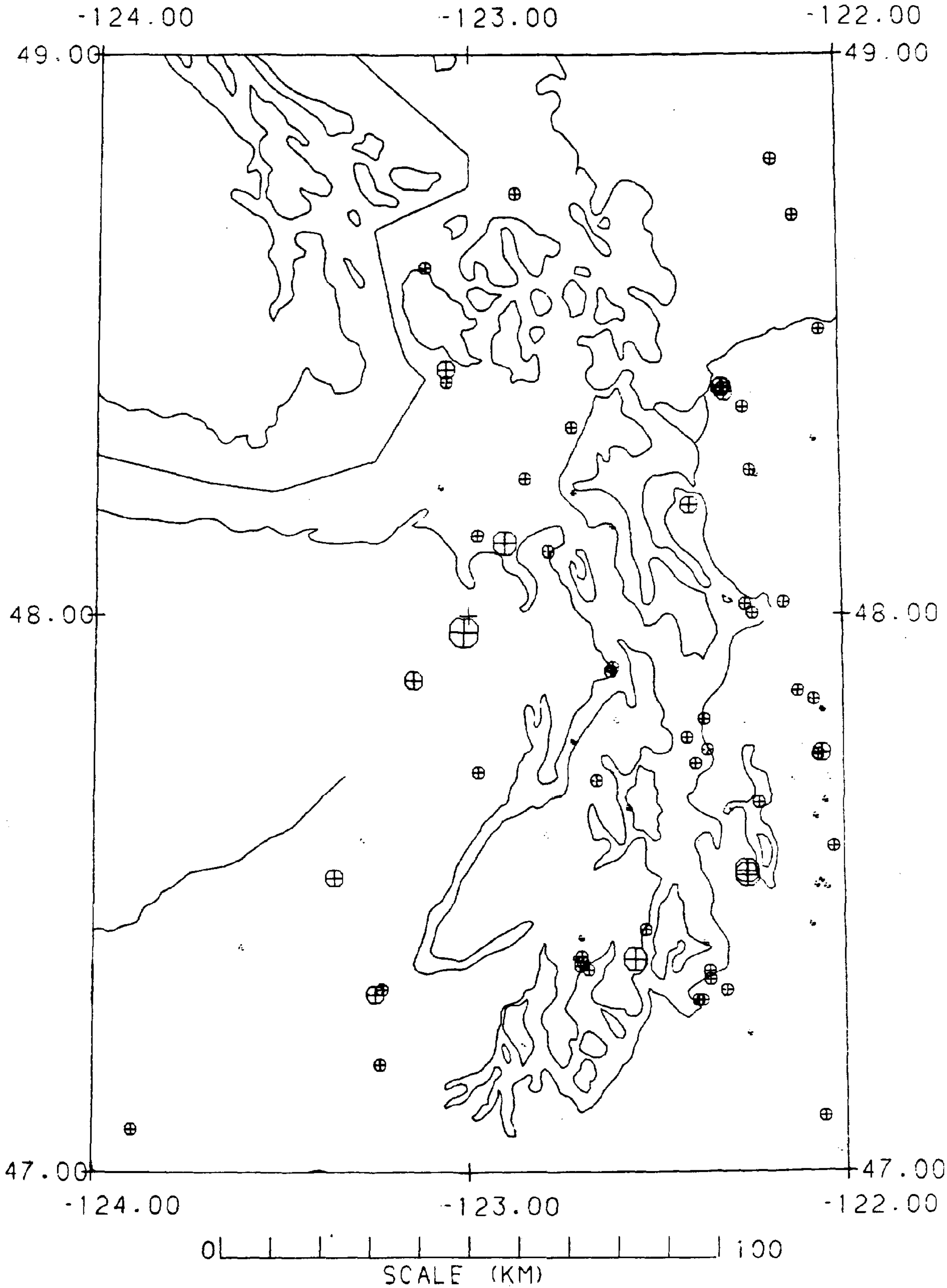


Figure II-4 Seismicity of Puget Sound-Vancouver Island Region, 1980.

has done in its seismic risk analysis (Fugro, 1980; and reproduced as Figure II-5 in this text), is not satisfactory. Comparison of the lower risk Zone A in Figure II-5 with either Figure II-1 or Figure II-2 illustrates this point.

B. Shallow Earthquakes

Depth-magnitude relationships (the correlation of hypocentral depth to the earthquake magnitude) have until recently indicated that large Puget Sound earthquakes (5.0 M and greater) occur only at depths exceeding 40 kilometers. On February 14, 1981 a shallow (4 km) earthquake occurred at Elk Lake. The main shock had a magnitude of 5.5, and was followed by over 300 smaller aftershocks.

A plot of all events greater than Richter magnitude 1.0 is presented in Figure II-6. The data used in this plot were obtained from digital recordings obtained at the Geophysics Program of the University of Washington. The University of Washington state network includes more than 100 active stations, all of which telemeter their seismic information in real time to the central recording computer located at the Geophysics Program laboratory.

The Elk Lake swarm was recorded by a majority of the network stations, providing excellent azimuthal control and good depth control. Although the depth of the initial event and the following swarm was shallow (between 4 and 10 km), the accuracy of the depth estimates is still reasonably good, and is comparable in quality to an intermediate or deep earthquake. The reason for increased potential error is that the Puget Sound Seismic Model has only a single layer for the top 5 km of the crust, and that the close-in seismic stations, which would provide the best control for depth in a shallow event, were overloaded by the large events. Estimated average depth accuracy is ± 0.5 km.

The importance of the Elk Lake event is that it demonstrates that large, shallow earthquakes can occur in Western Washington. This, coupled with the random spatial distribution of earthquakes in the region, indicates that critical facility design in Clallam County should consider the potential for large shallow events.

C. Attenuation Relationships

The evaluation of the seismic quality factor Q is an important part of an earthquake risk evaluation for a

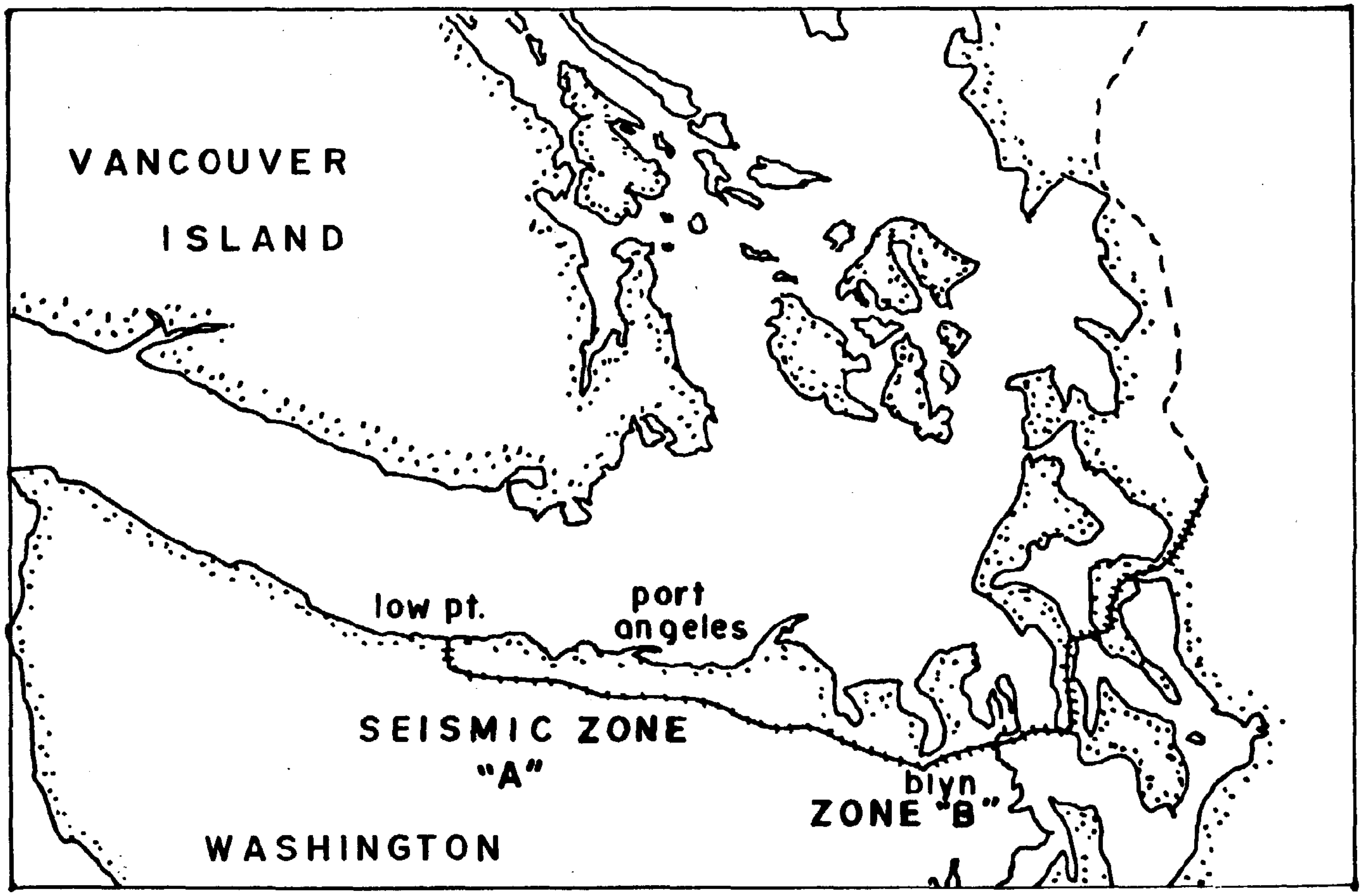
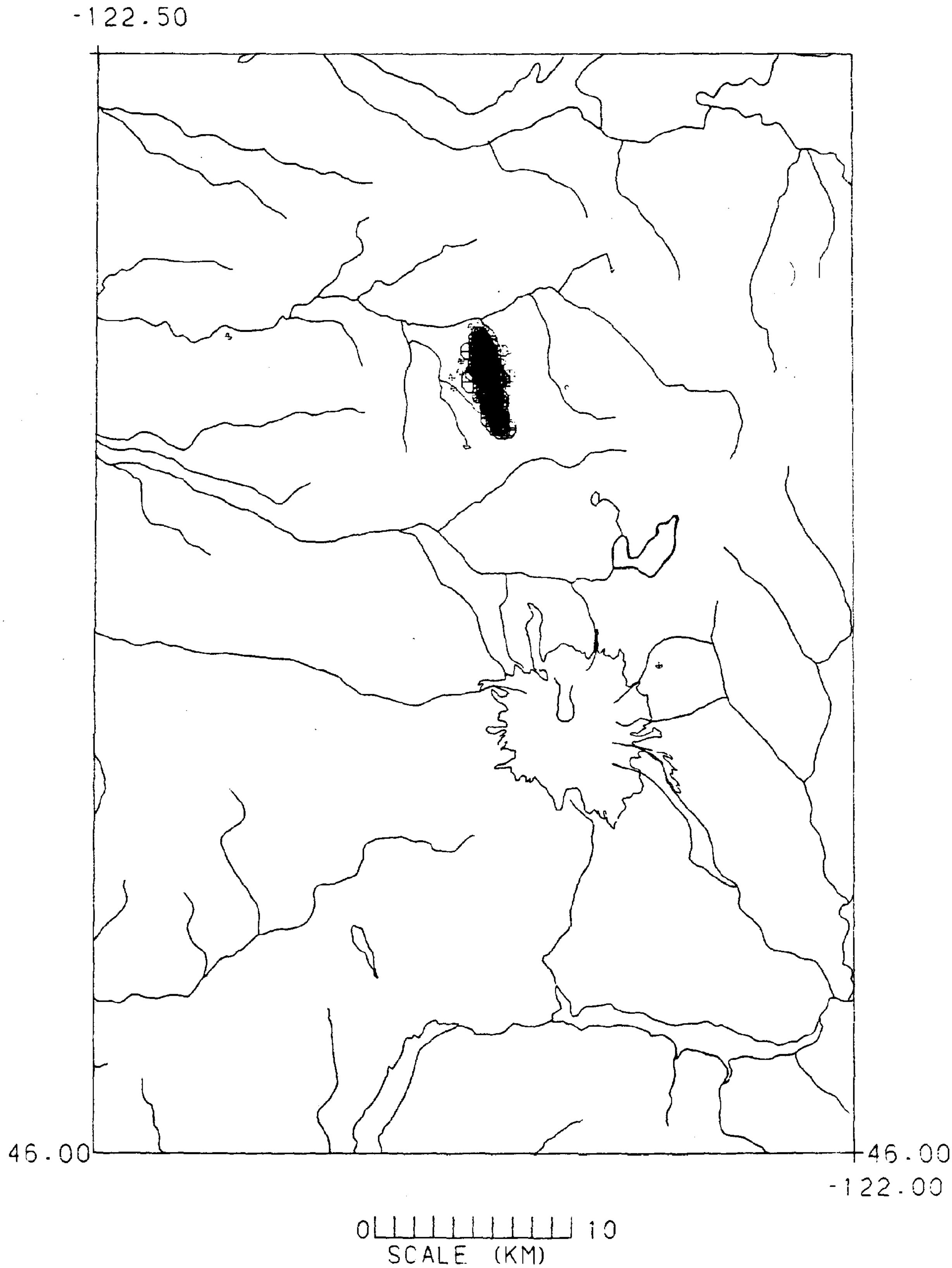


Figure II-5 Map indicating applicant's proposed seismic zones A and B.

Figure II-6 Elk Lake Earthquake Swarm (Feb. 14, 1981). Elk Lake is 18 km North by NW of Mt. St. Helens.



particular region. An understanding of the degree of seismic dissipation can allow more accurate modeling of potential ground motion and thus provides greater insight into the problem of damage prediction and design criteria for critical structures.

The estimation of Q for compressional waves traveling through the upper crust in the Puget Sound region represents the first concerted effort at measuring the attenuation characteristics in this area. Previous work has been only on a regional or continental scale. Solomon and Toksoz (1970) found that the northwest U.S. was located in a band characterized by higher P wave attenuation, relative to the California coast and the Great Plains region. It should be pointed out that the resolution of their measurement is a dimension equivalent to the combined widths of Washington and Oregon and thus is somewhat irrelevant. Langston and Blum (1977), however, also found that the region was characterized by high attenuation ($Qp = 65$) using teleseismic Pp data. Langston (1981), in a short review of Langston and Blum (1977), indicated that the low Q may be due in part to scattering effects, implying that the Q value should be higher than reported.

Data

The data used in the calculations were from selected events of the Elk Lake swarm. Several hundred events occurred within a few days after the main shock of February 14, and out of these events were picked for quality of location, impulsive signature, high signal-to-noise ratio, and maximum range of receiving stations.

A map of the stations used in the study is shown in Figure II-7. Also included in the figure is the location of the Elk Lake swarm. The geometry of the station array is that of a line bearing north up the axis of the Puget Trough. Elk Lake is at the southern-most end of the line. This geometry also allowed for a velocity model check since it represents a single-ended refraction line.

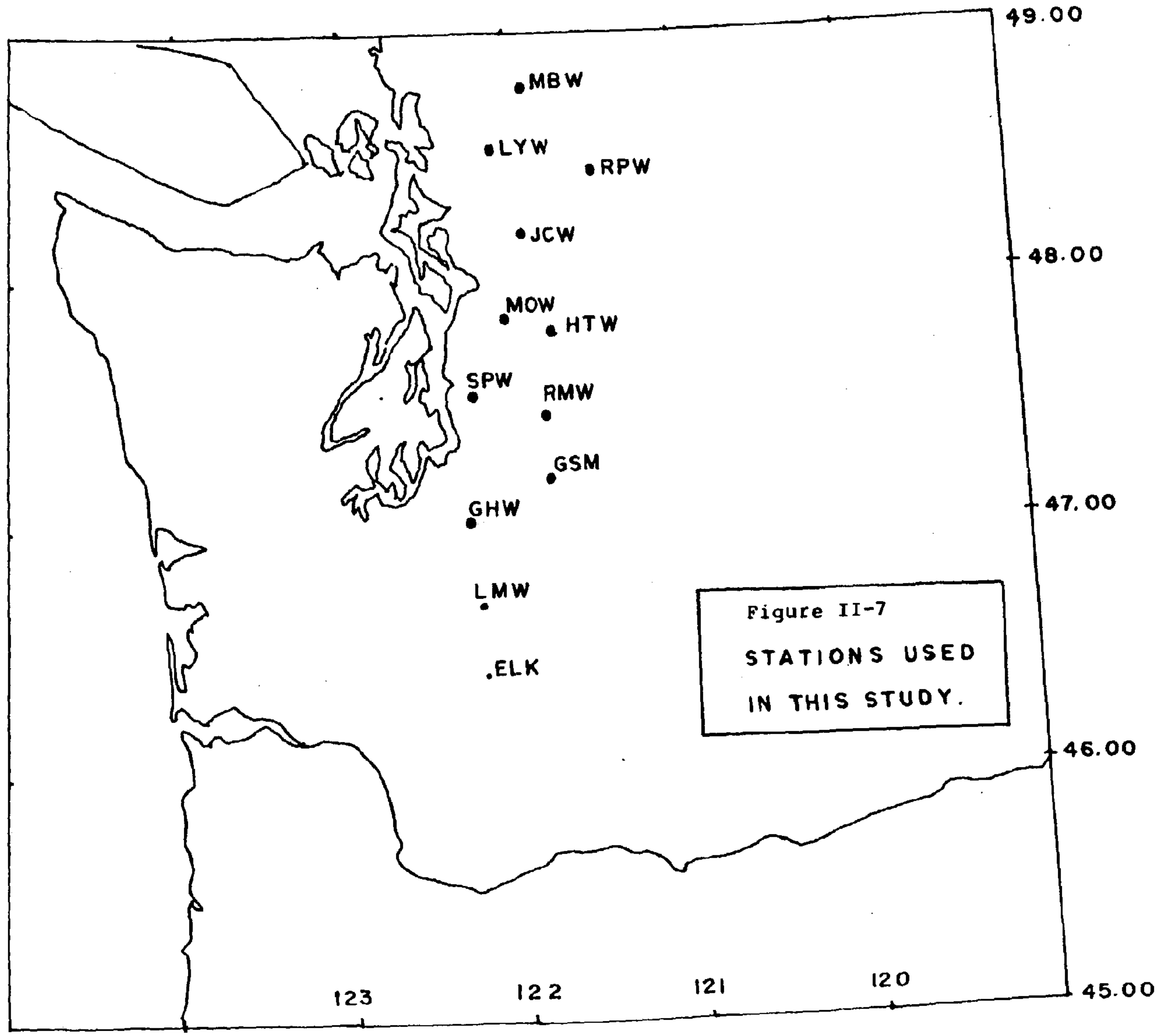


Figure II-7
STATIONS USED
IN THIS STUDY.

Method of Analysis

Three methods were considered for this study: the maximum sustained peak method, the Aki-Chouet scatter-coda method, and the spectral ratio technique.

Initial calculations using the sustained peak method showed significant scatter and proved to be less consistent than required. The reason for this is not immediately at hand; however, the problem of multipathing, scattering, and topography may combine in the Puget Trough to cause significant amplitude fluctuations within the area.

The Aki-Chouet scatter method was not attempted due to certain technical requirements of the technique which were not met by the network. Specific conditions must be met between seismometer bandwidth and source frequency. The method is important, however, since it is least sensitive to the problems of scattering, topography, geometric spreading, and the like.

The spectral ratio technique, as used by Teng (1968), Solomon and Toksoz (1970), Solomon (1972), and others, has become as widely accepted a technique as the peak-sustained method. It has as an advantage that it can be used with seismic records that even have minor clipping.

Revised Attenuation Parameter

The spectral ratio technique was used in this study in association with a forward-modeling program using seismic ray tracing. Although the structure of the Puget Trough is acknowledged to be heterogeneous, the velocity models available for use are all flat-layered ones. This is because only limited refraction data are available in the region and an adequate two-dimensional model does not exist at this time. Ray tracing was conducted using a velocity model refined from the standard Puget Sound seismic model.

The results of this study are summed up in Figure II-8. This figure provides the actual ray trace sequence for the refined model, the velocity model for the Puget Sound region, and final computed multilayer Q model for the region.

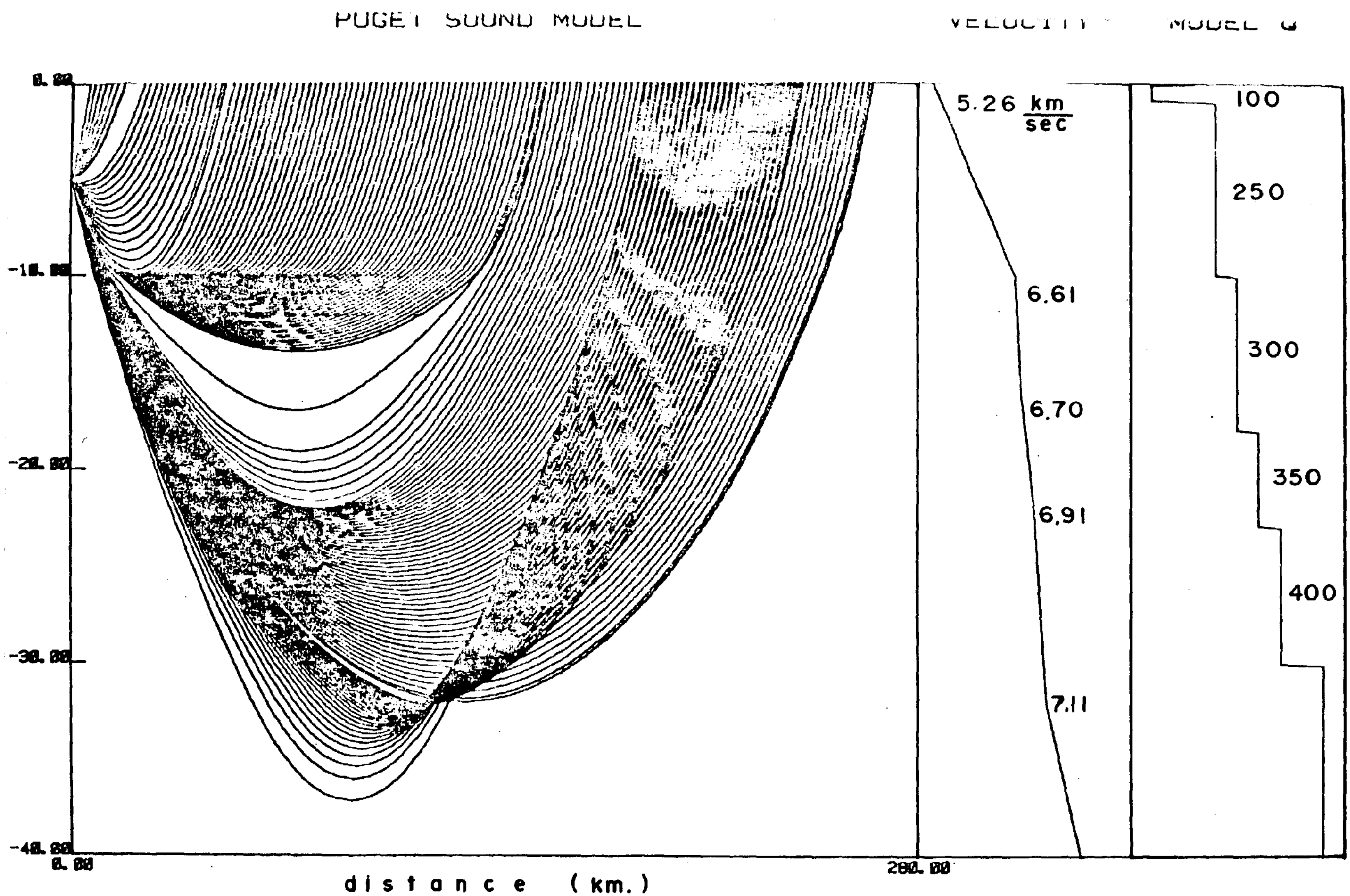


Figure II-8 Combined ray trace, P-wave velocity model, and Q model for the Puget Sound lowlands, using the Elk Lake events as the seismic source.

The Q model reveals a Q of 100 for the first two kilometers of the crust, followed by a continually increasing Q with increased depth. The average Q value for mid-crust (~15 km) is 300 ±50; this corresponds to an attenuation coefficient of 7.87 x 10^{-3} for this depth.

One conclusion of this study is that the Puget Sound region is not an area of high seismic attenuation. Q values of 65, as reported by Langston (1981), may be appropriate for near the surface, but do not correspond to the transmission characteristics at depth.

This Q model and its corresponding attenuation coefficient has been measured in the Puget-Vancouver region, and as such represents an appropriate attenuation relationship for use in a seismic design analysis. The applicant (Fugro, 1980) does not use in its design analysis a local or regional attenuation relationship, but rather it uses one developed for Southern California earthquakes. The applicant does not demonstrate that the earthquakes and structure of the Puget-Vancouver region are similar to the earthquakes and structure of Southern California, a discussion which might have laid an argumentative foundation for using the California attenuation relationship.

Conclusions/Recommendations

Seismicity in the Puget Sound-Vancouver Island region is high. The northern portion of the Olympic Peninsula has a high-to-moderate seismicity with no obvious changes in earthquake distribution which might be used to identify zones of lower seismic risk. Although the large historic earthquakes have been deep-focus events, the Elk Lake event demonstrates that large shallow earthquakes will occur in the region. Seismic risk calculations must therefore consider the Clallam County area as one homogeneous seismic zone, and must take into account the potential for shallow events. The applicant uses a two-zone calculation, which is not acceptable. The basis for this rejection is not one of competence, but is primarily due to the use by the applicant of an incomplete seismic data base. The applicant's analysis may be acceptable if Zone B, the higher risk area, is extended westward beyond Low Point, and an improved attenuation relationship is used. Utilization of an attenuation formula appropriate for the Puget Sound region may not alter the results of the analysis, but usage of relationships developed for Southern California is not appropriate unless substantiated.

SECTION III: LOW POINT FACILITIES

Introduction

This section reviews the applicant's submitted materials which consider the geotechnical details of the proposed Low Point moorage and tank farm facility. The reports used in this section include Harding-Lawson, 1980 (#HLA 9053,012.01), Harding-Lawson, 1980 (#HLA 9053,013.04), and Fugro, 1980 (Appendix I). The Harding-Lawson reports emphasize the preliminary nature of their studies, and the present analysis takes this into account.

Discussion

The Low Point area is proposed for use as the location for tanker off-loading and for an oil tank farm facility. Required geologic/geotechnical information includes depth to bedrock, type of sediment cover, liquefaction potential, near-surface structure, and potential for mass-wasting (slumping, sliding, etc.). Engineering properties of soil and bedrock will not be discussed.

High frequency seismic profiles were made by the applicant just offshore from Low Point (#HLA 9053,012.01). The applicant has submitted only interpreted line drawings of these data. A general explanation of the high frequency reflection technique and the types of equipment used, and a discussion of measurement error is provided in Appendix III-1 of this report.

For the most part, the area is characterized by mild topography and long slopes. Minor structural outcrops occur. Sea bottom consists of consolidated sedimentary rock at the surface, or is overlain by 1 to 3 feet of sediments. No deeper structure (except at Whiskey Creek) was interpreted from the data. The Whiskey Creek structure is a small sediment-filled basin.

Liquefaction damage in the offshore area will be minimal because of the very shallow depths of sediment. Structures located offshore would have a foundation in consolidated rock, and if liquefaction did occur only the first few feet of material could slough away. Assuming that this potential is considered in the foundation design, liquefaction will not pose a significant problem.

Offshore slumping in this area also plays a minimal role. Although slopes in local areas exceed 5°, generally the topography is flat with a thin sandy cover. Slumping will be minimal in this area.

Exploration efforts at the onshore portion of the Low Point facility was restricted to a reversed seismic refraction line and two soil borings. The borings reveal silty clay soils overlaying siltstone bedrock. Excavation to consolidated bedrock is planned in the tank farm design, hence liquefaction will not be a problem at the tank facility. The refraction lines show 10 to 20 feet of low velocity material (the silty clay) over bedrock, dipping north down to the beach area. During periods of high rainfall this top layer will become partially saturated and groundwater will follow along the bedrock contact. Slumping of the bluffs along the beach at Low Point may be enhanced by this flowage.

Recommendations

Liquefaction damage potential for the Low Point area is small if structure foundations are located on bedrock. Two soil borings represent reconnaissance and not exploration, and several borings must be made to adequately characterize the tank farm facility.

Submarine slumping does not pose a great problem at the site. Slumping rates of the bluffs onshore may be changed with major construction at the tank farm site, since moisture control will be required for engineering purposes (#HLA 9053,013.04). Flow of petroleum products or contaminated water, if injected into the soil layer, will flow along the bedrock contact and drain down the bluffs. Although this represents significant contamination to the local groundwater and bluffs, it is fortuitous that the runoff will not flow into a major aquifer.

Structurally, the Low Point site does not have any significant problems. More detailed work is needed, however, in the form of soil borings as mentioned above.

SECTION IV: ANCHOR PENETRATION

Introduction

A significant problem in the deployment scheme of a pipeline is to provide adequate protection from anchor penetration. Penetration may occur from a direct vertical drop of the anchor from a ship, or from the intersection of the pipeline with an anchor which is being dragged along by a ship. Anchor drag distance may extend several thousands of feet, depending upon anchor style and weight, ship size and inertia, and sea conditions. Penetration depth into the sediments along the submarine crossings also will vary considerably as a result of the above conditions, as well as with sediment type, sediment strength, seabottom topography, and shallow structure below the mudline.

The anchor penetration problem has been discussed by the applicant in Section 3.3 of Harding-Lawson report #HLA 9053,017.04.

Discussion

The evaluation of anchor penetration depth can be performed in several ways. Calculations using measured strength data from the soil types under question should be made, regardless of the final method used for depth and local estimation, since local sediment type and depositional characteristics will have an effect on bulk strength. The applicant's discussion of anchor penetration consists of a presentation of a table of anchor penetration depths for several anchor sizes, for two anchor styles, and two sediment types. The table is reproduced here as Table IV-1. The applicant does not discuss local sediment variations nor the possibility of strength variations within a single sediment type. The applicant also does not provide laboratory strength data to compare with the applicant's standard table. Their table provides penetration depths for two sediment types, using the terms "mud" and "sand". Mud may be defined as a mixture of water with clay and/or silt, plus minor miscellaneous materials such as organic debris, erratic material, etc. Sand may be defined as detrital material of size range 2 to 0.06 mm in diameter. The

TABLE IV-1

ANCHOR BURIAL DEPTHS
(FROM VALENT AND BRACKETT, 1976)

Anchor Weight	Fluke Tip Burial Below Bottom			
	Standard Stockless		Danforth or LWT	
	Sand	Mud	Sand	Mud
lb	ft	ft	ft	ft
3,000	3	7	8	23
10,000	5	11	9	28
20,000	6	12	10	a
30,000	7	17	a	a

[a]No data

applicant suggests mapping the submarine crossing into areas of mud and sand, and using the table to estimate depths. However, the materials typical of the crossings will always have some percentage of both mud and sand. The applicant does not suggest a provision in its procedure for this unavoidable condition. It is conceivable that significant underestimation of penetration depths could be made if a sandy mud or a silty mud is classified as "sand". The table also does not list penetration depths for 30 ton anchors, which would be carried by 300,000 dwt tankers. The applicant does not discuss the problem of anchor drag and subsequent variations in drag depth.

Recommendations

The concept of using a standard table for determining anchor penetration depths is satisfactory if provisions are made for the variability in sediment composition which exists along the submarine crossings. Acceptance of design penetration depths should be made only after adequate mapping and strength tests have been performed. Penetration depths for 30 ton anchors should be included in the analysis. Maximum depth of penetration for anchors dragging through the sediments must also be submitted. A reference depth should be used in the design; for example, set the pipeline burial depth to be four feet below the computed penetration depth for the largest anchor to be frequently used by ships crossing the route. This provides a maximum continuous protection for the pipeline and provides a built-in safety margin. The applicant's discussion of anchor penetration is minimal and does not set forth the true design depths, which could approach depths of 20 feet or greater. The applicant's table of depths must be accompanied by a map detailing the location of regions which are made up of "mud" and "sand" and of mud-sand mix.

SECTION V: SUBMARINE CROSSINGS

Introduction

This section reviews and critiques the materials submitted by the applicant which consider the submarine portion of the proposed pipeline. The primary documents reviewed are HLA 9053,012.01, HLA 9053,002.01, and Fugro, 1980. Submarine slumping, structure and sediment liquefaction potential is evaluated. Anchor penetration has been discussed in Section IV.

Discussion

The purpose of the reports referenced above was to obtain geologic, geophysical, and geotechnical information about the bottom and sub-bottom sea floor along the Oak Bay, Admiralty Inlet, and Saratoga Passage pipeline route corridor. The data gathered consists of a small sequence of Vibracore samples and Vibracore jet tests, elementary physical property tests on the Vibracore samples, and continuous bathymetric, high frequency seismic and side-scan sonar profiles.

The seismic source used was an electro-mechanical type of transducer which generated frequencies in the 0.5 to 2.0 kHz band. This frequency range is adequate for shallow penetration of the bottom sediments and has the potential for good resolution (see Appendix III-1 for an explanation of different seismic sources, their typical depth of seismic penetration, and typical resolution). The high resolution of the seismic source, coupled with the high resolving properties of the side-scan sonar, should have provided high quality profiles of the sub-bottom; however, the interpreted line drawings submitted by the applicant show a fairly low resolution. The form of data presentation (short segments of profiles on single pages) is also poor, and is not conducive to integrated interpretation. The profile interpretations do not discuss faulting or possible faulting, nor is there a discussion of why some of the seismic reflectors mapped in the interpreted profiles suddenly are truncated (Plate 13B, reference HLA 9053,012.01). Abrupt truncation of a series of reflectors is often indicative of faulting or mass wasting. No references to regional faults and the possibility of active sub-bottom faulting are made in the applicant's discussion of the submarine crossings.

Slope stability along the submarine crossings has not been adequately addressed by the applicant. Slumping along slopes of less than 10 degrees have been caused by earthquakes equal to or lesser than the design earthquake of 7.5 (see Table 1 in Appendix V-1). The potential sediment volume in large slumps can be great (Table 2, Appendix V-1), and potential damage is greater if slump-initiated turbidity currents are generated. The geophysical profiles submitted by the applicant show that along the Oak Bay crossing slopes exceed 30% on the west side and 20% on the east side. Samples from the Vibracore station in Oak Bay indicate silty mud of low strength. Slumping potential is very high, as is sediment liquefaction (discussed below). Slumping along the Admiralty Inlet crossing may occur also, with western slopes of 8-10% and of greater than 10% on the east side. Recent, loose sediments are perched on these flanks of the inlet and could very well prove to be unstable, given the design earthquake. The slumping potential along the Saratoga Passage Corridor is greater than in Admiralty Inlet. Slopes to the west exceed 35 to 40%, and eastern slopes exceed 30%. Thin sediment layers are perched on these slopes, and will not be stable under the design earthquake conditions.

Liquefaction potential for all crossings has been analyzed. The data used in this analysis include the Vibracore sample analyses and sample tests. The ground motion accelerations were that of Johnson and Rasmussen (1980). Relative densities of 60% were assumed for Vibracore T values of less than 10 sec/ft. Liquefaction is the temporary loss of cohesion of a soil, caused by oscillatory motion. This phenomenon occurs in the following manner. When a saturated, low-to-medium dense sand is subjected to ground shaking, the material tends to compact and decrease in volume. This change in volume will in turn cause an increase in pore pressure, since fluid drainage is slow relative to the rapid loading of the volume. If this volume decrease causes a pore pressure that is equal to or greater than the overburden pressure (i.e., the intergranular stress becomes zero), then the soil has no strength and will physically become a flowing mud. The potential for liquefaction is a function of the initial relative density of the soil, the degree of severity of shaking, and its duration. In general, the probability of liquefaction increases as the relative density decreases, the shaking increases in severity, and the number of cycles (duration) increases. Grain size distribution also plays an important role, with soils having a mean grain-size diameter of 0.1 mm (very fine sand) considered most susceptible to liquefaction.

The procedure used to evaluate liquefaction potential was that of Seed and Idriss (1970), which is generally accepted as the most reliable of liquefaction computations.

The potential for liquefaction for a given soil type can be defined as the ratio of the earthquake-induced stress in the soil, τ_e, to the stress $_c$ required to initiate liquefaction. A τ_e/τ_c ratio greater than one indicates potential liquefaction of the soil.

Calculation of the earthquake-induced stress can be made by the following relationship:

$$\tau_e = 0.65\ r_o \frac{a_{max}}{g} r_d$$

where r_o is the overburden pressure at the specified depth, a_{max} is the maximum ground surface acceleration, g is the acceleration due to gravity, and r_d is the soil deformation coefficient, determined experimentally.

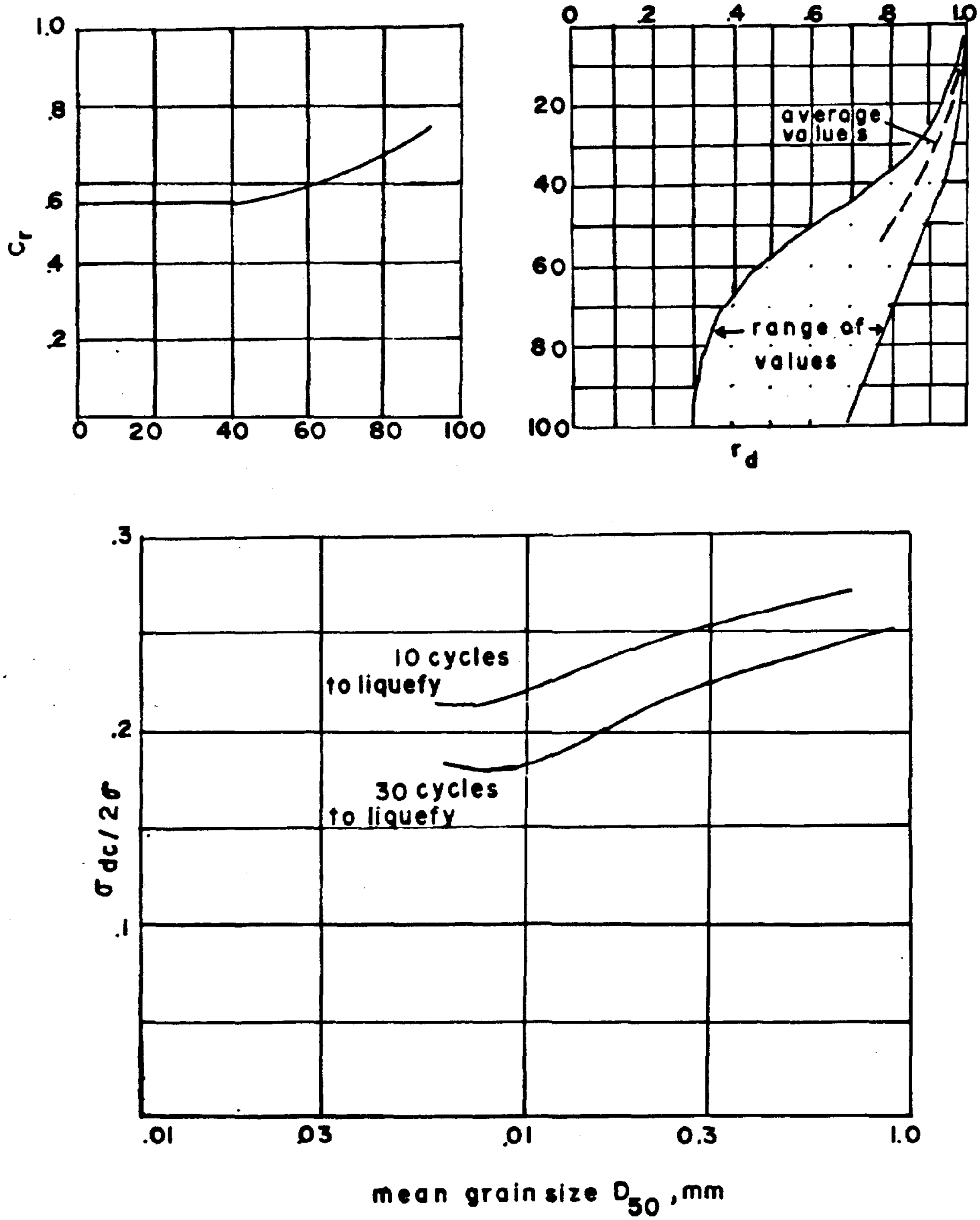
Calculation of the earthquake-induced stress can be made by the following relationship:

$$\tau_c = \sigma_{eo}\ C_r\ \left(\frac{\sigma_{dc}}{2\sigma_a}\right) \frac{D_r}{50}$$

where σ_{eo} is the effective overburden pressure at the specified depth, C_r is a correction factor for laboratory data, D_r is the relative density, and $\left(\frac{\sigma_{dc}}{2\sigma_a}\right)$ is a stress ratio determined from dynamic triaxial soil tests.

The relationship defining the variables in these two equations are evaluated by Seed and Idriss (1970) from numerous previous studies, and are presented in Figures V-la, b, and c.

figure V - 1 a,b,c.
liquefaction curves of Seed-Idress (1970)



The results of the analysis show that the potential for sediment liquefaction for Oak Bay and for portions of Saratoga Passage and Admiralty Inlet are very high when considering the maximum 7.5 M earthquake. Liquefaction potential under the 6.5 M probable event is significant, although the stiffer sandy silts will most likely not liquefy. The greatest potential for mass wasting is along the steep flanks of each of the crossings.

Conclusions

Mass wasting along the submarine corridor is a distinct probability, given the design 7.5 and 6.5 earthquakes. Slumping and sediment liquefaction will most likely occur along the steep slopes on the east and west sides of each of the crossings. Details of sub-bottom structure are not available.

Recommendations

More detailed seismic profiles are needed to adequately evaluate the sub-basement structure. Additional sediment sampling and sediment tests are needed to detail liquefaction problem. Contingency plans or alternate routes should be submitted in order to mitigate the slope slumping problem.

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APPENDIX II-1

EARTHQUAKE DATA USED IN SEISMIC STUDY

A	5612260811	60.00	48N0000	123W0000	00.00	
A	5709000810	48.00	48N4800	122W4200	00.00	
A	5904021030	00.00	47N0270	122W5340	00.00	4.3
A	6005070811	60.00	48N0000	123W0000	00.00	
A	6310090813	28.08	48N2502	123W2202	00.00	
A	6410290814	00.00	48N3000	123W3000	00.00	
A	6508260500	00.00	48N3000	123W3000	00.00	5.0
A	6806200809	12.00	48N0000	122W1800	00.00	
A	6902180811	01.20	48N0702	122W4530	00.00	
A	7001110813	28.08	48N2502	123W2202	00.00	
A	7003161003	00.00	48N2502	123W2202	00.00	
A	7101210340	00.00	47N0270	122W5340	00.00	
A	7106200809	19.20	47N3582	122W1980	00.00	
A	7202160335	00.00	48N2502	123W2202	00.00	
A	7310192200	00.00	47N3582	122W1980	00.00	3.7
A	7312170811	33.60	47N0270	122W5340	00.00	3.7
A	7803181430	00.00	47N1422	122W2598	00.00	3.0
A	8012080154	00.00	47N3000	122W3000	00.00	
A	8012101300	00.00	47N3900	122W3150	00.00	3.7
A	8012130440	00.00	47N3000	122W3000	00.00	5.7
A	8012150200	00.00	47N3900	122W3150	00.00	3.0
A	8012210716	00.00	47N3900	122W3150	00.00	3.7
A	8012300725	00.00	47N3900	122W3150	00.00	3.0
A	8101060656	00.00	47N3900	122W3150	00.00	
A	8101070020	00.00	47N3900	122W3150	00.00	
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A	8101310545	00.00	47N3900	122W3150	00.00	3.0
A	8103150630	00.00	47N3900	122W3150	00.00	3.0
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A	8409220600	00.00	47N1422	122W2598	00.00	3.0
A	8505040730	00.00	47N0270	122W5340	00.00	
A	8506271326	00.00	47N0270	122W5340	00.00	3.7
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A	8903162200	00.00	48N0000	122W3000	00.00	
A	8900000200	00.00	47N1152	122W1788	00.00	2.3
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A	9002020925	36.00	48N0900	122W3900	00.00	
A	9003080811	33.60	47N0270	122W5340	00.00	3.0
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A	9103080330	00.00	48N1800	122W4800	00.00	
A	9109000809	43.92	47N1416	122W2598	00.00	
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A	4205112000	00.00	48N5502	122W1902	00.00	
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A	4311290043	00.00	48N2400	122W5400	00.00	5.0
A	4403030000	00.00	47N1800	122W3600	00.00	3.0
A	4403310330	00.00	48N2802	122W1398	00.00	
A	4409180814	00.00	47N0600	122W4200	00.00	3.7
A	4409180852	37.00	47N0600	122W4200	00.00	3.7
A	4501280506	08.10	48N1452	122W2262	00.00	5.0
A	4506152225	02.00	48N0000	123W0000	00.00	4.3
A	4511120405	00.00	48N0000	122W3000	00.00	5.0
A	4602061011	00.00	48N3000	122W1410	00.00	3.7
A	4602150317	47.00	47N1800	122W5400	25.00	5.8
A	4602230854	53.00	47N0270	122W5340	00.00	5.0
A	4612271643	00.00	47N2400	122W3000	00.00	3.7
A	4701050809	19.20	47N3600	122W1980	00.00	3.0
A	4704020058	00.00	47N2400	122W5400	00.00	4.3
A	4709201030	00.00	47N1200	122W2400	00.00	4.3
A	4809242235	00.00	47N5130	122W3522	00.00	5.0
A	4904131955	43.00	47N1500	122W3000	00.00	7.0
A	4911291303	00.00	47N3600	122W3000	00.00	3.7
A	5004141103	48.00	48N0000	122W3000	00.00	5.0
A	5012030157	00.00	47N5682	122W1800	00.00	4.3
A	5107200745	00.00	48N0312	122W1050	00.00	3.0
A	5108181837	10.00	48N3720	122W5700	00.00	2.0
A	5108200953	56.00	48N0300	123W4200	00.00	2.0
A	5108221022	52.00	48N4200	123W4020	00.00	2.0
A	5109060428	37.00	48N4080	123W2280	00.00	3.0
A	5110071159	31.00	47N4020	123W3000	00.00	3.0
A	5110092259	27.70	48N1080	122W4620	00.00	3.7
A	5111290024	35.00	48N5520	122W2820	00.00	2.0

A	5112072020	19.00	48N3720	123W1620	00.00	2.0
A	5112120306	25.00	48N3600	123W4620	00.00	1.5
A	5201040214	10.00	48N3900	123W4380	00.00	2.0
A	5201251550	54.00	48N2820	122W5400	00.00	1.5
A	5201312243	12.00	48N5400	122W3600	00.00	2.0
A	5202062025	39.00	48N2580	123W3780	00.00	2.0
A	5202201907	07.00	48N4200	123W1200	00.00	3.7
A	5202210000	00.00	48N3102	122W1050	00.00	3.0
A	5202220939	31.20	48N3600	123W0600	00.00	4.3
A	5203141459	36.40	48N3600	123W0600	00.00	3.7
A	5203160550	21.00	48N3180	123W4080	00.00	2.0
A	5203202136	18.00	48N0480	123W3720	00.00	2.0
A	5203210441	43.00	48N4080	123W3180	00.00	3.0
A	5203220201	36.20	47N4200	122W2400	00.00	3.0
A	5204042051	06.00	48N4080	123W0780	00.00	3.0
A	5204162225	41.00	48N1920	123W1320	00.00	3.0
A	5204162331	15.00	48N1920	123W1320	00.00	2.3
A	5204162335	45.00	48N1920	123W1320	00.00	1.6
A	5204170027	45.00	47N5280	123W3480	00.00	2.3
A	5204191905	54.00	48N4080	123W0780	00.00	2.3
A	5205012012	37.00	48N2100	123W2820	00.00	3.0
A	5205191836	12.00	48N1620	123W3480	00.00	3.5
A	5206020859	34.00	48N4200	123W0780	00.00	2.0
A	5207191154	00.00	48N1800	123W1200	00.00	1.5
A	5207231042	00.00	48N4080	123W4500	00.00	1.5
A	5208021550	00.00	47N3000	122W2400	00.00	
A	5208061731	00.00	47N3000	122W2400	00.00	4.3
A	5208070348	33.00	48N3300	123W4080	00.00	2.0
A	5209220721	46.00	48N3300	122W5100	00.00	3.0
A	5210121706	24.00	47N1200	123W1800	00.00	
A	5210212110	33.00	48N4200	123W1680	00.00	3.0
A	5210281555	27.00	48N4200	123W1800	00.00	3.0
A	5211202131	00.00	48N5400	123W5580	00.00	3.0
A	5301200654	05.00	48N4200	123W0600	00.00	3.0
A	5301301843	47.00	48N1620	123W4320	00.00	2.0
A	5302021741	00.00	48N4200	123W1500	00.00	2.0
A	5302200516	00.00	48N3900	123W0420	00.00	2.0
A	5302211126	00.00	48N3420	123W4380	00.00	3.0
A	5302241939	05.00	47N3582	122W1980	00.00	3.7
A	5302250929	00.00	48N3780	123W0720	00.00	3.0
A	5302272044	00.00	48N4320	123W1920	00.00	2.0
A	5303100002	00.00	47N3000	123W3000	00.00	2.0
A	5303230703	08.00	48N5400	123W4380	00.00	2.0
A	5303251652	00.00	48N4080	123W1380	00.00	2.5
A	5304082244	10.00	48N1920	123W3000	00.00	2.0
A	5305270930	00.00	48N3000	122W1410	00.00	3.7
A	5306022207	58.00	48N4500	123W3900	00.00	2.0
A	5306040011	03.00	48N3480	123W3180	00.00	2.5
A	5306161753	20.00	48N4500	123W4620	00.00	2.5
A	5307110815	00.00	47N3582	122W1980	00.00	
A	5307170857	45.00	48N3720	123W5220	00.00	2.0
A	5308101122	25.00	48N4980	122W5520	00.00	3.0
A	5308201832	41.00	47N4800	123W4800	00.00	3.0
A	5401150636	26.00	48N1980	123W4020	00.00	2.0

A	5401241749	20.00	48N3780	123W1500	00.00	2.0
A	5402071040	39.00	48N4500	123W3180	00.00	3.0
A	5402202342	19.00	48N4080	123W3300	00.00	2.5
A	5403252116	35.00	48N1380	123W4020	00.00	3.0
A	5403300529	18.00	48N5520	123W1620	00.00	3.0
A	5404222300	00.00	47N3000	122W1800	00.00	
A	5404221928	00.00	48N1320	123W4080	00.00	2.0
A	5404250100	00.00	47N3000	122W1800	00.00	
A	5404262200	00.00	47N3000	122W1800	00.00	
A	5404270000	00.00	47N3000	122W1800	00.00	
A	5405050142	00.00	47N1800	122W2400	00.00	4.3
A	5405141906	00.00	48N2520	123W4200	00.00	2.0
A	5405151302	32.00	47N2400	122W3000	00.00	5.0
A	5406030758	00.00	48N0000	123W3000	00.00	3.0
A	5406181508	44.00	47N3600	122W3600	00.00	
A	5408011721	59.00	48N3900	123W1980	00.00	3.0
A	5408020723	53.00	48N2520	123W4800	00.00	3.0
A	5408051026	56.00	48N5280	122W5700	00.00	3.0
A	5409011242	00.00	48N1200	123W0000	00.00	3.0
A	5409040116	00.00	48N2580	123W4500	00.00	2.0
A	5409212332	00.00	48N0600	123W4200	00.00	2.0
A	5410131933	00.00	48N1680	123W3360	00.00	2.0
A	5410132149	00.00	48N1680	123W3360	00.00	2.0
A	5411010633	53.00	48N5400	123W5520	00.00	2.0
A	5411030535	00.00	48N2400	123W0000	00.00	3.0
A	5411080252	29.00	48N4020	123W1080	00.00	3.0
A	5411122331	00.00	48N1800	123W3300	00.00	3.0
A	5411201013	00.00	48N5100	123W1500	00.00	3.0
A	5412081839	00.00	48N3900	123W0720	00.00	2.0
A	5501071754	24.00	48N4080	123W1020	00.00	1.3
A	5501101219	05.00	48N2400	123W5400	00.00	1.5
A	5501111020	11.00	47N5820	123W4980	00.00	3.1
A	5501201016	07.00	48N4920	122W2520	00.00	2.0
A	5502070017	57.00	48N4800	122W1980	00.00	2.1
A	5502112145	25.00	48N4500	122W4380	00.00	2.2
A	5502241000	50.00	47N5220	123W1020	00.00	2.0
A	5503112242	51.00	48N1500	123W3600	00.00	1.7
A	5503260655	50.00	48N0300	122W0198	00.00	5.0
A	5504260013	12.00	48N5100	122W5880	00.00	3.0
A	5505032124	26.00	48N1200	123W1200	00.00	1.9
A	5505131949	34.00	48N1320	123W3720	00.00	2.1
A	5506061523	36.00	48N4980	123W3900	00.00	2.0
A	5506181515	30.00	48N3000	123W4200	00.00	1.0
A	5507050752	10.00	48N4320	123W3300	00.00	3.0
A	5507220651	19.00	48N0180	123W4800	00.00	2.0
A	5507231902	34.00	47N4200	123W1800	00.00	3.0
A	5507291335	12.00	48N1800	122W5400	00.00	3.0
A	5508102234	20.00	48N3720	123W5520	00.00	2.2
A	5508271953	36.00	48N2400	123W4800	00.00	1.0
A	5509150937	35.00	48N2400	123W3600	00.00	1.1
A	5510091421	30.00	48N4320	123W5520	00.00	2.5
A	5510202159	10.00	48N2400	123W1200	00.00	1.5
A	5511101241	24.00	48N5220	123W0000	00.00	1.7
A	5511212219	52.00	48N3000	122W2520	00.00	3.0

A	5511252106	49.00	48N1800	123W4800	00.00	2.4
A	5512150652	05.00	47N3600	123W4800	00.00	3.0
A	5512240126	14.00	47N5400	122W5400	00.00	2.3
A	5512301851	31.00	48N3600	122W3000	00.00	2.8
A	5512301945	24.00	48N3900	123W4380	00.00	1.5
A	5601070428	38.00	47N3420	122W2580	00.00	3.5
A	5601211014	25.00	48N1620	123W0900	00.00	2.4
A	5601251055	31.00	47N3000	123W4800	00.00	2.0
A	5601260116	16.00	48N1980	122W2580	00.00	5.0
A	5602090057	14.00	48N4200	123W1020	00.00	3.1
A	5602090101	19.00	48N3780	123W0300	00.00	2.1
A	5602090118	58.00	48N3780	123W0300	00.00	2.4
A	5602090128	35.10	48N1800	122W3600	00.00	
A	5602090130	30.00	48N3780	123W0300	00.00	1.8
A	5602090136	14.00	48N3780	123W0300	00.00	1.6
A	5602090138	57.00	48N0000	122W5400	00.00	1.9
A	5602141350	24.00	48N1380	122W4980	00.00	2.3
A	5602141355	00.00	48N0702	122W4530	00.00	3.7
A	5603081732	12.00	48N4320	123W0420	00.00	1.8
A	5604082228	13.00	48N3180	123W0420	00.00	3.3
A	5604260648	21.70	47N3600	122W1800	00.00	3.0
A	5604261648	23.00	48N3000	122W1200	00.00	2.2
A	5604300058	26.00	48N1500	123W3600	00.00	1.7
A	5606042233	22.00	48N3600	122W3000	00.00	2.0
A	5607150601	05.00	48N2520	122W4920	00.00	2.4
A	5607201339	34.00	47N5580	122W1500	00.00	2.5
A	5607222052	21.00	47N4500	122W2700	00.00	1.1
A	5608152321	10.00	48N2520	123W3180	00.00	1.6
A	5608160312	19.00	48N3000	123W3000	00.00	1.5
A	5608290442	55.00	48N3600	122W3600	00.00	1.9
A	5610030045	50.00	48N2220	122W3000	00.00	2.2
A	5610201327	55.00	48N2400	122W4800	00.00	2.2
A	5610312224	12.00	48N1620	123W3780	00.00	1.9
A	5611031857	23.00	48N1620	123W3720	00.00	2.0
A	5611031901	40.00	48N1800	123W4200	00.00	2.0
A	5611100908	31.00	48N3000	123W0000	00.00	2.0
A	5611152323	36.00	48N3000	123W5400	00.00	2.1
A	5611180357	00.70	47N5400	122W0600	00.00	
A	5611182357	02.00	47N4800	122W1200	00.00	2.2
A	5611220023	44.00	48N5400	122W5400	00.00	2.8
A	5611252359	49.00	47N2400	122W3000	00.00	2.5
A	5612072343	03.00	48N1980	123W5580	00.00	2.6
A	5701081346	12.00	47N4200	123W1800	00.00	2.6
A	5701100159	34.00	48N4080	122W5220	00.00	1.0
A	5701210822	28.00	47N2400	122W5400	00.00	2.4
A	5701260116	06.00	48N1980	122W2580	00.00	3.5
A	5702051922	59.00	48N3720	123W1800	00.00	2.3
A	5703020933	03.00	48N2400	123W3600	00.00	1.0
A	5703132308	08.00	48N1200	123W3000	00.00	2.5
A	5703141115	54.00	48N5100	122W2820	00.00	3.1
A	5703250807	34.00	48N1800	123W4200	00.00	1.2
A	5703280445	24.00	48N1800	123W4320	00.00	2.3
A	5704022146	29.00	48N4200	122W1200	00.00	2.0
A	5704221212	21.00	47N5400	122W1800	00.00	1.7

A	5704242256	10.00	48N5820	122W1020	00.00	2.7
A	5704252006	08.00	48N1320	123W4020	00.00	2.4
A	5705042109	25.00	47N2100	122W2298	00.00	4.3
A	5705061835	30.00	48N4080	123W2700	00.00	2.2
A	5705120732	36.00	47N5580	122W3120	00.00	2.5
A	5705161654	08.00	48N4800	122W4200	00.00	2.4
A	5705290935	03.00	47N4620	123W1800	00.00	2.9
A	5705300050	40.00	48N3600	122W3600	00.00	1.6
A	5707271343	06.00	48N5280	122W2100	00.00	1.9
A	5708151313	16.00	48N3000	122W3000	00.00	1.2
A	5708201123	59.00	48N1680	123W1620	00.00	2.7
A	5708210346	15.00	48N4200	123W5580	00.00	2.0
A	5708220407	45.00	48N4800	122W1200	00.00	1.9
A	5708300153	26.00	48N4800	122W3600	00.00	1.7
A	5709052159	38.00	48N2400	123W2580	00.00	1.5
A	5709122303	26.00	48N4380	123W2220	00.00	2.9
A	5709122307	59.00	48N4200	123W2400	00.00	1.5
A	5709122309	32.00	48N4080	123W0780	00.00	2.0
A	5709130147	44.00	48N4200	123W0780	00.00	1.8
A	5709131429	19.00	48N4320	123W0120	00.00	2.2
A	5709140320	53.00	48N4200	123W5700	00.00	3.4
A	5709190620	53.00	48N4200	123W1800	00.00	1.8
A	5709210237	07.00	47N5400	122W4800	00.00	1.9
A	5709212322	42.00	48N3780	123W0420	00.00	1.8
A	5710202204	16.00	48N2460	123W0720	00.00	1.9
A	5711012123	16.00	48N1320	123W3780	00.00	2.4
A	5711040459	36.00	47N2400	123W3000	00.00	2.4
A	5711050652	03.00	48N3000	122W2400	00.00	1.9
A	5711132011	40.00	48N2460	123W2400	00.00	1.4
A	5711140354	34.00	48N5580	123W2220	00.00	1.6
A	5711151806	53.00	48N1800	123W4800	00.00	2.4
A	5711250917	50.00	47N2400	123W3000	00.00	2.5
A	5712221954	45.00	48N0600	122W0600	00.00	2.5
A	5801212059	05.00	48N1920	123W4380	00.00	2.7
A	5802042301	02.00	48N3000	123W4800	00.00	1.2
A	5802101051	25.00	48N4200	122W4920	00.00	2.2
A	5803021438	06.00	48N4320	123W2100	00.00	1.4
A	5803071806	29.00	48N4800	123W2400	00.00	1.5
A	5803092316	32.00	47N2400	122W3000	00.00	2.1
A	5803312213	40.00	48N1920	123W4380	00.00	2.5
A	5804280209	58.00	48N2400	122W3600	00.00	2.0
A	5804292005	22.00	48N2400	123W3600	00.00	2.8
A	5804292014	55.00	48N2520	123W4380	00.00	2.5
A	5805071103	28.00	48N3780	122W3180	00.00	3.3
A	5805222214	38.00	48N4320	122W0120	00.00	3.0
A	5805302123	20.00	48N0600	123W4200	00.00	2.7
A	5806022120	33.00	48N4380	123W3780	00.00	1.7
A	5806281018	15.00	48N0600	123W0000	00.00	2.3
A	5807031111	25.00	48N4680	122W0900	00.00	2.1
A	5807032110	45.00	48N1320	122W3420	00.00	2.4
A	5807040556	51.00	48N0600	122W0480	00.00	2.8
A	5807091732	46.00	48N4200	123W1680	00.00	2.4
A	5807100423	20.00	48N4800	122W2400	00.00	3.0
A	5807101451	34.00	48N1380	122W3300	00.00	2.4

A	5807102006	10.00	48N5220	122W1200	00.00	2.8
A	5807130141	52.00	47N4800	122W1800	00.00	3.1
A	5807210551	35.00	48N4800	122W1800	00.00	2.3
A	5807292114	17.00	48N4320	123W1320	00.00	2.0
A	5807310722	11.00	48N3600	123W0600	00.00	2.5
A	5808081804	05.00	48N1680	123W4500	00.00	2.7
A	5808142121	42.00	48N3300	123W1920	00.00	1.9
A	5808230526	48.00	48N4380	123W0120	00.00	2.4
A	5808311733	56.00	48N2400	123W3600	00.00	1.6
A	5809110035	51.00	48N5400	122W0900	00.00	2.5
A	5809190218	36.00	47N5400	122W4200	00.00	3.1
A	5810122231	02.00	48N4080	122W4080	00.00	2.2
A	5811022214	40.00	48N3480	123W4200	00.00	1.9
A	5811090747	37.00	47N3600	122W2400	00.00	2.1
A	5811282232	48.00	48N3780	123W0720	00.00	1.9
A	5812280802	53.00	48N4320	123W0720	00.00	2.2
A	5812281550	13.00	48N4080	123W1380	00.00	2.2
A	5812281958	12.00	48N4200	123W1500	00.00	2.4
A	5812310754	49.00	48N4800	122W1800	00.00	2.1
A	5902010751	14.00	48N5220	123W3180	00.00	2.3
A	5902042251	58.00	48N3000	123W4800	00.00	2.6
A	5903141958	25.00	48N5580	122W1080	00.00	2.4
A	5903160013	04.00	48N2820	122W3720	00.00	2.2
A	5903212038	55.00	48N3600	122W4200	00.00	3.2
A	5903270703	13.00	48N0420	123W4980	00.00	2.9
A	5904040204	58.00	48N4020	123W4200	00.00	2.2
A	5904041334	11.00	48N4980	122W1200	00.00	2.0
A	5904042025	38.00	48N4200	123W3600	00.00	2.2
A	5904200027	22.00	48N4800	123W1020	00.00	2.1
A	5904200155	33.00	48N4620	123W2100	00.00	2.0
A	5904220714	44.00	48N4500	123W1500	00.00	2.3
A	5905022009	17.00	48N5700	122W1080	00.00	2.2
A	5905022035	48.00	48N4320	123W2280	00.00	2.4
A	5905090024	51.00	47N3000	122W4200	00.00	2.4
A	5905100204	16.00	48N4620	123W2220	00.00	2.7
A	5905112053	46.00	48N3600	123W0180	00.00	1.3
A	5906162148	38.00	48N3420	123W4800	00.00	1.4
A	5907040527	22.00	47N5400	123W0480	00.00	3.0
A	5907081727	38.00	47N5400	123W3600	00.00	2.2
A	5907212124	50.00	48N4200	123W4200	00.00	1.6
A	5907220405	52.00	48N1800	122W4200	00.00	2.5
A	5907220407	10.00	48N1200	122W4200	00.00	2.4
A	5907300719	19.00	48N2400	122W3180	00.00	2.4
A	5908202307	19.00	48N3000	123W3900	00.00	1.8
A	5908222342	54.00	48N3300	122W4980	00.00	2.3
A	5908232311	15.00	48N2400	122W3000	00.00	3.1
A	5908251712	22.00	48N2820	122W2820	00.00	2.9
A	5909020235	44.00	47N5400	123W0000	00.00	2.5
A	5909042057	35.00	48N4620	123W1800	00.00	3.4
A	5909170548	47.00	48N2400	122W4200	00.00	2.8
A	5910010507	39.00	48N0600	122W0600	00.00	1.7
A	5910042140	50.00	47N4200	123W0000	00.00	3.3
A	5910160003	24.00	48N2400	123W4800	00.00	1.5
A	5910220337	28.00	48N0000	122W0600	00.00	2.7

A	5910311943	57.00	48N1800	123W0000	00.00	2.0
A	5911110202	41.00	48N3600	122W3000	00.00	2.9
A	5911110238	39.00	48N2400	122W3000	00.00	2.1
A	5911182348	32.00	48N2400	122W3600	00.00	3.4
A	5911190438	08.00	48N3012	122W3660	00.00	
A	5911210109	59.00	48N2400	122W3900	00.00	2.3
A	5912092054	42.00	48N3600	123W0600	00.00	1.0
A	5912120621	53.00	48N3900	123W0600	00.00	1.4
A	5912120624	17.00	48N4398	123W1500	00.00	4.3
A	5912120625	33.00	48N4200	123W0600	00.00	3.1
A	5912120638	57.00	48N4200	123W0600	00.00	0.5
A	5912120651	30.00	48N4200	123W0600	00.00	3.3
A	5912120738	23.00	48N4200	123W0600	00.00	0.7
A	5912121029	57.00	48N3600	123W1800	00.00	2.4
A	5912132132	43.00	48N3600	123W0600	00.00	2.1
A	5912142339	58.00	48N4200	123W0600	00.00	1.1
A	6001021834	09.00	48N4500	123W1620	00.00	2.2
A	6002101648	15.00	48N5100	123W0000	00.00	1.9
A	6002131133	49.00	48N1980	123W4080	00.00	1.2
A	6002190005	56.00	48N4200	123W4200	00.00	2.1
A	6002260548	47.00	48N4800	123W3600	00.00	1.5
A	6003171808	10.00	47N3600	122W0600	00.00	2.1
A	6003221031	52.00	48N4380	123W1500	00.00	1.9
A	6003270139	21.00	48N5400	123W1800	00.00	2.5
A	6003280725	45.00	48N4380	123W1200	00.00	1.2
A	6004091433	05.00	48N3600	122W4200	00.00	1.2
A	6004092059	36.00	48N2400	122W3600	00.00	1.0
A	6004110647	34.00	47N3420	122W1500	00.00	3.3
A	6004161309	36.00	48N2400	122W3000	00.00	1.0
A	6004202223	53.00	48N3000	123W4800	00.00	1.7
A	6004290206	19.00	48N3000	123W4800	00.00	2.1
A	6005260732	20.00	48N4200	123W1200	00.00	2.1
A	6006080509	56.00	48N4800	123W0600	00.00	2.3
A	6006260633	18.00	48N5400	122W2400	00.00	1.0
A	6007031102	31.00	48N4200	123W1200	00.00	
A	6008242010	29.00	47N4200	122W1800	00.00	2.0
A	6009101506	34.00	47N3000	122W4200	00.00	4.9
A	6010050259	47.00	48N3600	123W5220	00.00	2.4
A	6010120517	14.00	48N0000	123W3600	00.00	2.3
A	6011010634	02.00	48N4200	123W1200	00.00	1.7
A	6011022225	29.00	48N2820	123W5220	00.00	2.0
A	6012241747	58.00	48N3120	123W5820	00.00	1.6
A	6012241850	16.00	48N4680	123W3180	00.00	2.1
A	6101280000	00.00	48N0420	122W2400	00.00	
A	6103110706	10.00	48N4800	122W2400	00.00	2.2
A	6103142322	45.00	48N4800	122W2400	00.00	1.9
A	6104010101	19.00	48N2400	122W1200	00.00	2.9
A	6104010102	57.00	48N4200	122W1800	00.00	2.5
A	6104010107	35.00	48N2400	122W0600	00.00	2.2
A	6104011610	20.00	48N5400	122W1200	00.00	2.3
A	6106041640	45.00	47N4800	123W4800	00.00	2.9
A	6106152158	27.00	48N1200	122W4200	00.00	2.2
A	6107010859	59.00	47N5400	123W4200	00.00	2.2
A	6107010924	36.00	47N4800	123W4800	00.00	2.3

A	6107090744	49.00	48N3180	122W2520	00.00	2.7
A	6108210326	02.00	48N4500	122W4380	00.00	2.3
A	6109042000	00.00	47N3180	122W5700	00.00	2.7
A	6109071811	17.00	48N0900	122W5580	00.00	2.0
A	6109090000	00.00	47N5352	122W0060	00.00	
A	6110150453	13.00	47N1200	123W1380	00.00	2.9
A	6110181345	59.00	48N5400	122W1800	00.00	2.2
A	6110192037	49.00	47N3000	122W5400	00.00	3.0
A	6111150647	09.00	47N5400	123W1200	00.00	2.2
A	6111280307	56.00	47N0600	122W3000	00.00	2.5
A	6111300812	50.00	47N1200	122W0600	00.00	3.1
A	6112182208	36.00	48N4980	122W4800	00.00	2.7
A	6112250000	00.00	47N0240	122W1440	00.00	
A	6112251227	44.00	48N0000	122W2400	00.00	2.2
A	6202200728	23.00	48N4200	123W0000	00.00	2.0
A	6203180409	42.00	48N1200	123W0000	00.00	2.1
A	6205150955	24.00	48N5580	122W0780	00.00	1.8
A	6205200441	03.00	48N4080	122W4800	00.00	2.3
A	6205300336	23.00	47N3000	122W3000	00.00	2.2
A	6207050316	02.00	47N1800	123W0000	00.00	1.9
A	6207161400	00.00	47N0270	122W5340	00.00	3.7
A	6210052151	44.00	48N1200	122W0900	00.00	2.6
A	6211200420	48.00	48N4800	123W0600	00.00	1.9
A	6211282239	46.00	48N4380	123W2220	00.00	1.3
A	6301160643	13.00	48N1620	122W4800	00.00	2.3
A	6301220413	46.00	48N5280	122W1320	00.00	2.2
A	6301242143	00.00	47N2400	122W0600	00.00	5.0
A	6303300257	45.00	48N5220	122W2280	00.00	2.3
A	6305090508	20.00	48N5520	123W0300	00.00	2.0
A	6305161901	25.00	48N4080	123W0900	00.00	1.9
A	6306101619	52.00	48N0000	122W4800	00.00	2.8
A	6306120515	07.00	48N4020	123W1560	00.00	2.5
A	6308180024	26.00	47N3000	122W3600	00.00	3.2
A	6308260920	43.00	48N0000	123W0000	00.00	3.1
A	6309081553	32.00	48N3000	123W0000	00.00	2.5
A	6309130342	19.00	48N4200	123W1200	00.00	1.5
A	6404171018	00.00	47N4800	123W2400	00.00	2.8
A	6407141550	03.30	48N5400	122W3000	33.00	5.0
A	6407301532	21.00	48N4200	122W4800	00.00	3.0
A	6407302047	24.00	48N4200	122W4800	00.00	2.8
A	6410140633	00.00	47N4200	122W0600	00.00	4.3
A	6410151432	37.50	47N4200	122W0600	33.00	4.1
A	6410171234	17.90	47N3600	122W0600	00.00	3.4
A	6501180045	54.00	48N4200	122W0600	00.00	2.0
A	6502182359	13.00	48N5400	122W1200	00.00	1.9
A	6504291528	43.30	47N2400	122W2400	57.00	6.5
A	6508060402	11.00	48N3600	123W0000	00.00	2.8
A	6510231627	59.80	47N3000	122W2400	23.00	4.8
A	6512161719	11.00	48N4800	122W4200	00.00	2.6
A	6603131736	11.00	48N2400	122W3000	00.00	3.0
A	6604300702	19.00	48N1200	122W4200	00.00	2.8
A	6606060000	00.00	47N1380	122W5220	00.00	
A	6606111734	30.30	47N4998	122W3300	33.00	3.7
A	6606241745	00.00	47N1422	122W2598	00.00	3.0

A	6610090746	37.00	48N0000	123W0600	00.00	2.6
A	6610290157	59.00	48N4800	122W4200	00.00	3.2
A	6611011022	53.60	47N3600	122W1800	00.00	3.0
A	6611011122	54.00	47N3600	122W1800	00.00	3.0
A	6611222244	48.00	48N1200	122W1800	00.00	2.5
A	6701180658	20.40	47N1800	122W3426	22.00	3.6
A	6703070351	08.40	47N5058	122W3930	35.00	4.2
A	6703120116	30.00	47N4200	122W4200	00.00	3.2
A	6705080123	50.00	47N1800	122W3600	00.00	2.3
A	6705252322	34.00	48N0912	122W4818	33.00	4.3
A	6706201147	44.00	48N5400	123W1200	00.00	3.6
A	6707121726	42.00	48N0000	122W4800	00.00	2.2
A	6710262059	36.00	47N3000	123W4200	00.00	2.4
A	6711290318	54.00	48N5400	123W0000	00.00	2.3
A	6712182140	46.00	48N2400	122W1800	00.00	2.6
A	6801200921	47.00	47N3000	122W4200	18.00F	2.5
A	6803061315	12.00	47N2700	122W3120	18.00F	2.3
A	6804130310	03.00	48N3600	123W1500	18.00F	2.1
A	6805121727	33.00	48N3600	122W3000	18.00F	2.5
A	6806152352	25.00	48N3600	122W4800	18.00F	2.0
A	6806190551	43.00	47N1200	122W3000	00.00	4.0
A	6806251301	14.00	47N5400	123W1200	18.00F	2.3
A	6807191928	14.00	48N5400	122W1800	18.00F	2.6
A	6808231520	02.00	48N3420	122W3780	18.00F	1.7
A	6809060846	37.00	48N4020	122W1320	18.00F	2.5
A	6809061216	30.00	47N5700	122W4800	18.00F	3.9
A	6809252009	34.20	47N4800	122W4200	00.00	2.5
A	6810070750	55.00	48N1200	122W2400	18.00F	2.5
A	6811041119	38.00	47N3000	122W3000	18.00F	2.4
A	6811120401	31.00	47N3000	122W2400	18.00F	1.9
A	6811281030	29.00	47N1800	122W4680	18.00F	2.7
A	6812071605	56.00	48N1200	122W4200	18.00F	2.4
A	6902140833	37.50	48N4308	123W0510	00.00	4.5
A	6906121645	20.00	48N5400	122W1800	18.00F	2.2
A	6906121654	13.00	48N5400	122W1800	18.00F	2.3
A	6908131604	44.00	48N3600	122W4800	18.00F	2.7
A	6908131853	54.00	48N4200	122W5400	18.00F	2.9
A	6908191542	53.00	48N4800	122W3600	18.00F	2.8
A	6908222041	12.00	47N5400	123W3000	18.00F	2.3
A	6911280951	27.00	47N3000	122W3000	18.00F	3.0
A	6911280951	32.90	47N2400	122W4200	00.00	3.5
A	7001031457	34.00	47N1800	122W4800	18.00F	2.5
A	7002102021	11.80	47N4200	122W1800	33.00	3.9
A	7003071045	30.00	48N4800	123W1800	18.00F	2.9
A	7004051500	24.00	47N3000	123W3000	18.00F	3.2
A	7005180529	54.00	48N3600	122W4200	11.00	4.0
A	7007050056	15.50	47N3420	123W0888	40.00	2.0
A	7007080000	12.00	47N0708	122W0090	03.00	2.7
A	7007090100	32.90	47N3378	122W0312	13.00	1.3
A	7007142337	24.00	47N2490	122W4608	30.00	1.4
A	7007181006	11.00	47N3786	122W0864	29.00	2.1
A	7007191152	12.00	48N1074	122W2538	14.00	1.9
A	7007220132	48.30	47N4392	123W2364	59.00	1.3
A	7007230134	06.50	47N3090	122W5364	26.00	1.2

A	7007290407	27.00	47N4716	122W5106	34.00	2.2
A	7008021850	13.40	47N5046	122W3570	23.00	2.4
A	7008050952	23.50	47N4932	122W3852	26.00	1.3
A	7008070643	30.10	48N1086	122W3540	22.00	2.1
A	7008080553	10.90	47N2826	122W2352	22.00	1.4
A	7008082236	39.70	47N2190	123W0594	36.00	3.0
A	7008110737	27.50	48N0948	122W2562	15.00	1.8
A	7008142359	54.80	47N4044	122W1002	31.00	2.1
A	7008231212	47.60	47N3876	122W0258	25.00	2.0
A	7008240444	37.80	47N0276	122W0126	09.00	2.7
A	7008292357	19.00	48N0000	122W3000	18.00F	2.4
A	7008301549	44.30	47N2856	122W4362	25.00	1.8
A	7009020741	46.70	48N0582	122W3450	62.00	1.9
A	7009240528	00.10	47N2826	122W5052	25.00	2.1
A	7009250002	25.10	47N0330	122W0462	02.00	2.3
A	7009250029	13.70	47N0486	122W0522	00.00	1.7
A	7009250819	02.40	47N0348	122W0450	03.00	1.9
A	7009270952	57.60	47N4464	122W5070	20.00	1.5
A	7009272320	30.80	47N4950	122W2556	26.00	2.8
A	7009300835	53.70	47N3972	123W0570	44.00	1.5
A	7010011823	21.10	47N2400	122W2394	25.00	1.7
A	7010012355	51.30	47N4452	122W1938	28.00	2.1
A	7010031930	53.60	47N0300	122W0132	09.00	2.3
A	7010071241	42.00	47N3126	122W5748	08.00	1.6
A	7010110027	46.10	47N3168	122W1752	25.00	1.7
A	7010130432	23.70	47N3174	122W1908	24.00	1.7
A	7010162135	10.40	47N4224	122W2172	25.00	2.0
A	7010181309	12.80	47N3516	122W4818	18.00	2.8
A	7010242232	07.90	47N2004	122W2238	16.00	4.1
A	7010270451	50.30	47N3894	122W1086	04.00	2.0
A	7010311048	41.70	47N1950	122W2262	08.00	2.0
A	7011010628	03.20	47N2010	122W2298	13.00	2.1
A	7011070037	50.80	47N2400	122W2406	24.00	2.1
A	7011091333	39.00	47N3000	123W3000	18.00F	2.4
A	7011111246	39.20	47N2964	122W4980	16.00	2.0
A	7011201850	22.40	47N3534	122W5400	22.00	2.3
A	7011211237	40.20	47N3462	122W0798	19.00	1.9
A	7011252111	39.40	47N0762	123W0132	37.00	3.0
A	7011280326	02.40	47N3978	122W0462	22.00	1.9
A	7011290748	32.90	47N3504	122W3522	29.00	2.1
A	7012051421	39.20	47N3048	122W4452	25.00	2.5
A	7012081928	59.60	47N3168	122W3582	29.00	2.1
A	7012190148	44.90	47N2214	122W4020	25.00	2.7
A	7012250816	34.00	48N0360	122W4596	16.00	2.1
A	7012261144	56.10	47N3222	122W4608	21.00	2.2
A	7012270224	27.00	47N3174	122W3930	29.00	1.5
A	7101070840	04.00	47N2196	122W3996	25.00	1.5
A	7101120121	39.60	47N5154	122W2604	23.00	2.3
A	7101121504	25.30	47N3186	122W5010	24.00	1.7
A	7101140326	19.80	48N0090	122W4974	21.00	3.0
A	7101140829	37.40	47N1770	123W2124	39.00	3.8
A	7101252137	52.90	48N2280	123W1488	49.00	3.5
A	7101280120	18.30	47N4992	123W2418	39.00	2.8
A	7102030215	37.30	47N0822	122W5310	63.00	1.6

A	7102051518	23.80	47N3750	122W1164	26.00	2.0
A	7102072358	58.40	47N2418	122W5406	43.00	3.0
A	7102211356	35.20	47N4770	122W0216	15.00	2.2
A	7103060710	07.50	47N1950	122W4152	27.00	2.4
A	7103150628	29.60	47N3822	122W4068	13.00	2.3
A	7103161704	56.80	47N5766	122W4836	09.00	1.8
A	7103161809	12.70	47N1998	122W2286	14.00	2.1
A	7103302233	39.20	47N2466	122W3798	42.00	2.7
A	7104030234	31.80	47N3678	122W5538	18.00	3.2
A	7104041026	04.50	48N0402	123W2424	33.00	1.8
A	7104072103	54.60	47N4482	122W0936	25.00	2.1
A	7104111811	48.00	47N3522	122W4368	27.00	1.7
A	7104120616	26.40	47N2826	122W2100	27.00	2.0
A	7104240149	45.80	47N3276	122W4710	17.00	1.6
A	7104240753	23.50	47N4410	122W2316	25.00	1.9
A	7105060515	19.70	47N4392	122W0540	20.00	2.0
A	7105141737	40.90	47N2946	122W1518	25.00	2.2
A	7105171941	17.00	48N5400	123W1200	18.00F	2.6
A	7106040021	45.30	47N3198	122W5148	17.00	1.0
A	7106050602	05.20	47N1704	122W1638	17.00	2.3
A	7106051316	40.30	47N3228	122W5352	23.00	1.9
A	7106140011	15.50	48N0882	122W4434	19.00	2.4
A	7106230012	04.70	47N2478	122W5544	22.00	1.8
A	7106230921	49.20	47N3588	122W1038	22.00	1.5
A	7106231032	50.10	47N3528	122W1128	22.00	2.3
A	7106231121	13.40	47N3600	122W1026	23.00	1.4
A	7106231341	16.80	47N3450	122W1254	22.00	2.2
A	7106240226	52.80	47N3480	122W1158	23.00	3.3
A	7106241806	51.30	47N3618	122W0960	22.00	1.6
A	7106251345	40.00	47N3438	122W1224	22.00	3.0
A	7106251430	38.00	47N3492	122W1188	22.00	2.0
A	7106251722	24.20	47N3510	122W1128	23.00	2.3
A	7106252248	53.90	47N3456	122W1338	22.00	1.6
A	7106262202	14.40	47N3468	122W1164	23.00	3.3
A	7106262203	41.20	47N3408	122W0858	25.00	
A	7106290740	52.90	47N5172	122W4212	18.00	0.9
A	7107031407	18.40	47N3558	122W1080	22.00	1.9
A	7107041954	48.90	47N3552	122W1068	22.00	1.6
A	7107121237	55.70	47N3516	122W1122	23.00	2.0
A	7107181841	22.80	47N3054	121W5994	20.00	2.3
A	7107191816	59.90	47N5082	122W3738	24.00	2.5
A	7107241405	59.30	47N4488	122W5298	19.00	1.7
A	7107241707	22.40	47N4968	122W3084	26.00	2.3
A	7108020556	31.00	47N2094	122W3468	18.00	1.6
A	7108062001	58.80	47N3468	122W4530	25.00	1.8
A	7108102026	47.80	47N3438	122W1260	22.00	3.1
A	7108111341	03.50	47N3480	122W1182	23.00	2.3
A	7108130339	42.40	47N5142	122W3354	21.00	2.2
A	7108150558	20.00	47N3588	122W1050	21.00	1.8
A	7108180114	45.10	47N2292	122W1890	16.00	2.0
A	7108231215	24.30	47N3510	122W4326	49.00	1.2
A	7108241046	16.60	47N2682	123W0600	37.00	2.6
A	7108261335	07.30	48N0372	122W5628	33.00	1.9
A	7108270124	47.00	47N2880	123W0564	42.00	2.6

A	7108300827	32.20	47N2430	122W3690	16.00	2.6
A	7109050332	00.30	48N2076	123W0924	56.00	2.6
A	7109061831	10.10	48N2430	122W4548	39.00	2.2
A	7109092032	58.60	47N3414	122W1266	23.00	3.5
A	7109100428	15.70	47N3420	122W1338	22.00	2.0
A	7109100654	03.90	47N3498	122W1212	23.00	2.3
A	7109121219	06.60	47N1662	122W1248	09.00	2.4
A	7109200121	17.70	47N4440	123W0102	03.00	1.5
A	7109200435	07.40	47N3816	122W1896	22.00	1.9
A	7109230757	07.30	47N2724	122W2022	22.00	1.2
A	7109240916	43.00	48N2886	123W0282	10.00	3.0
A	7110030516	26.40	47N3528	122W1164	22.00	1.7
A	7110031733	14.70	47N3474	122W1254	22.00	2.3
A	7110032003	30.10	47N3534	122W1266	21.00	1.8
A	7110041845	19.50	48N1566	122W5406	22.00	3.2
A	7110110408	38.10	47N1992	122W2118	19.00	2.1
A	7110121254	20.20	48N0192	122W4242	01.00	2.1
A	7110170949	24.90	47N4368	122W3510	22.00	2.4
A	7110211001	59.30	47N4302	122W3612	26.00	2.8
A	7110211201	51.20	47N1236	122W1056	20.00	1.7
A	7110221705	32.20	47N2436	122W4386	26.00	2.1
A	7110230943	31.20	47N3540	122W1188	22.00	1.8
A	7110271415	41.30	47N3492	122W1164	23.00	2.3
A	7110290928	24.50	47N4626	122W4254	51.00	3.0
A	7110310053	34.20	48N1188	122W4272	19.00	2.4
A	7111060525	28.90	47N1236	122W1206	10.00	1.3
A	7111160018	55.80	47N5568	122W1854	61.00	2.8
A	7111161324	49.70	47N1698	122W1632	33.00	1.4
A	7111161509	22.30	47N3468	122W1950	06.00	1.1
A	7111161806	08.40	47N3222	122W3636	19.00	1.1
A	7111202056	45.70	47N3594	122W1110	21.00	1.6
A	7111202139	44.80	47N4368	122W2688	80.00	1.5
A	7111220608	24.10	47N5196	122W4146	21.00	1.7
A	7111280601	17.10	47N1224	122W1092	13.00	1.9
A	7111281735	45.50	47N2208	122W1932	09.00	1.9
A	7111281852	41.10	47N5010	123W5778	43.00	3.4
A	7112042126	47.80	47N3102	122W2076	27.00	1.7
A	7112060451	29.50	47N2118	122W1920	08.00	2.0
A	7112070330	00.20	47N2886	122W1806	25.00	1.4
A	7112070530	01.70	47N4188	122W1080	19.00	1.9
A	7112082014	33.50	47N3504	122W4914	24.00	2.2
A	7112121947	00.60	47N4878	122W3060	28.00	2.0
A	7112132059	03.60	47N0306	123W2676	28.00	3.6
A	7112142105	03.60	47N3402	122W1380	22.00	2.6
A	7112212006	49.30	47N2706	122W5964	06.00	1.8
A	7112212243	37.20	48N0012	122W2802	27.00	2.6
A	7112222046	53.80	47N3126	122W5202	20.00	3.4
A	7112251433	17.80	47N4254	122W0984	30.00	1.8
A	7112270218	40.20	47N3354	122W1416	23.00	2.1
A	7112271255	45.80	47N3552	122W4824	27.00	2.2
A	7112271323	44.70	47N3606	122W4764	25.00	1.7
A	7112280750	00.30	47N3432	122W1284	23.00	4.4
A	7112280754	33.10	47N3456	122W1278	20.00	2.2
A	7112280755	37.20	47N3378	122W1386	23.00	

A	7112280755	47.30	47N3318	122W1344	23.00	1.5
A	7112280757	54.50	47N3384	122W1296	22.00	2.2
A	7112280930	34.20	47N3354	122W1410	23.00	1.8
A	7112281219	09.50	47N3372	122W1296	22.00	1.8
A	7112301432	17.70	47N3624	122W4380	16.00	3.2
A	7112310145	15.10	47N0858	122W3822	25.00	2.9
A	7112311408	14.70	47N3078	122W5112	25.00	1.2
A	7201010949	49.20	47N3450	122W1242	22.00	2.6
A	7201020501	32.10	47N3528	122W2784	21.00	2.1
A	7201040852	07.30	47N1224	123W0516	07.00	2.3
A	7201050143	19.90	47N3462	122W4116	56.00	1.2
A	7201052247	21.50	47N4296	122W3558	17.00	1.9
A	7201101001	27.50	47N3480	122W1278	21.00	2.6
A	7201132206	16.60	47N1908	122W3624	45.00	3.6
A	7201140920	24.80	47N2196	122W2352	18.00	2.2
A	7201142017	22.00	47N2964	122W5580	24.00	2.8
A	7201150735	06.10	47N3612	122W3924	24.00	1.9
A	7201151215	45.40	47N4902	122W1500	24.00	2.3
A	7201161704	51.10	47N2208	122W2382	16.00	2.9
A	7201181002	41.30	47N2214	122W2382	19.00	1.5
A	7201191810	29.60	47N3054	122W2358	25.00	1.9
A	7201210050	06.40	47N3528	122W1206	22.00	2.8
A	7201251725	54.60	47N3804	123W4938	54.00	2.6
A	7201271051	53.80	47N3840	122W1500	11.00	2.2
A	7201281446	29.60	47N3684	122W1122	20.00	1.4
A	7202031450	36.40	47N2772	122W2058	26.00	2.0
A	7202042016	17.00	47N1986	122W1950	21.00	1.4
A	7202221235	04.90	47N1956	122W4554	07.00	3.4
A	7202252106	31.50	47N3660	122W5574	18.00	2.4
A	7202260255	10.60	47N3864	122W0132	26.00	1.8
A	7202270827	56.30	48N0534	123W0516	51.00	2.4
A	7202290035	04.50	47N3432	122W1302	22.00	2.3
A	7203010657	33.30	47N3516	122W0504	12.00	2.1
A	7203021208	35.50	47N1464	122W4008	48.00	1.7
A	7203022012	13.10	47N4518	122W2358	23.00	2.5
A	7203022236	23.60	47N4518	122W2316	23.00	2.5
A	7203041510	42.00	48N1434	122W3210	38.00	2.1
A	7203100215	31.40	47N1968	123W2226	10.00	1.6
A	7203101236	55.00	47N3432	122W1242	22.00	2.0
A	7203130148	51.90	47N4926	122W2514	26.00	2.2
A	7203190916	09.70	47N4836	122W2328	24.00	1.6
A	7203210725	19.10	47N1914	122W4584	20.00	2.3
A	7203290358	03.70	47N2736	122W2016	23.00	1.5
A	7204022215	20.10	47N1944	122W4554	20.00	1.6
A	7204041101	53.30	47N5334	122W0510	24.00	3.0
A	7204041106	37.10	47N5358	122W0408	31.00	2.3
A	7204041111	30.80	47N5430	122W0306	36.00	1.6
A	7204100136	22.10	47N2376	122W1740	07.00	2.1
A	7204171036	30.90	47N2712	122W2076	23.00	1.8
A	7204171053	36.10	47N2760	123W2832	42.00	1.9
A	7204171820	51.20	47N3618	122W1314	10.00	1.9
A	7204182006	48.80	47N5178	122W4086	35.00	1.9
A	7204191016	08.00	48N2826	122W1380	03.00	2.8
A	7204191056	04.40	47N2532	122W4590	22.00	1.5

A	7204210143	24.60	47N1728	122W3576	40.00	2.0
A	7204240410	01.60	48N2748	122W1596	04.00	2.4
A	7204260435	48.50	47N3498	122W5508	43.00	2.0
A	7204270013	14.80	47N1884	122W0906	10.00	1.8
A	7204271619	18.60	47N5142	122W3642	25.00	2.0
A	7204290806	47.00	48N2088	122W2340	20.00	2.4
A	7204291142	30.70	47N3732	122W2604	25.00	3.0
A	7204291841	58.20	47N4704	122W5202	24.00	1.5
A	7204292102	28.50	48N2616	122W2178	01.00	2.2
A	7205011256	50.60	47N3678	122W3564	27.00	2.4
A	7205021331	59.30	47N3426	122W1302	22.00	1.9
A	7205030735	08.40	48N2148	122W1092	21.00	1.8
A	7205081906	10.30	47N3420	122W1242	22.00	2.5
A	7205141726	15.90	47N3474	123W0036	15.00	
A	7205180050	31.90	47N3078	122W5118	20.00	1.7
A	7205180507	39.30	48N2514	122W4806	13.00	3.1
A	7205200701	53.20	47N2730	122W2094	24.00	2.8
A	7205201632	18.50	48N2526	122W2466	01.00	2.9
A	7205201956	19.20	48N2562	122W2436	01.00	2.8
A	7205210117	26.00	47N5118	122W3810	34.00	2.0
A	7205220523	42.90	47N2970	122W5484	20.00	2.4
A	7205232248	09.40	48N0102	122W1050	46.00	1.7
A	7205250743	52.10	47N3558	122W1320	06.00	1.0
A	7205250817	04.90	47N3582	122W1302	06.00	0.9
A	7205301945	52.80	47N0396	122W1284	10.00	2.2
A	7206020755	58.00	47N4284	122W1392	22.00	2.8
A	7206021018	28.90	47N4554	122W2340	21.00	1.9
A	7206080857	01.40	47N4416	122W3078	24.00	1.6
A	7206131922	07.10	47N2844	122W4398	26.00	1.7
A	7206132248	38.40	47N4188	122W3600	19.00	1.5
A	7206160257	46.60	47N1482	122W4686	18.00	1.8
A	7206162050	23.50	47N3456	122W1278	21.00	2.7
A	7206190541	09.50	47N4488	122W4950	22.00	1.0
A	7206211308	19.90	47N4086	122W4224	28.00	1.6
A	7206241541	16.20	47N3456	122W3522	43.00	1.4
A	7206250142	21.90	47N5718	122W0762	25.00	4.0
A	7206250149	31.00	47N5808	122W0714	32.00	2.5
A	7206280433	30.30	47N1278	122W3648	43.00	2.6
A	7206281816	54.60	48N2424	122W2850	20.00	3.2
A	7206302118	36.90	47N5736	123W0168	51.00	2.7
A	7207051846	20.60	48N2484	122W3498	01.00	2.1
A	7207082009	08.40	47N5652	122W0102	11.00	2.5
A	7207160349	15.50	48N3108	123W2358	53.00	1.8
A	7207171144	31.90	47N3546	122W1122	11.00	1.8
A	7207171413	57.80	48N1266	122W4416	17.00	2.0
A	7207171609	46.40	47N1782	122W3732	23.00	1.4
A	7207172109	36.80	47N3246	122W5280	22.00	3.1
A	7207241921	21.80	47N3168	122W3450	43.00	2.2
A	7207260727	13.80	48N0366	122W5166	64.00	1.0
A	7207270644	20.50	47N3402	122W1386	24.00	1.8
A	7207281504	01.20	47N4548	122W2736	26.00	3.0
A	7207281525	07.20	47N4566	122W2754	26.00	2.0
A	7207290157	59.70	48N4476	122W4776	83.00	2.4
A	7207290355	13.10	47N2706	122W2046	23.00	2.3

A	7207301754	32.00	47N5220	122W5352	19.00	1.9
A	7207310255	16.80	48N3720	122W1908	06.00	1.7
A	7208012211	45.00	47N4674	122W5376	15.00	1.7
A	7208042314	15.00	48N0942	122W4476	24.00	1.8
A	7208111228	08.50	47N2694	122W2784	43.00	0.8
A	7208141458	16.30	47N4548	122W2382	47.00	2.0
A	7208150523	31.80	47N5298	122W0318	38.00	1.6
A	7208200959	14.00	47N2724	122W2076	23.00	1.4
A	7208201039	49.10	47N4698	122W2082	29.00	1.4
A	7208261608	56.10	47N2946	122W2238	33.00	1.6
A	7208262033	57.20	47N4500	122W1782	25.00	1.9
A	7209020108	31.00	47N4380	122W0516	08.00	1.8
A	7209031137	13.30	47N0336	122W3564	09.00	1.3
A	7209050937	08.20	47N1938	122W4530	18.00	1.4
A	7209051045	23.30	47N2052	122W4686	27.00	1.0
A	7209061027	35.30	47N1932	122W4548	18.00	2.0
A	7209061450	44.10	48N1014	122W4818	65.00	2.3
A	7209061613	50.00	47N1416	123W0288	31.00	2.0
A	7209071755	15.00	48N1584	122W0288	16.00	2.1
A	7209080428	01.80	47N3468	122W4800	25.00	2.2
A	7209110412	45.60	47N3636	122W1572	09.00	1.8
A	7209130518	52.10	47N4392	122W2466	25.00	1.8
A	7209131133	50.60	47N3474	122W4914	21.00	2.5
A	7209150216	15.10	47N3276	122W3078	26.00	1.2
A	7209190433	04.30	47N1314	122W1374	01.00	1.6
A	7209191930	07.30	48N1938	123W1728	33.00	1.8
A	7209212031	48.50	47N3336	122W4440	05.00	2.1
A	7209261030	24.50	47N3174	122W0246	22.00	2.0
A	7209261438	44.70	47N5784	122W5718	50.00	2.8
A	7210011228	55.60	47N2736	122W5352	21.00	2.0
A	7210041238	50.50	48N2250	122W1452	19.00	3.2
A	7210060758	19.30	47N5640	122W4458	06.00	1.6
A	7210080627	13.40	47N2232	122W2064	29.00	1.3
A	7210100738	54.30	47N4056	122W3486	02.00	0.9
A	7210100958	18.90	47N3378	122W3936	31.00	1.1
A	7210101126	53.40	48N2916	122W1764	21.00	2.7
A	7210112312	31.50	47N4728	122W2112	27.00	2.4
A	7210120136	46.60	47N3780	122W4314	26.00	1.5
A	7210121307	36.90	48N1770	122W0780	15.00	2.9
A	7210130531	04.30	47N4788	122W4566	22.00	2.0
A	7210130800	53.00	47N3534	122W1734	08.00	2.5
A	7210132259	09.60	47N2982	122W0534	03.00	1.9
A	7210162208	32.10	48N4980	122W0732	15.00	3.0
A	7210190201	48.70	47N3378	122W1356	23.00	1.7
A	7210220650	56.50	47N3186	122W0600	18.00	1.3
A	7210220657	23.00	47N5412	122W3246	20.00	1.7
A	7210220916	28.30	47N3402	122W1266	23.00	3.8
A	7210230351	33.80	47N1200	122W1188	09.00	2.0
A	7210260329	50.30	47N5604	122W5448	21.00	1.4
A	7210302028	43.50	48N2532	122W2106	14.00	2.1
A	7211020830	02.80	47N3402	122W1368	23.00	1.8
A	7211031157	58.00	47N3396	122W4422	20.00	3.0
A	7211032348	31.20	47N4326	122W5436	48.00	3.0
A	7211061838	39.30	47N1764	122W5478	23.00	3.7

A	7211090419	18.40	48N2694	123W2004	52.00	4.1
A	7211141826	24.10	47N4464	122W1494	22.00	3.3
A	7211170652	17.70	47N0288	122W1914	25.00	1.2
A	7211180939	26.40	47N5172	122W4062	23.00	1.7
A	7211182302	35.30	47N4524	122W3744	20.00	1.4
A	7211182309	01.10	47N3438	122W2652	16.00	1.8
A	7211200909	41.60	47N3372	122W1362	23.00	1.9
A	7211221238	26.30	48N3936	122W1116	01.00	2.4
A	7211221358	50.10	48N4146	122W0906	14.00	2.0
A	7211251053	08.60	47N3108	122W0528	18.00	1.5
A	7211282227	47.60	47N5250	122W4848	46.00	2.0
A	7211290913	52.80	48N3924	122W1110	01.00	2.4
A	7211292148	13.20	47N4524	122W5064	07.00	1.5
A	7211292149	30.20	47N4398	122W5094	07.00	1.5
A	7211301512	46.50	47N3744	122W1710	16.00	1.3
A	7212011239	36.40	47N2754	122W2052	27.00	1.0
A	7212021629	07.60	48N2970	122W1602	21.00	2.1
A	7212031017	41.80	47N2898	122W4560	18.00	3.6
A	7212050237	51.10	47N3456	122W1080	23.00	1.3
A	7212050725	57.20	47N3420	122W1428	19.00	1.4
A	7212061032	26.70	47N5208	123W2658	46.00	3.9
A	7212061735	53.60	47N4596	122W2742	26.00	3.3
A	7212061942	26.50	47N5640	122W4260	14.00	1.7
A	7212090155	34.50	48N3540	122W5982	11.00	3.3
A	7212090157	37.00	48N3564	122W5784	08.00	2.0
A	7212091314	37.20	48N5112	122W0702	11.00	2.7
A	7212091330	47.30	48N5148	122W0678	11.00	2.6
A	7212091956	46.80	47N2898	122W3150	27.00	2.7
A	7212121245	04.20	47N3666	123W0936	44.00	2.8
A	7212240802	39.40	47N4596	122W3234	26.00	1.9
A	7212250358	14.10	47N2604	122W3438	17.00	2.1
A	7212252318	37.70	47N3354	122W1452	23.00	1.9
A	7212271645	49.30	47N2802	122W1536	26.00	1.3
A	7212290820	53.20	47N2202	122W3960	24.00	1.8
A	7212301443	01.00	47N5136	122W1590	23.00	1.8
A	7301010420	58.90	48N1974	122W0630	20.00	2.3
A	7301011113	05.50	47N3564	123W0282	40.00	1.8
A	7301011143	29.70	48N2076	122W0558	20.00	2.4
A	7301020434	59.00	48N4248	122W3732	21.00	2.3
A	7301030017	05.30	47N5958	122W4656	49.00	1.0
A	7301132302	41.10	47N4782	122W4584	21.00	1.6
A	7301231317	16.50	47N4626	122W2814	26.00	1.6
A	7301251530	31.20	48N2682	123W1176	24.00	2.8
A	7301280924	21.50	47N3630	122W4692	23.00	1.2
A	7301290215	36.00	47N3396	122W1362	23.00	1.9
A	7301291010	23.70	47N3606	122W0210	18.00	1.8
A	7301300539	41.80	47N3972	123W4602	52.00	3.0
A	7302021237	05.50	48N0198	123W1848	46.00	2.1
A	7302060722	49.10	47N3774	122W0378	11.00	1.7
A	7302062255	59.70	47N2910	122W3306	47.00	3.0
A	7302090233	54.70	47N2898	122W4344	24.00	1.9
A	7302100554	51.20	47N1626	122W3138	73.00	1.3
A	7302130828	22.60	47N3270	122W1704	24.00	1.6
A	7302151435	08.90	47N4338	122W4260	24.00	2.0

A	7302180106	34.20	47N4668	122W3246	23.00	1.5
A	7302190247	59.10	48N3306	123W0306	00.00	1.6
A	7302210807	41.60	47N3294	122W5010	09.00	2.1
A	7302220447	17.20	47N1602	122W5118	24.00	3.8
A	7302221651	54.90	47N3282	123W0858	07.00	1.5
A	7302241732	30.30	47N0120	122W1224	70.00	1.6
A	7302242310	49.30	47N3120	122W2184	26.00	2.1
A	7302250203	21.80	48N4350	122W4572	54.00	2.5
A	7302262041	07.20	48N4734	122W2352	09.00	2.5
A	7303021401	52.10	48N0996	123W0876	28.00	2.7
A	7303050944	42.30	48N1974	122W0660	19.00	2.5
A	7303141010	08.20	48N1818	122W3420	38.00	1.8
A	7303241209	10.70	47N5382	122W3996	18.00	2.0
A	7303250558	50.10	47N2154	122W2388	23.00	2.4
A	7303280805	17.80	48N4134	122W4284	11.00	2.1
A	7303301048	50.60	47N1086	123W1044	39.00	1.7
A	7303310751	11.90	48N3144	122W3756	01.00	2.0
A	7304020008	31.00	47N2154	122W3036	22.00	1.8
A	7304070751	56.80	47N3378	122W4296	25.00	2.2
A	7304130410	20.70	47N3714	122W1278	26.00	2.0
A	7304130703	08.90	47N4938	122W4572	52.00	3.7
A	7304200352	41.00	47N3192	122W0240	22.00	2.2
A	7304230111	26.60	47N4350	122W3234	35.00	1.7
A	7304230522	29.40	47N3828	122W4746	26.00	2.1
A	7304240748	05.10	47N0468	122W3582	24.00	2.6
A	7304292205	02.10	47N4668	122W2796	23.00	2.1
A	7304301757	39.20	47N3300	122W4710	30.00	1.6
A	7305010537	31.40	47N3420	122W1362	22.00	1.8
A	7305011836	53.60	47N2394	122W4734	10.00	2.6
A	7305031419	39.70	48N2178	122W4818	06.00	1.8
A	7305072158	49.80	47N4794	122W4824	20.00	1.9
A	7305100619	18.10	47N5148	122W3576	25.00	2.6
A	7305130726	59.10	47N3114	122W2082	28.00	1.8
A	7305151259	44.00	47N4116	122W0564	15.00	1.8
A	7305231256	03.90	47N2364	122W3894	23.00	1.1
A	7305261236	47.00	47N3816	122W1074	06.00	1.4
A	7305261706	50.20	47N3798	122W0996	07.00	2.4
A	7305261836	23.30	47N3840	122W1014	07.00	1.8
A	7305262149	29.00	47N4254	122W3546	18.00	1.1
A	7305270654	19.80	48N1896	122W4968	26.00	1.7
A	7305310042	54.00	47N2088	122W2940	16.00	2.0
A	7305310845	29.10	48N2136	122W2688	04.00	2.3
A	7306020334	13.20	47N5874	122W3054	48.00	1.8
A	7306031116	03.20	48N2466	122W1470	18.00	1.9
A	7306040040	55.50	47N4056	123W2820	48.00	1.8
A	7306060012	07.00	48N3954	123W0564	19.00	3.0
A	7306110421	27.50	47N5346	122W3678	10.00	1.5
A	7306110638	46.70	47N2202	122W4050	26.00	1.9
A	7306111219	22.90	47N3090	122W0990	04.00	1.9
A	7306121544	25.60	48N5556	122W0324	04.00	2.3
A	7306141254	35.70	47N3780	123W1362	49.00	3.0
A	7306150336	26.70	47N2094	122W2964	22.00	2.0
A	7306160951	16.40	48N0642	122W5214	27.00	1.0
A	7306170728	32.10	47N3984	122W5730	42.00	1.6

A	7306211139	55.60	47N3258	122W3312	11.00	1.3
A	7306260243	00.80	47N4848	122W2280	17.00	1.3
A	7307041214	18.40	47N3318	122W4734	24.00	2.1
A	7307051843	24.00	47N1806	122W2214	36.00	1.7
A	7307120642	43.80	47N4638	122W3234	09.00	1.4
A	7307130627	57.80	47N3606	122W1512	07.00	1.7
A	7307151244	57.90	47N3720	122W1248	24.00	1.1
A	7307151354	02.50	47N3492	122W4488	25.00	0.5
A	7307171741	08.70	47N4056	122W4062	23.00	1.4
A	7307190943	25.60	47N1692	122W1536	23.00	1.5
A	7307210530	20.10	47N5274	122W3510	14.00	1.5
A	7307221256	48.00	47N2808	122W5064	24.00	2.9
A	7307242150	59.40	47N5868	122W0756	15.00	2.8
A	7307250354	23.40	48N2652	123W1800	47.00	1.5
A	7307260846	25.30	47N0978	122W0042	01.00	1.9
A	7307272016	11.80	48N3072	122W1914	20.00	2.1
A	7307312037	01.00	47N2658	122W3456	21.00	1.3
A	7307312041	22.80	47N2724	122W3528	20.00	1.1
A	7308080050	43.90	47N3510	122W4836	15.00	1.2
A	7308102212	14.70	47N1356	122W1158	18.00	1.7
A	7308111002	24.20	47N1356	122W1212	18.00	1.9
A	7308121511	20.00	47N3828	123W3408	51.00	3.5
A	7308182302	12.40	47N4794	122W2340	36.00	1.9
A	7308200202	37.00	47N2214	121W5976	09.00	1.7
A	7308250825	59.10	47N4986	122W1074	20.00	1.7
A	7308261857	27.00	47N2418	122W5796	16.00	2.4
A	7308261900	07.50	47N2292	122W4938	26.00	0.6
A	7308261900	19.30	47N2652	123W0198	34.00	1.6
A	7308261907	40.20	47N5166	122W0768	27.00	1.8
A	7308290618	05.40	47N4896	123W0282	47.00	2.3
A	7308301503	00.60	47N3738	122W1242	25.00	1.6
A	7308302314	22.30	47N3498	122W1950	07.00	1.6
A	7308310529	56.70	47N3546	122W1920	08.00	1.5
A	7308310906	04.60	47N3570	122W1878	08.00	1.5
A	7309010313	05.00	47N3468	122W1950	07.00	1.5
A	7309010316	48.00	47N3564	122W1920	08.00	1.9
A	7309010320	32.00	47N3474	122W1956	07.00	1.5
A	7309011056	01.70	47N3792	122W2442	07.00	1.5
A	7309020342	38.50	47N3546	122W1896	07.00	1.9
A	7309021057	30.30	47N3558	122W1932	07.00	2.0
A	7309030946	20.30	47N3498	122W1926	07.00	1.6
A	7309031403	39.10	47N3774	122W2484	07.00	1.6
A	7309031410	54.40	47N3516	122W1920	07.00	1.3
A	7309031600	56.50	47N4206	122W3618	22.00	1.4
A	7309041957	08.50	48N1464	123W0744	20.00	1.5
A	7309050018	39.50	48N0672	122W4062	58.00	2.1
A	7309050139	33.90	47N3546	122W1920	07.00	1.9
A	7309060815	16.50	47N3972	122W2484	06.00	1.0
A	7309081138	55.80	47N3516	122W3546	23.00	2.8
A	7309081209	16.10	47N3540	122W3426	20.00	1.8
A	7309081259	46.40	47N3510	122W3522	23.00	2.7
A	7309081507	39.40	47N3492	122W3510	22.00	1.9
A	7309102120	34.40	48N5538	122W1470	14.00	1.8
A	7309111231	53.80	47N2646	122W2826	10.00	1.3

A 7309111533	21.00	48N5118	122W1614	05.00	2.4
A 7309111539	37.40	48N3750	123W0648	14.00	1.9
A 7309112249	51.70	48N3648	123W0486	10.00	1.8
A 7309120904	52.50	47N0546	123W4314	21.00	2.5
A 7309121251	19.90	47N2016	122W2484	07.00	1.6
A 7309140552	06.00	48N0714	122W4020	23.00	1.5
A 7309142118	41.20	47N3498	122W2040	07.00	1.6
A 7309150227	44.00	47N4794	123W0630	45.00	2.0
A 7309160100	29.50	47N4584	122W1938	26.00	2.4
A 7309161949	37.80	47N3438	122W5808	14.00	2.0
A 7309162154	36.40	48N4248	122W2640	21.00	2.3
A 7309180025	09.90	47N3582	122W1974	08.00	1.5
A 7309240727	32.10	48N3792	123W1938	63.00	2.8
A 7309252255	16.70	47N3582	122W1872	07.00	1.9
A 7309261640	08.50	47N3570	122W1920	08.00	2.4
A 7309262107	09.30	47N3546	122W1974	08.00	2.8
A 7309270700	13.30	47N3564	122W1764	07.00	2.3
A 7309270747	21.30	47N3600	122W1956	08.00	2.0
A 7309270839	02.10	47N3618	122W1872	08.00	1.6
A 7309270854	30.40	47N3552	122W1878	08.00	1.7
A 7309271357	08.50	47N3564	122W1908	08.00	1.6
A 7309272309	45.00	47N3582	122W1920	08.00	2.2
A 7309281325	35.00	47N3546	122W1890	07.00	1.7
A 7309282250	25.40	47N3504	122W1914	06.00	2.1
A 7309290002	02.20	47N4506	122W2550	25.00	1.5
A 7309291213	34.40	48N0060	122W3918	04.00	1.6
A 7309291624	23.20	47N3606	122W2388	08.00	1.3
A 7309291712	25.40	47N3504	122W2118	06.00	1.7
A 7309300648	15.30	48N0204	123W1710	45.00	1.6
A 7309301426	57.30	47N3612	122W1980	07.00	1.3
A 7310010536	17.40	47N5658	122W3366	21.00	1.6
A 7310011020	19.70	47N3522	122W2070	08.00	0.9
A 7310020600	46.70	47N3600	122W1950	08.00	1.7
A 7310030423	52.10	48N2358	123W1536	35.00	1.7
A 7310050317	02.60	47N5748	122W3306	25.00	2.8
A 7310050448	58.50	47N3648	122W1608	08.00	1.7
A 7310050931	08.70	47N4482	122W3252	20.00	1.6
A 7310060651	25.40	47N4692	122W2310	31.00	1.4
A 7310071348	09.40	47N3588	122W1950	08.00	2.0
A 7310071349	34.40	47N3612	122W1956	08.00	1.9
A 7310071353	10.30	47N3612	122W1938	08.00	3.3
A 7310071357	06.30	47N3498	122W1944	07.00	1.7
A 7310071419	33.80	47N3834	122W2814	06.00	1.5
A 7310071431	34.80	47N3522	122W1950	08.00	1.9
A 7310071636	02.20	47N3624	122W1938	08.00	2.8
A 7310072330	17.40	47N3618	122W1596	08.00	2.4
A 7310072334	42.90	47N3594	122W1638	09.00	2.5
A 7310072337	41.10	47N3612	122W1596	08.00	1.7
A 7310080104	19.00	47N3630	122W1602	08.00	1.8
A 7310080437	46.50	47N3630	122W1614	09.00	1.8
A 7310080531	44.30	47N3612	122W1656	08.00	1.5
A 7310080534	19.60	47N3696	122W1542	08.00	2.8
A 7310090931	24.90	47N3588	122W2004	08.00	1.7
A 7310091956	39.30	47N3558	122W1872	07.00	2.3

A	7310100050	36.30	47N4548	122W2748	29.00	1.6
A	7310100053	42.70	47N3588	122W1974	08.00	2.5
A	7310100302	11.60	47N1368	123W1068	14.00	1.5
A	7310101948	56.20	47N3570	122W1866	08.00	1.7
A	7310120935	25.10	47N3624	122W1872	08.00	2.8
A	7310121202	09.80	47N3564	122W1878	08.00	2.6
A	7310131544	46.60	47N3564	122W1914	08.00	1.8
A	7310141301	49.20	47N3882	122W5004	47.00	1.1
A	7310141705	08.10	48N1854	121W5994	17.00	1.6
A	7310150528	53.90	47N3528	122W1962	08.00	1.6
A	7310170635	35.40	47N3336	122W1680	08.00	1.6
A	7310191717	00.30	47N3276	122W4956	23.00	1.5
A	7310191921	25.70	47N3660	122W1800	05.00	1.5
A	7310191923	16.70	47N3612	122W1890	07.00	1.9
A	7310211630	17.80	47N2748	122W2070	18.00	1.9
A	7310222258	48.30	47N3654	122W1962	07.00	1.5
A	7310251132	48.40	47N3600	122W1914	08.00	2.6
A	7310301732	10.00	47N3582	122W1920	08.00	2.1
A	7311022029	09.40	47N1050	122W1896	09.00	1.6
A	7311031622	01.00	47N3564	122W1938	08.00	3.0
A	7311031625	12.00	47N3594	122W1950	07.00	2.3
A	7311031708	24.00	47N3498	122W2166	07.00	1.5
A	7311031842	38.00	47N3564	122W1884	08.00	1.9
A	7311070934	44.20	48N1728	122W3798	17.00	2.1
A	7311071145	14.90	48N3600	122W1488	13.00	1.9
A	7311100135	55.40	48N1224	122W4110	36.00	2.0
A	7311140132	53.30	48N3624	123W0486	12.00	2.7
A	7311140718	10.60	48N3402	122W4170	12.00	1.6
A	7311190848	49.10	47N3672	122W1944	07.00	1.4
A	7311190909	27.10	47N3564	122W1920	07.00	2.9
A	7311190915	00.90	47N3450	122W1980	07.00	1.9
A	7311190916	46.50	47N3780	122W1716	07.00	1.2
A	7311191452	34.10	47N3714	122W1932	07.00	1.4
A	7311201335	08.90	48N5118	122W0456	09.00	2.4
A	7311210700	35.00	47N1938	122W5280	55.00	1.8
A	7311220223	34.80	47N1776	122W2622	20.00	1.8
A	7311260711	33.90	47N1794	122W1770	07.00	1.6
A	7312011107	06.80	47N4026	122W1902	10.00	1.9
A	7312050957	39.00	48N2460	123W3180	10.00F	1.7
A	7312070959	19.10	47N3558	122W0240	17.00	1.9
A	7312081603	14.10	47N4608	122W2496	15.00	1.3
A	7312091245	12.10	47N4596	122W4872	23.00	2.4
A	7312092213	35.70	47N3168	122W3558	27.00	1.8
A	7312141410	10.60	47N3552	122W1914	08.00	2.0
A	7312141421	49.50	47N3552	122W2112	07.00	1.4
A	7312141425	22.30	47N3594	122W1914	08.00	2.9
A	7312141427	18.50	47N3528	122W2070	08.00	2.0
A	7312141430	15.60	47N3462	122W2142	07.00	1.6
A	7312141433	06.40	47N3750	122W1824	06.00	1.4
A	7312142025	17.50	47N5682	122W2232	29.00	1.9
A	7312160256	20.70	47N3510	122W2214	07.00	
A	7312170713	52.20	47N3522	122W2010	07.00	1.7
A	7312251443	40.60	47N3402	122W1374	23.00	2.4
A	7312260437	31.30	47N3450	122W2124	07.00	1.8

A	7312261140	56.50	47N3558	122W2058	08.00	1.9
A	7312261700	28.30	47N3522	122W1956	07.00	1.8
A	7312291647	59.80	48N0192	122W4482	52.00	2.8
A	7401061233	35.30	47N4596	122W5010	50.00	3.1
A	7401070332	38.60	47N2844	122W4530	19.00	2.0
A	7401090400	54.10	47N4932	122W2244	35.00	1.3
A	7401281049	46.10	47N2490	122W4386	23.00	1.3
A	7402031821	34.50	47N3732	122W1908	05.00	1.7
A	7402031936	25.30	47N3828	122W1974	01.00	1.9
A	7402080508	10.30	47N2118	123W0888	42.00	1.5
A	7402110318	39.30	47N2886	122W1608	09.00	2.2
A	7402110802	09.70	47N2946	122W1464	10.00	1.8
A	7402240831	15.30	47N5346	122W1236	25.00	1.8
A	7402250411	27.90	47N2802	122W5586	16.00	1.7
A	7402270907	54.00	47N4884	122W0174	30.00	1.8
A	7403022033	29.70	48N4368	122W2610	12.00	2.3
A	7403070246	27.60	47N5904	122W3000	19.00	1.9
A	7403140238	58.80	47N1206	122W0894	25.00	1.5
A	7403150232	01.20	47N3624	122W1506	09.00	2.4
A	7404070333	33.80	47N3138	122W2184	24.00	1.1
A	7404071339	54.10	47N3264	122W1278	00.00	2.0
A	7404071803	28.60	47N3048	122W4014	23.00	0.8
A	7404080445	51.00	47N1938	122W2256	22.00	1.0
A	7404080819	04.30	47N3702	122W1788	08.00	0.9
A	7404090914	46.30	48N3786	123W0492	08.00	1.4
A	7404110224	30.90	47N3558	122W1926	07.00	2.3
A	7404120351	36.20	47N3588	122W1914	09.00	1.5
A	7404140435	35.80	47N4920	122W2142	08.00	0.8
A	7404200038	59.20	48N4860	122W1008	05.00	2.1
A	7404202102	58.70	47N5562	122W0264	17.00	2.1
A	7404210239	49.00	47N2466	122W0144	09.00	1.5
A	7404220454	55.20	47N4914	122W2346	23.00	1.6
A	7404241921	32.00	47N3546	122W2526	26.00	1.0
A	7404251441	08.30	47N3018	122W2184	24.00	1.6
A	7404260157	27.40	47N3216	122W2418	20.00	1.3
A	7404260742	44.90	47N5994	123W1152	02.00	0.9
A	7404271451	25.80	47N2688	122W1842	01.00	1.6
A	7404300305	14.90	48N2682	122W4896	09.00	1.0
A	7405040738	47.50	48N5412	122W2292	11.00	1.3
A	7405041025	05.20	48N4260	122W2502	06.00	1.4
A	7405041133	13.40	48N4344	122W2556	10.00	1.4
A	7405051454	02.80	48N2208	123W1326	05.00	0.5
A	7405070624	34.40	47N3678	122W1914	06.00	1.4
A	7405070726	43.10	47N3822	122W1974	02.00	1.2
A	7405070944	14.50	47N3594	122W1932	07.00	1.2
A	7405081832	34.60	47N3540	122W2010	09.00	1.3
A	7405081924	10.20	47N3978	122W1260	06.00	1.3
A	7405092310	22.70	47N3540	122W1992	08.00	1.2
A	7405120249	21.80	48N1356	123W2196	38.00	1.7
A	7405141710	23.50	47N3000	122W5640	15.00	1.6
A	7405161304	36.40	48N0624	122W5904	53.00	4.2
A	7405172013	00.70	48N2508	123W1122	27.00	2.2
A	7405201839	58.80	47N2472	122W5010	51.00	1.2
A	7405220030	15.70	47N3582	122W1932	07.00	1.4

A	7405221158	18.30	48N3648	122W5820	14.00	3.1
A	7405221222	02.50	47N2082	122W0252	16.00	3.0
A	7405221511	18.40	47N2610	122W0462	19.00	1.4
A	7405240805	56.60	47N2736	122W0396	16.00	1.9
A	7405241513	25.60	47N1968	123W0690	44.00	2.0
A	7405242105	42.60	47N2532	122W0168	19.00	2.2
A	7405270533	09.70	47N1956	122W0048	19.00	1.7
A	7405270554	46.50	47N1938	122W0054	19.00	1.6
A	7405270818	23.60	47N1920	122W0216	15.00	1.1
A	7405271101	43.20	47N2010	122W0276	11.00	0.6
A	7406011135	29.20	47N5310	122W3522	16.00	0.6
A	7406030828	48.60	47N0180	122W3456	18.00	2.2
A	7406041751	03.80	47N3528	122W1998	08.00	1.6
A	7406041841	48.30	47N3474	122W2304	06.00	1.4
A	7406042243	50.30	47N3450	122W2064	08.00	2.0
A	7406050922	24.70	47N3606	122W1608	08.00	1.7
A	7406062216	31.50	48N4392	123W0690	71.00	2.3
A	7406080942	29.90	47N3522	122W2076	07.00	1.1
A	7406100606	55.80	47N3990	122W0054	07.00	0.7
A	7406100707	14.20	47N5064	122W5142	22.00	1.9
A	7406120528	53.80	47N5628	122W1194	09.00	1.4
A	7406150222	47.00	47N1776	122W1782	21.00	1.9
A	7406151408	00.70	47N5010	122W4200	22.00	1.4
A	7406160710	41.50	47N2106	123W2904	08.00	1.9
A	7406161805	59.60	47N2244	122W0528	08.00	1.4
A	7406211601	08.80	47N4668	122W4302	21.00	1.5
A	7406221730	28.40	47N3642	122W1956	07.00	2.0
A	7406230054	55.40	47N3534	122W1980	08.00	2.8
A	7406230056	56.10	47N3816	122W1998	04.00	0.6
A	7406230128	37.90	47N3570	122W2028	08.00	1.4
A	7406231610	44.90	47N3888	122W1896	02.00	1.2
A	7406240108	12.30	47N3516	122W2160	07.00	1.3
A	7406241144	41.40	47N4356	122W3552	12.00	0.9
A	7406251147	09.10	47N3030	122W5730	16.00	1.0
A	7406252031	32.60	48N3432	123W3348	08.00	1.1
A	7406260414	01.70	47N2934	122W5922	15.00	1.2
A	7406260516	04.20	47N3564	122W1968	08.00	1.8
A	7406260516	51.20	47N3570	122W1992	08.00	1.5
A	7406260518	39.30	47N3666	122W1944	07.00	1.7
A	7406261416	18.40	47N5844	123W1974	45.00	1.5
A	7406261853	27.50	47N3054	122W5808	14.00	1.1
A	7407030957	32.70	47N4602	122W2694	19.00	1.3
A	7407032228	38.60	47N3492	122W5448	22.00	0.3
A	7407061734	54.10	47N2226	122W0384	04.00	1.0
A	7407060718	46.40	48N0654	122W4848	53.00	2.1
A	7407091046	56.60	48N2382	123W1008	48.00	1.4
A	7407091950	31.70	47N1986	122W4068	25.00	2.3
A	7407110614	33.50	47N4434	122W1596	34.00	1.8
A	7407111458	54.20	47N4440	122W1962	24.00	1.7
A	7407160615	11.70	47N1950	122W3762	22.00	1.0
A	7407200127	42.90	48N0192	123W0894	06.00	0.9
A	7407231049	48.30	47N4482	123W1164	43.00	1.4
A	7407231058	40.30	47N3414	122W0432	13.00	1.6
A	7408031203	19.10	47N4758	122W2046	04.00	1.5

A	7408091011	57.00	47N2466	122W2940	22.00	1.7
A	7408102152	28.20	47N2352	122W4368	24.00	2.2
A	7408152333	04.00	47N1884	122W2418	06.00	2.8
A	7408161307	42.30	48N1218	122W4836	16.00	1.9
A	7408181901	37.10	47N4674	122W1746	24.00	2.1
A	7408190817	00.10	47N5724	122W0978	31.00	2.4
A	7408211547	55.90	47N4944	122W3000	20.00	2.0
A	7408250441	57.20	48N2460	122W2550	28.00	1.9
A	7408251058	51.70	47N3030	122W5112	20.00	1.4
A	7408251735	34.20	48N4722	123W1272	16.00	1.8
A	7408270713	57.40	47N5514	122W5466	21.00	2.2
A	7408271004	33.10	47N1584	122W1770	14.00	0.9
A	7408291336	00.10	47N2328	123W1596	05.00	1.5
A	7408301923	38.20	47N4788	122W4560	21.00	1.2
A	7408302126	42.10	47N0666	123W0666	04.00	1.3
A	7409050229	19.80	48N1362	122W5658	52.00	1.8
A	7409060458	02.60	47N3972	122W2322	23.00	2.2
A	7409112328	40.60	47N3120	122W4686	06.00	1.0
A	7409140256	26.10	47N4974	122W1476	23.00	1.1
A	7409171336	37.60	48N4992	122W0942	06.00	1.8
A	7409180727	07.40	48N1626	123W1122	47.00	2.2
A	7409190452	07.40	47N2364	122W0552	08.00	1.9
A	7409200510	13.50	47N3468	122W4074	12.00	1.0
A	7409250316	34.20	48N1260	123W1458	41.00	2.1
A	7410011528	36.60	48N1320	123W0012	29.00	2.3
A	7410161029	28.60	47N1812	122W2472	06.00	1.4
A	7410191830	45.60	48N0258	122W4368	10.00	1.4
A	7410240651	18.50	47N3450	122W5022	24.00	1.7
A	7410250429	05.50	47N2340	122W3108	22.00	2.0
A	7410270718	11.30	48N2904	123W0408	25.00	1.4
A	7410290508	18.00	48N1782	122W4230	27.00	2.0
A	7410310741	18.50	47N4788	122W4608	23.00	1.7
A	7411012022	58.60	48N4062	123W1284	58.00	3.5
A	7411012356	28.40	48N3036	122W2184	24.00	2.4
A	7411021640	30.00	48N3432	122W2904	09.00	2.0
A	7411040445	16.60	47N3462	122W1500	06.00	2.2
A	7411041146	47.70	47N4764	122W1938	31.00	1.7
A	7411060929	26.00	47N2454	122W0054	22.00	2.3
A	7411112311	45.00	47N2934	122W0024	25.00	2.3
A	7411140511	03.10	47N2598	122W5346	06.00	2.0
A	7411151349	39.20	48N3186	122W0030	03.00	2.2
A	7411160822	34.50	47N5310	122W4788	09.00	1.5
A	7411161037	05.60	47N5532	122W2316	20.00	1.3
A	7411170901	53.50	47N1758	122W4704	16.00	1.3
A	7411222003	30.90	48N2664	122W1248	09.00	1.2
A	7411250147	19.80	48N0990	122W4470	24.00	1.8
A	7411271200	20.80	47N5868	122W0192	36.00	1.8
A	7411292147	36.10	47N3228	122W4428	19.00	1.5
A	7412010301	13.20	47N2718	122W1740	21.00	1.6
A	7412010328	49.70	47N2886	122W1698	24.00	1.9
A	7412010623	57.80	47N3594	122W1926	07.00	2.9
A	7412010733	59.70	47N3732	122W1944	07.00	1.4
A	7412010738	48.60	47N3612	122W1920	08.00	1.3
A	7412021620	19.60	47N2874	122W1704	23.00	1.6

A	7412081224	23.50	48N2460	122W0474	30.00	1.8
A	7412151758	06.10	48N3024	122W0348	01.00	2.8
A	7412151806	58.90	48N3006	122W0450	01.00	2.1
A	7412241549	06.50	47N1794	122W1470	31.00	0.5
A	7412252120	08.00	47N3774	122W3414	13.00	1.4
A	7412270329	46.20	47N3528	122W3048	26.00	1.2
A	7412281659	37.10	47N3036	122W1548	07.00	1.4
A	7412281708	28.30	47N2994	122W1608	17.00	1.0
A	7412290922	50.90	47N3702	122W1968	01.00	1.5
A	7412301153	13.30	47N2268	122W4020	25.00	2.4
A	7412311322	44.70	47N2286	122W4422	23.00	1.1
A	7412311617	39.70	48N0906	122W3684	24.00	1.5
A	7501031151	19.58	47N4194	122W4069	11.90	1.5
A	7501031211	07.50	47N3804	122W1176	25.60	1.1
A	7501060009	39.35	47N4313	122W1761	25.10	1.9
A	7501070611	51.51	48N2412	122W2383	03.00	2.7
A	7501072041	20.01	47N2971	122W1740	23.00	1.5
A	7501151224	09.75	48N2530	122W2691	32.10	2.2
A	7501202144	45.03	47N2905	122W1699	26.20	2.5
A	7501272024	47.45	47N5154	122W3597	18.70	1.2
A	7501290831	50.80	47N5806	122W2692	23.90	1.3
A	7502010859	21.33	47N4042	122W0838	19.90	1.5
A	7502020051	47.02	48N4049	122W2088	01.00F	1.6
A	7502202335	56.98	47N2335	122W4411	24.70	1.3
A	7502271637	20.54	47N2173	122W4311	22.90	1.1
A	7502280145	02.44	47N5234	122W4385	10.10	1.4
A	7503012111	33.76	48N0203	122W2606	30.80	0.8
A	7503020904	25.41	48N5070	122W5999	55.70	1.6
A	7503120342	33.38	47N4768	122W4540	20.90	2.0
A	7503120626	09.73	48N2320	122W2437	02.40	1.9
A	7503131116	59.20	47N3422	122W5064	19.60	1.4
A	7503191712	23.56	47N2033	122W0217	16.60	2.8
A	7503301515	17.23	47N2100	122W2354	13.90	2.0
A	7504010126	26.32	47N1175	122W5274	22.80	1.5
A	7504012232	54.75	47N2947	122W1673	25.20	2.2
A	7504090004	40.95	48N3127	121W5995	10.60	2.6
A	7504161909	29.21	47N3349	122W5432	43.80	3.8
A	7504230103	42.35	47N0461	122W3899	46.80	4.0
A	7504281749	57.36	48N5058	122W3401	04.80	1.4
A	7505132332	36.38	47N2870	122W1690	23.90	1.4
A	7505220659	57.83	48N3013	122W0612	12.00	1.4
A	7505290100	06.80	47N3892	122W3723	23.60	1.6
A	7506051850	54.35	47N3065	122W2000	23.80	1.8
A	7506070209	39.46	47N4981	122W5165	46.20	1.4
A	7506081348	01.86	47N4581	122W2729	23.20	1.7
A	7506100930	29.51	48N3504	122W2589	01.00F	1.0
A	7506101159	00.49	47N4856	122W2090	06.70	0.9
A	7506131843	31.01	47N4463	122W3340	01.00F	1.7
A	7506170105	00.53	48N2230	122W1572	01.10	1.0
A	7506220833	32.80	47N3422	122W1230	21.90	1.4
A	7506221050	24.71	47N5401	122W0163	14.60	0.9
A	7506222331	56.25	48N0625	123W1603	47.90	1.8
A	7506291615	22.83	48N3905	123W0001	17.00	1.6
A	7506300148	28.96	47N3033	122W4302	22.70	1.2

A	7506300551	21.76	47N2048	122W0138	19.30	1.9
A	7507010638	14.94	47N3275	122W3866	24.30	1.6
A	7507010800	34.99	47N4033	122W0687	01.00F	1.0
A	7507010940	21.15	47N1578	122W2348	15.00	1.4
A	7507030942	19.44	47N2873	122W1734	24.20	1.4
A	7507041325	22.46	47N1850	122W2478	12.40	2.0
A	7507081446	58.51	47N4408	122W3489	05.00	1.4
A	7507100003	33.26	47N4474	122W5510	16.70	1.8
A	7507121009	22.61	47N2917	122W2766	49.10	2.3
A	7507130542	10.98	48N1778	122W0552	13.70	1.5
A	7507140550	34.56	47N1942	122W2439	06.40	3.4
A	7507141133	11.70	47N1897	122W2455	05.40	1.8
A	7507150543	15.25	47N1856	122W2530	09.70	1.0
A	7507241142	11.76	47N1929	122W2415	06.10	3.6
A	7508022039	20.98	48N3054	122W2770	28.30	1.7
A	7508051539	38.72	47N3781	122W4136	24.20	1.7
A	7508121611	00.70	47N4364	122W5204	17.20	1.5
A	7508121922	47.43	47N4203	122W3575	18.60	1.7
A	7508130530	23.68	47N4230	122W3566	18.20	1.7
A	7508130940	27.19	47N3748	122W4567	16.90	1.2
A	7508160713	27.34	47N3340	122W5522	15.90	1.2
A	7508220743	01.47	47N5438	123W0953	41.40	1.9
A	7508230400	27.35	47N4195	122W0212	20.30	2.2
A	7508241059	22.80	47N0558	122W5329	44.40	2.6
A	7508252138	56.89	48N0272	122W3752	28.60	1.5
A	7508301840	11.73	47N4970	122W3015	25.20	2.0
A	7509010235	48.08	47N3158	123W3230	37.60	0.9
A	7509021127	44.37	47N0343	122W0588	09.50	2.1
A	7509050227	00.81	48N2637	122W5252	01.00F	0.8
A	7509060452	05.45	47N3127	122W4791	22.60	2.3
A	7509071320	35.75	47N5003	122W3240	01.00F	1.0
A	7509081353	57.79	47N2703	122W0005	16.20	2.3
A	7509090957	52.75	47N4581	122W1922	22.50	1.5
A	7509100246	24.84	47N2899	122W1665	24.90	1.3
A	7509101246	57.03	47N4697	122W2756	22.00	1.7
A	7509120232	44.91	47N3251	122W2351	16.10	1.2
A	7509122158	56.52	48N2310	122W2907	05.50	1.7
A	7509150109	08.44	48N1845	122W0503	14.50	2.0
A	7509160200	04.10	47N2872	122W1658	23.70	1.1
A	7509160551	10.47	48N1861	122W0492	14.70	2.1
A	7509160630	41.31	48N1813	122W0454	14.20	1.6
A	7509162309	19.35	48N5387	122W1075	03.70	2.1
A	7509171801	22.56	48N1826	122W0537	12.90	1.9
A	7509171959	20.63	47N0324	122W1084	10.40	1.5
A	7509180903	23.93	47N5232	122W1353	25.60	1.8
A	7509210500	03.91	48N1898	122W0555	09.50	1.8
A	7509252123	51.14	47N5632	122W2457	25.10	3.1
A	7509280604	24.01	48N1482	122W3625	20.60	1.7
A	7509290600	42.43	48N4023	123W0058	18.60	1.6
A	7509291208	05.92	48N1436	122W3850	20.10	1.1
A	7509300724	19.79	48N3718	122W5972	15.20	1.3
A	7510011406	34.99	48N2832	123W2505	10.70	1.1
A	7510032231	25.04	48N3281	122W4243	12.30	3.0
A	7510070421	00.75	47N3641	122W4094	21.80	1.6

A	7510130839	29.24	48N3594	122W1133	10.10	1.5
A	7510141254	09.09	47N4637	122W4760	22.10	1.0
A	7510220341	37.40	47N2486	122W4025	22.20	1.0
A	7510231359	07.36	47N4515	122W5188	27.40	0.5
A	7510231907	29.01	47N3961	123W0431	04.50	0.8
A	7511011944	32.62	48N1951	122W5217	54.50	2.3
A	7511111813	09.92	47N5440	122W3128	03.00	1.4
A	7511131159	58.48	47N3030	122W1880	22.70	2.2
A	7511170113	54.80	47N4897	122W0460	27.80	1.0
A	7511171115	01.26	47N2388	122W3977	21.60	1.5
A	7511191347	36.49	48N2693	123W3079	16.60	2.1
A	7511210004	57.80	47N5047	122W0023	08.60	1.6
A	7511222337	27.11	47N2255	122W2643	21.50	1.6
A	7511271047	25.67	47N5048	122W3230	28.80	1.8
A	7511271241	45.58	48N0795	122W3031	01.00F	1.5
A	7511280824	16.98	47N1836	122W3641	26.40	2.0
A	7512060958	14.20	47N3901	122W3583	22.50	1.8
A	7512070046	25.79	47N3951	122W1106	11.80	1.6
A	7512071248	04.82	47N3794	122W3560	23.70	1.1
A	7512071836	55.93	47N2608	122W1836	18.10	1.0
A	7512092006	02.89	47N3363	122W1338	23.10	1.3
A	7512110332	32.59	47N3866	122W0281	08.30	1.3
A	7512132114	42.60	48N2339	123W4397	07.10	1.4
A	7512140141	27.40	48N0845	123W1071	14.50	0.9
A	7512141740	20.92	47N3490	122W3420	23.00	1.5
A	7512182137	34.98	47N5588	122W4177	07.60	1.0
A	7512240617	01.05	47N2838	122W1757	26.60	1.6
A	7512251858	55.27	47N1974	122W0223	09.50	0.7
A	7512290740	11.97	47N4653	122W1981	26.40	2.3
A	7512300917	53.36	47N1227	122W4081	42.90	2.3
A	7601020356	26.00	47N1933	121W5969	17.70	1.7
A	7601040040	01.11	47N5238	122W1118	13.00	1.4
A	7601040526	29.50	47N4382	122W1827	23.00	1.9
A	7601042154	13.20	47N3752	122W1134	29.50	1.8
A	7601051325	43.64	47N2798	122W3543	43.70	3.3
A	7601070646	56.85	47N4280	122W4079	21.20	1.4
A	7601070911	56.25	47N5628	122W5510	52.70	2.1
A	7601100452	44.37	47N3852	122W2017	20.10	1.1
A	7601120047	06.97	48N1844	122W0480	14.80	2.1
A	7601120051	48.47	48N1890	122W0480	15.10	2.0
A	7601190049	00.51	48N3027	122W4030	08.20	1.8
A	7601210506	38.05	47N3518	122W2166	09.80	1.4
A	7601221606	49.14	47N1397	123W2543	43.40	1.0
A	7601221813	48.34	47N4925	122W2008	01.00F	1.3
A	7601230949	43.13	47N3856	122W0351	21.40	1.3
A	7601270309	31.06	47N5232	122W0920	19.10	2.9
A	7601280323	49.87	47N3988	122W0344	09.70	1.6
A	7601290138	31.23	47N1505	122W5068	13.10	1.5
A	7601291118	55.28	47N5101	122W5203	19.90	1.3
A	7601300455	10.76	47N5270	122W3915	20.30	1.7
A	7601310319	51.66	47N5911	122W1483	05.30	1.1
A	7601310649	48.46	48N1869	122W0486	16.70	1.6
A	7601311227	14.17	48N2086	122W1903	19.40	3.2
A	7601311416	52.96	48N1776	122W1437	13.60	0.8

A	7602091713	03.54	47N0557	122W4433	50.10	1.3
A	7602111917	42.36	47N2365	122W0803	08.50	2.1
A	7602130613	27.19	47N5017	122W5660	25.50	0.9
A	7602190514	54.58	48N1654	123W2632	11.50	1.0
A	7602191013	53.05	47N5071	122W2590	09.20	1.1
A	7602220357	53.04	48N1141	122W3910	17.20	1.3
A	7602220438	55.05	47N5079	122W0053	28.50	2.6
A	7602281336	21.43	47N4352	122W1811	28.50	1.4
A	7602291330	50.19	48N1971	122W0026	16.90	1.6
A	7603011059	26.75	47N3835	122W0570	09.70	1.1
A	7603011333	10.52	47N4802	122W1561	01.00F	1.1
A	7603051204	33.20	47N3394	122W4183	20.30	1.5
A	7603100125	12.78	48N2835	123W3429	19.60	1.3
A	7603100128	01.00	48N3978	123W0190	19.90	1.9
A	7603132221	41.57	48N3912	122W1871	16.50	1.9
A	7603151027	38.84	47N2714	122W4125	18.70	0.9
A	7603152359	22.23	48N1390	122W2464	52.20	1.0
A	7603161550	00.77	47N4999	122W1856	22.50	1.4
A	7603162246	26.93	47N1786	122W1346	25.50	0.9
A	7603250749	05.84	47N5009	122W0100	36.20	1.4
A	7603311741	02.98	47N5891	122W1083	26.00	1.6
A	7604012237	56.23	47N4828	122W1980	09.00	1.5
A	7604041430	38.16	47N2318	122W4399	28.90	2.2
A	7604060001	47.02	48N5862	122W0529	01.40	1.5
A	7604080220	46.89	47N2326	122W4417	23.50	1.6
A	7604090057	18.80	47N2269	122W4318	23.20	0.9
A	7604110556	21.22	47N2914	122W3286	27.00	0.9
A	7604111249	56.89	47N1985	122W4154	05.80	1.2
A	7604140637	14.53	48N3218	122W3141	19.80	0.8
A	7604140807	39.17	48N0874	122W3875	31.70	1.1
A	7604142027	00.77	48N3967	122W1798	08.30	1.0
A	7604172123	40.11	48N3839	123W0084	14.40	1.6
A	7604191008	35.74	47N1907	122W3446	49.70	1.3
A	7604221324	03.04	47N4662	122W5121	22.50	0.6
A	7604280839	58.26	47N4657	122W1987	31.80	2.7
A	7604280909	51.04	48N3406	122W1778	07.60	1.5
A	7604280925	03.06	47N4596	122W2039	26.00	2.0
A	7604280929	00.69	47N4619	122W2033	28.40	1.7
A	7604290026	19.04	47N4871	122W2289	19.10	1.5
A	7604290650	30.90	47N1678	122W1638	12.30	1.6
A	7604300601	02.47	47N4594	122W0760	23.80	1.0
A	7604301106	00.14	47N2412	122W4438	34.10	2.3
A	7604301946	49.34	47N4726	122W4662	22.10	1.7
A	7605031230	45.24	47N2074	122W2492	19.80	1.4
A	7605032340	23.48	48N1893	121W5972	15.30	1.4
A	7605040126	34.46	47N4594	122W2017	29.90	1.3
A	7605040534	50.34	47N3585	122W3206	29.20	1.2
A	7605041208	57.30	48N3905	122W5946	19.90	2.2
A	7605050108	19.24	48N0731	122W3956	58.60	2.4
A	7605050652	53.66	48N2007	122W0491	17.00	1.2
A	7605051923	09.50	48N4091	123W0938	22.70	2.4
A	7605062332	17.50	47N3217	122W3418	10.30	0.9
A	7605090512	29.23	47N1757	122W1483	17.80	2.0
A	7605092029	20.51	47N0626	122W3650	17.50	1.4

A	7605110012	15.47	47N0388	122W0915	07.80	1.8
A	7605121004	44.87	47N2547	123W0882	13.90	1.2
A	7605150521	08.03	47N5722	122W1167	36.30	1.2
A	7605160835	13.86	48N5066	123W2598	67.80	4.9
A	7605161851	52.42	47N2562	123W0822	09.60	1.3
A	7605221932	58.19	47N2496	122W0597	18.70	1.7
A	7605231134	41.01	47N1665	122W1605	18.90	1.1
A	7605232350	28.23	47N4634	122W3467	14.90	1.1
A	7605251453	23.69	47N0822	122W4187	38.40	1.6
A	7606010741	33.69	47N2286	122W4217	23.00	1.3
A	7606020652	13.66	47N3717	122W3789	22.20	1.8
A	7606020716	33.32	48N4386	122W2129	04.60	1.1
A	7606022053	59.66	47N2059	122W3397	13.30	2.6
A	7606040830	54.92	47N4270	122W1694	30.70	1.7
A	7606070020	42.66	47N1711	122W5249	42.50	1.0
A	7606070635	24.43	47N1589	123W3912	22.90	1.3
A	7606210021	41.30	48N2008	122W1583	11.80	2.0
A	7606221455	37.66	48N2116	122W3250	16.50	1.5
A	7606250423	18.67	47N3489	122W4883	24.00	1.4
A	7606281412	45.94	47N0842	122W0649	18.60	1.2
A	7607040555	47.73	48N2535	122W0523	21.70	1.5
A	7607080318	22.90	47N1558	122W0412	18.60	1.4
A	7607101902	45.64	47N5532	122W1967	36.40	1.6
A	7607111819	50.83	47N2623	122W0002	10.50	1.5
A	7607130800	04.80	47N4836	122W2306	26.20	1.4
A	7607180818	52.58	47N4940	122W2108	01.00F	1.1
A	7607210640	10.09	47N2308	122W4261	24.50	1.5
A	7607230906	01.72	47N4848	122W2077	21.10	1.1
A	7607231823	09.94	47N4615	122W2207	41.50	0.8
A	7607291418	20.15	48N3509	122W3635	06.20	1.5
A	7608030756	03.95	48N5679	122W4460	19.60	2.6
A	7608040604	48.97	47N2119	122W1959	23.30	1.3
A	7608060536	17.47	47N4354	122W1527	31.20	1.2
A	7608111034	18.71	47N3386	122W4176	20.80	1.1
A	7608111100	58.24	47N2796	122W4316	23.20	1.1
A	7608121343	23.86	47N3756	122W1220	31.20	1.1
A	7608140405	27.42	47N4735	122W2042	29.90	1.3
A	7608201137	04.32	47N2890	122W1842	35.80	1.5
A	7608211052	38.23	47N2906	122W1728	23.50	1.6
A	7608220044	00.26	47N1847	122W2562	17.30	0.9
A	7608231202	11.22	48N0649	122W2807	01.00F	1.7
A	7608251914	12.14	47N3073	122W0560	17.70	1.5
A	7608262233	34.84	47N1854	123W1674	09.00	1.7
A	7609020849	07.69	48N0145	122W3348	28.40	1.4
A	7609021336	10.98	48N1184	122W4645	23.50	4.2
A	7609021336	11.00	48N1230	122W4566	24.00	4.3
A	7609021348	22.17	48N0904	123W0903	61.90	1.4
A	7609030344	10.36	47N3499	122W1709	28.90	1.3
A	7609030457	28.79	48N1244	122W4780	20.50	1.2
A	7609080821	01.63	47N2256	123W0568	49.50	4.5
A	7609081947	43.94	48N1172	122W4632	28.80	2.0
A	7609122123	06.71	47N3207	122W2156	19.90	1.1
A	7609162034	58.47	47N2596	122W4271	11.60	1.4
A	7609172006	51.87	48N1191	122W3456	30.30	1.2

A	7609210007	46.52	47N4149	122W3501	09.10	0.8
A	7609211536	42.40	48N0754	123W0670	35.80	1.0
A	7609250439	24.51	47N4116	123W0461	46.60	1.9
A	7609260019	38.89	48N1086	123W1254	44.30	2.0
A	7609260538	17.99	47N3364	122W2154	31.40	1.1
A	7609261506	37.54	47N2291	122W4289	23.60	1.0
A	7609271505	03.16	48N4059	122W4753	66.30	1.7
A	7610010935	55.02	47N5439	122W1175	27.00	2.1
A	7610021446	51.62	47N3978	123W0355	04.30	1.3
A	7610032101	23.36	47N3536	122W3800	27.60	1.1
A	7610041914	07.32	48N1270	122W4662	23.40	1.7
A	7610091742	30.73	47N2743	122W4521	21.40	1.7
A	7610181110	41.78	47N2360	122W0040	18.40	2.2
A	7610190807	23.41	48N1392	122W2136	33.90	1.5
A	7610200932	36.86	48N3312	123W2972	18.10	1.4
A	7610201224	14.06	47N2412	122W0139	15.70	1.8
A	7610201958	37.12	47N0294	122W1187	04.80	1.5
A	7610230239	20.27	47N5341	122W3805	11.40	0.9
A	7610231937	06.71	47N3749	122W1149	26.90	1.3
A	7610232325	03.17	47N1023	122W0965	21.90	1.2
A	7610290934	58.53	47N0750	122W5904	16.90	0.9
A	7610291755	58.72	47N5350	122W1369	31.90	1.6
A	7610301346	55.79	48N3010	122W0163	04.90	2.2
A	7611051546	25.67	47N2709	122W3270	24.70	1.8
A	7611151151	52.58	48N2841	123W2340	17.30	0.9
A	7611160741	35.73	47N2908	122W1709	24.90	1.5
A	7611161814	35.62	47N5280	122W5178	43.70	1.4
A	7611201439	05.36	48N2078	122W3119	18.70	1.5
A	7611240151	00.09	47N1674	122W1369	16.20	0.9
A	7612042032	44.73	47N4549	122W1674	50.90	1.4
A	7612050501	39.35	47N3621	122W3685	19.90	1.3
A	7612070635	22.20	47N5142	122W3018	01.00F	1.2
A	7612092322	16.76	47N3730	122W1270	26.20	1.5
A	7612110417	08.38	47N0950	122W4182	47.30	1.2
A	7612121419	34.31	47N5403	122W1329	31.00	1.0
A	7612130210	54.09	48N4621	122W2436	13.60	1.4
A	7612181804	31.32	47N2013	122W2875	13.30	1.7
A	7612191338	19.80	48N1075	122W3634	60.60	3.3
A	7612191945	47.22	47N2394	122W4249	22.10	1.5
A	7612230551	35.43	47N4814	122W5528	48.60	3.6
A	7612301457	57.00	47N2995	122W5696	45.90	2.2
A	7612310655	29.87	48N1024	123W0159	47.70	2.0
A	7701010902	53.11	47N4730	122W0349	27.40	0.8
A	7701041223	32.54	47N4576	122W3187	23.40	1.4
A	7701060009	49.55	48N2410	122W5069	39.00	0.9
A	7701070336	17.39	47N3130	122W4661	21.60	1.2
A	7701080221	53.07	47N2900	122W2404	32.50	1.1
A	7701241531	54.96	47N3392	122W1838	24.00	1.2
A	7701262337	16.80	48N1793	123W1005	47.20	1.3
A	7701310419	52.19	47N2976	122W2355	22.00	0.6
A	7702030623	31.88	48N4121	123W4287	19.30	2.2
A	7702061938	22.77	47N4795	122W2088	27.20	1.0
A	7702070542	15.57	48N3405	123W0266	03.60	1.2
A	7702082219	32.58	47N2986	122W0151	08.00	1.6

A 7702120346	11.17	47N4351	122W1736	23.40	1.3
A 7702180926	11.40	47N2649	122W1890	25.50	1.0
A 7702202139	02.07	47N4531	122W1885	26.50	1.6
A 7703070916	26.46	47N1750	122W3857	21.80	2.0
A 7703121622	55.36	47N5552	122W4834	01.00F	0.8
A 7703131251	19.09	47N1682	122W2244	21.70	1.0
A 7703151500	55.64	47N1824	122W0721	56.70	1.3
A 7703170044	11.97	47N2989	122W0142	06.50	1.0
A 7703171832	03.60	47N3070	122W2815	15.90	0.8
A 7703220004	38.73	47N1802	122W2475	12.50	1.1
A 7703231316	27.16	47N1838	122W0047	23.80	1.0
A 7703261739	55.69	47N1104	122W1279	01.00F	1.3
A 7703262041	17.18	47N1207	122W1037	14.00	2.3
A 7703262042	43.77	47N0920	122W1294	25.00	1.5
A 7704010308	32.13	47N4278	122W3533	17.50	0.9
A 7704021941	51.50	47N1181	122W0971	18.50	0.9
A 7704030928	27.87	47N4594	123W0294	40.50	0.7
A 7704041254	37.91	47N1196	122W1043	14.70	1.6
A 7704080110	57.01	48N3897	122W0946	08.80	1.5
A 7704110931	02.92	47N1171	122W1067	16.30	1.4
A 7704121719	26.57	47N3380	122W1710	09.00	1.2
A 7704141232	54.50	47N5009	122W5449	22.70	1.0
A 7704182217	36.28	47N1894	122W2392	07.20	1.3
A 7704191549	14.36	47N3027	122W2522	22.40	1.2
A 7704191605	22.64	47N1871	122W2405	09.30	1.2
A 7704260703	16.35	48N5856	122W2910	08.50	1.2
A 7704281939	48.77	47N5575	122W3924	01.00F	0.9
A 7705012310	35.39	47N3260	122W5367	17.50	1.1
A 7705020933	02.73	47N1280	122W1761	19.00	1.0
A 7705070110	02.81	47N3560	122W3410	18.70	1.6
A 7705081214	08.16	47N4481	122W5078	52.40	2.5
A 7705172122	22.81	47N4999	122W0593	01.00F	1.3
A 7705182009	45.05	47N0238	122W1401	07.10	1.6
A 7705291853	11.50	47N5070	122W3427	47.00	1.6
A 7706020341	33.14	47N2980	122W4369	20.60	1.3
A 7706020932	09.95	47N3034	122W2213	23.60	0.9
A 7706030138	05.00	48N5562	122W0102	00.00	1.3
A 7706102000	23.30	48N4998	122W0552	30.00	
A 7706120915	55.77	47N1185	122W1023	13.40	1.5
A 7706121705	55.05	47N1209	122W1012	16.40	1.6
A 7706122203	34.03	47N1913	122W1720	07.40	1.5
A 7706122259	24.87	47N1118	122W0947	16.10	0.6
A 7706140159	29.76	47N2597	122W2017	13.40	1.0
A 7706140538	05.98	47N2622	122W2029	22.90	0.7
A 7706140707	57.58	47N2665	122W2056	23.50	0.5
A 7706170616	02.08	47N4551	122W4289	19.80	3.3
A 7706172237	21.88	48N3440	122W5871	06.20	1.2
A 7706172243	07.05	48N1657	122W2475	24.30	1.5
A 7706190423	15.63	47N2311	122W3888	46.10	3.0
A 7706191945	56.69	47N1207	122W1035	13.20	1.4
A 7706200527	06.89	47N2892	122W5358	22.60	0.7
A 7706221215	35.81	47N3220	122W1604	01.70	0.9
A 7706221319	07.14	47N1167	122W0941	17.70	1.1
A 7706222139	25.83	47N2849	122W5415	20.40	1.0

A	7706241404	49.54	47N1177	122W1007	16.20	1.0
A	7706272158	38.25	48N3199	122W5094	04.50	1.3
A	7707011113	14.57	48N1572	122W0350	17.60	1.7
A	7707032036	08.61	48N2016	122W4996	15.60	0.6
A	7707041419	47.00	48N4833	122W0699	05.20	2.6
A	7707051340	03.61	47N4707	122W4842	19.60	0.9
A	7707100719	29.88	48N3489	122W2484	15.20	3.5
A	7707100719	30.60	48N4242	122W2262	27.00	2.5
A	7707110936	15.30	48N4032	122W2418	27.00	1.0
A	7707131845	36.25	47N3537	122W4799	14.90	2.2
A	7707150936	15.87	48N3263	122W2248	11.20	1.5
A	7707182128	31.50	47N0380	122W1376	06.20	2.1
A	7707190836	17.47	47N2589	122W4772	05.90	1.9
A	7707201856	22.22	47N5089	122W0888	63.70	2.2
A	7707210916	40.20	47N1899	122W4204	23.10	1.3
A	7707230710	03.16	47N1822	122W3903	23.40	1.7
A	7707250659	09.16	47N2610	122W2107	18.80	1.4
A	7707252104	03.94	48N0374	122W5068	53.80	3.7
A	7708021051	37.18	47N2800	122W4374	23.60	1.2
A	7708021108	04.90	48N5928	122W0792	27.00	1.2
A	7708030459	41.88	47N3351	122W3462	24.80	0.6
A	7708040946	12.14	47N3788	122W0762	08.70	1.7
A	7708041418	41.80	47N4477	122W3962	14.40	0.9
A	7708051139	57.12	47N4906	122W1754	17.90	2.6
A	7708051437	11.84	47N5203	122W3556	14.40	0.8
A	7708051842	16.32	47N4963	122W1922	00.80	1.4
A	7708080625	05.09	47N4955	122W2830	24.40	1.7
A	7708100718	07.69	48N0820	122W4581	21.10	1.1
A	7708110610	02.69	47N1177	122W0912	14.60	1.3
A	7708132306	59.74	47N4691	122W1939	20.60	1.3
A	7708140818	48.29	47N2829	122W4947	22.10	1.4
A	7708180355	13.04	47N1750	122W4569	07.30	1.3
A	7708180837	20.06	47N2235	122W4305	21.70	1.4
A	7708190101	09.19	47N2137	122W5196	35.20	1.3
A	7708200520	26.88	48N4544	122W3231	18.30	1.7
A	7708210234	24.01	48N0020	122W3855	23.70	2.3
A	7708221256	50.06	47N1193	123W0852	19.20	1.1
A	7708230514	21.30	48N0995	122W4554	19.40	1.2
A	7708271403	58.33	48N4178	122W3402	17.10	1.7
A	7708300718	40.08	47N2107	122W2518	20.70	1.3
A	7708311710	07.29	48N2614	122W4365	45.00	1.4
A	7709052112	45.10	47N2202	122W1986	01.00F	1.6
A	7709120029	09.20	47N4020	122W2999	25.30	1.2
A	7709142246	56.47	48N1212	122W4771	22.90	2.2
A	7709160432	36.27	47N4994	123W2034	40.30	1.0
A	7709222017	19.61	47N1161	122W0998	17.10	1.4
A	7709250624	33.43	48N3015	122W0789	11.00	2.6
A	7709260659	13.34	48N3319	122W2622	21.40	1.7
A	7709300518	43.19	48N2902	123W1405	10.40	1.1
A	7710010802	42.12	47N5166	122W3630	20.80	1.1
A	7710040227	13.27	47N3424	122W1577	37.20	1.2
A	7710042345	27.43	48N4062	122W3054	05.60	1.7
A	7710061503	03.02	48N3446	122W3790	19.60	1.6
A	7710080125	05.10	48N5880	122W1560	25.00	1.1

A	7710081506	42.73	47N4488	122W3541	22.00	1.4
A	7710090149	29.91	47N3472	122W3438	21.50	1.3
A	7710121818	45.64	47N5744	122W4757	09.60	1.0
A	7710140253	32.27	48N3079	122W0900	10.40	3.5
A	7710150424	07.24	48N1459	123W4772	49.30	3.1
A	7710151852	18.77	47N3130	122W2275	20.20	1.3
A	7710190022	41.27	47N2918	122W1744	24.10	1.7
A	7710212310	33.75	47N1704	122W4058	10.00	1.1
A	7710220439	57.49	47N4725	122W4688	09.10	1.0
A	7710220900	37.74	48N1365	122W4107	23.30	2.3
A	7710272359	21.35	48N2867	123W1995	43.40	1.5
A	7710281156	46.77	47N2001	123W2329	10.70	1.6
A	7710290132	04.17	47N2100	123W2875	11.50	2.3
A	7710290840	37.28	47N2132	123W2704	13.20	1.8
A	7710291035	48.41	47N2138	123W2841	11.40	2.6
A	7710311018	52.52	47N5857	122W3586	22.90	0.9
A	7711060136	59.15	47N2434	122W3979	21.40	1.0
A	7711061107	02.78	47N4845	122W2239	09.00	1.2
A	7711131834	32.40	48N2407	122W3233	25.00	2.2
A	7711150804	57.15	47N2947	122W5181	22.50	1.0
A	7711150941	57.86	47N2988	122W3702	17.70	1.3
A	7711241416	04.09	47N1620	122W1569	16.70	0.7
A	7711251540	02.05	47N2621	122W0548	18.60	1.9
A	7711261101	38.78	47N2618	122W1918	17.40	0.8
A	7711300507	42.43	48N0596	123W0836	41.00	1.0
A	7712070851	52.68	47N3753	122W1268	23.80	1.7
A	7712090806	42.52	47N4513	122W3295	23.20	2.1
A	7712121049	51.46	48N1832	122W0753	11.10	1.8
A	7712141559	33.89	47N4434	122W3595	26.80	0.9
A	7712151301	31.83	48N1857	122W2320	02.30	1.3
A	7712180737	21.94	47N1905	122W0403	07.90	1.1
A	7712181316	33.34	47N4401	122W2837	22.70	0.6
A	7712191429	47.03	47N3675	122W4569	21.60	1.2
A	7712232040	14.62	47N3059	122W2983	16.60	1.2
A	7712240957	22.91	48N2920	123W2231	01.00F	0.9
A	7712262240	34.89	48N0262	123W1803	44.60	2.0
A	7712271954	28.43	48N2207	122W5755	03.80	1.4
A	7712300311	17.73	47N2394	122W0484	17.50	1.1
A	7801021422	21.20	47N3822	122W0816	04.40	1.4
A	7801051509	04.30	47N3420	123W1554	44.50	2.4
A	7801070414	25.40	47N4758	122W2376	21.40	1.4
A	7801091638	16.50	47N3234	122W1056	24.20	1.4
A	7801101647	58.40	48N5694	122W1836	00.70	2.7
A	7801110914	21.40	47N4236	122W4218	53.10	2.0
A	7801130142	17.50	47N4452	122W4542	27.80	1.0
A	7801190646	36.20	47N5148	122W0582	22.30	1.7
A	7801221647	13.80	47N2916	122W4560	16.50	1.3
A	7801230914	59.90	47N4656	122W2718	15.20	0.7
A	7801240710	48.50	48N4536	123W1278	53.80	1.3
A	7801251403	27.60	47N2682	122W4614	23.30	1.0
A	7801260207	55.70	47N5130	122W3786	22.70	2.3
A	7801260709	53.00	47N0708	123W0936	47.60	2.0
A	7802031209	30.40	47N3102	122W0108	12.20	1.3
A	7802031930	41.30	47N0312	122W1212	05.10	1.6

A	7802051637	45.70	48N4182	122W1122	14.70	1.4
A	7802091114	37.90	47N3378	122W4710	23.30	2.0
A	7802101409	16.10	47N4824	123W1476	43.70	3.1
A	7802110612	13.20	47N2706	122W4344	20.90	0.6
A	7802121016	11.70	48N2100	122W3240	20.90	2.2
A	7802121758	36.90	47N3084	122W3942	21.90	1.2
A	7802142219	04.40	47N1356	122W4206	17.50	1.2
A	7802151042	06.50	47N3960	123W0006	47.00	1.0
A	7802230446	42.70	47N3570	122W0282	06.10	1.0
A	7802261400	34.40	47N4278	122W1278	20.50	1.4
A	7802262148	18.60	47N2934	122W2412	18.60	2.1
A	7802270609	23.70	48N1338	122W3414	17.50	1.2
A	7802271028	53.40	48N1278	122W3330	16.50	1.4
A	7802271147	12.80	47N4734	122W2322	16.70	2.1
A	7802271647	26.90	48N1320	122W3390	16.70	1.3
A	7803020541	27.90	48N0120	122W3384	52.10	1.5
A	7803030858	53.80	47N5112	122W1800	20.30	1.6
A	7803040753	52.00	47N4248	122W3594	20.90	1.8
A	7803040901	36.30	47N2160	122W4236	11.70	0.7
A	7803041359	51.00	47N2286	122W3870	25.50	1.4
A	7803051813	35.90	48N0342	122W5988	57.00	4.0
A	7803051813	36.10	48N0306	122W5832	56.50	3.4
A	7803061620	49.30	48N0432	122W3702	58.50	1.5
A	7803071414	01.90	47N4254	122W1398	19.60	1.5
A	7803110525	12.20	47N5154	122W3786	19.00	0.9
A	7803111552	11.20	47N2502	122W4248	24.60	4.6
A	7803111552	11.20	47N2496	122W4260	25.00	4.3
A	7803111631	09.90	47N2514	122W4068	24.60	1.0
A	7803111637	31.90	48N2340	122W1842	15.20	1.4
A	7803111649	00.20	47N2388	122W4164	22.10	0.8
A	7803111806	17.60	47N2436	122W4158	23.90	1.5
A	7803111940	48.60	47N2436	122W4218	23.20	1.8
A	7803112118	40.80	47N2448	122W4212	22.90	2.2
A	7803120122	14.50	47N2472	122W4194	23.00	1.6
A	7803120541	48.30	47N2526	122W4200	25.70	1.5
A	7803121335	55.00	47N2394	122W4158	22.70	1.4
A	7803121553	49.20	47N3372	122W1674	01.00	1.2
A	7803122018	05.60	47N2394	122W4056	21.20	0.9
A	7803151753	28.30	47N1872	122W4152	07.20	1.1
A	7803171138	47.60	47N2628	122W4818	21.70	1.0
A	7803171913	33.70	47N2376	122W4068	21.30	1.0
A	7803190550	45.50	47N3018	122W2418	18.40	0.9
A	7803191553	13.30	47N2424	122W4164	22.00	1.2
A	7803201321	08.00	48N3450	122W5934	48.70	1.1
A	7803201407	34.10	47N2454	122W4050	24.00	1.2
A	7803202358	12.50	47N2358	122W4020	20.50	0.9
A	7803221107	49.70	47N2478	122W4254	23.90	1.4
A	7803221600	35.10	47N4812	122W2268	16.50	1.4
A	7803232341	39.60	47N4788	122W4776	20.00	1.3
A	7803250626	32.70	47N2418	122W4266	24.00	1.2
A	7803260515	37.90	48N2076	122W4380	51.90	1.2
A	7803261103	05.40	47N5184	122W4362	09.80	0.8
A	7803270448	11.10	48N2436	122W3252	24.90	1.8
A	7803280814	26.50	47N2400	122W4134	20.50	1.1

A	7803282201	13.50	47N4068	122W1014	16.90	1.1
A	7803290117	48.70	47N3870	122W3192	21.40	0.9
A	7803290351	03.10	48N3192	122W5190	57.90	2.1
A	7803291216	38.40	48N1224	122W4572	24.00	2.7
A	7803291216	38.50	48N1182	122W4548	23.60	2.9
A	7803291426	45.20	47N2736	122W3846	08.20	1.2
A	7803310803	00.10	47N2490	122W4278	23.80	4.0
A	7803310803	00.20	47N2502	122W4290	23.00	4.2
A	7804010839	14.10	47N2784	123W0036	43.60	1.0
A	7804010937	48.60	48N1992	122W3534	22.00	1.2
A	7804022218	34.60	47N3282	122W5412	17.80	2.2
A	7804031952	33.80	47N2286	122W3972	21.50	1.1
A	7804060608	32.40	47N2508	122W4260	23.30	1.8
A	7804061259	28.10	47N2514	122W4326	24.60	1.8
A	7804082038	22.60	48N4314	121W5994	02.70	1.6
A	7804141159	56.90	48N4794	122W0822	07.20	1.9
A	7804161110	54.00	47N3720	122W4944	24.30	0.6
A	7804171530	03.70	47N2574	122W4170	22.50	0.9
A	7804181033	51.10	47N2370	122W4092	19.40	1.0
A	7804190332	37.80	47N2502	122W4188	23.70	1.2
A	7804191051	39.90	47N2514	122W4254	24.30	1.3
A	7804191850	05.90	47N4806	122W5442	06.60	1.1
A	7804202341	33.80	48N3162	122W4320	26.90	1.0
A	7804242347	28.60	48N3066	122W4110	20.30	1.1
A	7804250846	49.00	47N5310	122W3042	53.00	1.5
A	7804250952	31.70	47N1716	122W3996	23.60	2.2
A	7804251528	59.00	48N4740	122W2184	02.30	1.4
A	7804251906	32.60	48N4734	122W2166	03.60	1.3
A	7804261226	20.50	47N2472	122W4236	23.60	1.2
A	7804261549	53.20	47N1788	122W4020	29.30	1.2
A	7804262150	10.30	47N2454	122W4188	22.00	0.9
A	7804262200	18.60	48N3882	123W0096	15.90	1.4
A	7804270214	51.80	47N1764	122W3984	23.30	1.8
A	7804280906	40.40	47N2532	122W4200	23.90	1.1
A	7804300057	50.40	47N2286	122W3072	11.10	0.7
A	7804301916	09.40	48N3186	122W0210	01.70	1.7
A	7805012046	14.10	47N2478	122W4236	22.10	1.7
A	7805021328	27.70	47N2430	122W4110	22.20	0.4
A	7805021634	07.30	47N2580	122W4938	23.30	1.9
A	7805050358	28.50	47N1944	122W3840	26.10	1.6
A	7805050529	47.50	48N2916	122W3366	17.40	2.3
A	7805060201	02.40	47N4374	122W3564	16.30	0.5
A	7805060944	50.40	47N3216	122W2370	19.30	0.6
A	7805061118	45.20	47N2448	122W4158	21.70	0.6
A	7805070523	44.90	47N1980	122W3798	22.30	0.7
A	7805091822	02.60	47N2532	122W4140	25.80	2.0
A	7805100229	45.00	47N0966	123W0570	43.30	2.7
A	7805101500	10.10	47N2472	122W4368	23.50	1.5
A	7805101719	36.30	47N0228	122W1230	05.50	1.3
A	7805111850	20.50	48N2790	122W3360	20.60	1.4
A	7805120848	05.50	47N4830	122W3180	03.60	0.7
A	7805131159	18.50	47N3804	122W0318	13.80	1.8
A	7805151921	50.90	47N2418	122W4152	20.50	1.1
A	7805170443	36.30	48N4890	122W0816	04.80	2.5

A	7805181850	19.80	47N5388	122W3654	07.40	1.1
A	7805201406	15.00	48N1962	122W1140	07.40	2.5
A	7805210941	53.90	48N5328	122W5052	15.80	1.3
A	7805241402	04.60	48N3990	123W0012	19.10	1.0
A	7805241955	58.50	48N1212	122W4464	21.00	0.8
A	7805242238	30.10	47N3588	122W0516	13.30	0.7
A	7805242318	37.80	47N3120	122W4068	03.40	1.1
A	7805260847	51.40	48N0966	122W1788	12.10	1.0
A	7805261054	38.20	47N3036	123W2502	06.60	0.6
A	7805261546	55.20	48N1902	122W4644	20.20	1.5
A	7805272311	25.40	47N2466	122W4404	39.20	0.8
A	7805292328	48.50	47N2586	122W5070	08.60	0.9
A	7806010352	26.00	47N1488	122W4866	18.70	0.6
A	7806020351	38.00	47N1728	122W5382	19.40	1.2
A	7806020516	04.10	47N3456	122W4698	14.70	0.8
A	7806030852	13.50	47N3420	122W4914	16.50	0.9
A	7806031212	37.80	47N3258	122W0162	17.90	1.0
A	7806040232	22.50	47N0408	123W0066	39.90	0.6
A	7806040657	50.10	48N1014	122W3048	28.80	0.8
A	7806040837	16.90	47N2472	122W4248	23.20	0.8
A	7806041404	03.60	47N2400	122W4086	20.70	0.7
A	7806042033	41.90	48N3180	122W2304	15.30	1.5
A	7806050344	24.90	48N3168	122W2334	16.80	0.8
A	7806071515	14.20	47N2532	122W0582	15.30	0.9
A	7806080108	08.30	47N2484	122W4200	22.60	0.8
A	7806101046	43.20	47N2490	122W4284	23.70	1.1
A	7806102125	13.60	47N1572	123W1026	42.90	1.9
A	7806110134	05.30	48N2736	123W1350	48.70	1.5
A	7806140554	44.50	47N2304	122W4836	31.50	0.8
A	7806180053	04.30	48N2544	122W2928	28.20	2.2
A	7806200845	24.70	47N4686	122W2772	21.20	0.8
A	7806201440	20.80	47N3276	122W4320	49.60	3.3
A	7806210334	02.00	47N1938	122W3570	15.20	0.4
A	7806220549	16.00	48N0852	122W4692	27.60	0.8
A	7806220751	27.10	47N2466	122W4230	22.20	0.9
A	7806230627	06.50	47N3402	122W2244	23.40	0.9
A	7806250858	02.10	47N2694	122W2160	27.00	1.0
A	7806271348	36.40	48N1434	122W2256	23.20	1.1
A	7806281320	08.70	47N3144	122W3516	23.00	0.8
A	7807010355	16.60	48N2868	123W3468	16.10	0.9
A	7807021728	32.50	47N4338	122W0114	22.80	1.0
A	7807031435	15.50	47N4278	122W1488	21.60	1.0
A	7807070005	53.00	48N3090	123W1272	32.70	1.5
A	7807081101	50.50	47N1986	122W3762	22.20	0.9
A	7807081554	50.10	47N4698	122W3276	19.30	0.4
A	7807082153	02.40	47N3726	122W1212	25.10	0.9
A	7807090612	43.10	47N2484	122W0444	18.00	1.4
A	7807091720	08.60	47N4578	122W0762	20.60	1.1
A	7807130525	43.80	48N2988	123W1434	09.10	0.9
A	7807140503	41.40	48N3870	122W1758	20.50	1.5
A	7807140744	07.20	47N3726	122W1206	27.60	1.1
A	7807150257	01.20	47N3726	122W1176	25.20	0.9
A	7807190342	23.70	47N3678	122W1104	26.30	0.7
A	7807191411	58.30	48N1818	122W0648	12.70	0.8

A	7807200320	03.10	47N4530	122W1410	20.90	0.9
A	7807210838	31.00	47N0912	123W0726	17.40	1.3
A	7807210838	51.90	47N0912	123W0756	16.90	1.3
A	7807220001	18.10	48N4434	122W5784	20.50	1.2
A	7807230547	45.60	48N0732	122W4398	27.70	1.9
A	7807290513	34.30	47N5274	122W3660	17.20	1.5
A	7807290642	41.80	48N4974	122W2730	01.50	1.3
A	7807290756	31.90	47N2442	123W1110	40.90	1.2
A	7807300612	01.00	47N0924	123W2088	31.60	0.8
A	7808052219	59.20	47N4722	122W4692	08.90	0.6
A	7808061305	23.20	48N2736	122W2544	16.20	1.4
A	7808081619	06.00	48N1254	122W0348	13.80	1.0
A	7808090149	06.50	47N4470	122W2280	20.70	0.8
A	7808102251	57.40	47N3276	122W0108	18.40	1.1
A	7808112254	15.00	47N2514	122W4308	23.30	1.0
A	7808120155	05.90	47N2496	122W4284	23.60	1.6
A	7808130646	30.70	47N3180	122W2880	19.20	1.7
A	7808171458	24.70	47N4776	122W0822	01.00	1.1
A	7808190151	18.30	48N3954	123W3522	53.90	3.9
A	7808190151	19.00	48N3774	123W3300	32.00	4.3
A	7808191125	08.20	48N3762	122W5952	14.60	1.2
A	7808231037	18.00	48N2274	123W1200	17.00	4.4
A	7808231037	18.50	48N2148	123W1338	20.90	3.6
A	7808240020	15.90	47N4746	122W3126	05.20	0.8
A	7808261739	42.90	48N0888	122W4602	25.50	1.3
A	7808270059	28.60	47N4524	122W3384	21.60	1.2
A	7808280217	11.30	47N3738	122W5748	46.90	3.2
A	7808280251	10.80	48N1734	122W3468	23.60	0.7
A	7808290338	44.80	47N5628	123W2238	38.20	1.2
A	7808291420	40.00	47N2556	123W0564	05.90	0.9
A	7808310246	08.30	47N2610	123W0618	06.50	1.6
A	7808311000	37.10	47N4758	122W2190	26.60	1.4
A	7809030545	00.40	47N5076	122W2922	22.30	2.1
A	7809050916	25.20	47N2922	122W5838	17.00	0.8
A	7809051317	46.80	47N3528	122W4872	20.30	1.0
A	7809060851	40.70	47N2514	122W4278	23.40	1.9
A	7809080557	32.60	47N4170	122W3222	05.90	0.6
A	7809090148	11.10	48N2934	123W0900	36.80	1.2
A	7809090836	56.90	48N1350	122W4338	24.00	1.4
A	7809140131	04.10	47N3654	123W0846	06.00	0.6
A	7809151649	26.80	47N2046	122W2028	14.20	2.2
A	7809161511	23.80	47N1962	122W1920	17.30	0.8
A	7809170232	00.60	48N5268	122W2040	21.00	1.4
A	7809202351	01.70	47N1938	122W3378	08.50	1.4
A	7809210322	03.20	47N5160	122W3774	20.50	0.5
A	7809210336	15.10	47N3042	122W5010	11.60	1.0
A	7809232302	47.30	47N2424	122W4188	21.80	0.7
A	7809241957	32.80	47N4212	122W5874	02.70	0.6
A	7809261734	52.80	48N1242	123W3066	01.00	2.0
A	7809271234	18.50	48N1590	123W1098	42.90	2.2
A	7809290927	55.80	47N4278	122W1662	21.30	0.7
A	7809291848	29.50	47N1860	122W4698	19.90	0.4
A	7809291852	14.40	47N1842	122W4740	21.80	0.6
A	7809300527	47.70	48N0702	123W0366	27.30	0.8

A	7809301904	09.90	47N4740	122W3168	46.20	0.6
A	7810021325	57.70	47N3876	122W4074	23.30	0.6
A	7810021442	54.20	48N3450	122W1698	06.50	1.0
A	7810050605	03.40	47N1944	122W1776	06.90	0.8
A	7810060455	42.50	47N3954	122W1494	27.10	1.4
A	7810060855	46.40	47N2244	122W1590	02.70	1.0
A	7810081026	34.50	47N3120	122W5130	22.70	0.5
A	7810081505	38.80	47N2208	122W2166	12.10	0.7
A	7810081615	43.70	47N5292	122W2232	32.50	1.4
A	7810131314	00.90	48N3606	122W2154	10.00	1.4
A	7810140916	33.40	47N4602	122W5070	22.70	1.3
A	7810141448	00.70	47N1218	122W0534	19.90	1.3
A	7810162013	36.00	47N1914	122W2424	22.80	1.5
A	7810162022	35.80	48N1950	122W2670	20.20	1.3
A	7810170613	26.20	48N1782	123W0948	41.70	0.8
A	7810170751	43.50	47N1854	122W1476	08.30	1.6
A	7810170816	17.90	47N5976	122W4998	50.10	1.3
A	7810171924	51.60	47N5094	123W0726	47.10	1.0
A	7810190208	45.60	48N2346	123W0420	20.30	1.1
A	7810221625	18.50	47N3288	122W2076	22.70	1.0
A	7810260528	13.40	48N1116	122W5790	23.70	1.1
A	7810261330	17.30	48N4740	122W0894	12.20	1.4
A	7810271316	34.50	47N2424	122W2328	17.50	1.2
A	7810281525	18.90	47N5178	122W0048	17.10	1.4
A	7811020159	39.10	47N4950	122W4332	22.00	0.8
A	7811020359	46.30	48N1230	122W4578	25.50	1.9
A	7811022131	18.60	48N1668	122W1014	17.60	1.5
A	7811081852	00.90	47N3054	122W3498	25.50	1.1
A	7811090359	51.50	47N1074	123W0138	31.70	1.1
A	7811122023	59.00	48N3318	122W1560	00.80	1.1
A	7811141010	10.20	47N4290	122W1446	23.70	1.2
A	7811150527	41.20	47N3126	122W2838	17.90	1.2
A	7811171555	30.80	48N1830	122W2724	52.50	1.1
A	7811210521	17.30	47N2874	122W5670	14.10	2.0
A	7811250618	28.20	47N2460	122W4182	21.90	1.0
A	7811281247	58.60	47N5010	122W4770	05.50	0.9
A	7811301124	37.90	47N0522	122W2544	43.70	1.2
A	7812010135	15.90	47N3078	122W3438	25.60	1.6
A	7812010742	42.70	47N2814	122W4086	31.00	0.4
A	7812030912	29.10	47N2964	123W0126	15.60	2.5
A	7812031352	48.90	47N4440	122W1842	25.40	1.7
A	7812060042	27.60	47N2460	122W4194	23.90	1.2
A	7812060451	43.10	47N1818	122W1734	01.00	1.0
A	7812060533	44.20	47N1626	122W1632	18.30	0.7
A	7812092209	58.90	48N1560	123W0852	48.60	1.6
A	7812130405	27.40	47N4908	122W2094	07.60	1.0
A	7812132059	11.30	47N2574	122W4854	24.60	1.3
A	7812140159	10.50	47N3666	122W1230	25.20	0.9
A	7812180152	23.60	48N2172	122W5052	19.30	1.6
A	7812181456	46.40	48N2208	122W5094	18.30	1.4
A	7812281218	58.30	47N1854	123W0978	42.00	3.4
A	7812290841	34.40	48N1590	122W3276	23.80	1.0
A	7901061348	54.65	48N5064	122W1063	01.00F	2.9
A	7901120606	37.43	47N3920	122W1302	20.60	0.9

A	7901130905	51.67	47N5658	123W0916	42.40	2.6
A	7901160430	00.21	48N3355	122W5996	05.70	1.1
A	7901161604	15.32	47N4634	122W1694	20.10	1.0
A	7901181751	40.91	47N1810	123W0816	39.40	1.6
A	7901190336	54.47	47N3060	122W1735	25.80	0.8
A	7901241238	40.71	48N1200	122W4613	24.60	2.5
A	7901271601	10.43	48N1228	122W4625	20.70	1.3
A	7902010027	15.46	47N3435	122W1891	20.20	0.9
A	7902011610	00.78	47N1827	122W3792	18.20	1.8
A	7902020321	10.83	47N2523	122W4283	23.00	1.0
A	7902030733	19.81	47N3030	122W0601	15.40	1.2
A	7902061109	48.83	47N0652	123W0704	26.40	1.6
A	7902090040	00.85	47N2709	122W4114	18.10	1.3
A	7902102336	46.07	47N2299	122W2779	08.40	2.2
A	7902120530	57.42	47N5183	122W0751	19.70	1.5
A	7902141653	29.23	48N0490	122W3699	27.00	1.0
A	7902181739	20.20	47N2515	122W4163	23.70	1.0
A	7902181758	55.78	47N3855	122W1228	20.70	0.7
A	7902190043	44.55	48N3244	123W2813	19.60	1.2
A	7902220606	49.99	47N2699	122W4355	21.60	0.8
A	7903070019	57.59	47N3892	122W1717	21.50	0.8
A	7903070808	24.87	47N3775	122W4592	26.20	1.4
A	7903071915	39.49	47N4541	122W2845	21.40	1.1
A	7903121037	20.81	47N1594	122W5007	07.10	1.2
A	7903121241	35.80	48N1204	122W4593	25.20	3.8
A	7903130329	33.31	48N1886	122W3293	29.40	1.0
A	7903140711	55.18	47N2673	122W0042	19.60	1.4
A	7903141222	29.19	47N2905	122W2064	25.10	2.4
A	7903171729	14.03	48N4548	122W4664	11.20	1.5
A	7903200518	55.23	47N3152	122W2707	19.60	0.9
A	7903222305	30.89	48N1838	123W1090	45.10	2.4
A	7903241517	27.07	48N2541	123W2716	11.30	1.5
A	7903260139	35.09	48N5008	122W2730	05.40	0.7
A	7903260707	41.75	47N1679	123W4421	32.00	1.5
A	7903271238	15.10	47N4281	122W0417	08.90	1.3
A	7903280710	50.23	47N2564	122W4187	22.00	0.9
A	7903301236	10.54	47N4645	122W4537	01.00F	0.7
A	7903302343	54.50	47N5615	122W1697	22.00	1.6
A	7903311513	17.63	47N4374	122W2339	23.40	1.1
A	7904020759	10.77	47N2837	122W3121	25.50	1.3
A	7904021138	08.12	47N1967	122W0091	18.50	0.8
A	7904021314	28.63	48N3151	122W2514	11.90	0.5
A	7904021904	44.57	48N5021	123W0946	19.40	1.4
A	7904051834	50.92	47N2792	122W2328	17.50	1.1
A	7904052253	00.26	48N2567	122W3446	26.50	1.5
A	7904052258	52.05	48N2624	122W3380	22.80	1.0
A	7904060107	44.47	47N5554	122W3206	49.80	1.8
A	7904061156	36.99	48N1261	122W4526	21.90	0.5
A	7904070819	37.78	47N3186	122W1218	23.10	1.3
A	7904110852	17.12	48N3282	122W2960	14.00	0.8
A	7904150646	30.18	47N3976	122W3993	21.90	1.3
A	7904151025	44.42	47N2156	122W2123	08.60	1.1
A	7904151421	49.42	47N1933	122W3697	20.20	1.2
A	7904170255	14.35	47N5031	122W4832	01.00F	1.1

A	7904200543	29.61	48N1198	122W4532	22.00	1.5
A	7904200940	51.79	47N5229	122W3613	18.90	1.8
A	7904201643	17.77	47N4416	122W3637	16.80	1.3
A	7904261100	57.85	47N4622	122W4958	23.80	0.7
A	7904291221	39.90	48N4838	123W2368	10.00F	1.5
A	7904291541	19.18	47N3695	122W1256	24.60	1.1
A	7905011959	14.64	47N2484	122W4287	24.90	1.4
A	7905012044	03.80	47N3150	122W4491	24.30	1.1
A	7905030335	32.00	47N2173	122W2105	08.70	1.8
A	7905100915	24.30	47N4416	122W1729	25.20	1.0
A	7905101208	07.57	47N3124	122W5579	01.80	0.9
A	7905101220	02.64	47N3729	122W1690	07.30	1.0
A	7905110541	29.00	47N2717	122W4118	27.20	0.4
A	7905161340	47.04	48N2181	122W5017	19.50	0.6
A	7905161559	50.24	48N3508	122W5641	52.10	1.3
A	7905180031	39.24	48N3815	122W5907	15.10	1.4
A	7905191628	10.80	47N2806	122W3905	24.50	1.0
A	7905200310	00.99	47N4428	122W3498	07.50	1.0
A	7905220032	11.66	47N5071	122W0201	01.00	1.3
A	7905220936	46.17	48N0286	123W0937	42.50	1.3
A	7905251940	51.75	48N2511	123W3598	18.20	1.0
A	7905260012	00.63	47N3587	122W4656	18.40	1.2
A	7905271726	17.89	47N4947	122W2720	22.40	1.2
A	7905281216	18.37	48N3980	122W0738	10.20	1.1
A	7905291302	30.73	47N5933	122W1403	08.40	1.2
A	7905300230	10.54	47N2303	123W1772	12.00	1.3
A	7905302232	47.32	48N3324	122W1932	10.90	1.1
A	7906121639	47.62	48N3206	122W3730	22.80	1.6
A	7906150420	35.93	48N1776	123W2726	20.70	1.2
A	7906160936	26.24	48N1256	122W4352	07.70	0.8
A	7906161133	51.30	47N1514	122W3985	24.00	2.4
A	7906161542	01.56	47N2276	122W4230	21.40	1.1
A	7906181439	10.10	47N5877	122W0987	01.00F	1.4
A	7906211355	18.55	48N2411	122W5794	47.00	1.7
A	7906220912	08.28	48N3960	122W5906	19.70	1.2
A	7906220936	40.41	48N5279	122W1416	09.90	2.0
A	7906231534	09.04	47N2176	122W0913	09.90	1.7
A	7906231534	57.76	47N2117	122W0877	16.20	1.3
A	7906232126	12.38	47N2131	122W0789	17.80	1.3
A	7906240421	00.09	47N5195	122W3766	15.00	0.9
A	7906270854	11.05	47N2264	122W2750	49.60	2.5
A	7906300932	55.66	47N2651	122W4506	23.70	0.5
A	7906301150	11.38	47N2471	122W4292	23.10	1.1
A	7907022308	22.52	47N4969	122W4115	21.70	1.5
A	7907042127	08.59	48N0673	123W0874	43.70	1.4
A	7907050112	08.17	47N0822	122W5767	44.80	0.8
A	7907091514	55.43	48N2301	122W4534	14.50	1.4
A	7907100506	49.34	47N2635	122W2173	17.90	1.0
A	7907110206	41.76	47N2515	122W4247	24.40	2.3
A	7907140306	38.79	47N2865	123W0400	08.10	1.6
A	7907191338	59.66	47N3999	122W0105	20.50	1.8
A	7907200736	14.15	47N2885	122W1682	24.90	1.2
A	7907201846	55.89	48N4171	123W0433	13.00	1.8
A	7907202117	03.62	48N1811	122W5949	47.60	1.3

A	7907211053	34.47	48N1931	122W2164	04.50	1.5
A	7907220411	30.98	47N4589	122W2864	21.40	0.6
A	7907221825	27.07	47N4473	122W2575	22.80	1.1
A	7907231703	33.38	48N4831	122W1533	03.20	1.6
A	7907240401	53.46	47N3671	122W3271	23.00	1.1
A	7907240619	39.77	48N1926	122W1685	07.20	1.1
A	7907240623	01.51	48N1873	122W1703	07.20	0.8
A	7907290744	34.05	47N4229	122W0225	25.70	1.5
A	7907301115	07.25	48N2829	123W1740	23.90	0.7
A	7907310629	44.15	47N5374	122W0843	26.20	2.2
A	7907310717	57.22	47N5380	122W0829	26.10	1.7
A	7908011801	49.18	48N0983	122W4250	01.00F	0.4
A	7908060132	46.03	47N3344	122W4137	12.20	0.8
A	7908060624	12.15	47N4375	122W0768	06.50	0.8
A	7908081100	34.74	47N2968	122W3061	22.50	0.7
A	7908090201	33.81	48N1004	122W4368	01.00F	1.5
A	7908100315	31.66	47N3229	122W4389	23.10	1.3
A	7908100522	46.10	48N1620	122W1399	08.60	1.3
A	7908100542	45.25	48N4342	122W0126	03.40	1.3
A	7908101748	09.39	48N4351	122W0032	03.90	1.4
A	7908120509	12.95	48N2925	122W2309	22.40	1.0
A	7908140409	43.37	47N3717	122W1236	26.80	1.2
A	7908142036	30.49	48N1125	123W0547	54.80	2.7
A	7908161730	16.22	48N1660	122W1037	17.00	1.1
A	7908180345	36.34	47N2468	123W1565	04.00	0.8
A	7908181219	52.05	47N1630	122W2346	20.40	0.8
A	7908290819	54.51	48N2117	122W3634	20.70	0.6
A	7909050349	18.85	47N3107	121W5999	07.30	2.1
A	7909050647	03.26	47N3067	122W0003	08.60	1.4
A	7909061120	25.92	47N2951	122W0623	22.10	0.7
A	7909081303	54.37	47N2618	122W4628	06.00	1.9
A	7909101815	32.37	48N3974	122W5990	18.30	1.4
A	7909111455	13.87	47N4859	122W5013	48.70	2.0
A	7909160744	22.23	47N2623	122W4774	06.00	1.5
A	7909290927	05.36	47N5621	122W2560	29.80	2.1
A	7909300130	35.84	47N4500	122W2422	20.70	1.1
A	7910020054	37.29	47N2507	122W4379	39.80	0.8
A	7910050637	34.97	47N3562	123W1595	50.40	2.1
A	7910051029	33.05	47N2537	122W4129	23.40	0.7
A	7910051638	27.85	47N4526	122W3340	20.00	1.0
A	7910091553	43.31	48N2405	123W1450	20.00	1.4
A	7910101154	23.49	47N3527	122W4446	25.30	1.5
A	7910102010	36.18	47N4562	122W3081	50.20	1.5
A	7910121715	58.17	47N4668	122W4934	23.50	1.3
A	7910151240	53.36	47N2892	123W2828	34.60	0.9
A	7910180843	16.97	47N2383	122W0363	08.20	0.8
A	7910180849	18.45	47N2383	122W0365	08.30	0.8
A	7910181916	31.93	47N2321	122W0503	09.30	0.9
A	7910200122	18.97	48N2433	122W1006	23.80	1.1
A	7910200615	50.83	47N1520	122W2600	10.60	1.0
A	7910241601	32.77	48N2179	123W2240	01.00F	1.6
A	7910252232	39.77	47N1987	122W2008	08.80	1.3
A	7910300032	15.60	48N0228	122W1919	34.10	2.4
A	7910301400	04.25	48N0171	122W1174	24.90	0.7

A	7910312047	48.28	47N0273	122W1214	04.10	1.4
A	7911021522	11.88	48N2504	122W0218	07.10	1.8
A	7911081541	12.00	47N5410	122W3009	38.90	1.6
A	7911090824	54.66	47N3305	122W3086	07.40	1.6
A	7911090958	19.13	47N4646	122W3491	20.90	1.3
A	7911091732	55.06	47N1407	123W5252	09.10	1.2
A	7911092043	15.15	47N2973	122W0237	05.70	1.0
A	7911101606	59.22	47N2800	122W4405	22.40	1.0
A	7911102355	25.68	48N0025	122W1439	25.10	2.0
A	7911111450	12.22	47N2940	122W1853	21.50	1.1
A	7911111502	25.45	47N2961	122W1813	22.00	0.9
A	7911121936	11.02	47N1778	122W2174	49.50	1.6
A	7911131234	36.83	48N0507	122W3892	01.00F	1.0
A	7911160814	24.46	47N5173	122W2783	11.70	1.0
A	7911171644	25.39	47N1627	122W1453	14.30	1.4
A	7911180437	25.99	48N3242	122W2244	05.70	0.8
A	7911210201	41.88	48N0107	122W1171	24.20	0.9
A	7911210335	47.41	47N3811	122W0329	18.30	1.4
A	7911232339	49.54	48N2622	122W3793	25.50	1.4
A	7911260614	49.96	48N2572	122W1912	03.80	1.3
A	7911262318	27.06	48N3230	122W2442	19.50	3.8
A	7911262323	37.61	48N3708	122W2402	08.30	1.2
A	7911262327	11.51	48N3285	122W2521	18.00	2.4
A	7911270213	47.08	48N3260	122W2456	16.80	3.5
A	7911270223	27.70	48N3195	122W2567	20.00	1.6
A	7911270231	15.09	48N3374	122W2528	15.40	1.7
A	7911270353	16.84	48N4336	122W2361	09.90	1.1
A	7911270508	51.88	48N2842	122W1912	04.40	1.5
A	7911271049	27.49	48N4653	122W2595	07.50	1.5
A	7911280308	21.78	48N2530	122W5362	54.00	2.4
A	7911280335	30.14	48N2919	122W1901	01.70	1.4
A	7911281549	18.44	48N3234	122W2439	19.70	2.1
A	7912020212	27.79	47N4161	122W0776	11.50	1.3
A	7912041208	31.85	48N3478	122W2581	28.40	2.1
A	7912071126	02.14	47N3191	122W2834	19.40	0.8
A	7912080026	49.98	47N4721	122W1101	27.00	1.3
A	7912090859	20.73	47N1384	122W1669	06.60	1.1
A	7912161027	18.42	47N2574	123W0229	21.30	0.7
A	7912161537	36.71	48N3372	122W2494	26.00	1.7
A	7912171036	34.01	47N2974	122W3431	17.70	1.1
A	7912191108	46.79	47N2232	122W1940	25.40	0.5
A	7912210823	39.64	47N3520	122W3797	21.80	0.6
A	7912221422	49.37	47N3316	122W3631	26.60	1.0
A	7912222219	22.30	47N2414	122W4061	21.60	0.4
A	7912230123	17.24	47N2411	122W0438	06.70	1.6
A	7912230313	28.32	47N4373	122W1525	22.80	1.1
A	7912251520	04.59	48N1026	122W4899	26.20	1.5
A	7912301654	58.77	48N1778	122W4032	36.40	1.7
A	8004161446	0.	48N0780	122W5404	50.83	3.8
A	8004270600	0.	47N2296	122W3347	23.13	3.7
A	8006082240	0.	47N5818	123W0076	50.82	4.3
A	8006180203	0.	47N2527	122W4252	25.08	0.
A	8006191859	0.	48N3054	122W0313	8.16	1.2
A	8006231605	0.	47N3200	122W1555	2.06	3.7

A	8006231609	54.61	47N3243	122W1561	5.90	3.3
A	8006270028	0.	48N2018	122W4327	52.90	1.3
A	8007011239	0.	48N1865	122W0569	12.93	0.
A	8007022058	0.	47N0285	122W1143	5.11	0.
A	8007040414	0.	48N2029	122W3114	9.50	0.
A	8007071006	0.	48N1272	122W4641	23.00	0.
A	8007111845	0.	48N1861	122W0561	12.66	0.
A	8007111845	0.	48N1861	122W0573	14.09	0.
A	8007111914	0.	48N1865	122W0551	14.27	0.
A	8007112314	0.	48N1873	122W0569	15.65	0.
A	8007141029	0.	48N1736	122W1260	7.02	0.
A	8007141433	0.	48N1754	122W1181	6.98	0.
A	8007141707	0.	48N2003	122W5695	45.90	0.
A	8007211103	0.	48N3177	122W3395	20.34	0.
A	8007301418	0.	47N4697	122W1879	0.36	0.
A	8008012046	0.	47N1493	122W1532	3.13	0.9
A	8008081412	0.	47N1826	122W2563	8.10	0.
A	8008111022	0.	48N3593	123W0534	10.08	0.
A	8008111024	0.	48N3568	123W0555	8.18	0.
A	8008111840	0.	48N3202	122W4156	49.72	0.
A	8008150336	0.	47N4218	122W3954	19.03	1.2
A	8008151209	0.	47N3834	122W0448	12.34	0.7
A	8008152110	0.	47N4547	122W2176	9.61	1.1
A	8008161646	0.	47N1973	123W1385	43.38	1.6
A	8008200228	0.	47N3506	122W0166	9.54	2.0
A	8008221601	0.	47N2223	122W4227	23.12	1.2
A	8008221859	0.	47N5397	122W3720	20.21	1.5
A	8008231402	0.	48N4516	122W5231	16.01	1.7
A	8008241632	0.	47N4579	122W2363	9.29	0.
A	8008290034	0.	47N2525	122W4206	23.06	0.9
A	8008312110	0.	47N4397	122W2367	23.84	1.3
A	8009020154	37.40	48N1181	122W2438	29.76	2.1
A	8009041535	66.52	47N4306	122W5847	45.16	1.2
A	8009061118	32.97	47N3172	123W2152	45.61	2.8
A	8009070252	22.56	47N4643	122W4322	15.90	0.8
A	8009110454	34.73	47N3987	122W1352	24.12	1.1
A	8009120352	2.96	48N1381	123W 440	25.28	0.4
A	8009121215	17.97	47N2020	123W1399	42.08	1.0
AP	8009220128	16.34	47N1165	123W1418	6.12	1.2
A	8009221718	0.	48N1556	122W1459	5.08	1.7
A	8009271222	14.23	47N3059	122W 105	0.10*	0.0
A	8009300437	69.15	48N2431	122W1912	18.51	2.7
A	8009300437	109.01	48N2389	122W1862	16.83	2.3
A	8009300539	39.77	48N2227	122W1559	7.39	1.4
A	8009301631	73.84	47N4509	122W 349	13.89	2.8
A	8010011247	47.09	47N4494	122W 406	7.00	1.3
A	8010032209	28.97	47N4679	122W2504	21.72	1.1
A	8010040236	35.38	48N2445	122W1892	15.75	2.7
A	8010040500	34.66	48N2426	122W1888	18.61	1.1
A	8010042113	60.20	47N3136	122W 369	19.21	0.8
AP	8010042351	30.99	47N4602	122W 620	0.95	0.8
A	8010070022	52.29	47N5436	122W3680	7.01	1.1
A	8010070815	22.54	48N4271	122W 717	1.11	1.4
A	8010071515	8.47	47N2616	122W3178	49.31	1.8

A	8010081055	50.36	48N2633	123W 354	21.64	2.9
A	8010090950	0.	47N4981	122W0329	20.08	0.1
A	8010091952	22.99	47N3106	121W5987	9.37	0.7
A	8010130117	-13.80	40N4434	123W5287	19.92	1.9
AP	8010131845	31.51	47N5095	122W 470	3.36	1.7
A	8010142048	3.20	47N2302	122W4297	23.67	1.0
A	8010150045	22.44	47N2261	122W4180	23.25	1.2
A	8010150048	40.17	47N3065	122W 283	7.00	0.9
A	8010151148	26.40	47N1961	122W1898	16.61	1.7
A	8010151705	33.86	47N2673	122W 522	26.34	0.6
A	8010171606	27.31	47N4236	122W 244	9.37	0.7
A	8010171929	0.	47N4234	122W0796	10.00	0.8
A	8010182144	0.	48N2496	123W0349	19.63	1.2
A	8010191731	0.	48N0020	122W1443	22.20	1.2
A	8010200223	0.	47N2182	122W4093	10.00	1.3
A	8010200514	36.37	47N2328	122W4197	24.90	1.4
A	8010201419	24.72	47N2079	122W2159	23.65	1.3
A	8010202330	0.	47N2169	122W2165	10.00	1.3
A	8010221714	0.	48N4836	122W1023	3.33	0.
A	8010222204	0.	48N1517	122W1360	10.00	1.0
A	8010230449	0.	48N4875	122W1057	2.77	2.0
A	8010240635	16.39	48N1473	122W5083	21.01	1.1
A	8010291005	0.	48N1889	122W0419	10.00	0.3
A	8010300645	22.00	47N3918	122W1776	27.36	1.0
A	8010310254	38.29	47N3635	122W4746	18.29	1.0
A	8010311100	59.72	47N1856	122W2349	15.32	1.8
A	8010312313	46.14	47N1854	122W2285	15.46	1.3
A	8011021824	7.42	47N2473	122W2225	22.00	0.7
A	8011070959	29.10	48N1322	122W4297	28.60	0.2
A	8011071445	5.22	47N1391	122W5126	22.00	0.7
A	8011081140	39.47	47N4881	122W2230	20.89	1.3
AP	8011130121	45.18	47N3085	122W 445	7.04	1.0
A	8011181944	20.69	47N4004	122W 286	8.43	0.8
A	8011191644	54.62	47N4329	122W3695	15.90	0.5
AP	8011200033	60.95	47N4508	122W0421	0.10*	0.2
A	8011201719	57.60	48N3297	121W5970	0.10*	0.9
A	8011210801	12.67	47N3595	123W1681	41.85	1.0
A	8011242001	54.34	47N4869	122W3628	22.00	0.6
A	8011300107	9.57	47N1920	123W1498	44.96	2.6
A	8011301440	31.19	47N5184	122W 724	27.80	1.1
A	8011301856	39.82	47N3929	122W3429	26.66	0.6
A	8012022228	38.62	47N2434	123W3625	0.10*	1.0

APPENDIX III-1

CHARACTERISTICS OF MARINE SEISMIC SOURCES

by

D. M. Johnson

Characteristics of Marine Seismic Sources

Introduction

"High resolution continuous seismic reflection" (or continuous seismic sounding) is the widest-used and most economical method for studying the first hundred metres of soil beneath the sea floor.

The method enables the geometry, structure and configuration of the geolocial strata to be determined. However, in the prevailing state of techniques, seismics alone does not make it possible to make any affirmation:

- as to the nature of the soils,
- and yet less, as to their physical and mechanical properties.

While certain interpretations sometimes justify a presumption as to the state of consolidation of the soils (owing to the degree of penetration, for instance of signals with a given frequency and energy), these assumptions must necessarily be verified by core samples or in situ geotechnical measurements.

Preliminary recording of seismic profiles on a marine site makes it possible:

- to fix the locations of the geological and geotechnical soundings (drilling/core drillings and in situ measurements) as a function of the variations in the configuration of the subsoil,
- to reduce the number of these soundings,
- to extrapolate where necessary the results of core drillings and in situ measurements.

All seismic techniques currently applied for the reconnaissance of marine soils use the continuous reflection method. The refraction method is applied only when seismic reflection proves to be inoperative or the results obtained do not yield the expected accuracy.

Several types of devices are used in "high resolution seismics." The main of them are:

- sediment sounders (or echo sounders)
- boomers

- sparkers
- side scan sonar

These devices are characterized by their transmission frequency and consequently the penetration of the signal and its resolving power (or definition):

- the penetration is inversely proportional to the transmission frequency,
- the resolving power (and relective quality) decreases with the penetration and increases with frequency.

Since "Boomer", Echo Sounders, and Side Scan Sonar was used in the Shannon-Wilson reports, a discussion of their characteristics has been included in this Appendix.

BOOMERS (AND THE UNIBOOM)

The boomer or thumper is an electromechanical source invented by EEG.

Principle and characteristics of the boomer

Principle of the boomer

The boomer consists of:

- an induction coil against which an aluminium plate is applied by a system of springs,
- a bank of capacitors (connected to a sparking circuit) producing electrical discharges through the coil at regular intervals.

With each discharge, the eddy currents induced in the conductive plate cause it to move violently away from the coil. The initial movement of the plate triggers the acoustic pulse.

Characteristics of the boomer and Uniboom

The acoustic signature of a 1,000 J boomer has a signal duration of about 5 ms.

The spectrum for this boomer ranges from 200 to 2,000 Hz.

From the standpoint of enery distribution, the figure reveals:

- a very high amplitude of the initial pulse peak (a),
- a peak of negative amplitude (b) extending the signal.

This secondary peak is caused by the cavitation which arises behind the plate in the depressurized zone.

In the Uniboom system, the secondary pulse is eliminated by providing an elastic diaphragm on the inner face of the plate from the depressurized side. This diaphragm then absorbs part of the enrgy and thus limits the cavitation.

The duration of the Uniboom signal is limited to about 0.2 ms.

The frequency spectrum ranges from 500 to 10,000 Hz on the average (the frequency decreases slightly as the energy output increases).

The resolving power:

- of the boomer proper is not less than 2 m, owing to the considerable length of the signal,
- with the Uniboom, it can theoretically get down to 30-40 cm (comparable to the best sediment sounders).

Principle and equipment of the echo sounder

Principle of the echo sounder

The echo sounder puts out a brief ultrasonic pulse which is reflected from the sea bottom. The return echo is amplified and then continuously recorded.

Let V be the speed of sound in water and t the time interval between the emitted and return echo, the depth H is given by:

$$H = \frac{Vt}{2}$$

Equipment of the echo sounder

Transmission and reception are ensured by a common electro-acoustic transformer or transducer which converts the mechanical vibrations into electrical vibrations of the same frequency.

Coupled to an electric pulse generator, the transducer converts the electrical energy into acoustic energy on transmission, and conversely the reflected acoustic signal is converted into an electrical signal.

The most widely used transducers are based on the piezoelectric properties of certain ceramics (barium titanate, zirconate). They vibrate at a certain resonance frequency. These vibrations, transmitted to the water, act as sound pulses.

The optimum frequency range, which depends on the depths of water and nature of the bottom, extends from about 15 to 200 kHz, depending on the type of device. The higher the frequency, the more efficient the absorption.

At the recording end, the propagation times measured are converted into depth, depending on the speed of sound in water (from 1,460 to 1,560 m/s in sea water). For a given speed, the rate of the stylus, which inscribes along a strip of paper, determines the scale of the soundings, namely the number of metres of water represented on the width of the recording paper.

Characteristics of transducers

Transducers are characterized by their nominal frequency, directivity and level of energy.

The nominal frequency of a transducer designates its transmission frequency under permanent excitation (i.e., resonance).

For precision echo sounders, used for bathymetry, the sound beam is relatively narrow. The following are typical orders of magnitude:

- for common echo sounders:

$10\text{-}20^{\circ}$ at 50-30 kHz

- for large diameter echo sounders with very narrow beams, used at great water depths:

$3\text{-}6^{\circ}$ at 30-15 kHz

The transmission level of a transducer is a measure of the energy transmitted along the axis of the transducer, measured one metre away. A high transmission for the same electric power is the sign of better efficiency.

Resolving power of an echo sounder

Resolving power of an echo sounder essentially depends on the duration of the pulse, the angle of the ultrasonic beam, the depth of the water and topography of the bottom.

A resolving power is limited by the fact that it is impossible to transmit an extremely brief signal.

If Δt is the shortest discernible time interval between two echoes, then the depth resolutions is:

$$\Delta H = \frac{V}{2} \cdot \Delta t$$

where: V is the speed of sound in water.

Principle of the side-scan sonar. Formation of the echoes

The side-scan sonar transducer acts both as transmitter and receiver of the ultrasonic signals.

The system generally consists of:

- a round-nosed cylindrical body towed from the vessel (known as the "fish"), containing one or two (1) transducers (together with the associated electronic circuits),
- a towing cable ensuring the elctrical and mechanical links to the towing vessel,
- a one or two rack recorder using either electro-sensitive paper or a magnetic tape.

The side-scan sonar transducer:

- transmits short sound pulses to the water, perpendicular to the direction of travel,
- receives the echoes recorded aboard the vessel (following conversion into electric pulses).

The frequencies used vary from a few tens to about 100 kHz, depending on the particular unit.

Formation of the images

The sound pulses transmitted at regular time intervals (the repetition rate essentially depends on the lateral range selected) and the echoes resulting from the irregularities on the sea bottom are recorded as a function of time (two-way trip): clearly, the nearest echoes arrive first, followed by echoes from more distant zones at ever increasing intervals.

Each group of echoes resulting from a transmission is displayed on the recorder in the form of a trace inscribed cross-wise by the stylus on the recording paper which moves longitudinally.

As the vessel advances and the pulses occur one after the other, an image is formed on the recording paper by

(1) The sonar is generally bilateral.

juxtapostion of the traces (somewhat similar to that obtained on a television screen).

Geometry of the ultrasonic beam

The fineness and precision of the recording are a function of the narrowness of the ultrasonic beam, and of the frequency and duration of the pulse transmitted.

The shape of the transducer is selected so as to transmit a fan-shaped beam:

- with an angle of a few degrees in the horizontal plane (azimuth),
- with an angle of about 10 to few tens of degrees in the vertical plane (elevation).

The ultrasonic beam can be broken down into the following:

- a primary lobe with an angle defined conventionally as the sector in which the sound intensity is only 3 dB beneath that of the axial (maximum) intensity,
- a number of secondary lobes.

Even though only the primary lobe is actually used in practice, the secondary lobes present a certain interest. In particular, the sub-vertical lobe:

- gives a section of the bottom of the sea along the path of the vessel,
- enables any echo from an object situated in the water near the vertical of the vessel to be identified (for instance a shoal of fish).

Formation of the echoes. Angle of incidence

The features of the bottom brought to light are:

- either of topographical nature (variation of the angle of incidence),
- or related to the physical characteristics of the soil (variations in the coefficient of reflection or backscattering).

The way in which topographic echoes are formed is shown in Fig. . All the folds in the bottom cause the angle of incidence of the acoustic rays to vary and hence also the amount of reflected energy.

The useful part of the recording is that corresponding to angles of incidence of less than 30°, where the coefficient of reflection varies sharply with the angle of incidence. The ideal conditions therefore prevail for detecting variations in the angle of incidence and hence variations in the topography.

A change in the nature of the bottom modifies the intensity of the signal as much or even more than a change in the gradient (especially if the angle of incidence is between 20 and 60°). The reflection coefficient varies considerably when changing from mud to pebbles or rock, while sand lies somewhere in between.

Characteristics of the side-scan sonar

The side-scan sonar is essentially characterized by its longitudinal and transverse resolving powers.

Lateral range

The maximum range of a side-scan sonar depends on many factors, the leading ones being:

- the characteristics of the instrument:
- the pulse duration,
- the transmission power,
- the signal/noise ratio,
- the frequency ($rF^2 = 1,300$ is an empirical formula expressing the range in kilometres for an optimum frequency in kilocycles),

- the physico-chemical properties of the medium through which the sound waves are propagated,
- the implementation parameters
- the height of the "fish" above the bottom,
- the inclination of the axis of the beam from the horizontal.

Distortion of side-scan sonar images

There are various causes for the distortion of side-scan images, including the following:

- the obliqueness of the beams
- the slope of the bottom,
- the anisotropy of the medium through which the rays propagate,
- the navigating conditions
- the scales on the recordings.

APPENDIX V-1

SUBMARINE SLUMPING AND THE INITIATION OF TURBIDITY CURRENTS

by

N. R. Morgenstern

SUBMARINE SLUMPING AND THE INITIATION OF TURBIDITY CURRENTS

ABSTRACT

The conditions under which submarine slumping is known to have occurred are reviewed and the agencies causing them are discussed. Special attention is given to earthquake effects. It is pointed out that slumps can result in a wide variety of sedimentary structures and many of these structures are associated with liquefaction. The strength of sediments is considered, and the influence of underconsolidation due to high rates of sedimentation on the strength of marine sediments is treated in detail. The mechanics of slumping are analyzed from the point of view of both drained and undrained failure. It is thought that some slumps transform into high-density turbidity currents. The evidence for the existence of such currents is summarized and a theory presented to show that a slump can achieve sufficiently high velocities to transform into a turbidity current if the pore pressures induced at failure are high enough.

INTRODUCTION

Much of the progress in understanding the processes involved in subaerial landslides has been possible only through detailed analysis of particular cases. A minimum requirement for carrying out such an analysis is knowledge of the slope profile, the shape and location of the major slip surface, the water pressure conditions at the time of failure, the appropriate soil strength parameters, and the soil densities. With these data it is possible to perform faily reliable calculations to account for the movements of the soil mass. In the case of subaqueous landslides or slumps the necessary information is seldom available and few properly documented case records exist. It is therefore necessary to extrapolate from experience gained in the study of subaerial movements. It is also essential to study the fossil structures of slumps preserved in the geological record in order to establish the conditions under which slumping has occurred and to observe the influence of the movements on the structure of the sediments. Observations of stable submarine slopes and knowledge of the properties of the sediments composing them can be used to bound the occurrence of slumps. A review of some of the information that is available regarding submarine slumping suggests that there are two problems associated with the phenomenon that deserve particular attention. The first is whether it is possible for slumps to occur on gentle slopes, particularly on the open continental shelf and slope. The second problem is to account for the wide variety of sedimentary structures that have been attributed to slumping. These range from large sheets of strata that have been transported intact to turbidites (Dzulynski and Walton, 1965). Turbidite deposits are widespread (see Bouma, 1962) and their origin is still a matter of some debate. One mechanism that has been suggested is the transformation of a slump into a turbidity current and subsequent deposition of the turbidite.

Most sediments involved in slumps are likely to be normally consolidated.

However, in regions of high rates of sedimentation such as exist in some deltas, there will be a lag between the accumulation of the material and the consolidation associated with it. This gives rise to an excess pore pressure and the sediment is accordingly weaker. This underconsolidated material is evidently prone to slumping. Overconsolidated sediments also exist in a marine environment, the overconsolidation having been induced by removal of overburden by erosion of sediment during the development of submarine canyons and channels associated with sea fans. It will be seen that some very steep slopes that have been observed must be composed of material that is either overconsolidated or cemented. Nevertheless, the amount of exposure of overconsolidated material (excepting in submarine canyons) is probably small, and the influence of this aspect of sediment behavior will not be considered in any detail.

In the following, data regarding slope angles for both stable and unstable profiles are presented, and the agencies that can induce slumping are discussed. A further section reviews the various sedimentary structures that slumping can produce and shows that sediments after slumping can achieve a broad range of mobility from rigid block motion to turbulent flow. Shear strength properties of sediments are then discussed with special reference to the influence of metastability and underconsolidation. The mechanics of various modes of failure are introduced. Finally the acceleration of a soil mass moving down a slope is analyzed, and some conditions that must be satisfied for transformation into a turbidity current are suggested.

OCCURRENCE OF SLUMPING

Slumping has been observed or has been inferred to have occurred on a wide range of slope inclinations. One of the first papers to draw attention to the possibility of slumping on slopes of gentle gradient was by Heim (1908) who described the slip that flowed into Lake Zug, Switzerland, in 1887. The slope had an inclination of 2.5 degrees. Unfortunately, the reasons for the initiation of the movement are not clear. The observations of Archanguelsky (1930) are also often cited in this context. In studying a sequence of cores from the Black Sea, he observed that recent sediments were often absent from the slope leading from the upper part of the shore terrace to the deep basin of the sea. He did, however, find such sediments in a state of intense deformation and with duplicate succession on the steeper lower slopes and concluded that they had slumped from above on inclinations of 1 to 3 degrees. Slumping on inclinations of 1 degree has been suggested by Shepard (1955) to account for the delta-front valleys associated with the Mississippi River. The existence of underconsolidated material in this region suggests that this explanation is likely. Submarine slumping of Norian strata in New Zealand has been discussed by Grant-Mackie and Lowry (1964) who describe an exposure of 530 ft of highly disturbed sediment. This layer lies within a sequence of regular undisturbed Upper Triassic strata but displays slump balls, welded contacts, and other features associated with submarine slumps. By correlating sediments and fauna the authors infer that the slope at the time of movement may have been less than 1/2 degree. Movement occurred during a period of tilting of 8 degrees by the sea floor and the slope angle quoted must be considered to be a minimum.

It should be noted that the possibility of slumping on such gentle slopes has been questioned by Moore (1961) excepting areas of rapid accumulation. In particular, Moore doubts the existence of slumping on the deep sea floor and normal open continental shelf. Regarding the continental slope, he observes that the amount of slumping will vary with the type of sediment, its rate of accumulation and the topographic features in the regions in which it is being deposited. Detailed discussion of some of Moore's conclusions will be given in a further section. However, it is of interest here to introduce some aspects of submarine topography in order to distinguish between the various gradients associated with ocean bottom features. A detailed discussion of submarine topography may be found in Shepard (1963), Hill (1963), and Menard (1964).

Moving seaward from a continent to the ocean floor, it is in general possible to distinguish between the continental shelf, continental slope and continental rise. Though by no means uniform, the average slope of the continental shelf is only $0^\circ 07'$ and is slightly steeper along the inner half. For the continental slope, Shepard (1963) quotes an average inclination of $4^{\circ}17'$ for the first 6000 feet of descent. Menard (1964) states that continental slopes are about 1 to 10 km high in the Pacific and have gradients of 1 to 10 degrees. However, the continental slopes are cut by submarine canyons. These are important to the problem of slumping because of the possibility of sediment accumulating in their heads, and the channeling effect that they provide for the flow of the sediment. The slopes of submarine canyons are also usually greater than that of the continental shelf. The continental rise is generally a smooth feature connecting the continental slope to the abyssal plain. Heezen and Menard (1963) quote an average gradient for the continental rise of 300:1 with some slopes as low as 700:1 and others as steep as 50:1.* Gradients of abyssal plains range from 1000:1 to 10,000:1. Other features of interest are the sediment fans at the mouths of submarine canyons, which have their origin in slump and turbidity current deposits, and the abyssal hills which are small undulations in the floor of the abyssal regions. On the basis of slope alone, it is evident that the continental slope is much more favorable for slumping than any of the other main regions mentioned above. The heads of submarine canyons provide an extremely suitable environment for slumping because of their steeper inclination and their action as sediment traps.

The effects of submarine slumping have been observed in various geological strata in many locations. Among the many examples that could be cited are the observations of Jones (1937) on Silurian rocks in North Wales and the discussion by Beets (1946) on Miocene slumping in northern Italy. Renz, Lakeman, and van der Meulen (1955) provide evidence for extensive submarine sliding in western Venezuela during the Paleocene and Eocene. For example, the geological section near the town of Carora reveals slipped masses of strongly contorted Paleocene shales containing many Cretaceous blocks and slabs. The slump material alternates with very fine-grained Paleocene sandstones and shales which were apparently deposited in quiet deep water. The authors suggest that periods of quiet sedimentation were interrupted by tectonic events along the border of the trough. Submarine slumping on a smaller scale has been inferred by Van Straaten (1949) from the evidence of contorted glacial clays in Finland, which, he suggests, may have slid off a steep-sided esker. Finally Kuenen (1949) has described structures attributed to slumping in the Carboniferous rocks of southern Wales and he favors the view that these movements took place down slopes not exceeding a few degrees.

Subaqueous slumps on slopes inclined at steeper angles than those mentioned in an earlier paragraph have been discussed by Terzaghi (1956) and Koppejan, van Wamelen, and Weinberg (1948). These include the slope failure in clean sands and gravel in Howe Sound, British Columbia, which probably had an inclination greater than 28 degrees, and the slides composed of fine sand that occur along the coast of Zeeland. Original angles of 15 degrees are known to exist in the latter case.

Dill (1964a, 1964b, 1966) has observed in considerable detail the movement of sediment in Scripps and La Jolla submarine canyons. Slumping in fine micaceous sand occurred on inclinations of approximately 30 degrees. Sand falls over steeper inclinations and gravity creep were also important processes aiding the transport of the material down the slope.

There are many mechanisms that can induce slumping. The most common one is probably over-steepening of the slope. This may occur due to deposition or possibly crustal tilting associated with local tectonic movement. Erosion due to water currents or turbidity currents may cause local over-steepening leading to progressive failure. Slumping is particularly common at the head of submarine canyons and in the vicinity of mouths of large rivers. These are both environments of rapid deposition. Heezen (1956) has observed that submarine cables near the mouth of the Magdalena River break most frequently in August and in the period of late November to early December. The breaks are probably due to turbidity currents initiated by submarine slumps. Progressive slumping or liquefaction are alternative mechanisms. These periods of frequent slumping correspond to the times when the river has just deposited its greatest sediment load. Dill (1964a) has found that the generation of gas associated with the decomposition of plant material that accumulates in a canyon head can lead to significant creep movements. Wave and storm action is unlikely to have any direct influence

*In accord with soil mechanics practice a gradient quoted in this way is the ratio of a horizontal to a vertical distance.

on the stability of deeply submerged slopes. However, slides in shallow water may be triggered by erosion or rapid drawdown, nd the displaced sediment acting as a sudden load could induce failure on a slope in deeper water. Shepard (1951) has reported the results of bathymetric traverses repeated for several years at the head of the submarine canyon at La Jolla, California. There was no correlation between storms and the observed mass movements which occurred on slopes of 5 to 8 degrees. An example of a slump which occurred in calm weather at the head of the Redondo Canyon has been given by Shepard and Emery (1941).

Loading due to severe earthquakes is widely accepted as an important agency causing slumps. Since some of these slumps may have transformed into turbidity currents and have broken submarine cables on their descent, the source areas have been of particular interest and studies have been made of the topography. From these bathymetric surveys it is possible to approximate the slope inclinations prior to failure (Heezen and Ewing, 1952; Heezen and Ewing, 1955; Houtz, 1962; Ryan and Heezen, 1965). Gutenberg (1939) provides evidence for a submarine slide, caused by the Chilean earthquake of November 11, 1922, having occurred on a slope of about 6 degrees at a location 100 miles from the epicenter. A case of submarine slumping due to an earthquake has also been presented by Ambraseys (1960). The Alaska earthquake of March 27, 1964, caused many submarine slumps. The largest reported to date occurred at Valdez and contained an estimated volume of 75,000,000 cu m (Coulter and Migliaccio, 1966). An inclination of 6 degrees was typical of large areas of the slump, which was composed mainly of loose to medium-dense gravelly sand containing thin lenses of silt. It is of considerable interest to note that no slump toe was discovered by the post-earthquake survey, and it therefore appears that a turbidity current was formed and the sediment moved out a considerable distance from shore. There is also a history in the Valdez area of numerous cable breaks occurring during or immediately after earthquakes.

Slope inclinations in the cases mentioned above are presented in Table 1, and where the submarine slope failure lay within the epicentral region, a comment is made accordingly. The magnitude and focal depths of the shocks are also given.

The largest recorded slump occurred in Sagami Wan, Japan, and was caused by the Kwanto earthquake of 1923. The average deepening over the area of the main slump was 100 m, and in all 7×10^{10} cu m of sediment were transported from the bay. Menard (1964) has compiled the approximate volumes of some major submarine slumps and these data are reproduced in Table 2, together with the Valdez case.

Stable slopes of various inclinations have also been observed. Kuenen (1950) reports that irrefutable evidence of slumping was not found in the deep basins of the Moluccas even though the slopes are as steep as 10 degrees in places and it is an area of high seismicity. Sea muds in thicknesses of half a meter or more have been found on slopes of at least 15 degrees. Moore (1960) has also observed recent sediments of at least one meter thickness on slopes up to 18 degrees. Buffington (1961) has found both Pleistocene sediments standing vertically and medium sand to be stable at 35 degrees in shallow water environments. During bathyscaph descents to water depths of about 3000 ft in the La Jolla fan valley, nearly horizontal beds of stiff cohesive clays alternating with cohesionless silts were found exposed in the wall of the channel, which sloped at 40 to 45 degrees (Moore, 1965). Lesser slopes in silty clay were also found. It is suggested that these steep slopes are the result of lateral erosion by turbidity currents. Slide action from the wall of the channel is also a contributing factor and explains the existence of down-slope grooves along the wall. There is no doubt that these sediments are overconsolidated. However, the ease with which the silts are disturbed suggests that diagenetic bonding may not in this case be a contributing factor to the strength of the sediments. The studies made by Emery and Terry (1956) of a submarine slope off southern California are also of interest here. Their echo-sounder profiles revealed that the shelf had an inclination of 1 degree, and the gradients of the upper portion of the slope were generally between 9 and 18 degrees. The lower slope was more regular and had an average inclination of 12 degrees. This average value is the same as that for the gullies found incising the upper slope. These gullies may be due to slumping. The slope is underlain by thick sediments, and coring with penetrations of 10 to 18 ft recovered samples of green mud. The

TABLE 1.

SOME SLUMPS CAUSED BY EARTHQUAKES

Location and Date	Slope degrees	Magnitude M	Focal Depth km	Within Epicentral Region	Reference
Grand Banks, 1929	3.5	7.2	Shallow	Yes	Heezen and Ewing (1952)
Orleansville, 1954	4-20	6.7	7	No	Heezen and Ewing (1955)
Strait of Messina, 1908	4	7.5	8	Yes	Ryan and Heezen (1965)
Suva, 1953	3	6.75	60	Yes	Houtz (1962)
Chile, 1922	6	8.3	Shallow	No	Gutenberg (1939)
Valdez, 1964	6	8.5	Shallow	Yes	Coulter and Migliaccio (1966)
Aegean Archipelago, July 9, 1956	10	7.5	15	No	Ambraseys (1960) and Admiralty Chart No. 1866 (1951), Royal Hellenic Navy

TABLE 2.

VOLUMES OF SUBMARINE SLUMPS

Location	Volume m^3
Magdalena River Delta	3×10^8
Mississippi River Delta	4×10^7
Suva, Fiji	1.5×10^8
Valdez, Alaska	7.5×10^7
Folla Fjord	3×10^5
Orkdals Fjord	10^7
Sagami Wan	7×10^{10}

grain size of the specimens seaward of the self break decreases with depth in an orderly way which suggests continuous deposition. The authors provide some cross sections with soil mechanics classification data. Of considerable importance are the quantitative data that a marine sediment 5 ft below the mud-line having a liquid limit of 55 percent, a plastic limit of 30 percent, and a natural moisture content of 70 percent is presently stable on a slope of approximately 15 degrees in an area of considerable seismic activity.

SEDIMENTARY STRUCTURES ASSOCIATED WITH SLUMPING

It is beyond the scope of this study to discuss in detail the many sedimentary structures whose origin has been associated with submarine slumps and the mass movements that ensue from them. However, it is of interest to review briefly the wide variety of slump structures that have been observed, because of the information this provides for assessing the problem of the mobility of sediments after movement has begun. More comprehensive studies have been provided by Bouma (1962), Dott (1963), and Dzulynski and Walton (1965).

It is possible to distinguish four major divisions of increasing mobility of moving sediment. This is not to imply that any slump must pass through each division, but it is simply a classification to illustrate the decreasing disorder of initial sedimentary structure. The first stage is a coherent slump where little mixing of sediment has occurred and the beds have retained their identity to a large degree. Features associated with this type of slump are pull-apart structures with intrusion of sandstone dikes as described by Kuenen (1953) and intraformational folding as described by Fairbridge (1946). The distinguishing feature of this division is that either the beds have not moved very far or the composition of the sediment above the slip surface gave it sufficient shearing resistance to maintain coherence even though it was intensely deformed. The second stage, which Dzulynski (1963) has called an incoherent slump, occurs when there has been extensive mixing of indurated sediment in a mass of sand, silt, or clay. Examples for this division are the slump structures mapped in Venezuela (Renz, Lakeman, and van der Meulen, 1955) and the features in flysch described by Dzulynski and Slaczka (1958) where the section contains many slump balls. The origin of pebbly mudstones (Crowell, 1957) is also probably due to incoherent slumping. The third division in increasing mobility results in fluxoturbidites. Here the mixing of the sediment and its velocity are not sufficient to develop the features characteristic of turbidites, which are the structures resulting from the final division, that is, turbidity currents. Graded bedding is an important criterion for distinguishing turbidites. It is possible that some turbidite structures can be explained by the pulsating bottom currents observed by Dill (1966).

Liquefaction plays an important role in causing many minor features observed in slumps, as well as decreasing the overall shearing resistance of the sediment and hence increasing its mobility. Liquefaction occurs most commonly in saturated loose sands and silts which, when loaded, collapse and transfer the load to the pore water. Pore pressure gradients can be set up which eliminate the shearing resistance of the sediment, and if the seepage velocity due to the hydraulic gradient is high enough, solid particles can be carried with the flow. Liquefaction is the cause of the sandstone dikes mentioned in the previous paragraph and the extensive sand volcanoes described by Gill and Kuenen (1957). In the latter case, the field evidence has prompted the authors to note that the extrusion of the sediment required a considerable period of time, starting in some cases before movement had ceased and in others after planing off of the slumped masses.

Terzaghi (1956) argued against the existence of slump-initiated turbidity currents on the basis of the short duration of liquefaction. He felt that the pore pressures would dissipate quickly and that the slump material would come to rest within a relatively short distance from its original location. However, after the Alaska Good Friday earthquake, sandspouting occurred for a duration of 5 to 10 minutes and it is likely that excess pore pressures existed within the sediment for longer than that (Reimnitz and Marshall, 1965). It is also common experience that sediments that have been liquefied after an earthquake remain extremely soft for some time. A more detailed discussion of the influence of pore-pressure dissipation on velocity of slump movements will be given in a later section.

Terzaghi and Peck (1948) state that a saturated sand must have a relative density less than 0.4 or 0.5 before it can start to flow. They also observe that the most unstable sediments have an effective size, D_{10}, less than 0.1 mm, and a uniformity coefficient,

$$\frac{D_{60}}{D_{10}},$$

less than 5. It is of interest to analyze the gradings of some slump and turbidity current deposits to see if they meet this criterion. This only provides a necessary condition that these materials were prone to liquefaction. It is possible that part of the initial grading was deposited elsewhere and the data being compared are not representative. The effective sizes and uniformity coefficients are given in Table 3 and for comparative purposes results from sediments liquefied after the Niigata earthquake of 1964 (Kishida, 1965) and from a fine sand which almost liquefied during laboratory shear tests (Bjerrum, Kringstad, and Kummeneje, 1961) are included.

Each case quoted in Table 3 including the complete graded sea bed from the Hudson sea fan, satisfies the criterion put forward by Terzaghi and Peck. Although this alone by no means establishes liquefaction as a mechanism, at least the grading of these deposits suggests that the source sediments may be prone to it.

STRENGTH OF SEDIMENTS

In terms of effective stress, the shear resistance along a plane of failure in a saturated soil is given by

$$\tau_f = c' + (\sigma - u)\tan \phi' \qquad (1)$$

where τ_f denotes the shear stress on

c' denotes the apparent cohesion (in terms of effective stress)

ϕ' denotes the angle of shearing resistance (in terms of effective stress)

σ denotes the total stress normal to the failure plane

and u denotes the pore pressure.

TABLE 3.

EFFECTIVE SIZES AND UNIFORMITY COEFFICIENTS

Sediment	Effective Size D_{10} (mm)	Uniformity Coefficient $\frac{D_{60}}{D_{10}}$	Reference
Core A180-1, Top	.016	3.3	Heezen (1963)
Core A180-2, 64 cm	.016	3.8	"
Hudson Sea Fan 0-4 cm	.022	4.4	Kuenen (1964)
" 4-18 cm	.035	3.7	"
" 18-24 cm	.053	3.0	"
" 24-48 cm	.053	3.4	"
" 48-72 cm	.060	3.3	"
San Pedro Basin (lower portion of graded layer)	.062	2.6	Gorsline and Emery (1959)
Niigata	.09	2.8	Kishida (1965)
Fine Sand	.07	2.5	Bjerrum, Kringstad, and Kummeneje (1961)

His experiments were carried out under isotropic consolidation and this will in general result in a higher value of the

$$\frac{c_u}{p}$$

ratio (Skempton and Bishop, 1954). The actual difference is difficult to estimate because the pore pressure parameter, A_f, depends upon the history of consolidation. It is likely that the most dominant factor accounting for the deviation from the correlation is carbonate bonding. Assuming the relation of Figure 2 to hold, a predicted value of

$$\frac{c_u}{p}$$

can be obtained from the plasticity index data given by Moore. Figure 3 shows that the ratio of the predicted to measured values decreases with increasing carbonate content. Higher values of

$$\frac{c_u}{p}$$

than might be expected have also been found in short cores of shallow water sediments from Lower Chesapeake Bay (Harrison, Lynch, and Altschaeffl, 1964) and in short cores of deep-sea sediments (Richards, 1962). Fisk and McClelland (1959), however, report that fully consolidated sediments from the Mississippi delta agree with the correlation. Although it is premature to generalize with regard to the undrained strength of recent marine sediments, it is unlikely that a fully consolidated stable material will have an undrained strength below the relation shown in Figure 2.

Terzaghi (1956) drew attention to the influence of high rates of sedimentation on the development of strength in a consolidating sediment. Excess pore pressures can develop in a stratum that is undergoing an increase in height due to deposition. These excess pore pressures will depend upon the rate of sedimentation, the height of the stratum, and the coefficient of consolidation of the material. The excess pore pressure at any level in the stratum will reduce the effective stress under which the material has been consolidated and, as is evident from equation (3), the undrained strength at that level will be reduced accordingly.

Consider the stratum shown in Figure 4. When fully consolidated, the maximum effective overburden pressures, p_m, at some depth, z, is given by

$$p_m = \gamma' z \qquad (6)$$

where γ' is the submerged density of the soil, assumed constant with depth. The increase of undrained strength with depth for a fully consolidated material may be denoted by

$$\frac{c_u}{p_m} = N \qquad (7)$$

If during consolidation excess pore pressures exist as shown diagrammatically in Figure 4, the effective overburden pressure, p, at any instant is

$$p = \gamma' z - u = \gamma' z\left(1 - \frac{u}{\gamma' z}\right) \qquad (8)$$

where u is the excess pore pressure at that instant. At any instant the excess pore pressure isochrome may be approximated by a linear variation with depth,

$$u = nz \qquad (9)$$

and equation (8) becomes

$$p = \gamma' z\left(1 - \frac{n}{\gamma'}\right) \qquad (10)$$

However,

$$1 - \frac{n}{\gamma'} = \bar{U} \qquad (11)$$

where $\bar{U}$ is the average degree of consolidation. Therefore the undrained strength available in an underconsolidated clay should be proportional to the average degree of consolidation, that is,

$$\left(\frac{c_u}{p_m}\right)_{\bar{U}} = N\bar{U} \qquad (12)$$

Estimates of the degree of consolidation in a layer subject to sedimentation at a constant rate can be obtained from the solution presented by Gibson (1958) for the problem of the progress of consolidation in a clay layer which increases in thickness with time. Considering a layer growing on an impermeable base at a constant rate, it is of interest to calculate the degree of consolidation for a range of rates of sedimentation and coefficients of consolidation when the layer has

For normally consolidated clays and granular soils, the apparent cohesion is zero and equation (1) becomes

$$\tau_f = (\sigma - u)\tan \phi'$$

It is possible to distinguish between structurally stable and structurally metastable soils. Metastable soils show a very large rate of volume decrease during drained shear and may even display an initial yield point at a stress less than their maximum strength. Some stress-strain relations for stable and metastable soils are shown diagrammatically in Figure 1.

Quick clays and very loose sands are examples of structurally metastable soils which may be defined as soils that, when brought to failure under drained conditions, deform further under undrained conditions.

For stable clays ϕ' varies between 20 and 35 degrees. A correlation between ϕ' and plasticity index has been given by Bjerrum and Simons (1961). Stable loose silts and sands typically have values of ϕ' between 28 and 34 degrees.

Large deformations in soils containing a clay content greater than approximately 35 per cent induce preferred orientation of the clay particles in the shear zone and cause a reduction of ϕ' (Skempton, 1964). Angles of shearing resistance as low as 10 degrees are not uncommon in clays that have been subject to large strains. Few data giving strength parameters in terms of effective stress are available for present day marine sediments. The results of Moore (1961, 1962) are ambiguous because the conditions of drainage in his tests are not adequately defined. This is not the case for the strength data for sediments from the experimental Mohole (Moore, 1964). The average of six results on the calcareous silty clay from one borehole gives a ϕ' of 28 degrees and a c' of about 8 psi. There is as yet no evidence to suggest that the effective stress strength paramenters of stable deep-sea deposits will be any lower than the range commonly encountered on land. Indeed, the presence of diagenetic bonding agents in some marine enviroments can make the sediment stronger than the usual range.

When a fully saturated soil is sheared under undrained conditions and the results are interpreted in terms of total stresses, the material behaves as though it is purely cohesive. This holds for saturated sands as well as for clays (Bishop and Eldin, 1950). For a normally consolidated clay or a sand in the ground, the undrained shear strength, c_u, is related to the stresses under which the soil has been consolidated, the effective angle of shearing resistance, and the pore pressures at failure by:

$$c_u = \frac{p \sin \phi' \left[K + (1 - K)A_f\right]}{1 + (2A_f - 1)\sin \phi'} \qquad (3)$$

where p denotes the vertical effective pressure,

K denotes the ratio between the horizontal and vertical effective pressures,

and A_f is the appropriate pore pressure parameter at failure (Skempton, 1954).

For stress conditions associated with no lateral yielding, as might be assumed to exist during deposition either horizontally or on a gentle inclination, K may be expressed empirically by (Bishop, 1958):

$$K = 1 - \sin \phi' \qquad (4)$$

Equation (3) then becomes

$$\frac{c_u}{p} = \frac{\sin \phi' \left[1 - \sin \phi' + A_f \sin \phi'\right]}{1 + (2A_f - 1)\sin \phi'} \qquad (5)$$

For any particular fully consolidated soil, the ratio

$$\frac{c_u}{p}$$

is a constant and indicates that the undrained strength increases with depth. It is know that this ratio correlates closely with the plasticity index of many marine clays (Skempton, 1957), and the correlation is given in Figure 2. Owing to sample disturbance and improvements in testing technique since the data were gathered, this relation may be considered to be a lower boundary to the true relation. However, there is no reason to expect that more refined data will produce major changes in the relation.

Moore (1964) has shown that the strength data from the Mohole sediments lie appreciably above the correlation. As he has observed, there are at least two factors which may account for this.

grown to a height that might be typical of a significant submarine slump. A height of 15 m has been assumed, and coefficients of consolidation from 1×10^{-5} cm^2/sec for a clay to 1×10^{-2} cm^2/sec for a coarse silt have been adopted. The degrees of consolidation of the layer for a range of rates of deposition from abyssal conditions to extreme deltaic conditions have been computed and are given in Figure 5, plotted against the rate of sedimentation for the range of consolidation parameters chosen. The results reveal that for a layer of this thickness, underconsolidation is only significant for silty clays and clays deposited at deltaic rates. Since the heads of some submarine canyons act as sediment traps, the rate of accumulation may be sufficiently high to suggest that underconsolidation is a factor associated with slumping in them. It is also possible to speculate that slumping occurred more frequently in the Pleistocene, during the recession of the glaciers, because of higher rates of sedimentation. This, together with turbidity current erosion and a lowered sea level during the Pleistocene, may be the dominant mechanism accounting for the origin of many submarine canyons (Kuenen, 1950; Shepard, 1963).

Subject to some assumptions, the relation between underconsolidation and strength presented in equation (12) is corroborated by the observations of Fisk and McClelland (1959) on the deltaic deposits on the continental shelf off Louisiana. The authors provide data for three locations of similar composition, but of different degrees of consolidation and hence of different strengths. The relevant information is assembled in Table 4.

Evidence of full consolidation for the Eugene Island stratum is provided by the fit of the

$$\frac{c_u}{p}$$

and plasticity index values with the correlation in Figure 2. For purposes of comparison the three cases are plotted on Figure 2. Assuming that the 96 ft of the Eugene Island sediment were deposited in 10,000 years gives a rate of sedimentation of 0.29 cm per year. Theoretically, infinite time is required for full consolidation. However, if it is assumed that consolidation is essentially complete when the degree of consolidation is 95 percent, it is possible to compute the coefficient of consolidation for the material from the theoretical relation obtained by Gibson (1958). A value of 2.7×10^{-4} cm^2 per sec is found, which is quite reasonable, considering the Atterberg limits of the material. Now, using this value, it is possible to compute the average degree of consolidation for the two other locations if the rates of sedimentation can be fixed. For the Grand Isle location, a rate of sedimentation of 3.5 cm per year has been used, based upon the accumulation of 170 ft in 1500 years. In the case of the South Pass location the base of the layer is indistinct, but bounds for its thickness have been given. Calculations have been carried out for both bounds with a time for deposition of 450 years. The computed degrees of consolidation are given in Table 5, together with the ratio of the observed

$$\frac{c_u}{p}$$

value to the maximum. The relation between degree of consolidation and available strength for this sediment is plotted in Figure 6, and it is seen that the linear relationship of equation (12) fits the data extremely well.

Metastable sands and silts which are prone to liquefaction are difficult to obtain in an undisturbed state. They are also difficult to reproduce in the laboratory, and therefore reliable data concerning their behavior are accordingly rare. Bjerrum, Kringstad, and Kummeneje (1961), however, have succeeded in carrying out both drained and undrained triaxial compression tests on a very loose fine sand. Their observations of the low strength mobilized are of particular interest. Under fully drained conditions, values of ϕ' as low as 19 degrees were found. Under undrained conditions, the very loose sand showed values of ϕ' as low as 11 degrees and a ratio of undrained strength to effective consolidation pressure as low as 0.11. The pore pressures set up during undrained failure were very high. Values of A of 2.7 were observed at failure and the results of one typical test showed that A continued to increase after failure to approximately 9. It is evident that both the drained and undrained strengths of very loose sands are much lower than those of corresponding stable materials. The undrained strengths are comparable to the lowest values observed in normally consolidated marine clays. Further-

TABLE 4.

DELTAIC DEPOSITS OFF LOUISIANA (FISK AND McCLELLAND, 1959)

Location	State	Liquid Limit %	Plastic Limit %	Plasticity Index % (average)	$\frac{c_u}{p}$	Depth ft	Age Years
Eugene Island Block 188	Fully consolidated	80-90	25-30	53	0.31	96	not less than 10,000
Grand Isle Block 23	Underconsolidated	80-90	25-30	53	0.15	170	not more than 1500
South Pass Block 20	Very underconsolidated	60-100	20-30	55	0.028 (average)	255-320	450

TABLE 5.

UNDERCONSOLIDATION OF DELTAIC DEPOSITS OFF LOUISIANA

Location	Rate of Sedimentation cm/year	Average Degree of Consolidation	$\frac{\frac{c_u}{p}\text{ (observed)}}{\frac{c_u}{p}\text{ (maximum)}}$
Eugene Island Block 188	0.29	1.00	1.00
Grand Isle Block 23	3.5	0.48	0.48
South Pass Block 20	17 21.6	.11 0.08	0.09

more, the exceedingly high pore pressures set up during undrained failure are probably an important factor aiding the post-failure mobility of such metastable materials.

Seed and Lee (1964) have studied the influence on the strength of a fine silty sand of pulsating loads such as might occur during an earthquake, and they demonstrated that in a given material consolidated to a particular void ratio, the deviator stress required to cause failure decreases with the number of pulses to failure. This also depends upon the principal stress ratio during consolidation and the manner in which the pulsating load test is carried out. Seed and Lee have found

$$\frac{c_u}{p}$$

values less than 0.1 for loose cohesionless soils subject to pulsating load.

Observations on the strength of sensitive clays, such as the quick clays of Scandinavia, may also have a bearing on the possible in-place strength of cohesive submarine sediments, if, due to the formation of weak bonds, they develop a loose structure. Bjerrum (1961) has discussed in detail the strength of materials with loose structure, and he cites tests on quick clay which gave drained angles of shearing resistance between 9 and 13 degrees. Of particular importance here is the observation that in undrained tests on such material, failure may occur before the *frictional resistance* is fully mobilized.

MECHANICS OF SLUMPING

As Moore (1961) has indicated, consideration of the equilibrium of an infinite slope with failure occurring on a plane or planes parallel to the slope provides an adequate framework within *which to discuss the mechanics* of slumping. It is possible to consider more complicated configurations (for example, Morgenstern and Price, 1965); however, the available data regarding slope profiles, sediment strength, and initiating mechanism are insufficient to warrant this. The strength of any sediment depends, among other things, upon the conditions of drainage operating during shear. It is therefore essential to distinguish between *drained* and *undrained* slumping. It will be seen that the slope inclination at which slumping occurs is strongly dependent upon whether the initiating process induces a drained or an undrained slump. A third type of slumping, termed *collapse* slumping, may also be denoted. This type of slumping is associated with metastable sediments, and although it has only been studied in a subaerial environment, the possibility of formation of metastable sediments in a marine environment suggests that collapse slumping may be an important mechanism there. It will be defined and discussed in more detail in a later paragraph.

No excess pore pressures exist at failure in a drained slump. By considering the horizontal and vertical equilibrium of a slice shown in Figure 7, the relation between the slope angle at failure and the properties of the sediment may be readily shown to be

$$\tan \alpha = \tan \phi' + \frac{c'}{\gamma' h} \times \sec^2 \alpha \qquad (13)$$

where α denotes the inclination of the slope to the horizontal

ϕ' denotes the angle of shearing resistance } in terms of effective stress

c' denotes the apparent cohesion } in terms of effective stress

γ' denotes submerged density of the sediment

and h denotes the height of sediment participating in the slump.

It is of interest to note that a comparable analysis for subaerial conditions would involve the bulk density of the material in the resulting form of equation (13). Therefore a given amount of cohesion is more effective in maintaining stability under submarine conditions, all other conditions being the same. When the sediment is a normally consolidated clay or an uncemented sand or silt, the following well-known relation holds at failure:

$$\tan \alpha = \tan \phi' \qquad (14)$$

Drained slumping is most commonly caused by depositional oversteepening. Since the ϕ' for stable material is generally greater than 20 degrees, and few features in deep water have inclinations as steep as this, it appears that drained slumping of stable sediments is not a dominant mechanism. It can, however, occur on the steep slopes of erosion channels. Steep slopes such as those observed by Moore (1965) require the existence of some cohesion whose origin is either in overconsolidation or cementing to account for their stability. Terzaghi (1956) stated that steep slopes of coarse-grained sediments are most commonly encountered in deltas deposited by mountain streams and cited the sand and gravel delta of Howe Sound, British Columbia, as an example. Here slope angles of 27 to 28 degrees are stable. The slump which occurred here must have originally had a slope steeper than this, and Terzaghi suggested that residual pore pressures after drawdown reduced the shearing resistance sufficiently to cause failure. This is not a drained slump like those considered above. The influence of drawdown pore pressures may be estimated by methods commonly used in the design of earth dams (Bishop, 1957; Bishop and Morgenstern, 1960) and will not be considered further here. Under fully drained conditions the mobility of the sediment will be small and it will come to rest when the slope angle is slightly less than the angle of shearing resistance. Mobility under undrained conditions will be considered in the section relating to the initiation of turbidity currents.

Undrained slumps may be caused by stresses set up during rapid deposition or erosion. Dynamic loading due to earthquakes will also produce undrained failure. Slumping in underconsolidated sediment is also best considered in terms of the undrained strength of the material.

The influence of an earthquake in the analysis of undrained slumping may be incorporated by introducing a horizontal body force, k, as some percentage of gravity and considering the equilibrium of a slice in the infinite slope. Earthquakes will in general also produce a vertical acceleration, but this is usually less than the horizontal acceleration, and for simplicity will be neglected here.

Considering the equilibrium of the slice shown in Figure 8, and resolving forces parallel to the slope one obtains

$$Cu \cdot 1 = W' \cdot \sin \alpha + k \cdot W \cdot \cos \alpha \qquad (15)$$

where Cu denotes the undrained strength mobilized at failure
- W' denotes the submerged density of the slice and is given by $\gamma' \cdot b \cdot h$
- W denotes the bulk density of the slice and is given by $b \cdot h$
- 1 is the length along the base of the slice

and k is some percentage of gravity. After simplification, equation (15) reduces to

$$\frac{Cu}{\gamma' h} = \frac{1}{2} \sin 2\alpha + k \cdot \frac{\gamma}{\gamma'} \cdot \cos^2 \alpha \qquad (16)$$

Equation (16) relates, for undrained slumping, the slope angle at which failure takes place to the undrained strength and density of the sediment, the height of the slope, and the horizontal earthquake acceleration, if any. For slopes of gentle inclination

$$\frac{Cu}{\gamma' h} = \frac{Cu}{P} = N \qquad (17)$$

and for many sediments

$$\gamma \doteq 3\gamma' \qquad (18)$$

Equation (16) now becomes

$$N = \frac{1}{2} \sin 2\alpha + 3k \cos^2 \alpha \qquad (19)$$

Values of N required to equilibrate a range of slopes inclined from 0 to 20 degrees, and subject to horizontal accelerations up to 15 percent of gravity, have been computed and are plotted in Figure 9. Considering first the stability of slopes free of earthquake loading, if the observed range of N values for most normally consolidated sediments (Figure 2) is taken to apply ($N<0.4$), few slopes subject to undrained loading can stand at inclinations greater than 25 degrees. Overconsolidated sediments and sediments with strong diagenetic bonds can, of course, stand more steeply. Slumping on very gentle gradients of, say, less than 2 degrees, without the aid of earthquakes, can only occur in very underconsolidated material. Terzaghi (1956) and Moore (1961) have already drawn attention to the evidence that the low strengths of the very underconsolidated Mississippi delta sediments are consistent with slumping on slope angles barely in excess of 1 degree. If very loose, cohesionless sediments have an N value of about 0.11 as found by Bjerrum, Kringstad, and Kummeneje (1961) it is seen that failure takes place on slopes of about 6 degrees, and it is of interest to note that this is a fairly typical inclination for the continental shelf.

Figure 9 shows that even small earthquake-induced accelerations are very detrimental to the stability of a submarine slope. However, in a detailed study of mass transport of sediment in the heads of Scripps Submarine Canyon, California, Chamberlain (1964) concluded that there is insufficient reason to believe that a relationship exists between the occurrence of submarine canyon deepenings and earthquake disturbances. Based on direct observations, Dill (1964a) states that earthquakes have little effect on the failures that cause the removal of sediment from the head of Scripps Canyon. The slope failures caused by earthquakes listed in Table 1 provide evidence that there is at least a correlation between submarine slumping and near earthquakes of large magnitude. It seems significant that all the shocks cited in this table had a magnitude greater than 6.5. Taking 6 degrees as a typical angle representing some of the cases listed in Table 1, and assuming the sediment to have undrained strengths in terms of N between .25 and .40, it is seen from Figure 9 that the slope must have responded with an acceleration between 5 and 10 percent of gravity.

The observations of Emery and Terry (1956), described in an earlier section, provide an interesting case of a relatively steep stable slope in a seismically active area. Since the sediment has a plasticity index of about

25 percent, the value of N might, from Figure 2, be at least 0.22 and the equilibrium slope for undrained failure without earthquake loading is 13 degrees. This fits well within the range of the observed slope angles and is close to the average of 12 degrees. However, steeper slopes were observed, and the index data quoted above refer to a slope of approximately 15 degrees. A slope of 15 degrees requires an N value of 0.25 for stability. This is within the scatter to be expected from correlation with Figure 2, but it leaves no margin for incorporating the influence of earthquake loading. To obviate this difficulty, it is worthwhile noting that although bedrock accelerations during an earthquake may be high, the response of the overlying sediment depends upon its modulus of rigidity, and if this is very low, the shear stresses induced in the sediment may be low, although the displacements will be large.* In a normally consolidated sediment the modulus of rigidity will vary with depth, and it could be that for typical ground motions associated with near earthquakes of magnitude less than 6, the dynamic stresses in the sediment are not very significant. If data on the variation of rigidity with depth in a slope could be obtained, the solution given by Ambraseys (1959) to the problem of the response to an arbitrary ground motion of an elastic overburden with varying rigidity could be used to investigate this point.

A collapse slump is defined as one that fails initially under drained conditions, but the deformations associated with failure bring about a large increase in pore pressures. These pore pressures reduce the shearing resistance, and the soil mass accelerates. This type of mechanism has only received detailed attention in the study of one landslide which occurred in a thin layer of quick clay (Hutchinson, 1961). It is probably a feature peculiar to structurally metastable sediments. The analysis of this slide, using pore pressures based upon ground water level observations, indicated that failure occurred with a drained angle of shearing resistance of only 7 ± 1.5 degrees. This value was substantiated by both in-place and laboratory shear box tests. Conventional isotropically consolidated undrained triaxial tests gave values of ϕ' of 25 degrees, and Bjerrum (1961) has suggested that the lower initial yield is destroyed by sample disturbance and reconsolidation. Further information on this phenomenon is given by Bjerrum and Landva (1966). Hutchinson (1961) also observed pore pressures in excess of hydrostatic pressure within the clay layer and remarked that the sliding caused breakdown of the clay structure, and hence part of the overburden load was transferred to the pore water. Therefore, although the initial failure occurred under drained conditions, further movement occurred under undrained conditions. This can only happen when the undrained resistance is less than the drained resistance at failure, as it was in the case discussed here.

Although these quick clays do not commonly exist in a submarine environment because they have been made metastable by the leaching of salt water, some submarine sediments may achieve metastability and high sensitivity in other ways and could be subject to collapse slumping. Therefore the possibility of initial slumping under drained conditions with acceleration under undrained conditions on slopes of 5 to 10 degrees cannot be excluded without further study.

Moore (1961) concluded that in general most sediments are theoretically stable to great thicknesses on very steep slopes. This conclusion was based upon the use of strength parameters typical for drained compression of stable sediments, and the analysis presented here, for this case, is in agreement. Undrained failure of stable, fully consolidated sediments can lead to slumping on slopes of more gentle inclination, particularly if the sediment responds to earthquake loading with a significant acceleration. Therefore considerable slumping may occur on the normal open shelf where

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*The dynamic shear stress in the sediment is given by:

$$\tau_d = \frac{\gamma}{g} \cdot Vs \cdot \dot{u} \tag{20}$$

where τ_d denotes the dynamic shear stress
Vs denotes the shear wave velocity
$\dot{u}$ denotes the particle velocity
and $\frac{\gamma}{g}$ denotes the mass density.

If the computed response of the sediment to earthquake loading shows low strain rates and hence low particle velocities, and if Vs is small due to the low rigidity, the dynamic stress, τ_d, will also be small.

collapse slumping may also be important. In agreement with Moore, the deep sea is probably almost free of slumping. This is because the gradients of most physical features there are very low; sediments are likely to be fully consolidated and possibly stronger due to diagenetic bonding, and the slopes are situated out of range of several of the agencies which can produce undrained failure. Slumping is undoubtedly frequent in areas of rapid deposition, and here may occur on very gentle gradients.

INITIATION OF TURBIDITY CURRENTS

When a slump takes place in a stable cohesive sediment of low sensitivity, experience of subaerial landslides suggests that shearing will take place on a plane or set of planes while the mass of the sediment remains relatively intact. The mass of sediment should come to rest at a new equilibrium position consistent with the strength obtaining after failure, and although it may exhibit features associated with a coherent slump, such as intraformational folding, it is difficult to imagine that the stresses acting on the slump mass during motion can disrupt its structure sufficiently to allow dispersion of the sediment and mixing with water. However, cohesive sediments of high sensitivity and cohesionless soils, particularly metastable ones, can achieve a greater mobility, and in the limit a slump may be transformed into a turbidity current.

There is considerable evidence that some sediments in the deep sea have had their origin in shallow water. In a study of deep-sea sands, Kuenen (1964) stated that practically all deep-sea sands were emplaced by turbidity currents. Heezen and Hollister (1964) suggested that although deep-sea currents are capable of transporting coarse material, they cannot account for the graded bedding which is a common feature of deep-sea sands. However, in the light of Dill's observations (1964a, 1966) of bottom current pulsations and creep and slump effects, these conclusions are possibly premature, and the presence of deep-sea sands cannot be taken as wholly unambiguous evidence for the existence of turbidity currents. Other evidence for turbidity current deposition includes the displacement of shallow-water benthonic fauna to deep water, and the relief and distribution of abyssal plains, channels, and fans (Menard, 1964). The timing of submarine cable breaks, after slumping was caused by an earthquake, demonstrates the mobility of the sediment. The first confirmation that a slump can transform into a turbidity current was given by Heezen, Ericson, and Ewing (1954), who discovered a graded bed of silt south of the Grand Banks. This bed had its origin in a turbidity current caused by the slump which occurred during the earthquake of 1929. Heezen and Drake (1964) have suggested that there was deep-seated coherent slumping as well in this case. Slumping has also been cited by Holtedahl (1965) as the initiating agency to account for the abundant recent turbidites found in the Hardangerfjord, Norway.

Not all turbidity currents have their origin in slumps. In the case of the Congo Submarine Canyons (Heezen and others, 1964) cable breaks occurred most frequently at the times of greatest bed load discharge, and since a delta is not being formed at the river mouth, it is possible that large sediment discharges continue directly as turbidity flows.

Only low density turbidity currents have been directly observed. These often occur due to the discharge of sediment by a river into a lake or reservoir. In the case of the Lake Mead turbidity current, it is known that the excess density is only about 1 percent and the velocity less than 2 ft per sec on a gradient of approximately 2000:1 (Gould, 1951). Kuenen (1950) postulated the existence of turbidity currents with densities comparable to the bulk density of typical sediments and was able to produce them in the laboratory. The density of turbidity currents in the sea remains debatable. The high-density current explains sea-floor phenomena more easily, but is yet to be observed. If the low-density current begins as a slump, it is not clear how the extreme dispersion of the sediment occurs. The twisting and abrasion of cables broken by the Suva turbidity current described by Houtz and Wellman (1962) favors the high density interpretation. Alternative mechanisms for a sequence of cable breaks, such as a wave of liquefaction or progressive slumping, appear less satisfactory.

Data on times of breakage of submarine cables provide evidence that turbidity currents can maintain velocities of about 15 to 30 ft per sec on the very gentle gradients of the abyssal plains. Although it is generally accepted that higher velocities are developed on the steeper continental slope, few conclusive data are available and the exact values are still debated. Menard (1964) suggests that the Grand Banks turbidity current reached a velocity of 63 ft per sec before it began to decelerate, and even higher values have been quoted.

While there has been considerable study of the mechanics of turbidity flow (see Johnson, 1962, 1964, for a review) little attention has been paid to the problem of how a current is initiated. Moreover, small-scale experiments carried out on a naturally sloping sea floor 40 ft below sea level were not successful in producing a high-density, high-velocity current (Buffington, 1961). In the following, the acceleration of a slump after failure is considered in an attempt to delineate some of the conditions necessary for a slump to attain sufficient velocity that it may transform into a turbidity current. These considerations may explain the failure of the experiments mentioned previously.

The problem is best treated in terms of effective stress. It is assumed that some unspecified mechanism has brought the cohesionless sediment on an infinite slope into a state of limiting equilibrium by inducing an undrained failure, and that the excess pore pressure in the sediment at this instant is given by

$$u = nz \qquad (21)$$

where u denotes the excess pore pressure
n is some number
and z is measured perpendicular to the slope, increasing downwards from the surface of the slope.

If the slice shown in Figure 10 is to be in a state of limiting equilibrium, it is readily shown that

$$\frac{n}{\gamma'} = \frac{\cos\alpha \tan\phi' - \sin\alpha}{\tan\phi'} \qquad (22)$$

From equation (22) the values of $\frac{n}{\gamma'}$ have been computed for a range of slope angles and for values of ϕ' of 10, 20, and 30 degrees. These values are plotted in Figure 11. If for a given value of α and ϕ' the magnitude of $\frac{n}{\gamma'}$ obtaining in the slope is less than that shown in Figure 11, motion will not occur. If, however, it is greater, though not necessarily liquefied, the sediment will not be in equilibrium and it will accelerate due to the force unbalance acting upon the mass. (The viscous stress acting on the upper surface may be neglected.) Assuming that the mass is initially at rest, the equation of motion gives

$$V_r = \frac{g}{\gamma}\left[\gamma'\sin - (\gamma'\cos\alpha - n)\tan\phi'\right]t \qquad (23)$$

where V_r denotes velocity for this rigid block model
t denotes time
and g denotes the acceleration due to gravity.

It is seen that for this model the velocity increases linearly with time, and depends upon the slope angle, the excess pore pressure gradient, and the density and strength of the sediment. A diagrammatic velocity profile is shown in Figure 10.

A more realistic model may be developed by incorporating a viscous resistance due to the strain rate in the sediment. This would give rise to a velocity profile of the type shown for this mode of flow in Figure 10. Since the slope is infinite there is no variation of any stress or strain-rate in the x direction. The equation of motion for an infinitesimal element accelerating in the x direction becomes

$$\gamma'\sin\alpha - \frac{\partial\tau_{xz}}{\partial z} = \frac{\gamma}{g}\frac{\partial V_v}{\partial t} \qquad (24)$$

where V_v denotes the velocity in the x direction.

There is no acceleration in the z direction. Incorporating a viscous resistance into the failure criterion for the sediment gives

$$\tau_{xz} = (\gamma'\cos\alpha\cdot z - nz)\tan\phi' - \eta\frac{\partial V_v}{\partial z} \qquad (25)$$

where η denotes the viscosity of the sediment.

The viscous term is negative here because, owing to the choice of axes, the velocity gradient is negative. Substituting equation (25) into (24) gives

$$\frac{\partial^2 V_v}{\partial z^2} - \frac{1}{a}\frac{\partial V_v}{\partial t} = -b \qquad (26)$$

$$\text{where} \quad a = \frac{g\eta}{\gamma} \qquad (27)$$

and $b = \left\{\frac{\gamma' \sin\alpha - (\gamma' \cos\alpha - n)\tan\phi'}{n}\right\}$ (28)

Equation (26) is to be solved subject to the boundary conditions

$$\begin{array}{l} t = 0,\ V_v = 0; \\ t > 0 \begin{cases} z = 0,\ \dfrac{\partial V_v}{\partial z} = 0; \\ z = h,\ V_v = 0. \end{cases} \end{array} \quad (29)$$

where h is the depth of the slump. This problem has been considered by Carslaw and Jaeger (1959) in the context of heat conduction and the solution is:

$$V_v = \frac{bh^2}{2}\left\{1 - \frac{z^2}{h^2} - \frac{32}{\pi^3}\sum_{n=0}^{\infty}\frac{(-1)^n}{(2n+1)^3}\cos\frac{(2n+1)\pi z}{2h} \cdot e^{\frac{-a(2n+1)^2\pi^2 t}{4h^2}}\right\} \quad (30)$$

Equation (30) may be expressed in terms of a dimensionless depth factor

$\frac{z}{h}$,

time factor

$\frac{at}{h^2}$,

and velocity factor

$\frac{2V_v}{bh^2}$

and plotted graphically as in Figure 12 to reveal the development of the velocity profile with increasing time. The maximum velocity occurs at the surface of the flow, and plotting the velocity factor against time factor for z = 0, it is seen from Figure 13 that for a small time a linear relationship exists. More particularly

$$\frac{2V_v}{bh^2} = 2\frac{at}{h^2} \quad (31)$$

Therefore, for small time

$$V_v = \frac{g}{\gamma}[\gamma' \sin\alpha - (\gamma' \cos\alpha - n)\tan\phi']t \quad (32)$$

and comparing equation (32) with equation (23) one finds

$$V_v = V_r \quad (33)$$

In the early stages of motion the maximum velocity developed in the frictional-viscous flow will be the same as that in the purely frictional flow. The average velocity will be slightly less. For larger times the viscosity will now be more significant. Viscosity data for sediments of high concentration are scarce. However, on the basis of experiments reported by Yano and Daido (1965) values of between 0.4 and 0.5 lb (force) sec per sq ft may be used in calculations for the concentration of sediments likely to exist in an accelerating slump.

The process of transformation into a turbidity current involves the onset of turbulence and the likelihood of some mixing with overlying water due to instability and wave formation at the interface. This is a difficult problem and is by no means fully resolved at present. Among the factors that would deter a slump from transforming into a turbidity current are rapid decrease of slope inclination and the dissipation of pore pressure. It is of interest, then, to adopt a relationship that has been applied to the steady state flow of a turbidity current in order to find a velocity at which it may be assumed that transformation is complete, and then, for an assumed slump, compute the time required to achieve this velocity. The degree of dissipation at this time can also be estimated.

A slump 30 ft thick is assumed to have occurred on a slope of 5 degrees and following Kuenen (1952) it is assumed that the Chezy equation is valid when the turbidity current is created. It is also assumed that the bulk density of the sediment is three times the submerged density. From the Chezy equation a velocity of 58.5 ft per sec is obtained. If it be further assumed that the angle of shearing resistance is 20 degrees and

$\frac{n}{\gamma'}$

is 0.8, this velocity is attained in only 340 seconds. It is evident that the degree of dissipation of pore pressure for a slump of this size after 340 seconds is negligible for all but the coarsest sediment. It seems probable that in the experiments carried out by Buffington (1961) the amount of sediment was so small that, aggravated by spreading, the drainage path was sufficienty small to allow almost instantaneous dissipation of the excess pore pressure.

For a slump to turn into a turbidity current, the analysis presented here shows that it is necessary that at failure the strength be reduced sufficiently to permit the acceleration of the mass, and that deeper slumps will transform more readily because, other things being equal, the dissipation of pore pressure will be less.

CONCLUDING REMARKS

Much of this study is necessarily speculative because of the paucity of reliable strength data for submarine sediments. It is evident that a more profound understanding of submarine slumping requires this information, as well as more detailed studies of topography, occurrence of slumping, and rate of accumulation of material in varying sedimentary environments. The development of underconsolidation in deltas and submarine canyon heads deserves special attention.

The transformation of a moving slump into a turbidity current is a complicated problem involving both soil and fluid mechanics. Conditions that must be satisfied for the onset of turbulence and the development of the dispersive forces that arise and maintain the sediment in suspension are not well understood. The mixing with overlying water is an important factor in the development of a turbidity current, and controls its density. This process must be clarified before the mechanics of turbidity currents of high density can be founded on a firm physical base.

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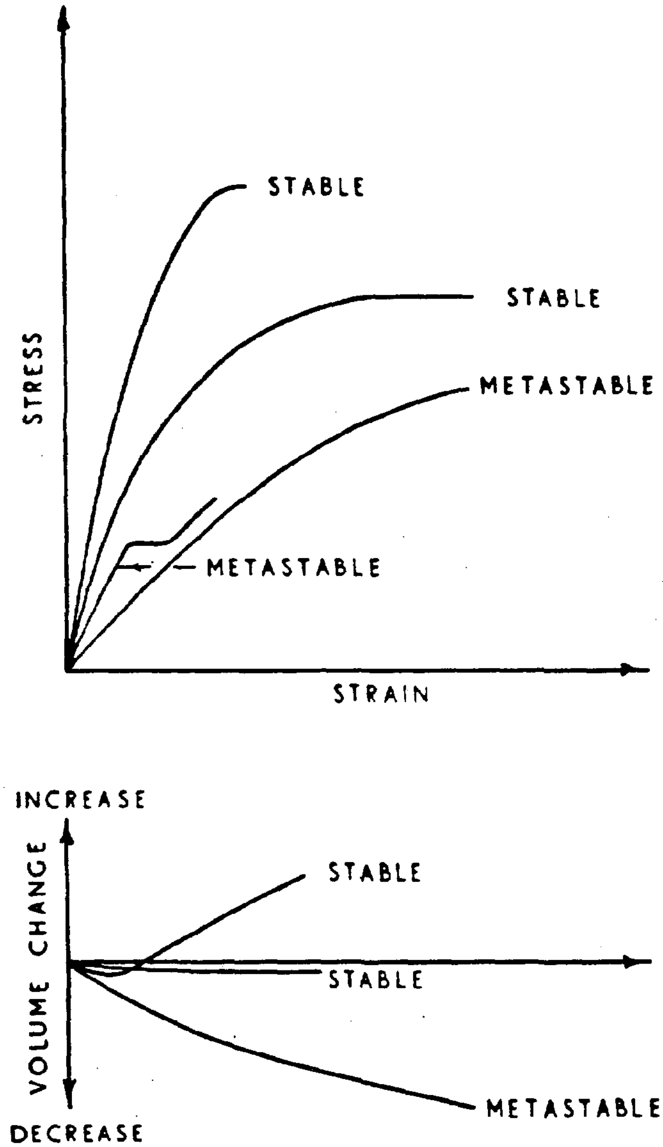

FIGURE 1. DIAGRAMMATIC STRESS – STRAIN RELATIONS FOR STABLE AND METASTABLE SEDIMENTS.

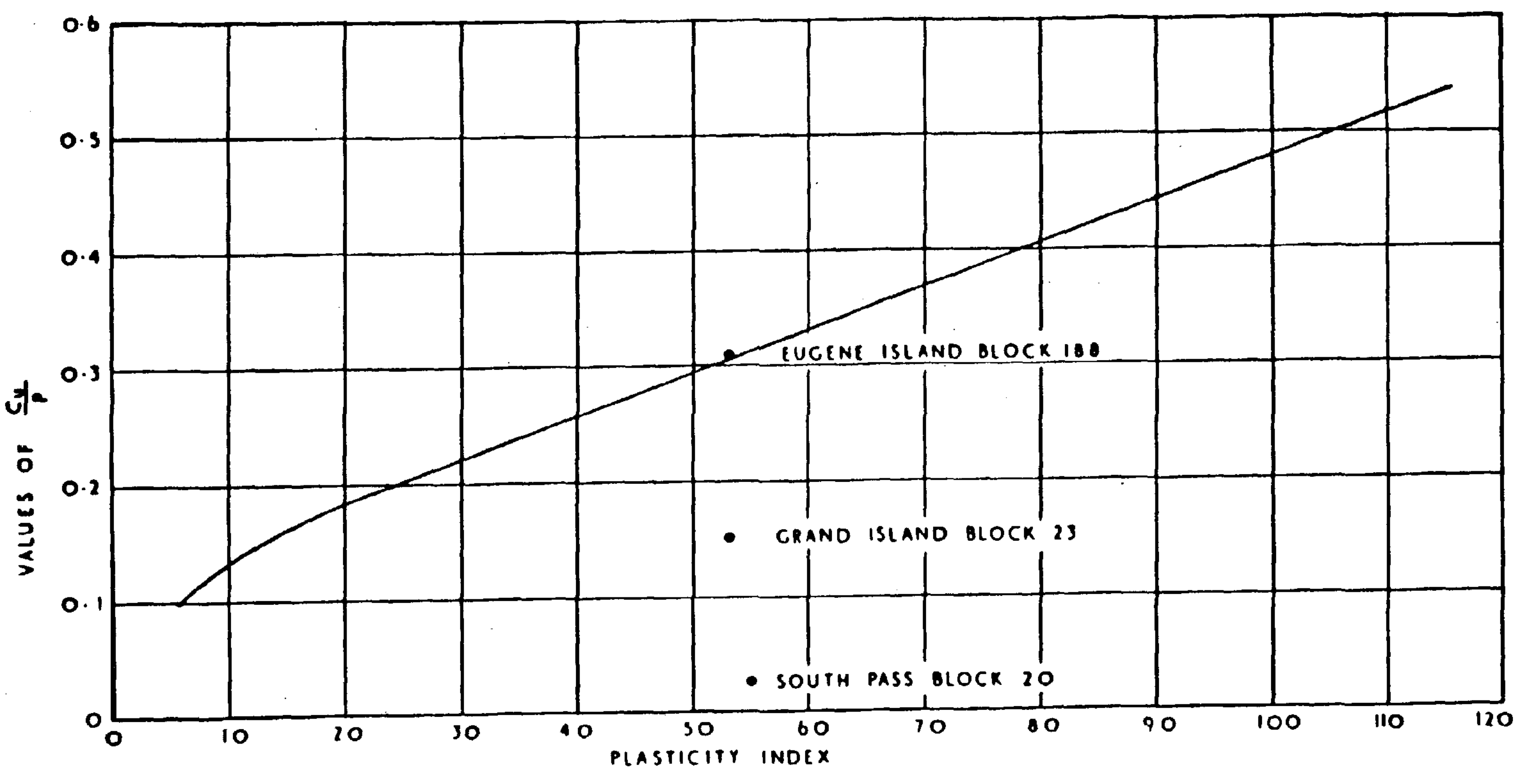

FIGURE 2. RELATION BETWEEN UNDRAINED STRENGTH AND PLASTICITY INDEX FOR NORMALLY CONSOLIDATED SEDIMENT.

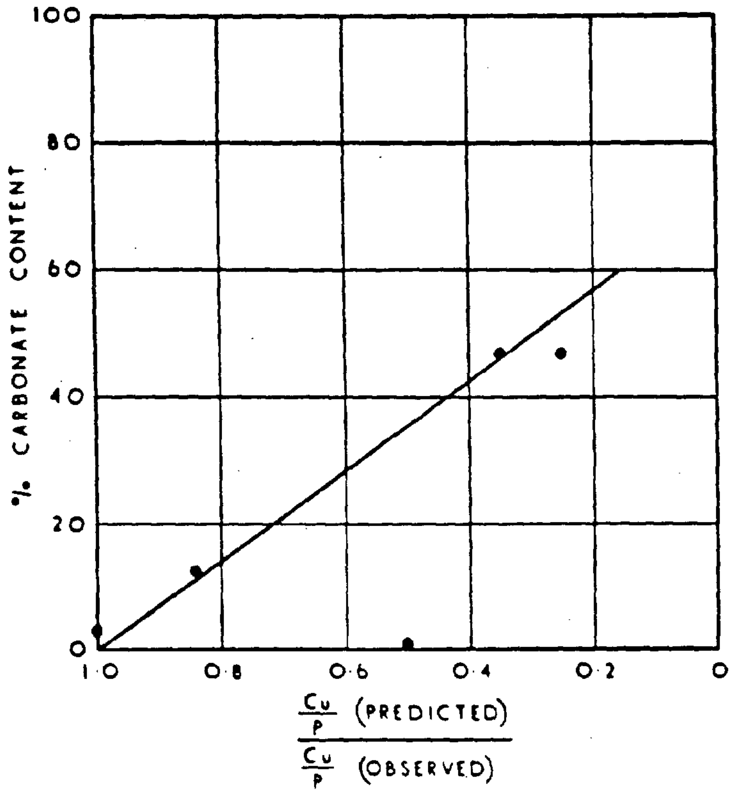

FIGURE 3. INFLUENCE OF CARBONATE CONTENT ON UNDRAINED STRENGTH OF SEDIMENTS FROM EXPERIMENTAL MOHOLE.

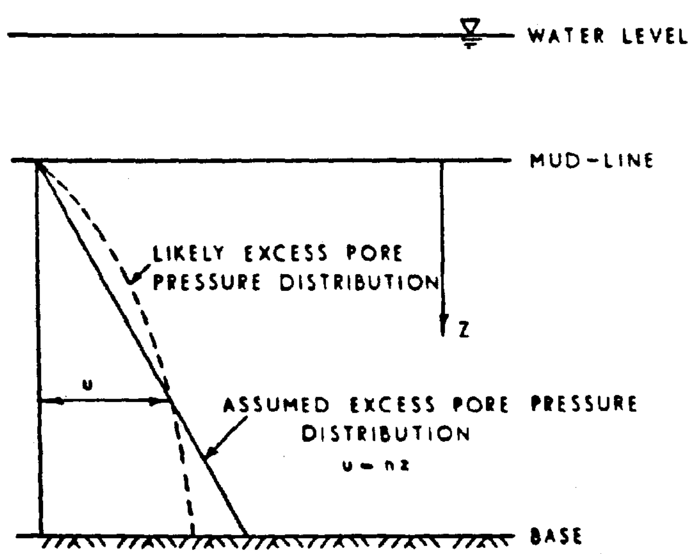

FIGURE 4. AN UNDERCONSOLIDATED STRATUM.

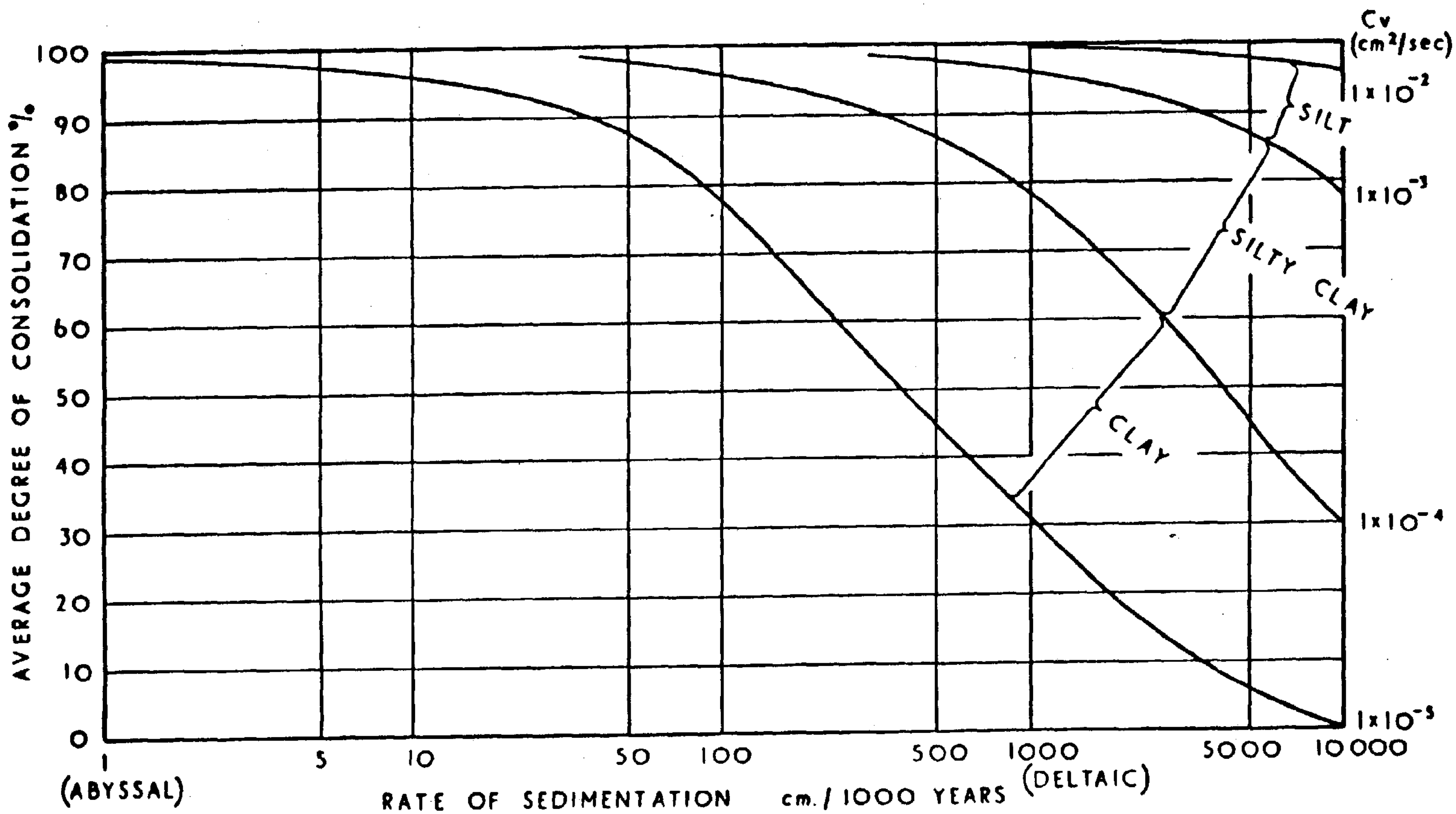

FIGURE 5. RELATION BETWEEN RATE OF SEDIMENTATION AND DEGREE OF CONSOLIDATION FOR 15 m LAYER.

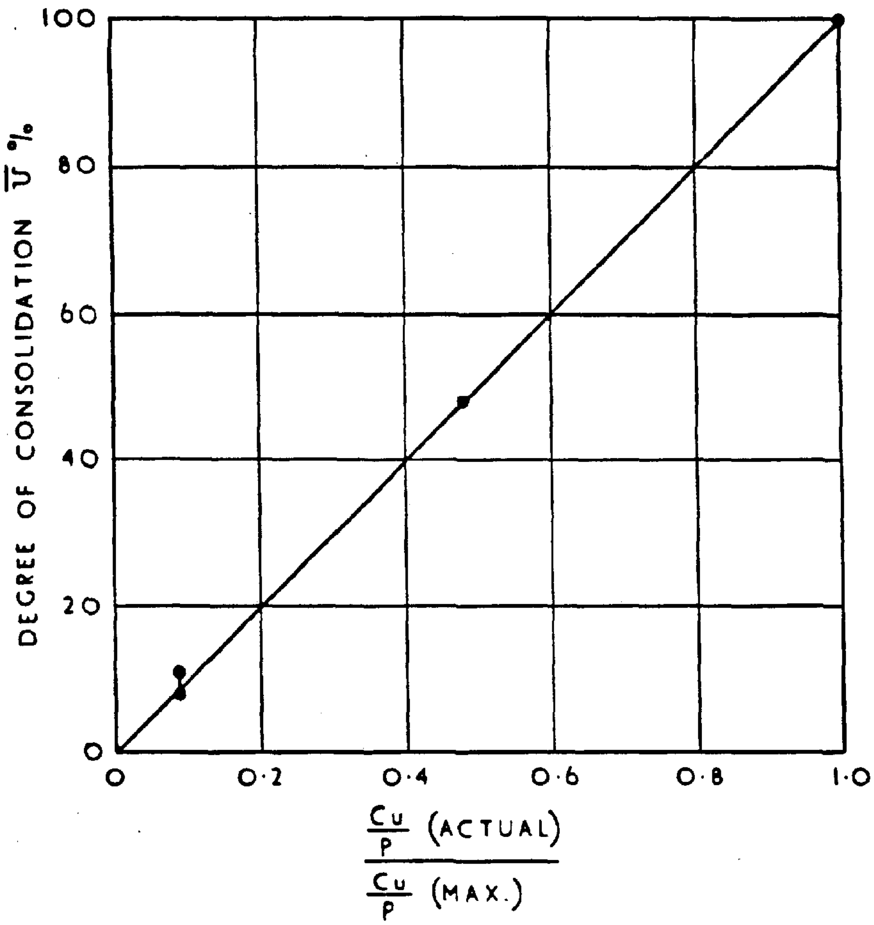

FIGURE 6. INFLUENCE OF UNDERCONSOLIDATION ON UNDRAINED STRENGTH OF MISSISSIPPI DELTA SEDIMENTS.

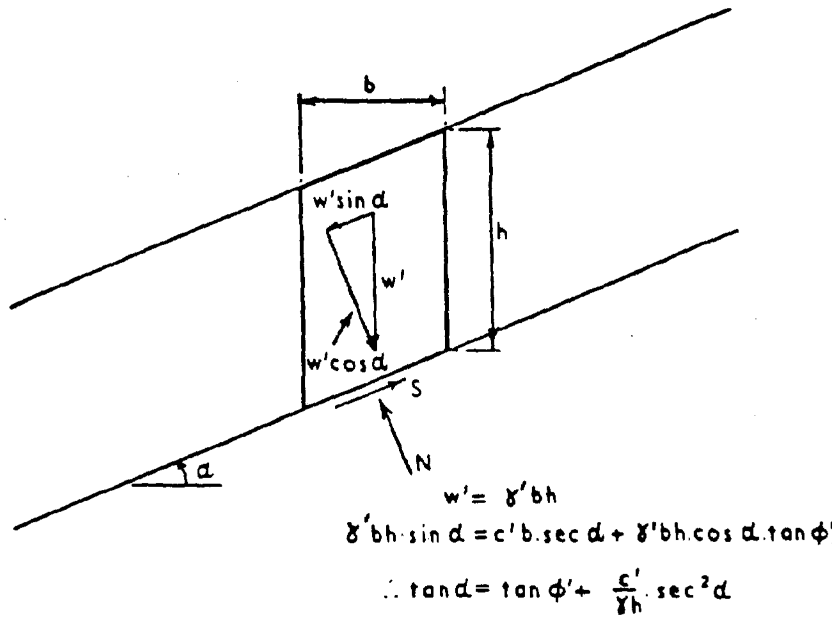

FIGURE 7. EQUILIBRIUM OF INFINITE SLOPE UNDER DRAINED CONDITIONS.

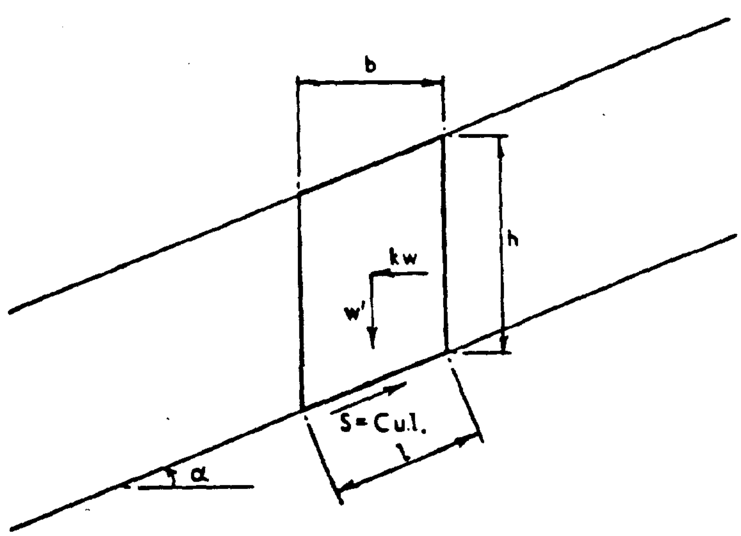

FIGURE 8. EQUILIBRIUM OF INFINITE SLOPE UNDER UNDRAINED CONDITIONS.

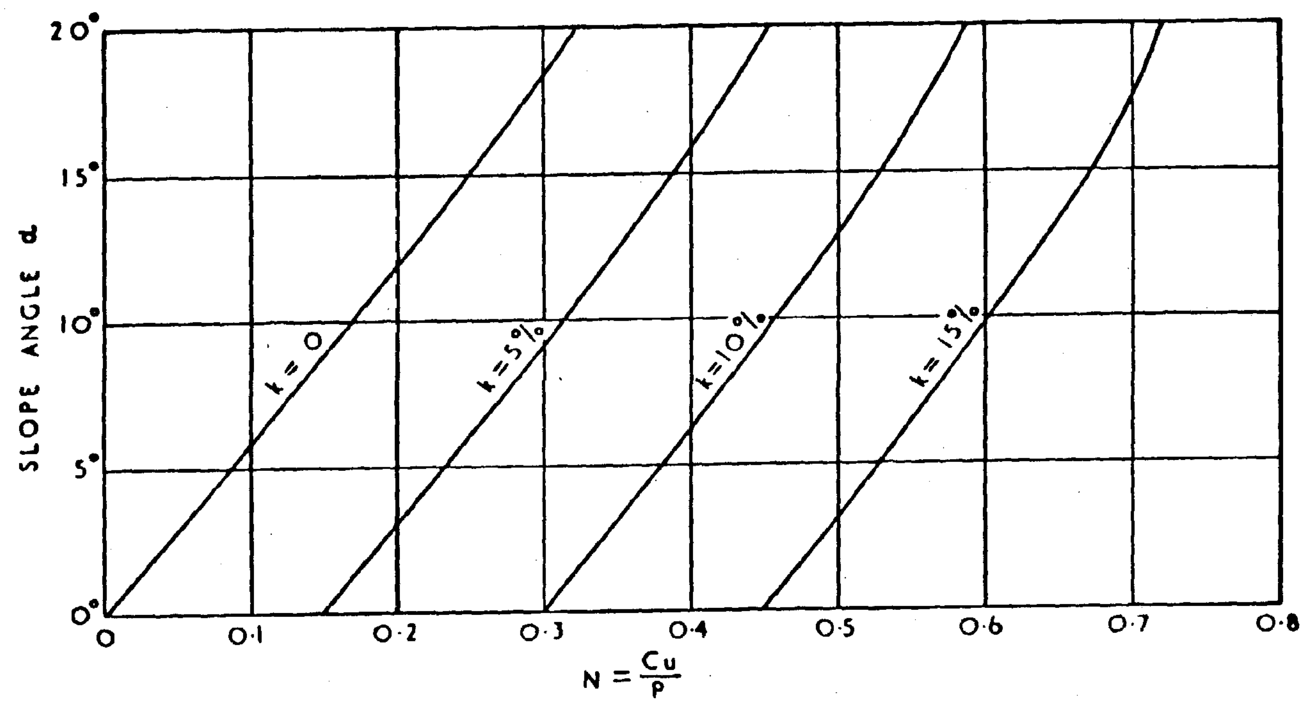

FIGURE 9. RELATION BETWEEN SLOPE ANGLE AND UNDRAINED STRENGTH FOR AN INFINITE SLOPE AT LIMITING EQUILIBRIUM AND SUBJECT TO AN EARTHQUAKE ACCELERATION k PERCENT OF GRAVITY.

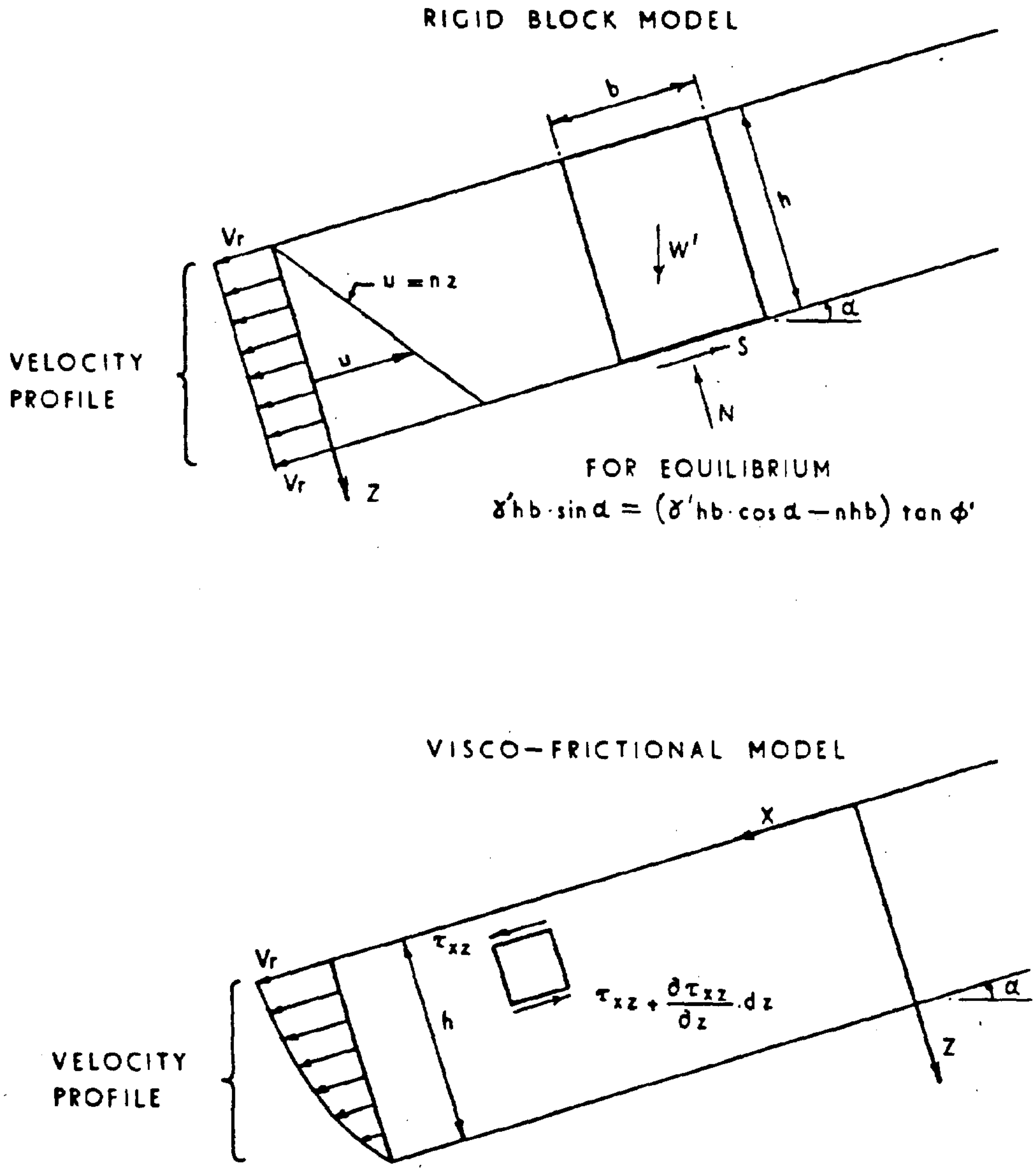

FIGURE 10. ACCELERATION OF AN INFINITE SLOPE.

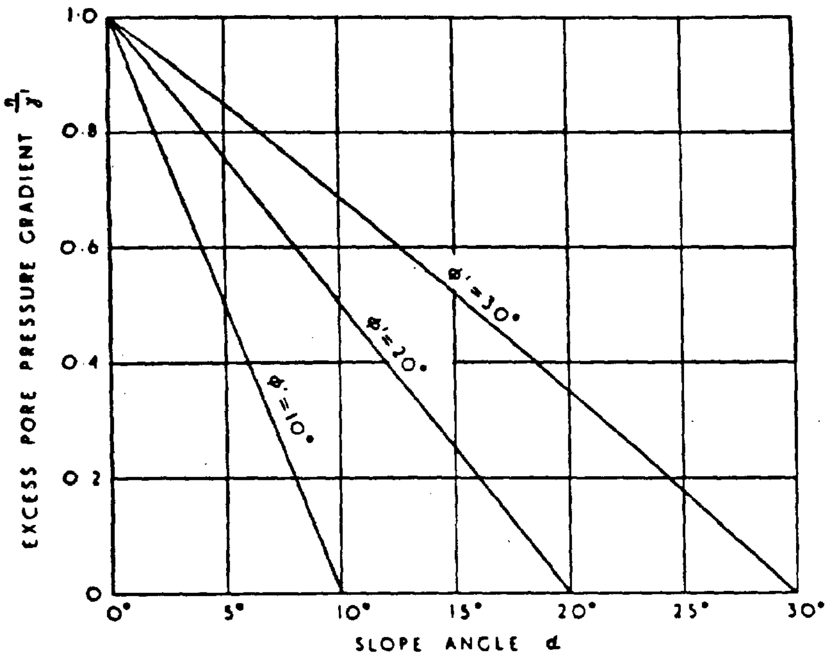

FIGURE 11. RELATION BETWEEN EXCESS PORE PRESSURE AND INCLINATION FOR AN INFINITE SLOPE AT LIMITING EQUILIBRIUM.

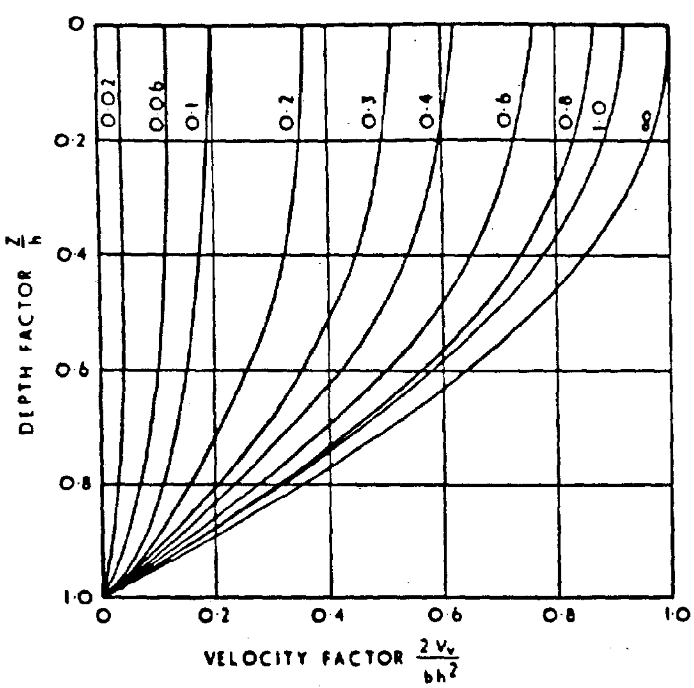

FIGURE 12. VELOCITY PROFILES FOR INCREASING VALUES OF TIME FACTOR $\frac{at}{h^2}$.

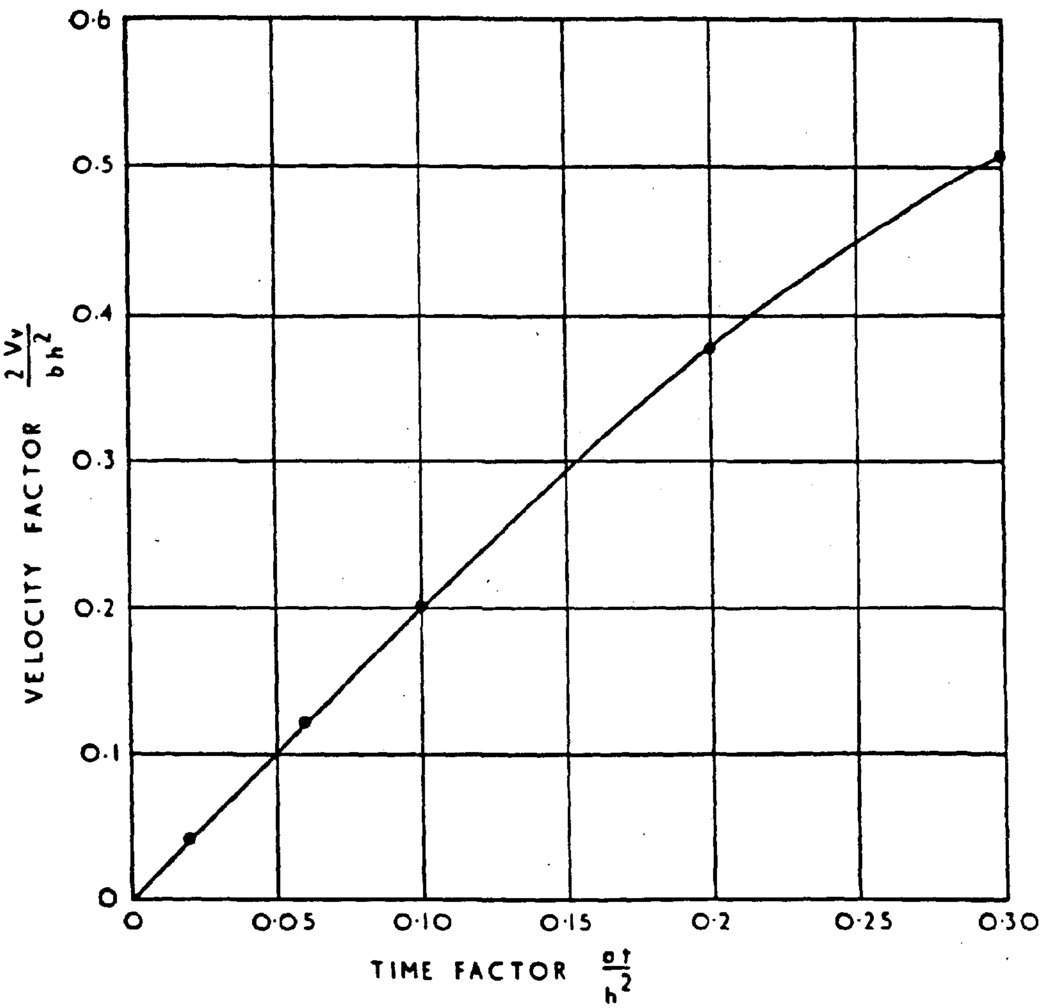

FIGURE 13. RELATION BETWEEN VELOCITY FACTOR AND TIME FACTOR AT $\frac{z}{h} = 0$.