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16. ABSTRACT

A. Background & History

The Tahoe Basin is unique in that it contains one of the most remarkably clear lakes in the world. Only two others of comparable size rival this beautiful body of water, Crater Lake in Oregon and Lake Baikal in Russia. This clarity is attributable mainly to several natural features of the basin. One is the character of the soil type. This is largely granitic and sterile in its composition. The sections of the basin which contain more of the volcanic type soil have relatively good natural ground cover and are in gentler terrain. Another feature is the small basin land area with respect to the lake area. This results in a very large portion of the precipitation falling on the lake surface. The final saving feature is the small amount of development that had taken place up until the early 1950's.

It is this last feature which has been dramatically altered in the last 20 years. Disturbance of the natural ground cover by clearing land for subdivisions, ski slopes, roads and highways, have opened the soil to erosive forces and resultant sedimentation. The sedimentation itself would take about three million years to fill the lake at its present rate of transport into the tributaries, however, the nutrients carried along with the eroded material have already become the next most important source of pollution. Algae growth is evident in many shoreline areas formerly clean and clear. With the sewage problem almost eliminated, sediment becomes the next area of concern.

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CALIFORNIA DEPARTMENT OF PUBLIC WORKS

DIVISION OF HIGHWAYS

INTERIM REPORT

CONTROL OF HIGHWAY-PRODUCED SILTATION

LAKE TAHOE BASIN

JULY 1971

DON FOSTER
STUDY ENGINEER

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A. Background & History

The Tahoe Basin is unique in that it contains one of the most remarkably clear lakes in the world. Only two others of comparable size rival this beautiful body of water, Crater Lake in Oregon and Lake Baikal in Russia. This clarity is attributable mainly to several natural features of the basin. One is the character of the soil type. This is largely granitic and sterile in its composition. The sections of the basin which contain more of the volcanic type soil have relatively good natural ground cover and are in gentler terrain. Another feature is the small basin land area with respect to the lake area. This results in a very large portion of the precipitation falling on the lake surface. The final saving feature is the small amount of development that had taken place up until the early 1950's.

It is this last feature which has been dramatically altered in the last 20 years. Disturbance of the natural ground cover by clearing land for subdivisions, ski slopes, roads and highways, have opened the soil to erosive forces and resultant sedimentation. The sediment itself would take about three million years to fill the lake at its present rate of transport into the tributaries, however, the nutrients carried along with the eroded material have already become the next most important source of pollution. Algae growth is evident in many shoreline areas formerly clean and clear. With the sewage problem almost eliminated, sediment becomes the next area of concern.

In October 1970, the Lahontan Regional Water Quality Control Board issued orders setting forth waste discharge requirements which affect surface water runoff from State highways and right of way.

Some of these requirements have progressed thus far to these definitions listed in the Interim Water Quality Control Plan, North Lahontan Basin, under "Policy Guidelines - Lake Tahoe Subunit" ---

"All construction, excavation, grading, cutting, filling, clearing, logging, or other operations which disturb the natural ground conditions within the Lake Tahoe Subunit shall be conducted in a manner which does not cause unnatural turbidity in the surface waters.

"Storm drainage from developed areas such as subdivisions, roadways, shopping centers, parking lots, etc., within the Lake Tahoe Subunit shall be controlled in a manner which does not result in excessive unnatural turbidity in surface waters.

"In the Lake Tahoe Basin after January 1, 1976, any surface drainage wastes discharged to the surface waters of the basin should be of approximately the same quality* as the receiving waters."

Under "Water Quality Objectives and Discharge Prohibitions - Lake Tahoe Subunit" ---

"The following additional prohibitions shall apply to the Lake Tahoe Basin portion of the Lake Tahoe Subunit.

a. The discharge of treated or untreated domestic sewage, industrial waste, garbage or other solid wastes, or any other deleterious material to the surface waters of the Lake Tahoe Basin is prohibited.

*Approximately equal quality - the waters in question must be of the same order of magnitude in water quality constituents. When used with respect to drainage waters, constituents to be examined would include turbidity, nutrients, and any other parameter which would serve as a significant index.

b. The discharge of solid or liquid waste materials, including soil, silt, clay, sand and other organic and earthen materials, to Lake Tahoe or any tributary thereto is prohibited.

c. The discharge of solid or liquid waste materials, including soil, silt, clay, sand and other organic or earthen materials to lands below the highwater rim of Lake Tahoe or within the 100-year flood plain of any tributary to Lake Tahoe is prohibited.

d. The threatened discharge of solid or liquid waste materials including soil, silt, clay, sand and other organic and earthen materials, due to the placement of said materials below the highwater rim of Lake Tahoe or within the 100-year flood plain of any tributary to Lake Tahoe, is prohibited."

The Division of Highways accepted these standards as desirable objectives for future highway planning in the area and as a goal for modification of control features on existing State highways. A full time engineer was assigned in November 1970 to commence a study of the siltation problem and to establish methods of siltation reduction and control.

There are about 66 miles of State highways in the basin as compared with over 370 miles of county roads, city streets and unimproved roads. Although the percentage in miles is small, success in the State's efforts to reduce siltation could produce benefits in preserving the clarity of the Lake, providing data for use by other agencies in doing the same, reducing long term maintenance costs and providing acceptable methods for future construction in this type of environment.

In May 1971, the California Highway Commission allocated $55,000 to finance the initial phases of the siltation study and control project.

Again in July 1971, the California Highway Commission allocated $105,000 to finance a continuation of these efforts into the 1971-72 fiscal year.

To get the Basin Study underway, District 03 called a meeting in January 1971 for representatives of all public and private agencies conducting research on the Lake Tahoe environment. The purpose of the meeting was to discuss problem areas and to pool information in order to avoid duplication of effort and so that data could be made available to all groups involved in special studies.

Following this meeting during the spring months, plans were formulated for sampling several streams at highway crossings. Testing equipment was purchased, and data collection was begun in order to evaluate the effect of highway drainage on tributaries entering the Lake.

Staff gauges were installed at eleven locations and subsequent stream velocity readings were taken for determining volumes of water at various stages.

Snow disposal sites were sampled and tested for sediment and chloride.

Samples of sand and cinders used for de-icing were obtained from different sources and tested for durability and resistance to powdering. New vacuum type equipment was demonstrated in connection with the sand removal operation in the populated areas.

A survey of all cut and fill slopes on all State highways in the Basin was made to determine the erosion rates in each watershed area.

The Basin Study as originally proposed in the District's letter of November 17, 1970, consists of three phases. Phase I - Study and Evaluation, Phase II - Analysis of Environmental Effects, and Phase III - Experimental Installations and Improvement Projects. It was not intended that these different phases be executed separately and so it is that with the summer season in progress, we are still studying and evaluating and analyzing,

but will proceed and overlap with experimental projects. A work authorization for $8,000 is now pending for the first of this important phase.

B. Liaison

In March the District accepted an invitation to be represented on the Tahoe Regional Planning Agency drainage committee. The Study Engineer has attended two meetings thus far. In addition to being able to voice the District's views on policy being established for the basin, this has provided a good means of establishing liaison with representatives of key agencies. The following agencies are represented on the drainage committee in addition to District 03:

Tahoe Regional Planning Agency	TRPA
U. S. Forest Service	USFS
Lahontan Regional Water Quality Control Board	LRWQCB
State Dept. of Fish & Game	DFG
City of South Lake Tahoe	SLT
Federal Environmental Protection Agency	EPA
County of Placer	Pla. Co.
County of El Dorado	ED Co.
University of California at Davis	UCD
U. S. Soil Conservation Service	SCS
Nevada State Highway Dept.	
County of Washoe, Nevada	
County of Douglas, Nevada	

Some unduly restrictive measures have been reworded and others eliminated from the proposed policy as a result of these meetings. At the same time, the feelings of the various agencies have been brought out, enabling the District to be prepared to plan for the policies that will be adopted.

The National Aeronautics and Space Administration (NASA) is involved in a program of developing equipment and techniques for using cameras and other sensors to survey and monitor environmental conditions throughout the nation. Part of their efforts involve high altitude flights (28,000') over Lake Tahoe during high runoff stream stages. Color pictures are taken partly for the purpose of detecting heavy concentrations of siltation in the streams entering the lake. We were able to schedule our sample taking to coincide with some of these flights, thus providing "ground truth data" for correlation with the photography. We also plan to make use of their information.

In a flight made in May by a State photographer and the Study Engineer, pictures were taken of the major stream inlets and water samples were obtained at the same time for correlation with these photos. This was a relatively low altitude flight (9,000' or about 3,000' above the lake). On this same flight a picture of the Incline Village area in Nevada was taken where the USGS and State of Nevada are involved in a cooperative study of the streams. A copy of this aerial was sent to the USGS representative in Carson City, and later proved to be helpful to him in his study. We have received a great deal of help from the USGS people during this study.

Our Tahoe Basin study is also being coordinated with the impact study for the proposed freeway in the South Lake Tahoe area. Data gathered thus far has indicated a number of considerations which should be incorporated in the design, however, the trial projects to be done this summer should yield more concrete information which can be used in developing construction procedures.

A slight revision in the replacement of pavement striping subsequent to the recent thin blanket paving program in South Lake Tahoe has provided more room on the outer edge for better ingress and egress of automobiles at driveways. It coincidentally provides a safer width of travel for the numerous bicyclists in this resort area. Comments from cycle enthusiasts indicate this has generated favorable public opinion toward the Division of Highways.

Numerous interviews with news correspondents in the basin have resulted in a great deal of favorable publicity regarding the Division of Highways' interest in preserving the lake and the surrounding environment.

The Study Engineer has given several talks on the subject of our efforts in the basin. These were received with favorable comment and resulted in further news coverage.

C. Main Problem Areas

Listed in the order of importance from the standpoint of being a contributing factor in the production of silt.

1. Roadway cut slopes.
2. Roadway embankment slopes.
3. Unpaved shoulders.
4. Unpaved ditches.
5. Silt, sand, and dust from winter maintenance operations.
6. Snow disposal sites.

D. Investigation of Problem Areas

1. Roadway cut slopes.

A review of the microlog film during winter months revealed areas

where intense field investigation was desirable for determining erosion rates.

Field investigation further revealed the actual amount of erosion that has been taking place, both long-term and annually. This investigation is the subject of a separate report, produced by the Environmental Improvement section of the Materials & Research Department in Sacramento. This report is entitled "Slope Erosion Transects, Lake Tahoe Basin, Interim Report, July 1971". It is Research Report No. M & R 657078.

It becomes increasingly evident that more consideration must be given to the angle of cut and fill slopes, especially in high elevations where soils are difficult to revegetate due to sterility and due to the short growing season. In numerous instances, by laying the slopes back a very slight amount, even natural revegetation will and has taken place. Rather than be classified as 2:1 or 3:1, maybe a percentage or degree should be stated after careful examination of the geologic features, including the natural angle of repose of the material.

Studies are being conducted in the field of revegetation on roadway slopes by the University of California at Davis in cooperation with the State.

This summer two commercial products will be placed on slopes on Route 89, near Luther Pass, to evaluate their effectiveness for erosion prevention as a temporary measure for possible use during future construction operations in the Tahoe Basin. Catch basins will be installed to measure the results of these applications in comparison with an untreated section. Material removed from these basins will be analyzed quantitatively and qualitatively.

Other methods of erosion prevention will be tried for different areas. Some of the possibilities are:

a. Natural rock slope protection.

b. Natural rock wall.

c. Serrating existing slopes to promote revegetation.

d. Laying the steeper slopes back to natural repose.

e. Use of slope paving in very special cases. (This is aesthetically unpleasing to many and it is also quite expensive.)

The problem of finding disposal sites for earthen material removed from cut slopes is partly resolved with the location of several abandoned borrow pits on Forest Service property. A review of these sites was conducted with Forest Service and Maintenance Dept. personnel in mid-July.

A very large site with a capacity of at least 100,000 C.Y. is located near the bottom of the grade on the old U.S. 50 alignment near Meyers. This will serve most of the South Lake Tahoe area for disposal of sluffed material, sweepings (or vacuumings) picked up in the business districts, and for broken concrete and asphalt concrete removed for pavement repairs. Stumps and unusable timber cuttings can be burned in this area too, under favorable conditions. Care will be exercised to prevent any runoff containing silt by constructing a rounded dike section around the perimeter, thus complying with LRWQCB policy.

A small capacity site (about 3,000 C.Y.) was located in the vicinity of the Bay View Resort near Emerald Bay.

Two sites with medium capacity (40,000 C.Y.) were found on Route 89 south of Meeks Bay. These will serve the area to the south, including

Emerald Bay. The access road to these sites will require some improvement and selective small tree removal. This has the approval of the Forest Service District Ranger.

All of these sites will serve as disposal sites for our maintenance operations as well as to repair the former borrow sites and restore the areas to their natural condition, thus serving dual purposes in keeping with environmental rehabilitation.

Another disposal site is being investigated in the Emerald Bay area which could be used to increase available parking area for visitors to the Vikingsholm exhibit. This property belongs to the State Department of Parks and Recreation.

This was the subject of a sub-report entitled, "Disposal Areas for Earthen Materials" dated April 16, 1971. Upon completion of negotiations with other agencies, this separate report will be updated.

One major area of concern in respect to cut slope erosion is the Emerald Bay slide. A small scale slide occurred here on May 24, 1953, and a large scale slide took place in the winter of 1955-56 at the same location. This latter event wiped out all vegetation in its path and there has been constant small scale sliding ever since. This is a maintenance problem, a concern for public safety, and a source of siltation.

Plans are underway to have a separate geologic study make for possible correction of the existing condition by our Headquarters Materials & Research Geology Department. All previous studies have been concerned with construction of a new facility. This study should take place this fall.

2. Roadway embankment slopes.

Field review of this area of concern revealed that embankment slopes are much better able to stabilize themselves naturally than cut slopes, partly due to their being less steep. This was evidenced by the prolific growth of natural vegetation which had established in areas where no planting had been done. The one operation which can prevent this plant establishment is the practice of side-casting or disposal of material removed from cut slope erosion over the embankment. Disposal sites suitable for the prevention of further siltation and yet within an economical haul distance are being sought in cooperation with the U. S. Forest Service and the Parks and Recreation Dept. as mentioned above. This will result in compliance with LRWQCB policy.

Embankment slopes when undisturbed are also more responsive to planting than cut slopes. One of the difficulties encountered in planting is lack of moisture during the first year of establishment. A cooperative effort to overcome this is being worked out between the U. S. Forest Service and the Ecology Corp. people, using personnel to tend plantings on slopes along State highways in the South Tahoe area. We will furnish test locations for their use.

3. Unpaved shoulders.

In December 1970, a field review of the portion of Route 89 between Eagle Creek and Emerald Bay was conducted to choose sections where no blading would be performed. This is to provide an evaluation of the effect of undisturbed roadside drainage. It was found that approximately 40 percent of this total length could be left undisturbed. A recent review confirms that much of the area can stabilize much better than when it is routinely shaped up by blading. Several factors necessitate reshaping. When traffic causes displacement of material at the

edge of pavement so as to result in a drop-off, material must be brought in to maintain safe travel. When sluffing occurs from an adjacent cut slope, removal is sometimes necessary to maintain drainage.

Paving the shoulders in some of the problem areas would eliminate the edge of pavement drop-off and would prevent erosion from occurring in the shoulder area.

Construction of the main collector system for sewage along Routes 89 and 28 on the west side of Lake Tahoe has caused a great deal of disturbance to the shoulder areas. A District requirement to lime treat the upper six inches of disturbed material with 4 percent hydrated lime is being negotiated for the next section of sewer to be placed this summer.

We will also experiment with lime treatment of material used to bring up the shoulder to the pavement level to eliminate drop-off. This should prevent further erosion as well as reduce the frequency of replacement.

4. Unpaved ditches.

The fourth most critical area of silt production cannot be divorced from the third, unpaved shoulders. In many cases the ditch should be paved as well as the shoulder to provide a continuous non-erodible section where soil conditions and gradient produce erosive conditions. Energy dissipators will be necessary in steep ditch grades and drop inlets with deep bottom sections will be required to collect silt from other sources in this instance.

The construction of natural rock bottoms on some steeper side ditches would serve to dissipate energy. This is the type of project

where low cost hand labor could be used. Another possibility for an Ecology Corp. type project.

These measures will undoubtedly be required to meet TRPA policy on storm drainage for roads. Quoted here is a portion taken from the second preliminary rough draft:

"Sec. 13. Roads. (Storm Drainage Tech. Rpt.)

All runoff from roads shall be collected in roadside ditches and carried to an approved point of discharge.

a) The roadside drainage ditches shall be paved or lined with a suitable material approved by the appropriate governmental official that will preclude the possibility of soil erosion in the ditch.

c) Roadway drainage systems shall be equipped with catchbasins designed to trap all soil, silt, clay, sand, and other organic and earthen materials in the runoff from the roads.

i) The settled material in the catchbasins shall be periodically removed to an approved disposal site where it will not be subject to erosion, or exported from the Tahoe Basin.

d) Runoff from roads should be discharged into pervious soils or filtering beds after the soil, silt, sand and other earthen materials have been removed in catchbasins. If drainage fields are not permitted, the runoff must be discharged into the natural drainage channel that corresponds to the particular section of road after the soil, sand, silt, clay and other earthen materials have been removed in catchbasins."

5. Silt, sand, and dust from winter maintenance operations.

Investigation thus far has indicated we may be able to make certain revisions in our maintenance procedures which will reduce this problem. Experimental work incorporating new types of equipment for street cleaning and revised specifications for de-icing sand or cinders will be carried on this next snow season.

Detailed results of the investigation to date are contained in a separate report to be issued soon.

6. Snow disposal sites.

An interim reported dated April 1971 covered the results of tests of the disposal sites. The tentative conclusions are that the deposition of sand, silt, and other detritus is confined mainly to the immediate area. Silt basins have been installed however, and a low dike section constructed at the South Lake Tahoe site so that measurements of the actual amount can be taken this next winter. Average salt content of the snow in these disposal areas proved to be at a level considered desirable for drinking water. Natural vegetation observed in these areas this spring tend to confirm the conclusion that the salt is not detrimental to the waters of Lake Tahoe.

The use of salt for de-icing has generated complaints for years, not only in the Tahoe Basin, but elsewhere in the State and the nation. Damage to automobile parts, accelerated deterioration of the steel and concrete in highway structures and alleged injury to roadside vegetation and pollution of adjacent lakes and rivers are a few of the main points of criticism. Much research has been done on this subject in the interest of finding a more suitable substitute which

is as effective and yet economically feasible. To date, the alternatives which show the most promise are urea and tetra-potassium pyrophosphate (TKPP) and these have certain undesirable features which might well outweigh any advantages. Urea, which is high in nitrogen content, could be a hazard in stimulating algae growth. TKPP contains phosphate, which is also undesirable in maintaining an ecological balance. Even though this latter mentioned chemical, TKPP, seems to have the least effect on roadside vegetation, the long-range effect has yet to be evaluated in conjunction with different types of soils and vegetation.

In the meantime, we are working with reduced application rates, various combinations of sand, cinders and salt which will yield the most benefits to the highway user and yet have the least effect on the roadside environment.

A fact that cannot be overlooked, is that the use of salt in the Tahoe Basin since the late 1940's has enabled the traveling public to enjoy all-year access to the winter sports available in this area in relative safety. Another fact is that vegetation immediately adjacent to the roadway shows little or no effect by salt in its growth. There are isolated cases of foliar burn on manzanita and small conifers near the roadway, but these are apparent only with close scrutiny. All such damage seems to be from foliar contact and not taken up by the roots. In an area near Interstate 80 west of Donner Summit on old U.S. 40 between the Kingvale Interchange and the Soda Springs Interchange, there is a prolific growth of small Lodgepole Pines very close to the edge of pavement over most of this length. These trees have

developed since the time that this section of highway was replaced by the freeway, about 1962. It is interesting to note that growth is just as thick and healthy on the westerly portion of this roadway as it is on the remainder. The westerly portion is used for access of snow removal equipment to the freeway and for homes and cabins in the area, and thus is heavily sanded and salted for that purpose.

There is some evidence of mechanical damage to the foliage of larger trees near the roadway from snow blast in areas where the high-powered equipment is used, but even this is not considered permanent and efforts are being made to blow the snow away from the foliage. We are also experimenting with smaller, more manueverable equipment.

A recent publication by the National Highway Research Board (Report No. 91) concerns the use of de-icing salts. It is brought out in this report that there are many plants and trees that have a high tolerance for salt. There are also many that have moderate and low tolerances. The amounts necessary to affect even those with low tolerance is far greater than the concentrations that we have found in random samples of snow taken near the roadway in the Tahoe Basin last winter. This is not meant to be conclusive and certainly more research is needed in this area. The Environmental Improvement Department in Sacramento is working with the Ecology Department of the University of California at Davis in developing studies which will help to answer the many questions regarding this controversial issue.

E. Results of Stream Sampling

A tabulation of the Turbidity and Suspended Sediment test results is included as Attachments A and B. It can be seen from these results that the spring runoff did not produce any alarmingly high concentrations of suspended material. The differences between upstream and downstream readings were not sufficient to indicate that the highway drainage was a major source of siltation and yet samples randomly taken during rain runoff of the side ditches showed relatively high readings.

It is tentatively concluded that more intensive sampling is necessary during rainstorm activity and less sampling is required on a routine basis. It is also quite probable that during the fall season we will see more evidence of the higher concentrations in runoff due to more intense rainstorms (less snow). Sampling of the actual side ditch runoff will be a more accurate indicator of the highway contribution than sampling above and below the highway crossing, but it will necessitate being on the site at precisely the right time to catch the peak runoff situation.

One additional factor necessary for a complete evaluation of the total sediment transport is the bed material transport measurement. This is done by means of a formula developed by recently retired Dr. H. A. Einstein, formerly of the University of California at Berkeley, under prescribed laboratory conditions. Data required for the formula has been collected in the field. As part of our study, samples of bed material have been taken and a grading analysis was run. Channel conditions were measured, such as roughness coefficient, slope, volume of water at the time of sampling. Calculations for the results are quite involved and very time consuming, therefore computer services are being used. Results are not yet available.

After all the data is complete for one weather year, graphs relating sediment transport to runoff will be developed so that the total sediment transport for one year can be calculated. This will be used for comparison with the amount from highway sources.

An interim technical report covering data thus far collected is being prepared in the Sacramento Materials & Research Environmental Improvement section. The report is tentatively entitled "Hydrologic and Sediment Transport Study, Lake Tahoe, September 1971".

F. Recommendations

It is proposed the following procedure be followed for a continuation of the Tahoe Basin Study.

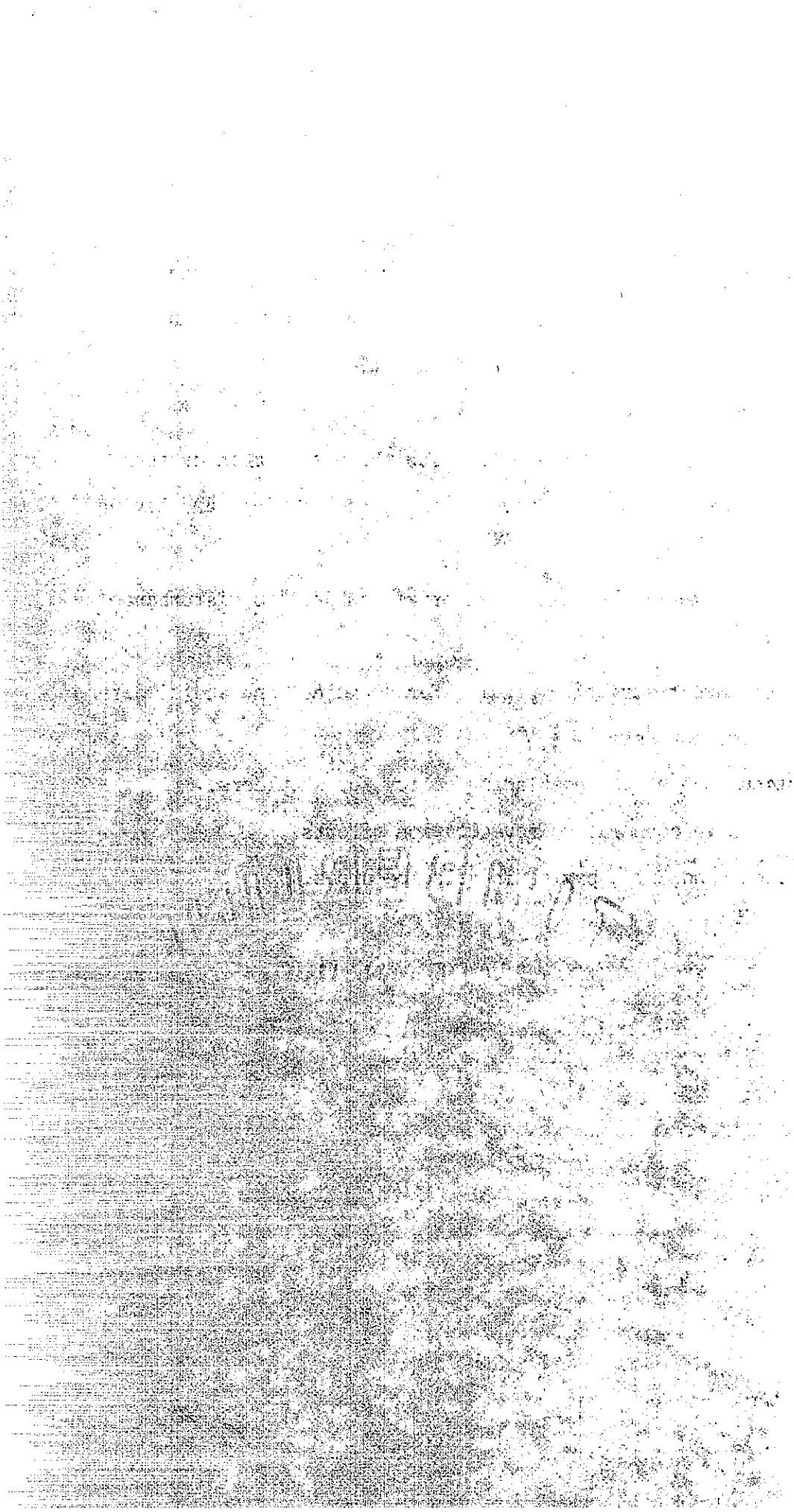
1. The sampling program be continued on a revised schedule to provide the following data:
   a. A basis for evaluation of corrective action.
   b. Establish base year data for comparison of changes due to future construction activities and revisions in maintenance procedures.
   c. Determine long range values for the ratio of highway siltation compared to that from other sources.

   It is felt this can best be accomplished by the proposed USGS sampling program now under consideration as a cooperative project.
2. Experimental projects be initiated by the District in as many areas as possible to serve two purposes.
   a. To find suitable methods of correction which can be applied at other similar type locations.

b. To provide immediate correction of some of the greater problem areas, thus affording some immediate reduction in siltation.

These projects will be done using maintenance forces, casual labor, minor contract, and possibly in cooperation with other agencies where they have a vested interest.

3. Some of the recommended projects are:
   a. Trial slope erosion prevention with the use of methods such as commercial products, revegetation, rock facing, and laying slopes back.
   b. Lime treatment to stabilize materials subject to disturbance by traffic.
   c. Use of more restrictive grading for de-icing sand and cinders on a limited basis.
   d. Continuation of the no-blading policy for shoulders.
   e. Continue in cooperative revegetation efforts.
   f. Shoulder and ditch paving in selected areas.



Attachment A

TEST RESULT SUMMARY

Turbidity Readings (JTU)*

March through June 1971

Watershed Area No.	Creek or Location	Highest Reading	Lowest Reading	Greatest Difference Upstrm./Downstrm.	Average Reading (Less than)
1	Tahoe St. Park	8.5	1.8	4.5/8.0	5
2	Burton	22	1.8	2.5/3.0	4
5	Dollar	4.9	1.5	1.5/3.0	4
6	Pla-28-4.76	65	6.4	32/42	40
7	Watson	6.0	1.5	4.3/4.8	5
9	Carnellian	9.5	2.5	-	6
10b	Snow	15	4.5	12/15	10
11	Griff	12	3.5	3.5/4.5	6
42	Bijou	12	1.6	4/12	5
43	Trout	25	1.0	6/13	5
43	Trout/Martin Av.	13	3.5	-	10
44A	Upper Truckee	44	0.2	42/44	10
B	Upper Truckee	45	1.2	6.2/7.5	5
C	Echo	3.0	0.4	-	3
D	Upper Truckee	6.0	0.8	-	3
44	Echo ED-50-69.0	2.3	0.4	-	3
44	Grass Lake ED-89-2.86	4.0	1.0	1.0/1.5	3
44	Grass Lake ED-89-4.73	5.5	1.5	1.5/3.0	3
44	Grass Lake ED-89-6.44	3.0	1.0	-	3

Watershed Area No.	Creek or Location	Highest Reading	Lowest Reading	Greatest Difference Upstrm./Downstrm.	Average Reading (Less than)
45	ED-89-8.73	275	6.5	14/16	10
46	Taylor	3.9	0.5	1.0/1.5	3
47	Tallac	3.5	0.3	0.6/1.5	2
49	Eagle	1.0	0.6	-	1
52	ED-89-21.8	1.0	0.6	-	1
53	Lonely	27	0.8	12/15	10
55	Meeks	0.7	0.4	0.4/0.5	1
56	General	1.5	0.3	1.0/1.5	1
57	McKinney	3.0	0.5	1.0/1.5	2
58	Quail	1.0	0.5	0.7/1.0	1
59	Homewood	14	0.7	0.7/1.0	3
60	Madden	2.0	0.3	0.8/1.5	2
62	Blackwood	4.0	0.8	1.5/2.0	3
63	Ward	3.5	0.5	1.0/1.5	2

* Readings shown are given in Jackson Turbidity Units (JTU). This is a measure of the "lack of clarity" of water. The lower the number, the clearer the water. Maximum allowable for the water of Lake Tahoe is 3 JTU. The Lake averages less than 0.5 JTU in most areas.

Attachment B

TEST RESULT SUMMARY

Suspended Sediment (mg/1.)*

March through June 1971

Watershed Area No.	Creek	Highest Reading	Lowest Reading	Greatest Difference Upstrm./Downstrm.	Average Reading
43	Trout	39	2	18/39	20
44A	Upper Truckee	88	4	9/22	18
44B	Upper Truckee	103	1	2/15	17
44C	Echo	23	1	-	5
44D	Upper Truckee	10	1	-	7
53	Lonely Gulch	53	1	1/19	21
56	General	15	1	11/15	5
62	Blackwood	38	1	9/16	10
63	Ward	28	1	18/28	10
2	Burton	61	1	3/8	9
10	Snow	11	2	3/6	8

* Suspended sediment is measured in milligrams of filtered sediment per liter of water sampled.

Attachment C

Precipitation/Snow Fall in Inches

Tahoe City 1970

Date	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1						.87/13.0
2						.80/8.0
3						.62/10.0
4	T/0				.11/0	.85/10.0
5			0.2/0		1.08/0	.26/T
6					.52/0	
7					.42/4.0	
8						.06/
9					.02/0	.96/2.0
10					.18/0	
11						
12					.70/2.5	
13						
14						
15						
16						1.06/10.0
17						1.22/30.0
18						.07/3.0
19				0.01/0		.08/2.0
20				0.12/T		
21				0.24/T		.33/6.0
22				0.20/T	.02/0	.03/T
23				T/0	T/0	
24				0.85/4.0		
25					1.64/0	
26				0.05/0	1.20/3.0	
27					T/0	
28					.32/5.0	.40/5.0
29					1.22/4.0	.42/5.0
30					.40/3.5	T/T
31				0.12/T		
Totals	T/0	0/0	0.2/0	1.59/4.04	7.83/22.0	8.03/104.0

Attachment C

Precipitation/Snow Fall in Inches

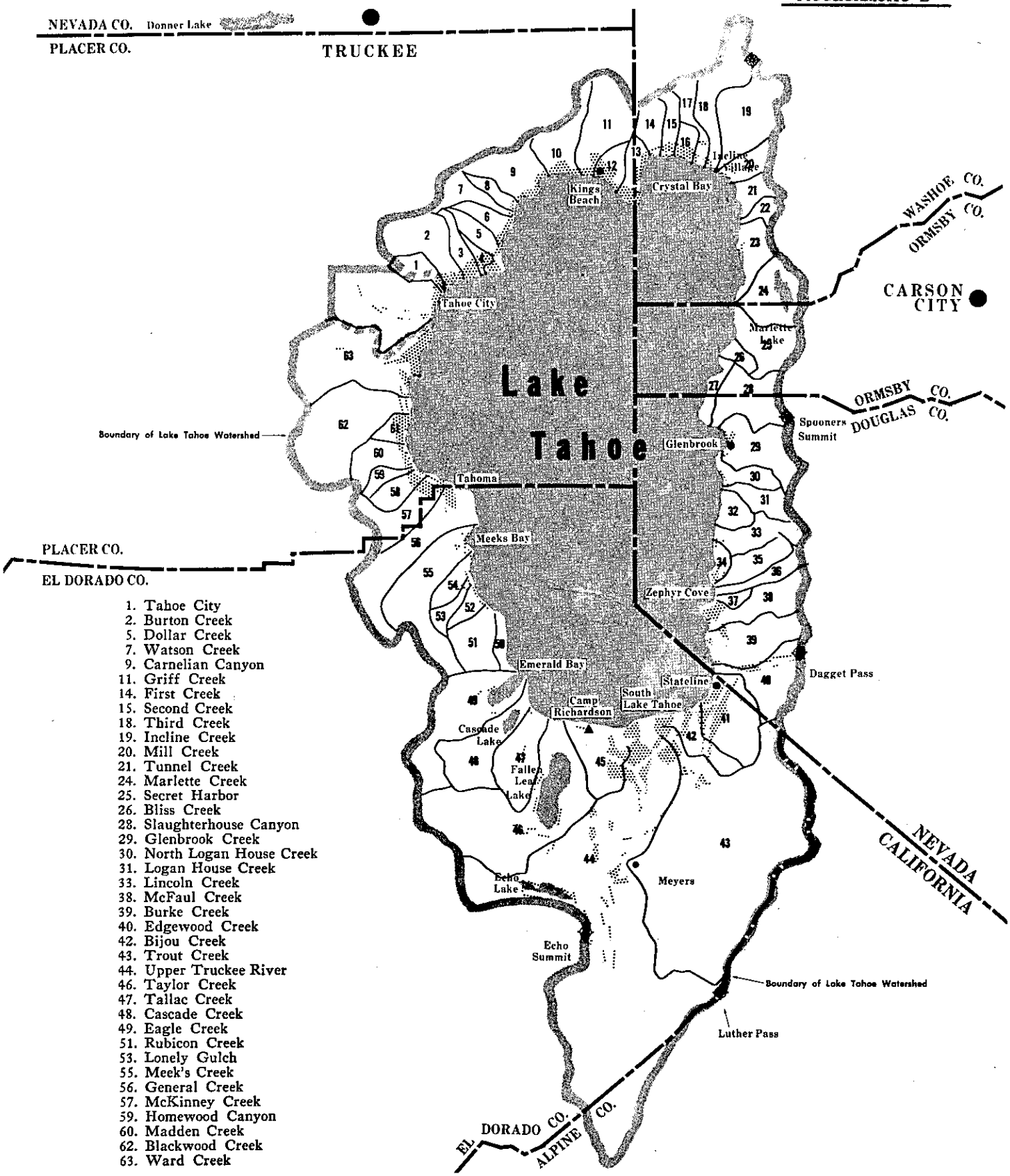
Tahoe City 1971

Date	Jan.	Feb.	Mar.	Apr.	May	Jun.
1			.30/10.0			
2	.22/4.0					
3			T/T		.15/0	
4			.09		.22/0	
5		T/T	.14/3.0		.02/0	
6						
7				.09/1.0	T/0	
8				T/0	.26/0	
9					.03/0	
10	.08/0			.28/1.0		
11	.15/2.0		.05/1.0	T/T		
12	.62/14.0		.59/3.0		.07/0	
13	.40/15.0		1.30/14.0			
14	.35/10.0		.20/2.0	T/0		
15		T/T	T/T			
16					T/0	
17	.32/T	.09/1.0	T/T	.29/4.0		
18	.06/0			.04/1.0		
19		.55/8.0				
20		T/T				
21				.32/4.0	.25/0	
22					.05/0	
23		.02/1.0	.04/T			
24			.73/T	.22/3.0		
25		.05/1.0	.19/3.0	.03/T		
26			1.90/1.0	.40/5.0	.02/0	
27			.65/1.0	T/T	T/0	
28		.20/8.0			.20/0	
29					.22/0	
30			0/T		.04/0	
31					.23/0	
Month Totals	2.20/45.0	0.91/19.0	6.18/38.0	1.67/19.0	1.76/0	

WATERSHEDS TRIBUTARY TO LAKE TAHOE

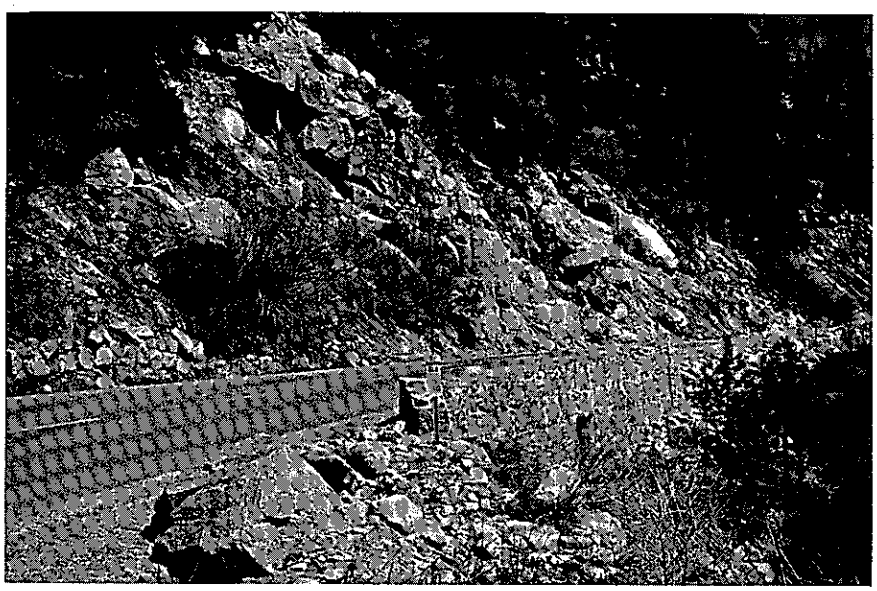
(Shaded areas indicate urban development.)

Attachment D



1. Tahoe City
2. Burton Creek
5. Dollar Creek
7. Watson Creek
9. Carnelian Canyon
11. Griff Creek
14. First Creek
15. Second Creek
18. Third Creek
19. Incline Creek
20. Mill Creek
21. Tunnel Creek
24. Marlette Creek
25. Secret Harbor
26. Bliss Creek
28. Slaughterhouse Canyon
29. Glenbrook Creek
30. North Logan House Creek
31. Logan House Creek
33. Lincoln Creek
38. McFaul Creek
39. Burke Creek
40. Edgewood Creek
42. Bijou Creek
43. Trout Creek
44. Upper Truckee River
46. Taylor Creek
47. Tallac Creek
48. Cascade Creek
49. Eagle Creek
51. Rubicon Creek
53. Lonely Gulch
55. Meek's Creek
56. General Creek
57. McKinney Creek
59. Homewood Canyon
60. Madden Creek
62. Blackwood Creek
63. Ward Creek

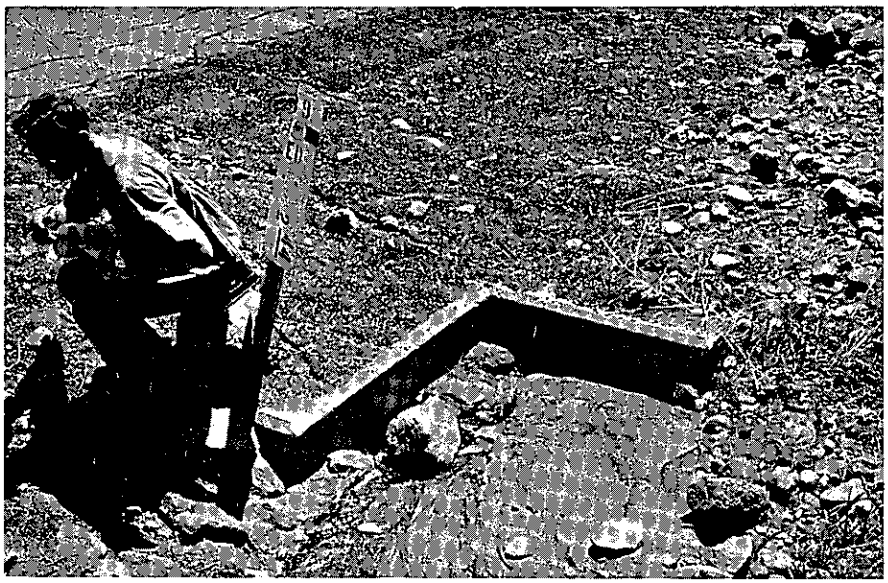
ED-89-17.55 Looking north at a rock fall area near Emerald Bay. Note small section of rock facing on the left.

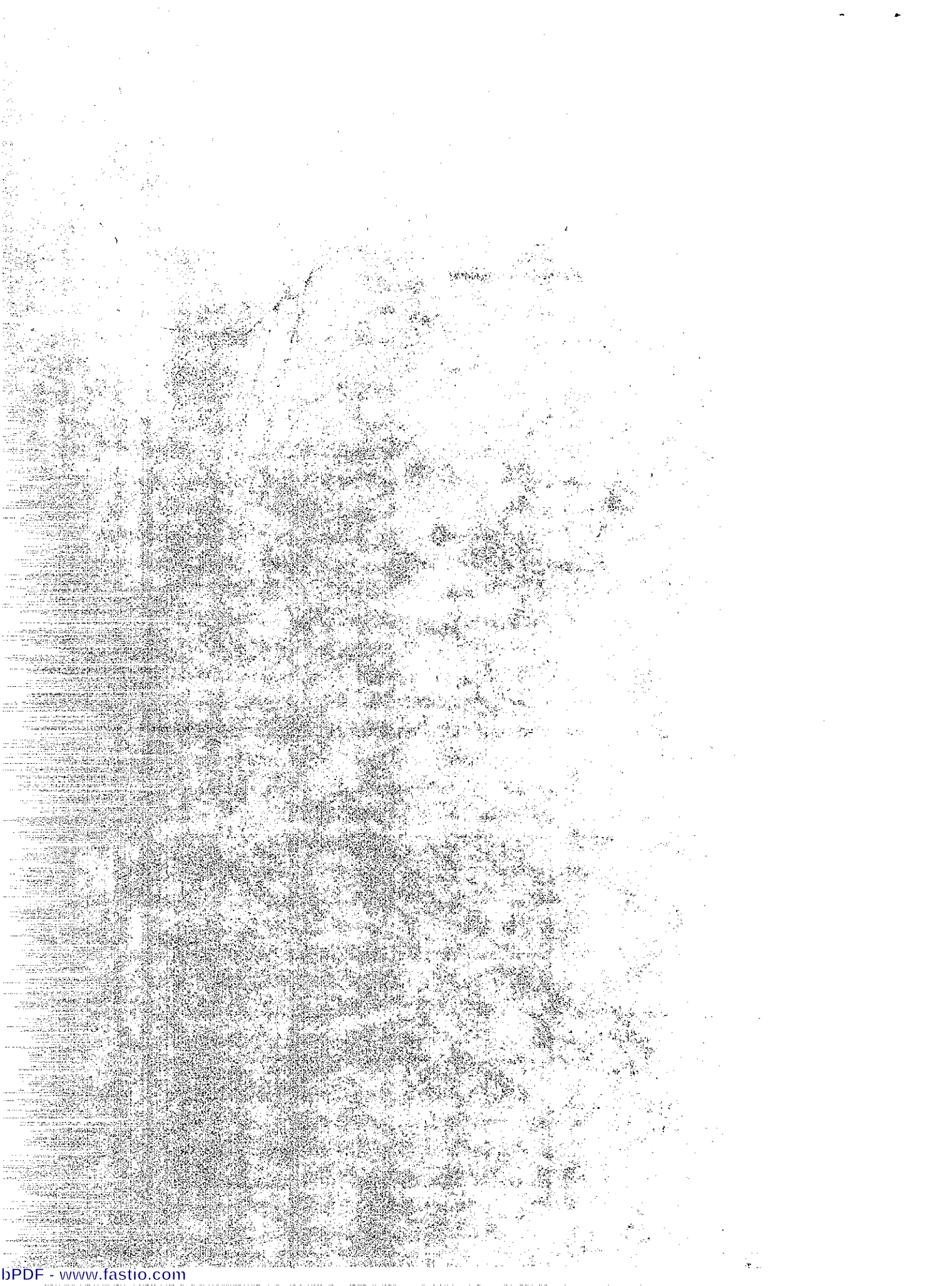


Section of old U.S. 50 grade south of Meyers. Rock facing has been in place many years.

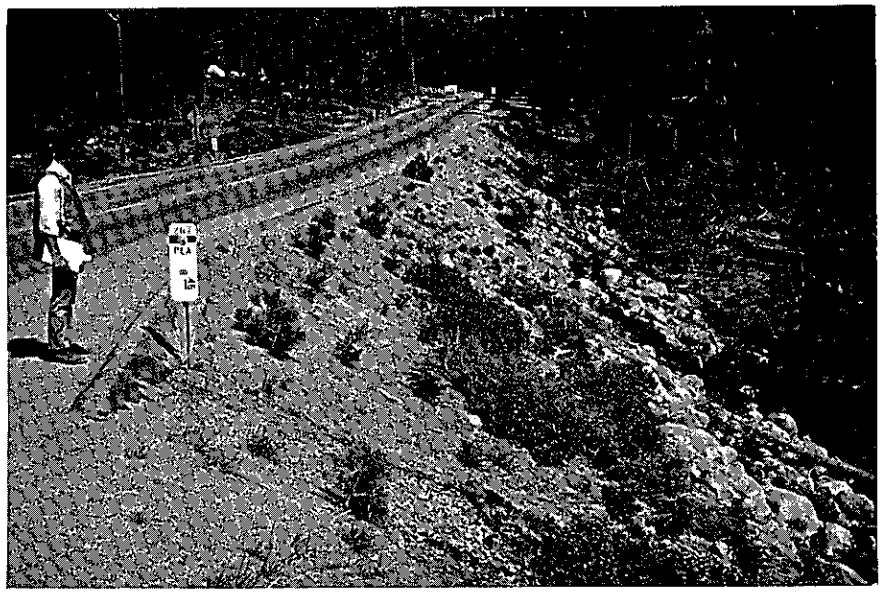
ED-89-2.4 Looking east at an eroded slope constructed in 1959 in the vicinity of Luther Pass.

Same location as above. Shows resulting sedimentation of downhill culvert.

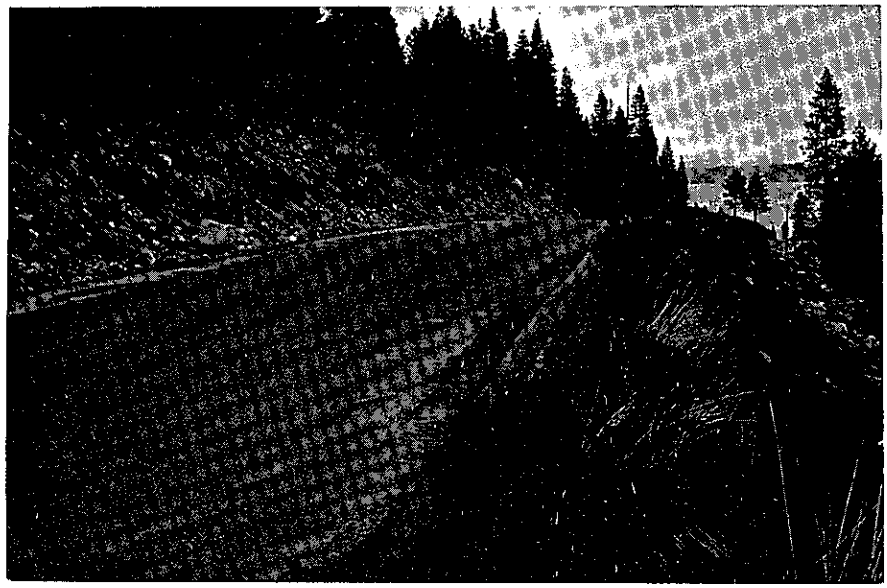




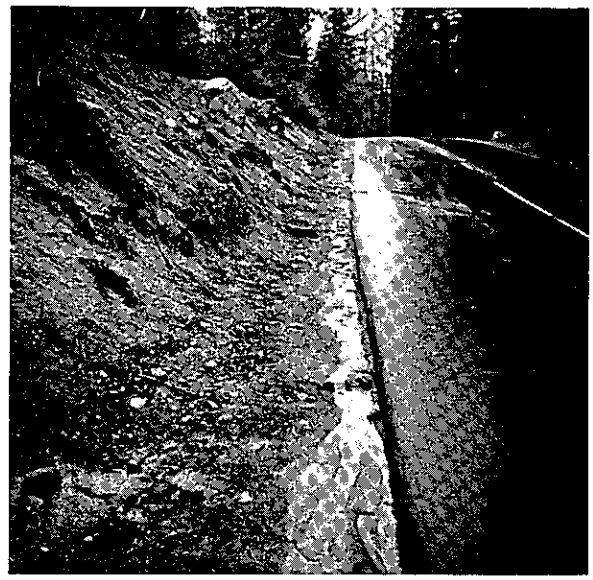
Pla-267-8.46 Looking east near Kings Beach on a section completed in 1958. Note the amount of natural revegetation which has occurred since construction.



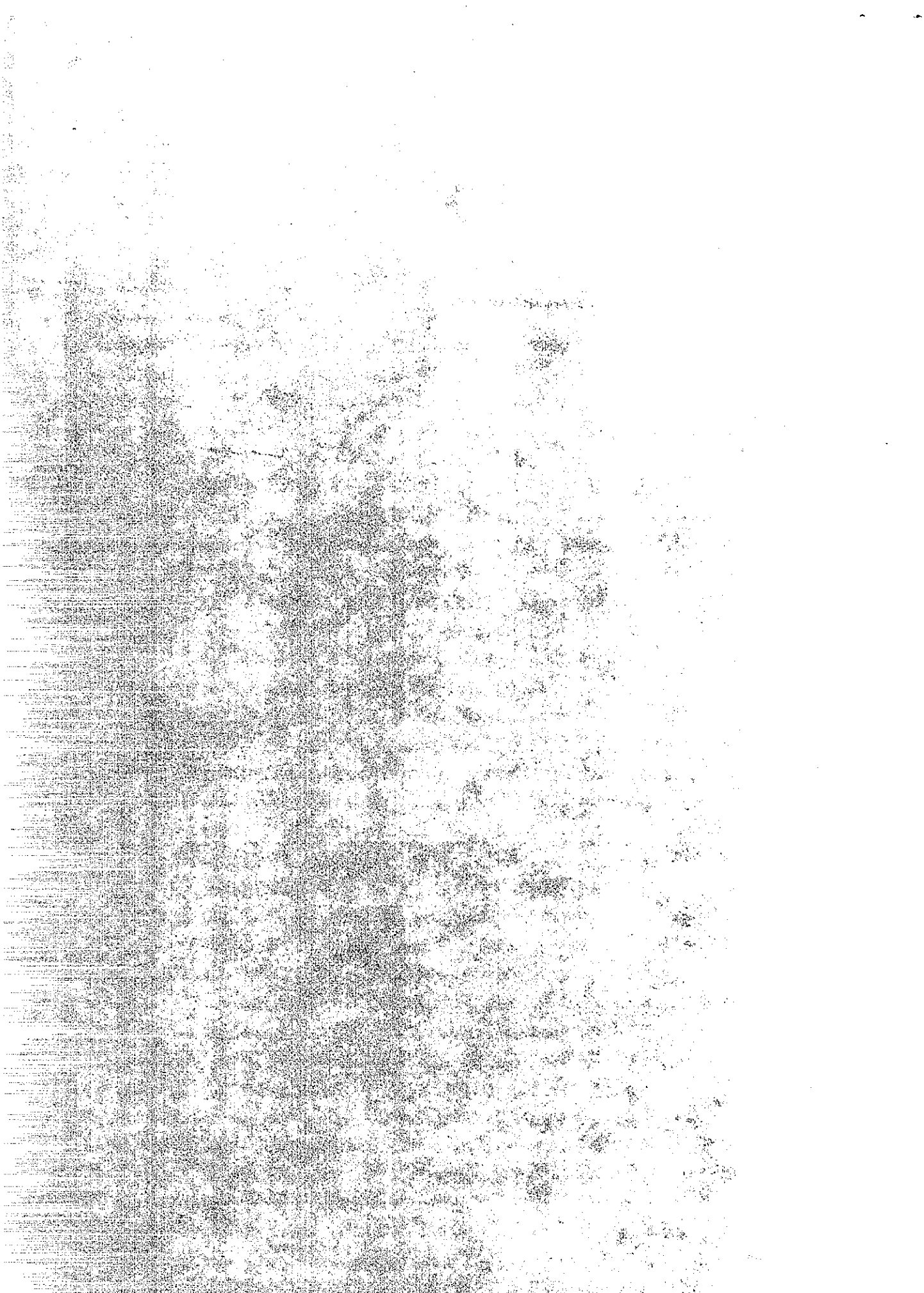
Subdivision road near Rubicon Bay. Grass is well established on fill slope but not on cut.



ED,Pla-89 Showing unstable shoulder condition in the wake of sewer construction - left - and edge of pavement drop-off caused by runoff or by traffic - right.

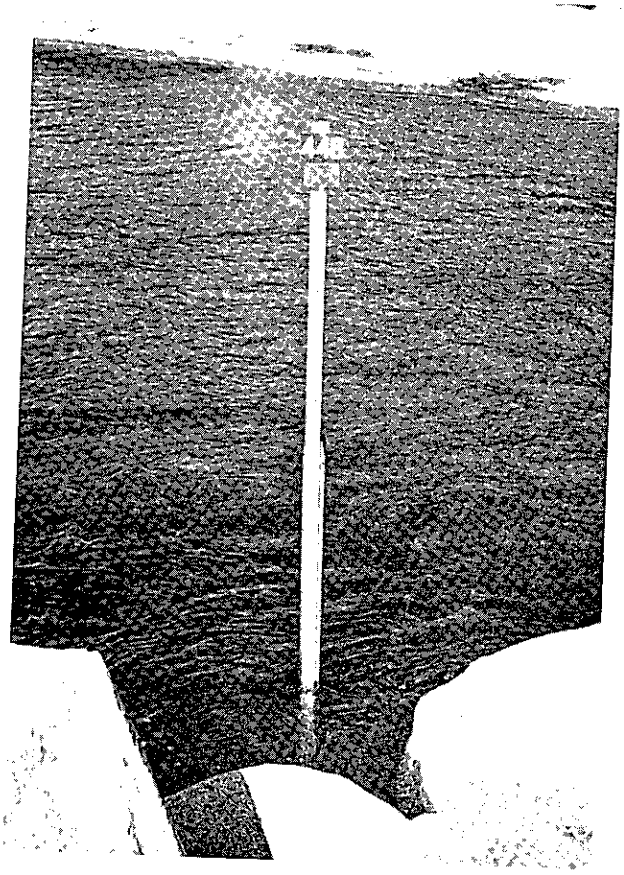


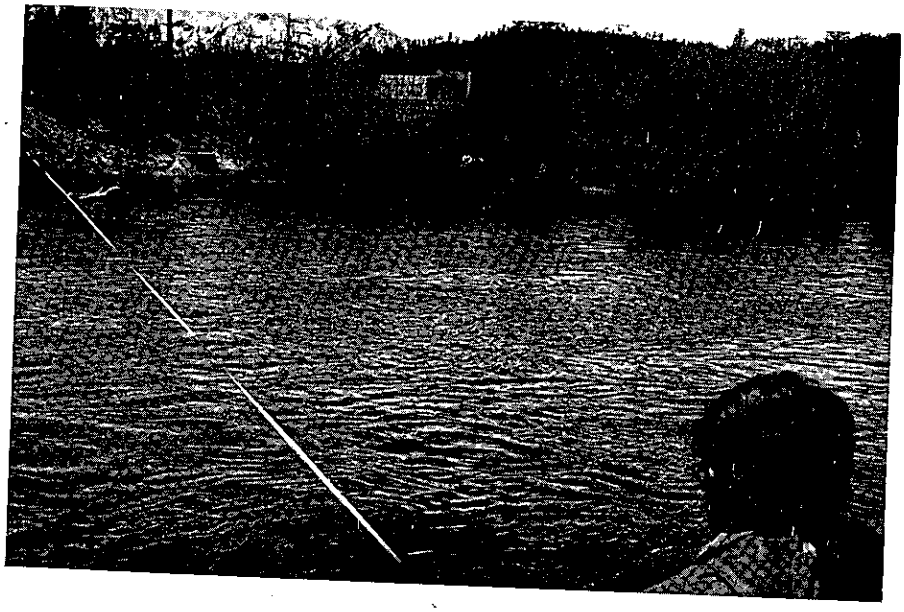
Pla-28-4.7 Looking north along an eroded shoulder adjacent to the State Highway just after a rainstorm.



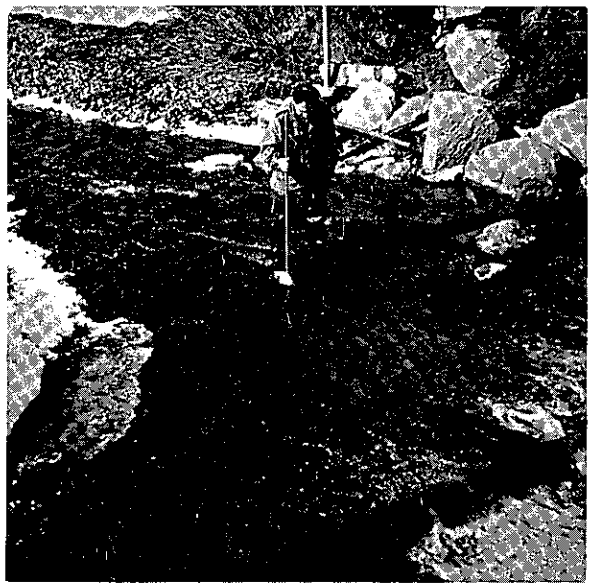
STREAM SAMPLING PROGRAM

Left - Staff Gauge - these were recorded daily during spring
Right - Cross Sectioning a stream for determining flow vs. stage
Bottom - Taking velocity readings with Price Current Meter





Taking a depth integrated sample with the USGS standard DH-48 sampling device.



Aerial view of the Upper Truckee inlet showing turbid water entering the Lake. The sharp line which forms a crescent is reportedly settled sediment.