PROGRESS REPORT

Summer, 1962

Oregon Project No. 526

A L S E A   W A T E R S H E D   S T U D Y

Effects of Logging Methods on Stream Flow

by

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September, 1962

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INTRODUCTION

Studies on the effect of logging methods on streamflow in the Alsea Basin in the Coast Range of Oregon were instigated in 1958. Of prime concern, and assigned to the Water Resources Institute at Oregon State University at Corvallis, Oregon, are three watersheds in T. 12 S., R. 10 W., W. M., Lincoln County, Oregon, which are being calibrated for streamflow and precipitation, and intensively studied from the standpoints of soils, vegetation, and fisheries. These studies are being effected by a joint effort of the Soils and Forestry Departments at Oregon State University; the United States Geological Survey, Forest Service, Bureau of Reclamation and Soil Conservation Service; the Oregon Game Commission, and the Georgia-Pacific Corporation. Actual harvesting of the Douglas fir timber on the area is tentatively scheduled for 1965.

Plans call for the Flynn Creek watershed to remain as a control, against which the effects of different types of logging on the other two watersheds may be checked as ramified in various parameters of streamflow and stream quality. Needle Branch, covered with a dense, fairly uniform stand of almost pure Douglas fir, is to be clear cut by standard Coast Range regional practices, and Deer Creek, with a mosaic of stands of alder and Douglas fir, is to be patch cut.

A complete watershed analysis, or inventory, of the three areas was prerequisite to recommendations for research activities and, along with recommendations for necessary watershed rehabilitation work, is presented here. Insofar as they are known, the data on climate, soils, and hydrology are summarized for all three watersheds, and subsequently each watershed is investigated individually as regards ownership, physical characteristics, and soils-vegetation complexes.

WATERSHED ANALYSIS

Climate

From the United State We''her Bureau (3) we find that "westerly winds predominate, carrying the modifying effect of the ocean over the western portion of the State,... Precipitation is largely of cyclonic origin, indident to the eastward movement of low-pressure areas over British Columbia, but the geographic distribution is greatly affected by topography. The heaviest rains occur on the slopes toward the ocean.... Precipitation is decidedly seasonal in character,... West of the Cascades, 44 percent of the precipitation occurs in winter, 24 in spring, 5 in summer, and 27 in fall. In the coastal areas snow seldom falls, and when it does it melts almost at once. ... Humidity...on the coast is high throughout the year. ... Strong southerly winds are an occasional feature of winter weather on the coast, and sometimes they are destructive. ...No sunshine record for the Oregon coast is available, but North Head, on the southern Washington coast, has an annual average of 1,981 hours."

The 26-year record (prior to 1941) at Toledo, about 10 miles north of the experimental areas, shows January average temperatures of 43.0°, and for July, 60.9°; the maximum and minimum temperatures for the period of record are 102 and 8°, respectively; average length of growing season (i.e., between last and first frost dates) is 195 days, and the average annual precipitation is 75.65 inches(3).

Without thunderstorms, the precipitation intensities for the area are relatively low, the 10-year return period 1-hour storm yielding approximately 1 inch (10). For durations less than one hour, intensities have been observed on the watersheds to attain as much as 2 inches per hour, but only for a few minutes. Rainfall frequencies for the Alsea Basin are shown in Figure 1. In slight contrast to the above-quoted more general Weather Bureau records, precipitation records on the watersheds for 1959 show about 80 to 95 per cent of the annual precipitation occurring during the dormant season, the remainder during the growing season. Probably less than 5 per cent of the total of about 96 inches falls as snow.

Table 1.--Precipitation on Experimental Watersheds for 1959

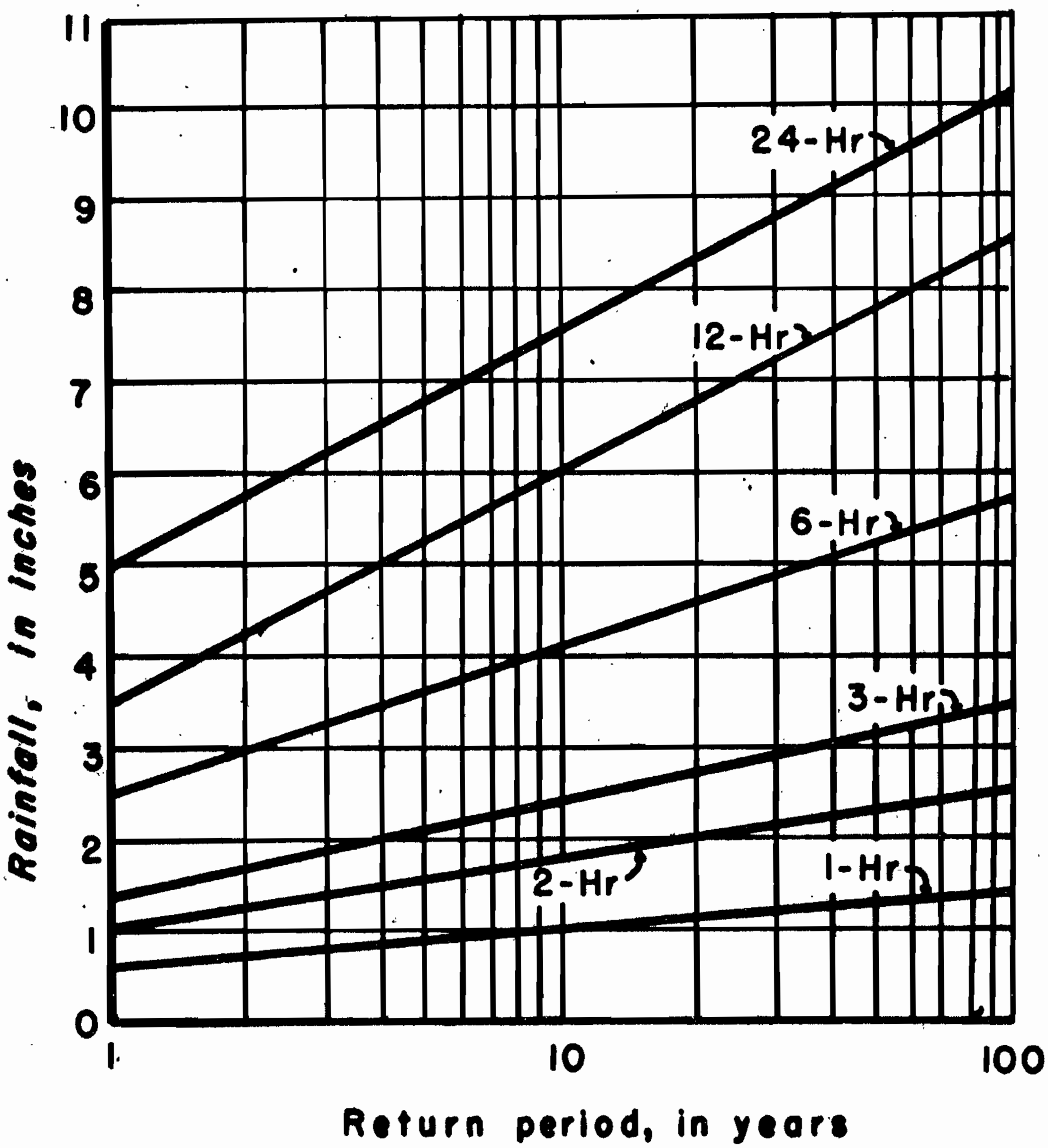
Period	Deer Creek	Flynn Creek	Needle Branch
growing season	15.40"	14.54"	16.45"
dormant season	81.54	74.69	87.15
total	96.94	89.23	103.60

Prevailing winds are southwest to west, and storm winds are gmnerally southerly, although the storm itself may be moving in an easterly direction. Fog is frequent, particularly in mornings during the summer, and often all day in the winter.

Although not analysed in detail, it is probably that there is neither a moisture surplus nor moisture deficit for the area, the lack of moisture evident in the summer due to increased evapotranspiration being amply satisfied by winter precipitation. Generally, the area would be classified as an humid climate, with precipitation

FIGURE 1

Rainfall Frequency for the Alsea Watershed[a]



[a] After U.S. Weather Bureau Technical Paper No. 40. (10)

exceeding evapotranspiration on an annual basis. It is a mild climate as a result of its proximity to the Pacific Ocean, and rarely experiences extremes of weather conditions.

Soils

The entire study area is underlain with level to sloping beds of sandstone (Figure 2), giving rise to a series of soils which are highly erosive when exposed. With steep slopes, abundant water in winter, and the heavy weight of the timber, soil creep and somewhat faster movements of soil are common.

The Tyee formation, classed as estuarine and marine sedimentary rock, is "rhythmically bedded feldspathic and micacious massive-bedded sandstone and subordinate siltstone.... Each bed is graded, ranging from coarse sandstone at the base to fine sandstone and siltstone above..." (6).

The primary soil stypes on the area are the Bohannon and Slickrock, with various topographic differences yielding several additional soil types or phases. "The Bohannon series consists of well drained moderately fine textured Brown Latosol soils developing in medium textured residuum or creep material from tuffaceous sandstone parent material." (2) The Bohannon soils exhibit surface runoff when the protective vegetation is removed, and the A and B horizons are rapidly and moderately rapidly permeable, respectively. The general color is dark brown for all horizons, 15 to 30 per cent gravel, moist friable, wet non-sticky to slightly plastic, fine to very fine pores, and pH approximately 5.0 throughout the profile. For a detailed breakdown of each horizon for both soil series, see Corliss (2).

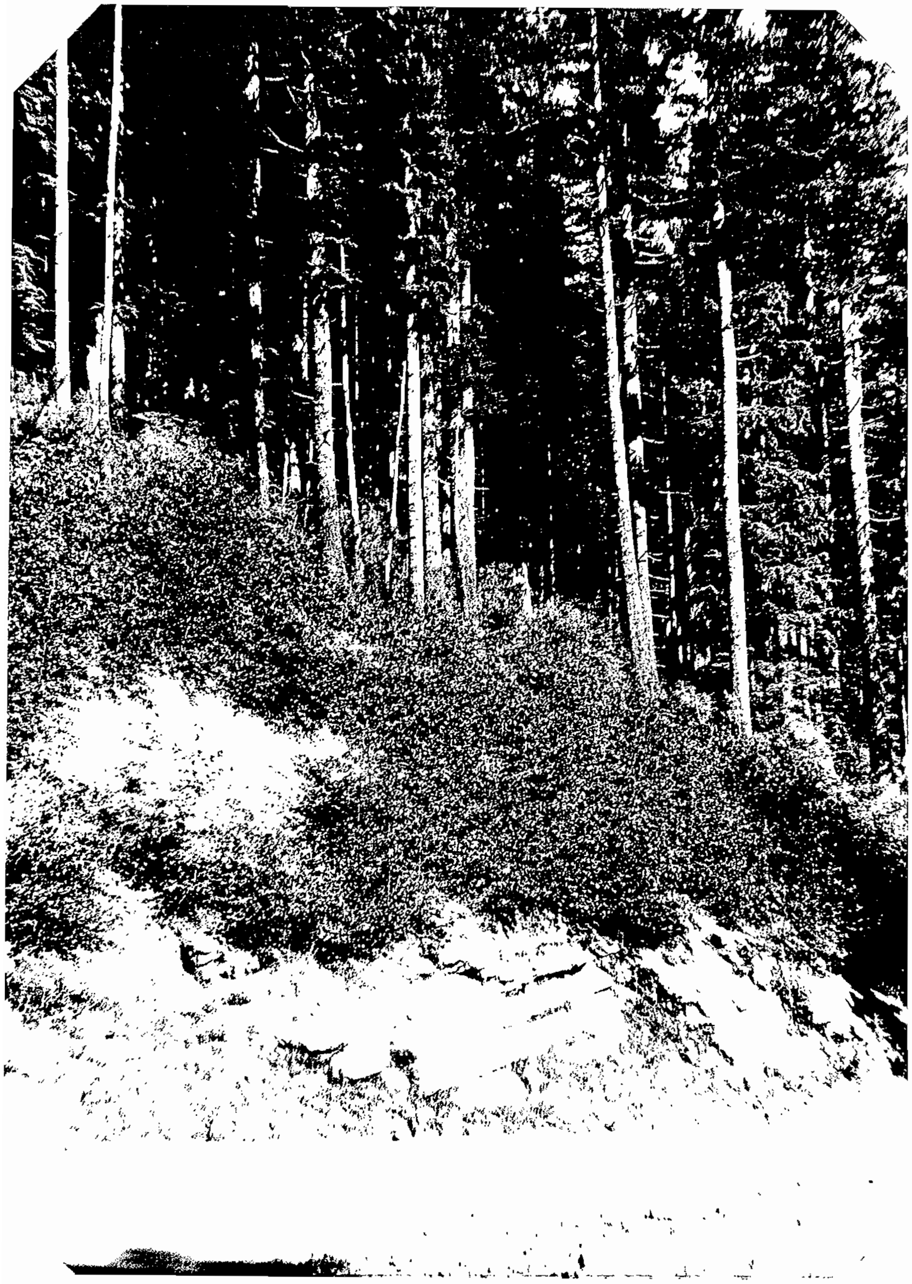


Figure 2.--Road cut along Georgia-Pacific haul road, showing tilted sandstone beds as well as typical Douglas fir timber and lower story vegetation.

The Slickrock series "consists of moderately well drained, moderately fine textured Brown Latosol soils that have developed from an Eocene deposit called Tyee tuffaceous sandstone." (2) Being a colluvial-type soil, in contrast to the residual Bohannon, Slickrock soils are generally found on more gentle slopes than the Bohannon in undisturbed areas. It may be expected, however, that following logging, Bohannon soils may slip and eventually become, or be covered by Slickrock creeps and slides. Such events serve to confound the distribution of the soils, and evidence of just such occurrences may be found in the area. The major profile difference between the two soils is more of a loamy texture in the Slickrock series, and greater horizonation within the B horizon. Plasticity, per cent gravel, color, porosity, and pH are similar to those of the Bohannon. Both A and B horizons are moderately rapid in permeability, and gleying or mottling in the colluvial Slickrock is "occasionally found."

The Linton, a stable soil of which the Bohannon is a creep phase, is found extensively on the watershed ridges, and (to date) un-named alluvial soils are found in a narrow band along the streams on Deer Creek and Needle Branch. The distribution of the Bohannon, Slickrock, and other types of soils on the three watersheds is presented in Table 2.

Table 2.--Percentage distribution of soils on the experimental watersheds[a/]

Soil type	Deer Creek	Flynn Creek	Needle Branch
Bohannon	48%	35%	62%
Slickrock	34	61	32
others	18	4	6

a/ Based on planimetered uncontrolled mosaic.

The effect of improper road construction and drainage is in evidence in the vicinity of the experimental watersheds, with severe gullying where water is not removed from the road at sufficient intervals and, in one instance, a road-caused gully may be found within Deer Creek.

With the fractured nature of the underlying sandstone beds, the possibility of deep seepage from the watersheds exists, but such loss of measured streamflow is, in all probability, negligible.

Hydrology

Weirs and continuous streamflow recorders were installed on all three streams by the U. S. Geological Survey in 1958, and complete records on streamflow and stream quality are available from September of that year.

A study has been made (7) on the hydrologic characteristics of the three watersheds but, through no fault of the authors, the erroneous areal figures for each of the watersheds renders the results subject to revision since runoff was analysed in inches depth on the watershed. The times of concentration, which may be determined regardless of flow unit, are highly variable on each area, ranging from one to four hours. Part of the problem here may be in definition of time of concnetration: further, the present location of precipitation gages near the mouth of the watershed instead of on the watershed itself may account for the inconsistencies. Considerable work remains to done with the streamflow records in order to fully characterize the patterns of runoff.

Physical characteristics of the three streams are summarized by Chapman, et al, (1) and maximum and minimum streamflow figures in cubic feet per second (c.f.s.) are given along with other pertinent data. These figures are converted to cubic feet per second per square mile (c.s.m.) in Table 3, based on the author's estimated areas of 806 acres for Deer Creek, 509 acres for Flynn Creek, and 169 acres for Needle Branch. As expected from investigations elsewhere, the maximum flow for all three areas in c.s.m. is nearly the same[1/].

Table 3.--Extremes of streamflow for the three watersheds[a/] (not including 1961 records)

Extreme	Deer Creek		Flynn Creek		Needle Branch	
	c.f.s.	c.s.m.	c.f.s.	c.s.m.	c.f.s.	c.s.m.
maximum	68.0	54.0	42.0	53.2	14.0	53.9
minimum	.5	.4	.2	.3	.1	.4

a/ subject to revision when final area figures are known.

Utilizing the c.f.s. flow data for the period 10/58 to 9/61 flood frequency curves were drawn for Flynn and Deer Creeks, and are presented in Figure 3. From this figure, it is seen that the c.s.m. peaks (using the presently available areal data for Deer and Flynn Creeks) work out to be approximately equal: thus, at the 1% point for Deer Creek, the expected discharge is 90 c.f.s. or, divided by 1.26 miles, 71 c.s.m., and for Flynn Creek, 64 c.-f.s. or, divided by 0.79 square miles, 80 c.f.s. At the 10% point

1/ Prior to the new estimates of watershed area, there was some concern over the fact that the area-derived c.s.m. maxima for the three watersheds were quite divergent.

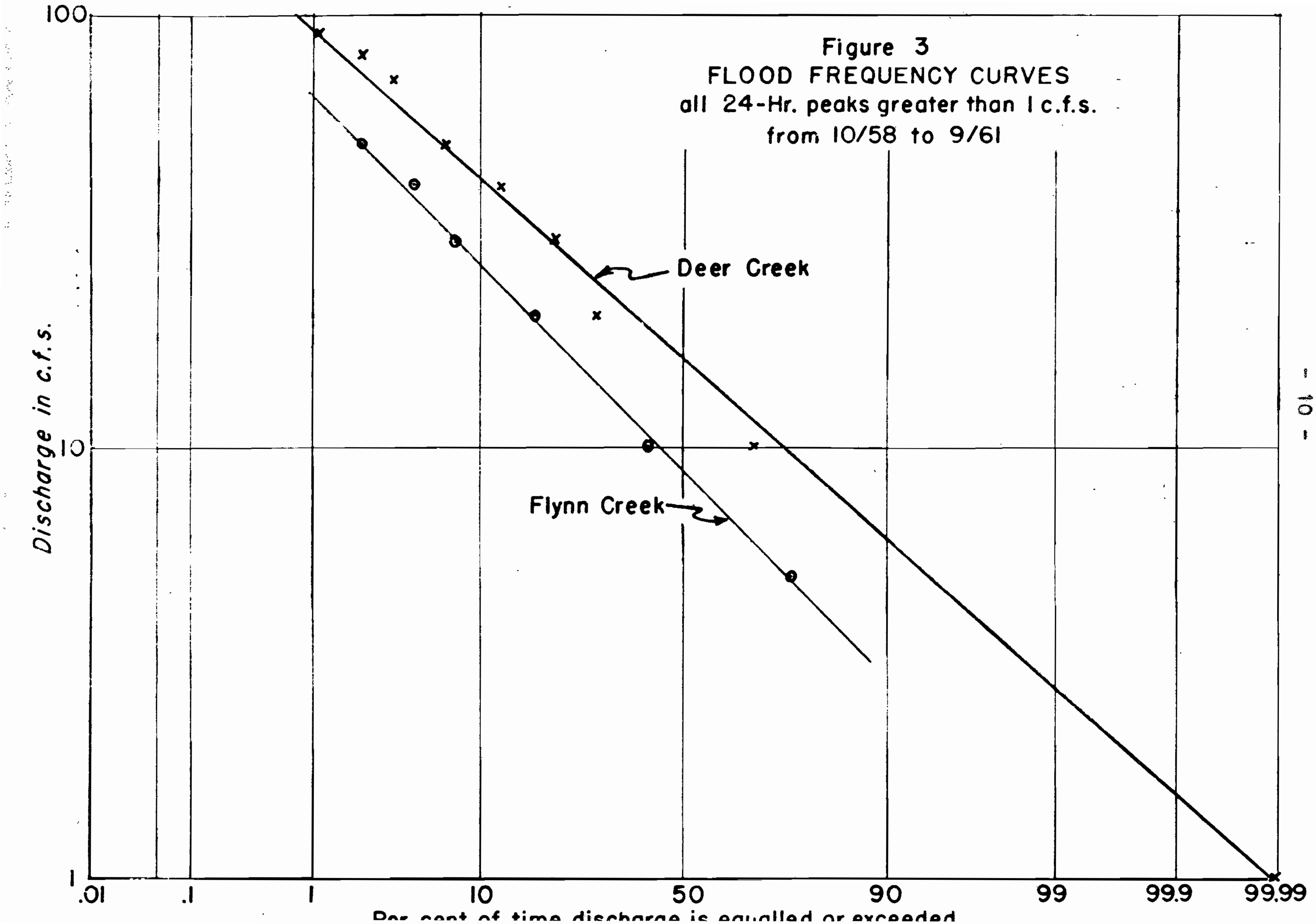


Figure 3
FLOOD FREQUENCY CURVES
all 24-Hr. peaks greater than 1 c.f.s.
from 10/58 to 9/61
Deer Creek
Flynn Creek
Discharge in c.f.s.
100
10
1
.01
.1
1
10
50
90
99
99.9
99.99

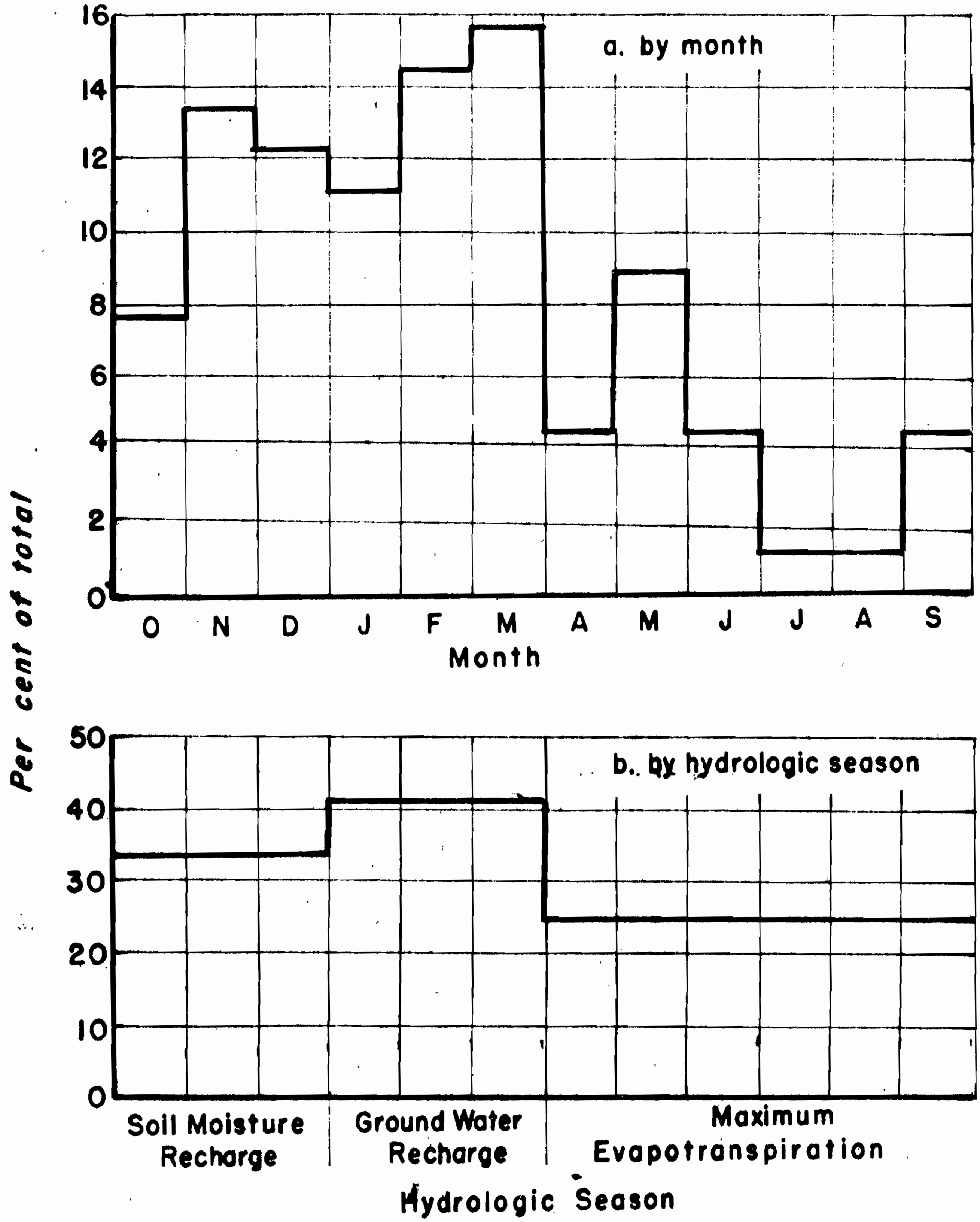
both watersheds yield 32 c.s.m. Noting that the data represent only two years of records, one is impressed by the good fit of the data and, further, noting that the maximum instantaneous peak expected according to the Geological Survey[2/] is about 200 c.sm. or less, which is consistent with Figure 3, a figure of 180 c.s.m. (achance occurrence of about 0.1) appears to be a safe figure to use as the upper limit in stream gage planning.

In Figures 4a and 4b the patterns of flood peak occurrence by month and hydrologic season are shown for Deer Creek and may, for the present, be assumed to be typical of the study area. These figures are acceptable regardless of area and illustrate the seasonal pattern of flood flows. When the calibration period is completed, these analyses should be run for each of the watersheds, along with correlations between watersheds regarding flood frequency, total and seasonal runoff, times of concentration, and turbidities.

Turbidity, in parts per million (p.p.m.) has been determined on each stream by batteries of single stage sediment samplers installed by the Geological Survey. The maximum figure for Deer Creek is 105, Flynn Creek 82, and Needle Branch 72 p.p.m. The minima for all streams are approximately zero.

2/ Personal interview with staff of the Surface Water Branch, Portland, Oregon, 7/6/62.

Figure 4
PATTERN OF FLOOD PEAK OCCURRENCE
DEER CREEK
10/58-9/61



Deer Creek

The present ownership of the Deer Creek watershed is the United States Forest Service. In 1911, the S. 1/2 SW. 1/4 of Sec. 2 and the N. 1/2 NW. 1/4 of Sec. 11 was recorded under the Homestead Act, and the land patented in 1919 by C. C. Brown. This 160 acres near the center of the watershed was transferred to S. J. Stewart prior to recording, who expanded the homestead to 320 acres by acquiring the N 1/2 SW. 1/4 of Sec. 11 and the S. 1/2 NW 1/4 of Sec. 11. According to the County Assessor's records, only 10 acres of this land was "improved" in 1935. In 1936, the homestead reverted to the Federal Land Bank in a foreclosure proceeding from where it passed into the hands of the Forest Service.

There is evidence that a shingle mill was constructed near the stream in the approximate center of the NW 1/4 of Sec. 11 (A)3/, although there is no sawdust residue or remains of a sawdust burner: it is thought that the stream was used for disposing of the waste. A road was constructed into the watershed, entering the area about 100 feet uphill from the present Georgia-Pacific Corporation shops, and forking about 200 yards inside the watershed, the left-hand fork allegedly climbing along the boundary to the Mill Creek Divide and thence to Elk City, and the right-hand fork, still traceable, angling down toward the stream and the first meadows where the homesteads and the shingle mill were located.

3/ Capital letters are keyed to those on the map in Figure 5.

Today, much of the streamside area shows the effect of either more extensive land use than is indicated by the Assessor's records, or else a definite natural disturbance (the area allegedly burned in the vicinity of 1850): much of the streamside soils are alluvial, indicating extensive downslope movement of soil material due to land clearing and subsequent erosion. The stream itself has cut down into this alluvium to a depth of four feet in some places, and gullies and active headcutting are in evidence, particularly along the elk trails which abound throughout the watershed. In one place (B) extensive elk travel has changed the course of one of the tributaries. The area may have been grazed at one time, and the elk have apparently taken over the trails and the extensive grassed areas (which still exist). The population of elk at the present time is unknown, but herds up to 25 animals have been seen in the vicinity and it is not unlikely that there are that many or more on the Deer Creek watershed.

The general aspect of the pear-shaped watershed issouth, with most of the slopes facing either west or east; the extreme western portion of the watershed exhibits a stream, tributary to the mainstem, which flows in a northerly direction before cutting east and south. The area, based on the uncontrolled mosaic photographs of 1958, is 806 acres or about 1.26 square miles; the perimeter is approximately 4.78 miles; the compactness coefficient of 1.19 is low and indicates little chance of serious flooding, even with major storm movement down the watershed, which is unlikely. Less than one per cent of the area has outcropping bare rock, and the drainage pattern is dendritic, with approximately 8 major

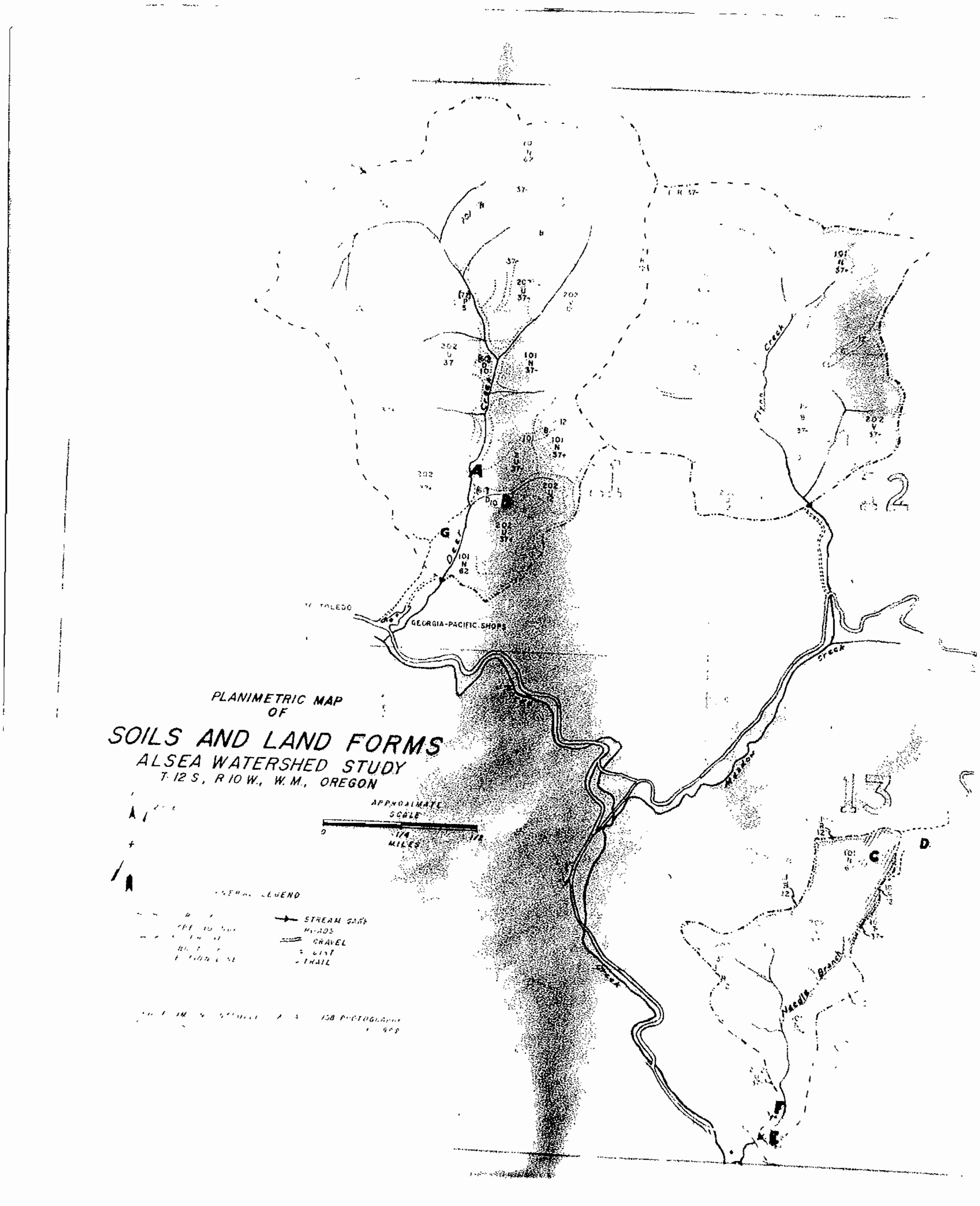


Figure 5.--Reference map for discussion of watershed characteristics, based on uncontrolled mosaic photographs of 1958.

tributaries to the main stream. Drainage density is probably normal for this high rainfall area, being on the order of 2 miles of permanent stream per square mile of watershed area[4].

Slopes near the mouth of the watershed, where there is little alluvial soil, are excessively steep, much of the area being over 60 per cent. The slope of the upper portions of the north and east sides of the watershed is also of this magnitude. It is particularly important to keep road locations controlled so that no road is constructed through these areas, nor directly downslope from them. In fact, the logging of any portion of the northeast quarter of the watershed is going to be exceedingly difficult with this latter requirement adhered to. Due to the lower density and quality of the Douglas fir in this area, the problem may not have to be faced. Elsewhere, the slopes are more easily traversed, although brush is heavier.

Approximately 17 per cent of the watershed area is in pure Douglas fir, 82 per cent in alder and alder-Douglas fir mixture, and about 1 per cent in meadow, mostly along the streams (5).

A 120° V-notch weir with continuous streamflow recorder is located upstream from the Georgia-Pacific shops in conjunction with automatic sediment sampling equipment (rising, single stage samplers), and about one-fifth of a mile from the stream's confluence with Horse Creek. A fish trap is maintained by the Game Commission downstream from this site, and stream temperatures are recorded continuously about 50 yards upstream. A recording rain

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4/ As pointed out earlier, all area and area-derived figures are subject to revision upon completion of the topographic maps.

gage is located near the shops. Numerous insect traps and permeability sampling stations are maintained along the stream by the Game Commission.

Approximately 50 per cent of the stream may be classed as Class 0 (no signs of erosion, banks well vegetated, no debris, and well-developed pools); 20 per cent as Class I (signs of incipient erosion, undercut banks, fresh sand and sediment in pools, and active sand bars); and 30 per cent Class II (accelerated erosion evident, with banks actively undercutting, and some tributaries gullied and depositing fans or deltas in the main stream) (4).

Flynn Creek

A homestead of 160 acres on Flynn Creek consisting of the E. 1/2 SW. 1/4 and W. 1/2 SE. 1/4 of Sec. 12 was owned by J. Flynn in 1905. This parcel of land has had a long history of speculation, being sold and resold by the same individual many times after it left Flynn's ownership. In 1947, it reverted to the County for non-payment of taxes, and subsequently was turned over to the Federal Government, who now own the entire watershed.

There is no record of any land clearing on the watershed itself, but improvements were apparently made in the existing meadows along Meadow Creek. Although not a consistent result of erosion, the absence of alluvial soils and a stable stream channel on the Flynn Creek watershed indicate no major disturbance on the area. No roads traverse the watershed, although the Deer Creek elk herd apparently uses the upper portions on the west side at least, with numerous trails crossing the watershed from the east side of Deer Creek towards the north boundary of Flynn.

This circular-shaped watershed faces south, with the major slopes facing east and west; a sizeable portion in the southwest corner faces north in contrast to both Deer Creek and Needle Branch. Based on the 1958 photographs, the area is estimated at 509 acres, or 0.79 square miles; the perimeter is 3.76 miles; the compactness coefficient, 1.18 which, even though lower than that of Deer Creek, may indicate potential flooding when coupled with the general circular shape of the basin. Less than one per cent of the area has outcropping rock, and the drainage pattern is dendritic. There are approximately 4 major tributaries to the main stream, and the drainage density (as in Deer Creek, not accurately determined) is probably lower than that of Deer Creek, indicating a less well-drained watershed. This, too, can have serious ramifications in the flood history of the watershed, with greater overland or subsurface stormflow, although the danger is somewhat mitigated, no doubt, by the relatively gentle slopes.

Although as steep in places as those on Deer Creek, the general picture on Flynn Creek is that of a much lower mean slope, with no areas mapped in excess of 50 per cent. Since Flynn Creek is to be the control watershed, roads and road location are of no consequence.

Almost 97 per cent of the watershed area is in alder and alder-Douglas fir mixture, and about 3 per cent in meadows which are scattered throughout the area (5).

A 120° V-notch weir, similar to that on Deer Creek, is located on the stream about one-third of a mile above the confluence with Meadow Creek, along with sediment sampling equipment. A fish trap is located about 75 yards downstream from the weir, and instrumentation and data collection and analysis is the same as on Deer Creek. A recording rain gage is located about one-quarter mile downstream from the weir.

All of the streams on Flynn Creek are classified as Class 0 (no signs of erosion, etc.).

Needle Branch

Needle Branch at present is privately owned by D. Stokes and F. Williamson. The timber rights are owned by the Georgia-Pacific Corporation who will cut the timber in accordance with the study plan in 1965.

Approximately 20 per cent of the watershed, the northeast portion (D), has been clear cut in conjunction with a harvesting operation that took place on Drift Creek. This is the steepest portion of the watershed and, not being logged with the remainder of the area, and being well stabilized with brush and advanced reproduction, will undoubtedly reduce the apparent effect of clearcutting the watershed. A road from the northeast norner of section 13 was constructed to homesteads on the ridges north of the watershed and was used in the logging operation mentioned above: it was re-opened during the summer of 1962 by Georgia-Pacific. It affords access to the upper portion of the watershed via a trail along grown-over logging roads to the clearcut area (D). Alluvial soils along the lower reaches of the stream testify either to considerable movement following logging, or to extensive natural soil movement from the steep upper slopes. The old County Road crosses the stream about 20 feet above the stream gage, and extends uphill for 10 chains without surface drainage or culverts: the ditches discharge directly into the ponding basin (E).

This irregular pear-shaped watershed faces south, with the major slopes facing east and west. The location of the watershed divide at the southwest corner of the watershed is along a very low alluvial or colluvial ridge, and may permit extensive leakage from the watershed to the drainage on the west (F). Based on the 1958 photographs, the area is 169 acres, or about 0.26 square miles; the perimeter is 2.95 miles; compactness coefficient 1.61, considerably higher than either of the other two watersheds, with a high probability of flooding if a storm traverses the watershed from north to south. Less than one per cent of the watershed is outcropped, and the drainage pattern is dendritic. There are three major tributaries to the main stream, and the apparent drainage density is more than 2 miles per square mile. Considering all characteristics, an intense storm over this watershed could result in severe flooding, particularly following harvesting.

With the exception of the northern portion, three-quarters of which has already been harvested, the slopes are about the same as those on Flynn Creek. Road construction is anticipated[5/]

5/ Personal discussion of unofficial logging plans with M. Ward, Logging Engineer, Georgia-Pacific Main Office, Toledo, Oregon, June 15, 1962.

to include a spur along the west side of the watershed located about one-half of the distance up the slope: this road will tie into the main haul road on Meadow or Horse Creek and may cross the upper end of the watershed to connect with the existing roads at that point. Most of the timber to be harvested will be transported out of the watershed via the southeast corner across the county road to the main haul road near Drift Creek. Such system, if developed, would require additional care on the steep portion of the drainage area.

Of the 80 per cent of the watershed remaining in timber, 64 per cent is in pure Douglas fir, and 16 per cent in mixed alder and alder-Douglas fir mixture (5).

Controls are similar to the other two watersheds, except that the weir is of the Columbus Deep Notch type. A precipitation gage and a solar radiometer are located at the site of the fish trap, about 50 yards downstream from the weir. Double-mass analysis by the Geological Survey indicates a change in the relationship between the streamflow on Needle Branch and Flynn Creek, with the streamflow of the former first exhibiting a decrease during the first few months of 1960. The cutoff wall of the weir is attached to the headwall of the culvert which carries the stream underneath the Georgia-Pacific main haul road, and this culvert was allegedly lengthened in early 1960. It is possible that the use of heavy equipment could have cracked the wall, although no defect is visible, and caused the apparent decrease in streamflow.

Approximately 70 per cent of the stream may be classed as Class 0 (no signs of erosion, etc.) and 30 per cent as Class I (signs of incipient erosion, etc.).

The soils and land forms and slopes complexes are shown in Figure 5, and the physical characteristics for all three watersheds are summarized in Table 4 for comparison, but note that all figures (except for number of tributaries and aspect) are subject to revision.

Table 4.--Physical characteristics of watersheds

Feature	Deer Creek	Flynn Creek	Needle Branch
area, acres	806	509	169
square miles	1.26	0.79	0.26
perimeter, miles	4.78	3.76	2.95
compactness coefficient	1.19	1.18	1.61
number of tributaries	8	4	2
drainage density, mi/mi^2	2+	2--	2++
shape	pear	circular	irregular pear
general aspect	south	south	south
proportion of area in			
Douglas fir	17%	0%	64%
alder and Douglas fir	82	97	16
meadow	1	3	0
cut-over	0	0	20
percentage of streams in			
Class 0	50	100	70
Class I	20		30
Class II	30		

Upon completion of the topographic maps, and with proper and reliable area figures, the bulk of the above watershed analysis will have to be checked and extended to include calculation of streamflow records and correlation of the latter with precipitation and between watersheds to provide a basis for evaluation of the effects of logging.

ACTIVITIES, SUMMER 1962

In addition to the above watershed analysis, the following jobs have been or will be completed by September 15, 1962:

1. station maintenance
    a. construction of tent shelter, access road, and water supply at site of Drift Creek Laboratory;
2. trail clearing
    a. around the boundary of Deer Creek
    b. general access trails within Deer Creek watershed, including old homestead road from shops to meadows
    c. trail from homestead road to northeast corner of Needle Branch;
3. surveying
    a. control lines from established corners to weirs on Deer Creek and Needle Branch
    b. around the boundaries of Deer Creek and Flynn Creek
    c. along all streams on all three watersheds
    d. coordination of ground control and aerial photography, including establishment of points on Deer Creek of known (relative) elevation and coordinates;
4. mapping
    a. preparation of planimmetric map of soils and land forms from uncontrolled mosaic
    b. aeriel photography, ground reconnaissance, and topographic maps of all three watersheds (latter is in progress);

5. instrumentation

   a. selection of gaging sites (see Recommendations and Appendix)

   b. construction of trapezoidal flumes, and design and construction of sediment sampler

   c. installation of trapezoidal flumes (at least one, possibly two or three by September 15) and sediment sampler.

In addition to the above, considerable time has been devoted to general reconnaissance, instrumentation specification preparation and construction, aiding the Game Commission's fisheries investigations program, computations and plotting of field survey notes, and vehicle and other equipment maintenance.

RECOMMENDATIONS

Watershed Rehabilitation

The first three of the following recommendations, listed in order of decreasing priority, are deemed essential to establishment of a satisfactory calibration period on the watersheds in order that the effects of logging may be thoroughly investigated:

1. with the aid of the Geological Survey, determine the cause of the apparent decrease in streamflow on the Needle Branch watershed and make necessary repairs to insure an accurate stream record;

2. with the permission of the County, provide proper surface drainage on that section of the County Road which drains into the Needle Branch ponding basin (E, on Figure 5) by constructing water bars, turnouts, and, if necessary, by installing culverts to bring the water collected in the inside ditch under the road and through the berm;

3. with the permission of the Forest Service, provide proper surface drainage on that section of road (G) which is badly entrenched for a distance of about 300 feet (Figure 6). The present effects of this erosion may be studied prior to rehabilitation, but the latter should be accomplished well in advance of logging. The rehabilitation work here may be incorporated with using the roadbed as a foundation for an instrumentation access road into the heart of the watershed (or for the main logging road, according to plans of the Forest Service);

Figure 6.--Portion of the abandoned old homestead road on the southwest portion of Deer Creek watershed, showing three-foot entrenchment. Note two outlined figures in distance. Location is [illegible] on Figure 5

4. with the permission of the Forest Service, provide necessary erosion control measures for gullied area (B) on Deer Creek, short of utilizing heavy equipment: a few man days and hand tools should suffice to either return the stream to its original course, or to prevent further and more extensive headcutting.

Instrumentation

Precipitation

Present precipitation records are obtained at the lowest point on the watersheds, in fact, below the elevation of the weirs in each case. Such location is not satisfactory for determination of the precipitation on the watershed itself, particularly in the Coast Range where topography has a great influence on total precipitation, nor is such location suitable for determination of times of concentration. Since records have been kept for several years at the present location, however, it would be a loss of data to move or terminate the recording gages at this time. These gages, rather, should be supplemented and, after adequate correlation with newly-established gages on the watershed, removed.

5. work up Precipitation Intensity Record forms for each of the three recording gages and keep them up to date;

6. Standard Rain Gages (U. S. Weather Bureau 8") should be located on the watersheds proper at the rate of about 1 per hundred acres: thus, two on Needle Branch, five on Flynn Creek, and eight on Deer Creek. Due to the proximity of Flynn and Deer Creeks, at least two of the gages could be located near the common boundary thus reducing the actual number of gages on each watershed. This

does not mean that the gages should be located on the boundary itself, but near it so that calculation of mean precipitation by Horton-Theissen Means will benefit both areas. Gages should be located near but not in anticipated logging road right-of-ways;

7. gages should be located according to topography and should be mounted on elevated platforms only where the designated location is in a "leave" area: such a program of gage location would yield additional information concerning amount of precipitation reaching the ground before and after logging. It is suggested that gages in areas to be logged be located on the ground immediately, and protection afforded during the logging operation (or removal and re-establishment) and retained in the cleared area after logging.

Runoff

Considerable attention has been given to the type of stream gaging installation to be used within the watershed (i.e., Deer Creek), where information on a smaller scale can be derived. These gages should be located on small watersheds where the land use above the gage is homogeneous. It is important that the logging practice above each weir be constant so that accurate determinations concerning sediment can be made (the principal justification for the stream gages is so that sediment data collected at the mouth of the tributary can be adequately documented as to relation to runoff and quantity and location of erosion). Due to sedimentation problems, the Parshall and H-Type flumes have been rejected (also due to the fact that the range of flows expected would necessitate too large an installation -- or dual installations); standard concrete weirs were rejected due to cost, fresh concrete toxicity, and general inaccessibility; and runoff sampling stations were rejected due to inconsistency with "continuous" sediment sampling. Finally settled on was the relatively new Trapezoidal Flume, Venturi Model, which is self-cleaning, and accurately registers streamflow from 0.5 to 60 second-feet. Further, this gage could be constructed from sheet metal and bolted together on site for installation. Specifications were obtained from the Forest Service and the 1 foot 1.25 to 1 Flume was constructed in the University's metal shop. (Details of construction and plans are in the Appendix). For smaller drainage areas, the plans for the flumes have been reduced in size by ratios determined from a nomogram based on expected peak flows and flume capacities (see Appendix). The locations for the flumes, determined from examining the logging plans for the Deer Creek watershed, are shown in Figure 7, and were assigned their locations according to the tentative logging plans, soils, slopes, and aspect, as well as a ground check on site potential;

8. complete installation and calibrate all flumes in the field, and establish schedule for intermittent checks and maintenance. Flumes should be calibrated in the approximate center of the throat section with a midget current meter, and may be checked for proper conformation of flow with common food coloring;

9. install recorder wells, connect pipes, and install recording instruments for each flume;

10. set up computation forms and procedures for streamflow records, such as outlined in Johnson and Dils (8), and keep up to date;

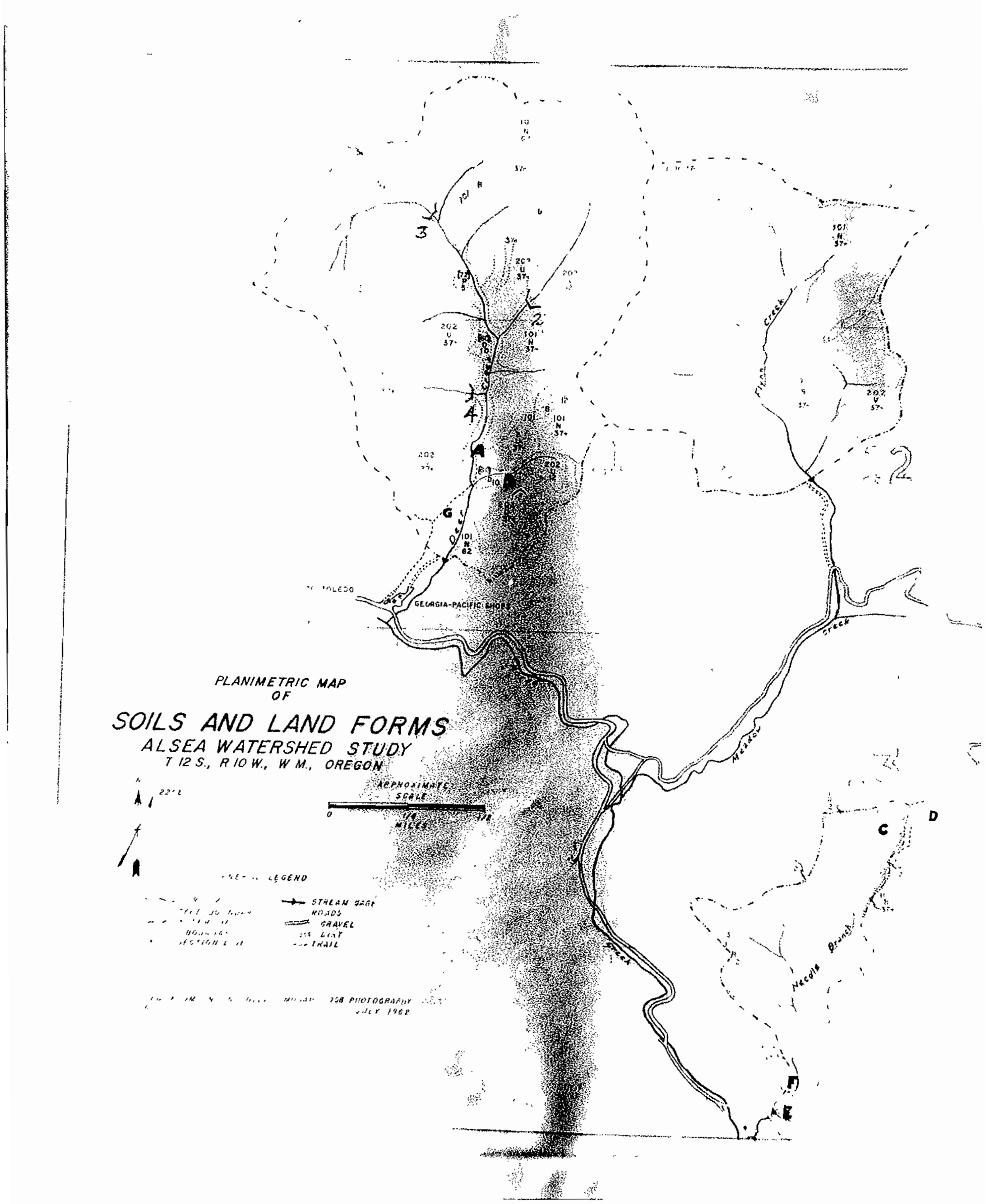


Figure 7.--Reference map for location of stream gages.

Sediment

The measurement of sediment is of prime interest to both the watershed manager in determining ways and means of rehabilitating eroded areas, and to the fishery biologist in investigation of the effects of sedimentation on spawning gravels and on food and light supplies within the stream, as well as to the forester in the prevention of erosion. Since Deer Creek is to be patch cut, sediment investigations will be concentrated on that area, although overall effects of clearcutting will be investigated on Needle Branch as well. Present sediment sampling installations at the mouths of the streams integrate the effective movement of sediment downstream, and additional data is needed on Deer Creek where land use will be non-homogeneous, to document soil movement. The lack of power facilities negates the installation of continuous sediment data collection, and rising, single stage dediment samplers as described and tested at the St. Anthony Falls Hydraulic Laboratory (9) and in general use by the Geological Survey will be employed.

A sediment sampler superstructure has been designed by the author for specific installation on the downstream apron of the trapezoidal flume (details and specifications are in the Appendix) and the apparatus should be checked in the field at various stages of streamflow to determine whether induced turbulence affects the sampling of sediment, or effects flow in the throat of the flume which would lead to erroneous streamflow measurements:

11. check hydraulic properties of sampler *in situ* as outlined above;

12. construct additional samplers for each flume and install;

13. arrange with Geological Survey for data collection and analysis and for forwarding of data to the University for filing.

General

The following recommendations pertain to the overall management of the study:

14. once gaging installations are completed in conjunction with anticipated logging plans on Deer Creek and Needle Branch, care should be taken to insure that no material deviation from those plans occurs. With the exception of obviously dangerous situations, this policy should be strictly adhered to to avoid waste of calibration period records;

15. at least one winter season before logging operations commence, precipitation, runoff, and sediment data should be completely analyzed for consistence between watersheds and for continuity within watersheds. Any inconsistencies should be carefully investigated at that time, and corrective measures taken before logging operations start to insure adequate control;

16. logging roads should be constructed one season prior to logging operations in accordance with common local practices;

17. if funds are made available, a carefully-constructed, gravelled road should be built on the alluvium, utilizing the old homestead road and extending it from its former termination to provide access to the gaging installations on Deer Creek;

18. Still more generally, living quarters at the Drift Creek Laboratory should be maintained or improved, including at least the inbtallation of a gas line from the main tank to the tent shelter so as to operate a refrigerator; trails should be cleared around the boundaries of Flynn Creek (presently flagged) and Needle Branch and mainbained, along with the trail around Deer Creek; a systematic trail system and data collection procedure should be established and maintained; and annual progress reports primarily on the year's activities should be prepared and filed. In order to accomplish the above, i.e., recommendation number 18, it will be necessary to keep one man on full time employment year 'round, preferably living at the Drift Creek Lab.

ACKNOWLEDGMENTS

The author is particularly indebted to a large number of persons directly and indirectly engaged with the Alsea study. My sincere thanks go to Mr. James T. Krygier for the aid and guidance during the summer, and for the opportunity of working on the project. Members of the staff of the School of Forestry have been extremely helpful in making available documents, equipment, and reference materials, and their advice has been invaluable. My appreciation is extended to Dr. Donald W. Chapman of the Water Resources Institute for a considerable amount of his time, and to Mr. Robert Philips and Mr. Russel Hammer of the Oregon Game Commission for their help in orienting me on the watersheds and for their continued help. Mr. Jack Rothacker, Forest Service, supplied valuable advice and reference material concerning stream gaging, as did Messers Goodwin, Phillips, Laird, and Williams of the Geological Survey. Finally, to the crew, Terry Stein, Chuck Weseman, and Mac Thompson, who cheerfully undertook their assigned tasks in the field, and faithfully completed them, I extend my sincere thanks. The latter join with me, I am sure, in extending our gratitude to Mr. Charles Chambers of Newport, Oregon, for the generous loan of one of his horses for packing equipment and stream gage material into inaccessible sites.

A P P E N D I X

TRAPEZOIDAL FLUME SPECIFICATIONS

The specifications for the standard, or original, 1 foot, 1.25 to 1 trapezoidal flume are shown in Figure A. Figure B is the nomogram utilized to determine the ratio to multiply each of the linear measurements in Figure A by in order to arrive at a flume size for a watershed of a given acreage. This conversion is based primarily on the Geological Survey estimate of peak runoff being about 180 c.s.m. and on the cross-sectional areas of the flumes when filled to capacities. Figures C, D, and E show the specifications for the 7/10-, 1/2-, and 1/3-size flumes, respectively. At the time of writing, the standard 1 foot flume has been comleted; the 7/10- and 1/3 sizes are planned for completion during the week of Septmber 12, and the 1/2-size is not yet scheduled. The plans for the latter (to be given to the O.S.U. metal shop) are filed under 1.6310 in the Alsea Watershed Study file.

STREAM GAGE SITE SELECTIONS

The full-size flume was installed near the upper end of the alluvium on the East Fork of Deer Creek, re-named Sonny Branch in honor of a most patient pack horse, and is shown as site 2 on Figure 7. Yet to be installed is the recorder well and recorder. The 7/10-size is to be installed on the upper end of the West Fork of Deer Creek (site 3), and will also require well and recorder. The 1/2 and 1/3 size flumes are planned for installation at sites 4 and 1 (Figure 7), respectively.

FIGURE A

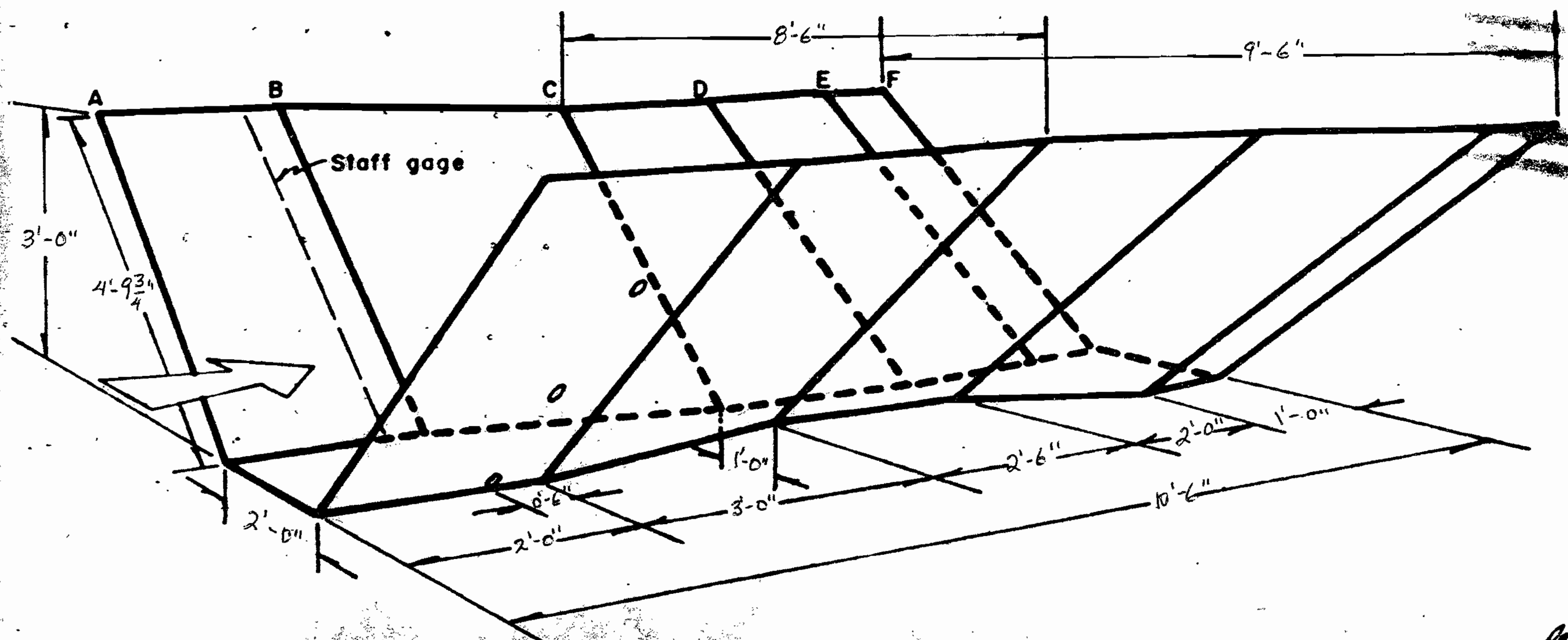
Specifications
for
1.25 - 1 TRAPEZOIDAL FLUME
capacity 60 c.f.s.

ADDITIONAL NOTES:

A-B 2'-0" B-C 3'-½"
C-D 2'-6" D-E 2'-¾"
E-F 1'-0"
Recorder well hole spacing 1'.
Angle iron braces at A, B, C, D, & F.

	bolts	spacing
Interior flanges 1" thus:	1/4"	9"
End flanges 1-1/2":	3/8"	9"
Top flange 1" hemmed:		

3/4" I. D. pipe 6" long threaded for field installation to well pipes plus one 20" from F toward D for sediment Sampler



P.E. Beck
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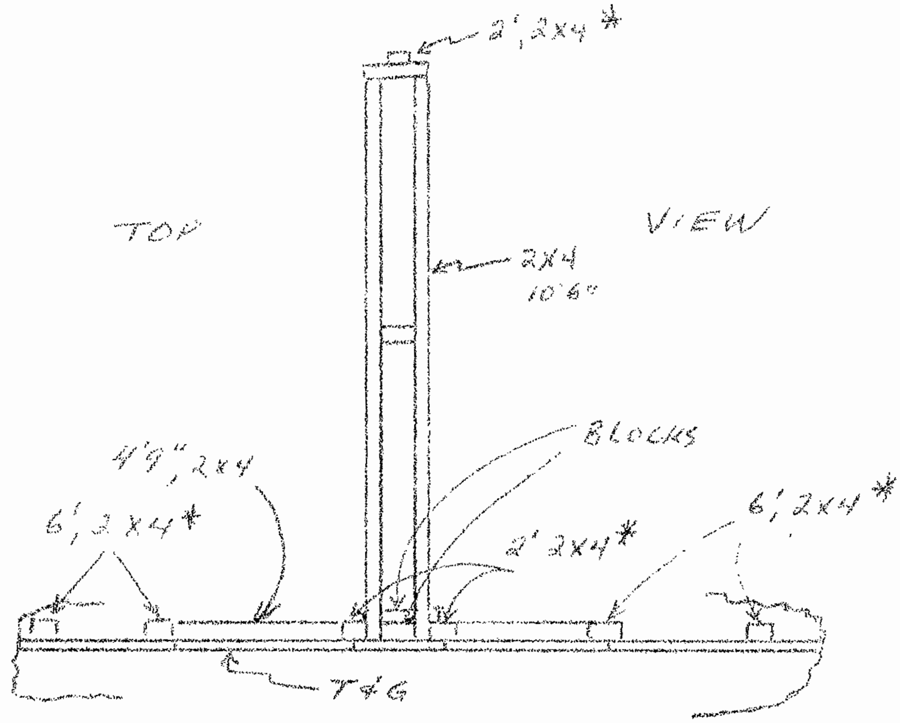
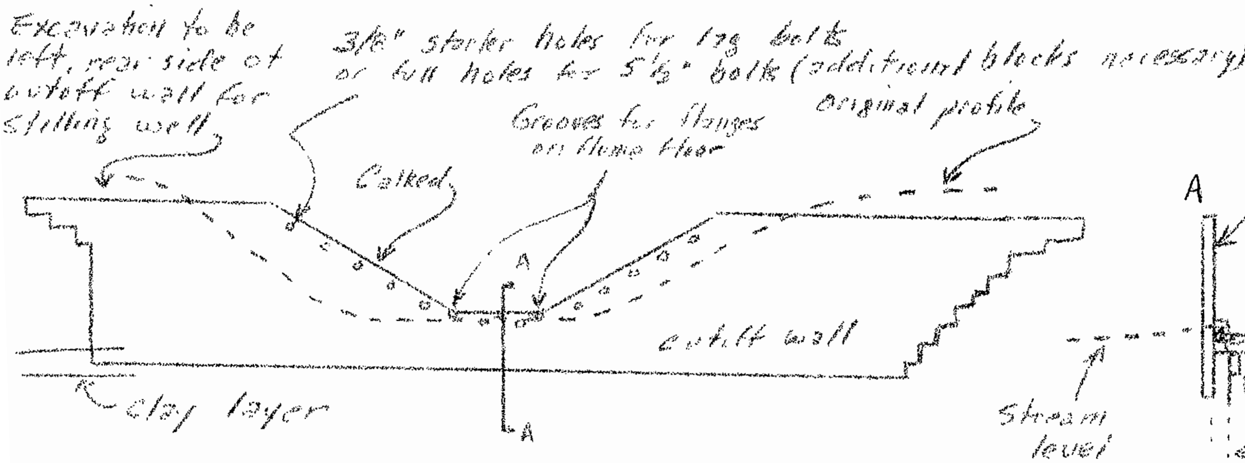
NOTES ON FLUME INSTALLATION
(Based on installation of 1 Ft. Flume on Sonny Branch)

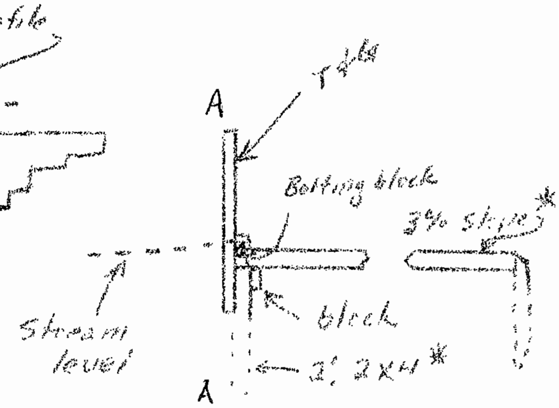


TOP VIEW

As of the above date, the back-filling job is not complete, but the original profile, restored upstream, is yet to be completed downstream from the cutoff wall & tamped around the flume.



UPSTREAM FACE

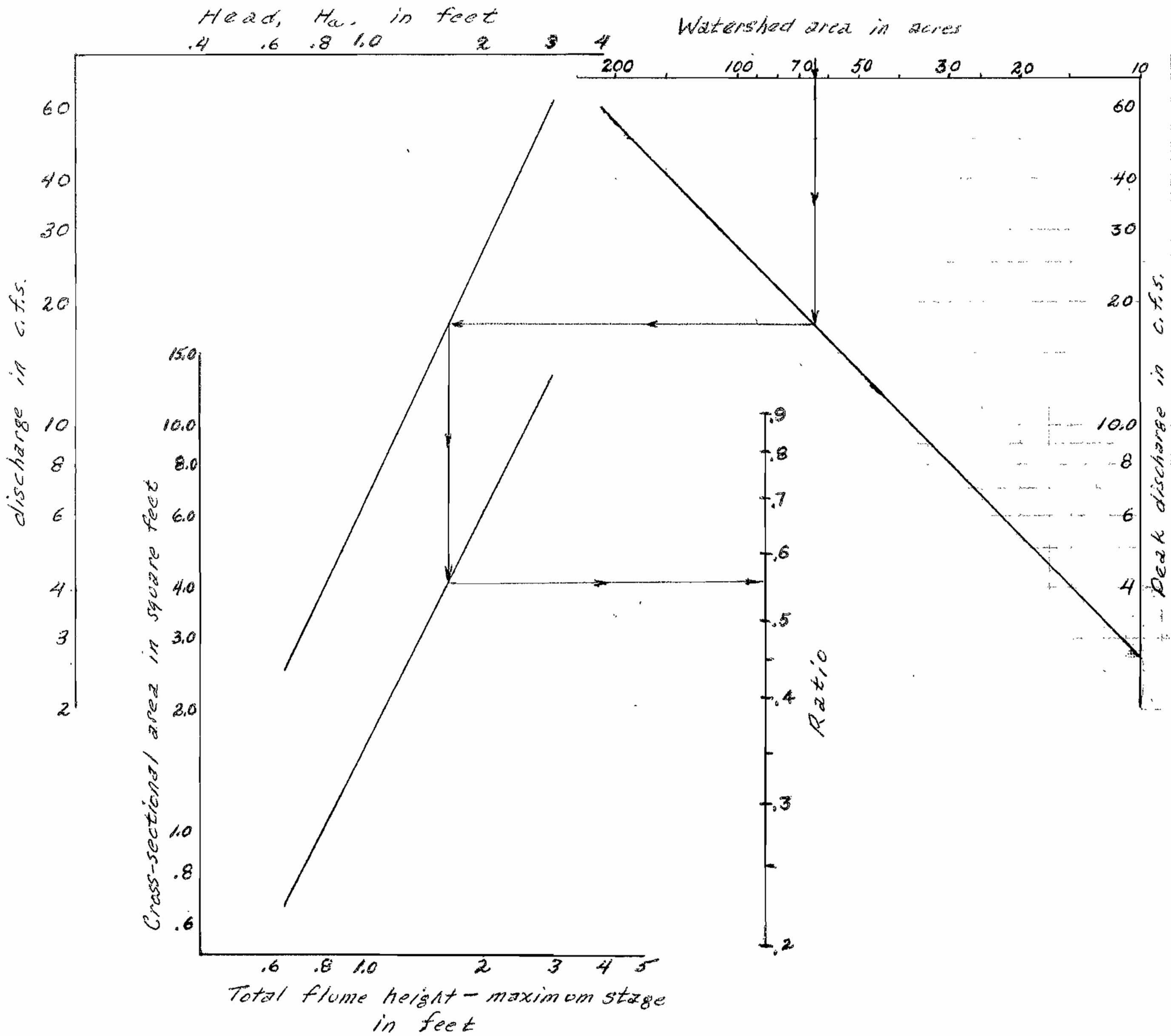


SIDE SECTION

* indicates stakes

FIGURE 1B
NOMOGRAM

for determining trapezoidal flume size
Alsea Watershed Study



Basis:

1. Maximum discharge for Alsea area, 180 c.s.m., from U.S. Geological Survey.
2. Theoretical Rating Curve for 1 Foot 1.25-1 Trapezoidal Flume, Venturi Model.
3. Maximum cross-section of throat of proportional-measurement flumes.
4. Ratios needed to multiply 1 Foot flume measurements by for desired size.

Peter E. Black
August 21, 1962

Example:
For a 64-acre watershed, multiply all linear measurements of 1 Foot flume by 0.55.

FIGURE C

Specifications for 1.25 - 1 TRAPEZOIDAL FLUME capacity 30 c.f.s.

ADDITIONAL NOTES:

A-B 1'-4 3/4" B-C Measure

C-D 1'-9" D-E

E-F 0'-8 3/4

Interior flanges 1" thus: bolts ___ spacing ___ 9/10 ths Size

End flanges 1-1/2": ___ ___

Top flange 1" hemmed: ___ ___

Recorder, well hole spacing 1'.

Angle iron braces at A, B, C, ~~D~~, & F.

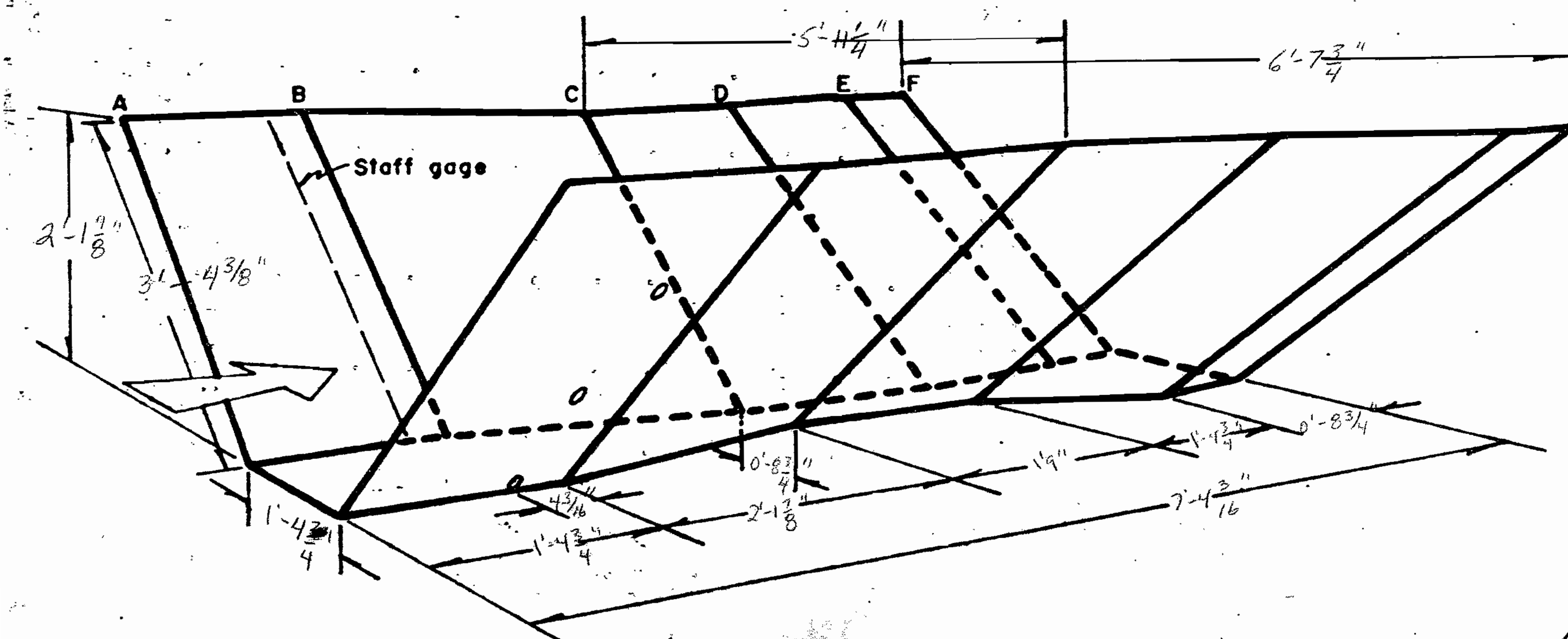


FIGURE D

Specifications for 1.25 - 1 TRAPEZOIDAL FLUME capacity 15 c.f.s.

ADDITIONAL NOTES:

A-B 1'-0" B-C Measure
C-D 1'-3" D-E
E-F 0'-6"

Recorder well hole spacing 6".

Angle iron braces at A, B, C, D, & F.

	bolts	spacing	
Interior flanges 1" thus:			1/2 Size
End flanges 1-1/2":			
Top flange 1" hemmed:			

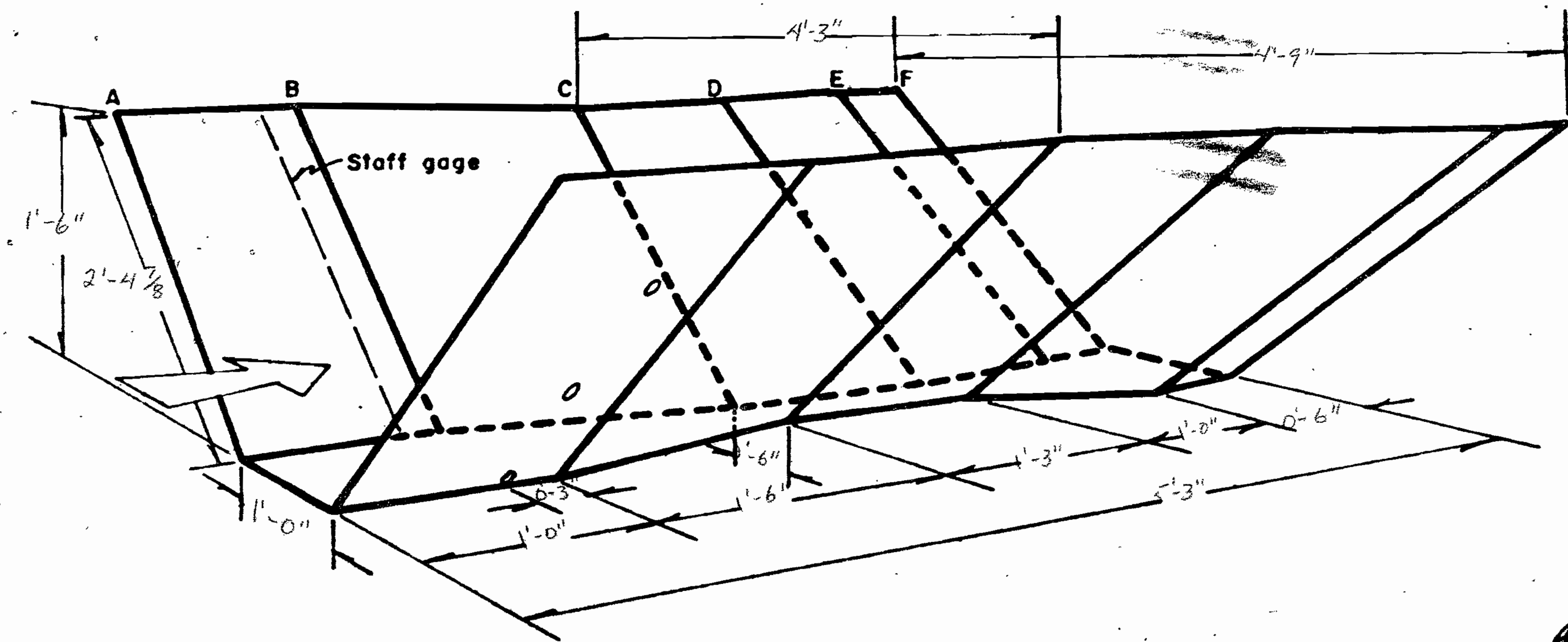


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FIGURE E

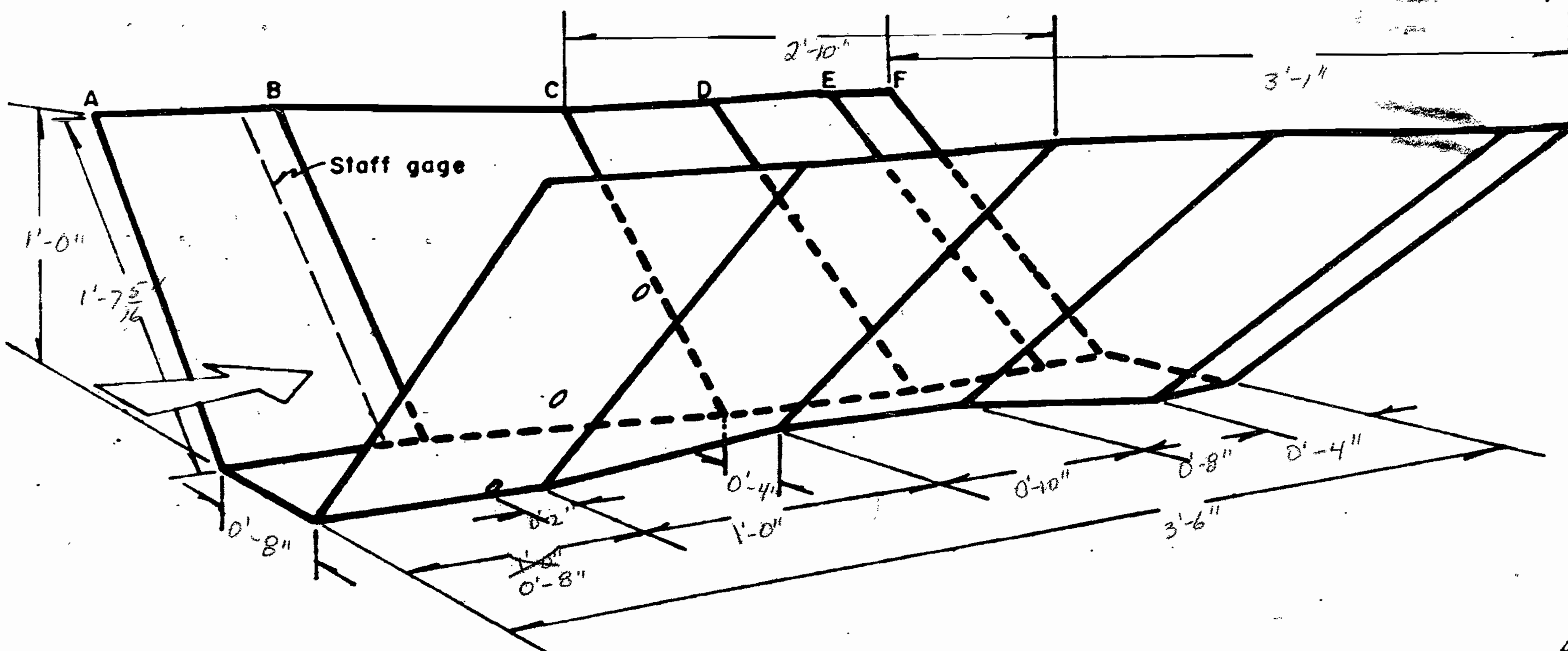
Specifications for 1.25 - 1 TRAPEZOIDAL FLUME capacity ___ c.f.s.

ADDITIONAL NOTES:

- A-B *0'-8"* B-C ____ *Measure*
- C-D *0'-10"* D-E ____
- E-F *0'-4"*
- Recorder well hole spacing *6"*.
- Angle iron braces at A, B, C, D, & F.

	bolts	spacing	
Interior flanges 1" thus:			*1/3 Size*
End flanges 1-1/2":			
Top flange 1" hemmed:			

Reverse sides for staff gage & well hole locations



P.E. Black 8-20-62

SEDIMENT SAMPLER

Plans for the sediment sampler to be installed in the trapezoidal flumes are in Figure F. Only one set of sampler plans is shown, that for the 1 foot flume, since the device may be adapted for other sizes merely by reducing the height of the supporting angle-irons above the upper-most shelf.

This sampler was devised in order to avoid the problems of 1) non-uniformity of samples between different streams both with respect to stage at which the sample is taken and to orientation of intake nozzles in the stream's cross section, and 2) difficulty of changing sample bottles during high water. The former problem is solved by controlling the height of the intake nozzles with a steel strip, perforated at 0.10' intervals, to which the nozzles are wired, and by mounting the structure directly in the center of the flume, supported by the flume's cross-braces, on the downstream end where it will not interfere with the laminar flow in the throat. The latter problem is solved by making the structure light in weight so that, by removing the two pins which hold the structure to the cross-braces, the entire unit may be removed for bottle-changing.

Additional flexibility and control is evident: a total of six (or more, if more shelves are added) samples may be taken either at six different stages, or by pairs, thus yielding stronger estimates of sediment load. Or a single sample may be taken at the lowest level, and duplicate samples above where variation is greater.

The cost of the sampler in the O.S.U. metal shop is estimated at $25 to 30, not including the sample bottles which are supplied by the Geological Survey. The finished sampler is shown in Figure G.

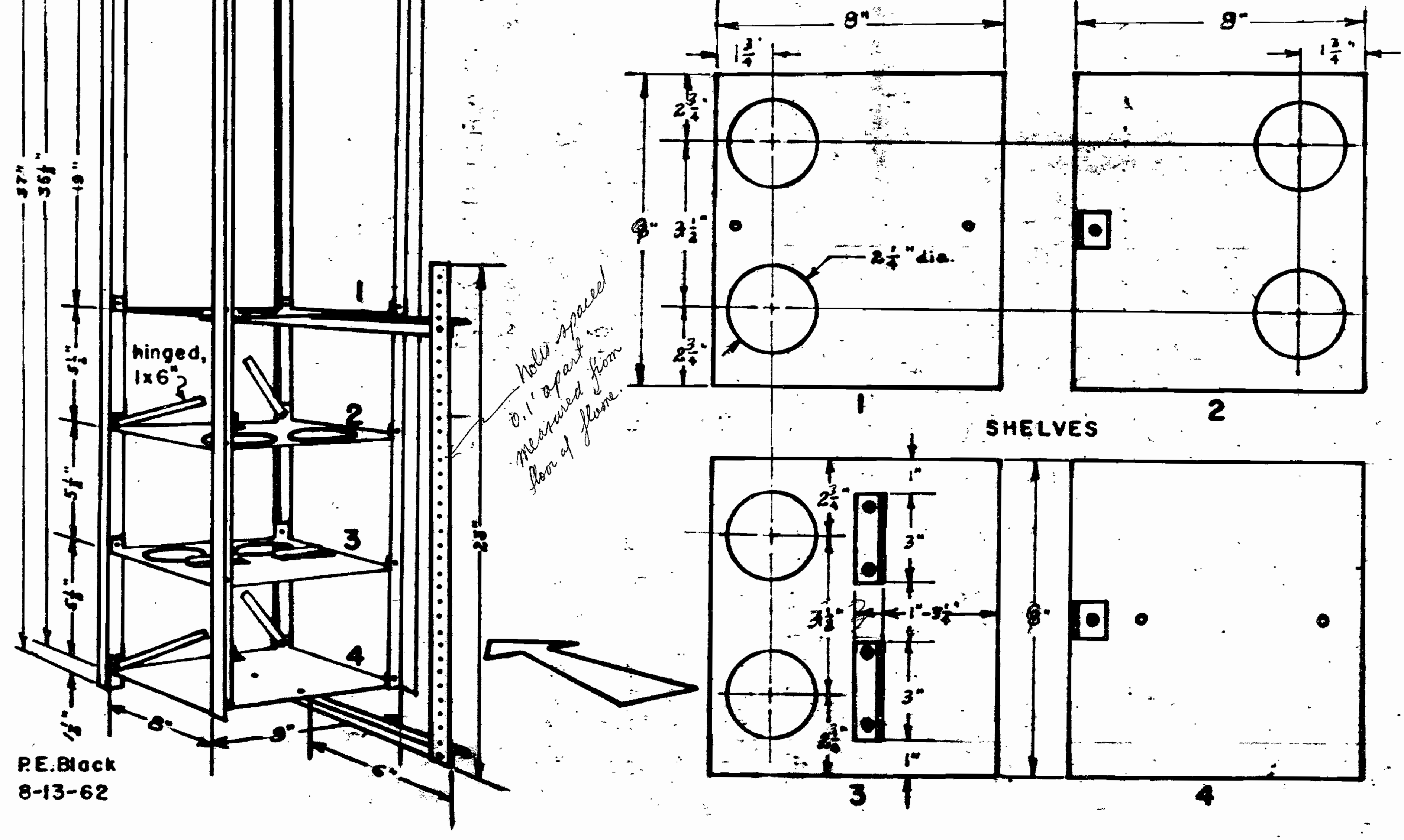
FIGURE F

PLANS FOR SEDIMENT SAMPLING INSTALLATION

For Mounting In

1 Ft.- 1.25:1 Trapezoidal Flumes

(Arrow indicates direction of water flow)



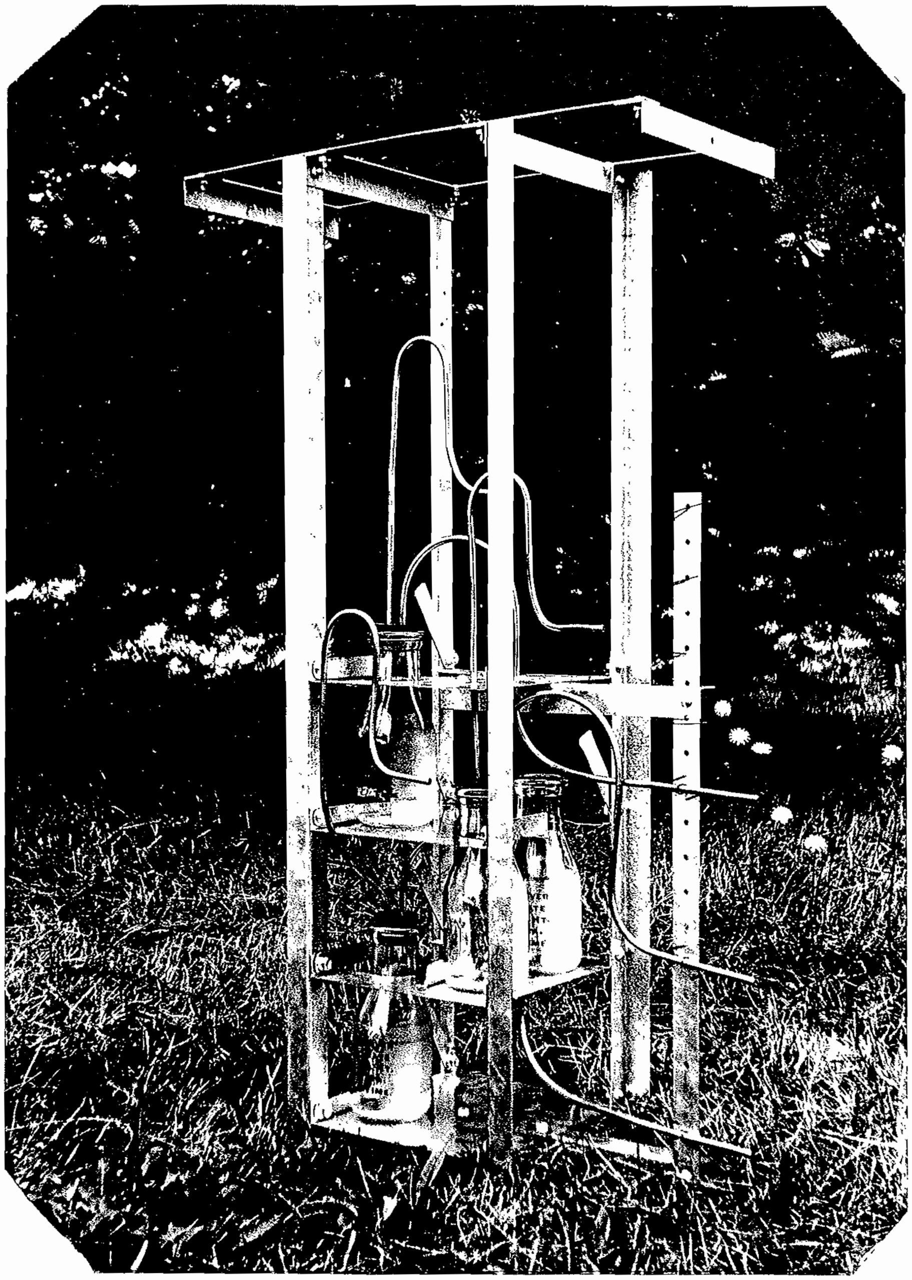


Figure 6.--Sediment Sampler Superstructure for installation in Trapezoidal Flume, full-size model.

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