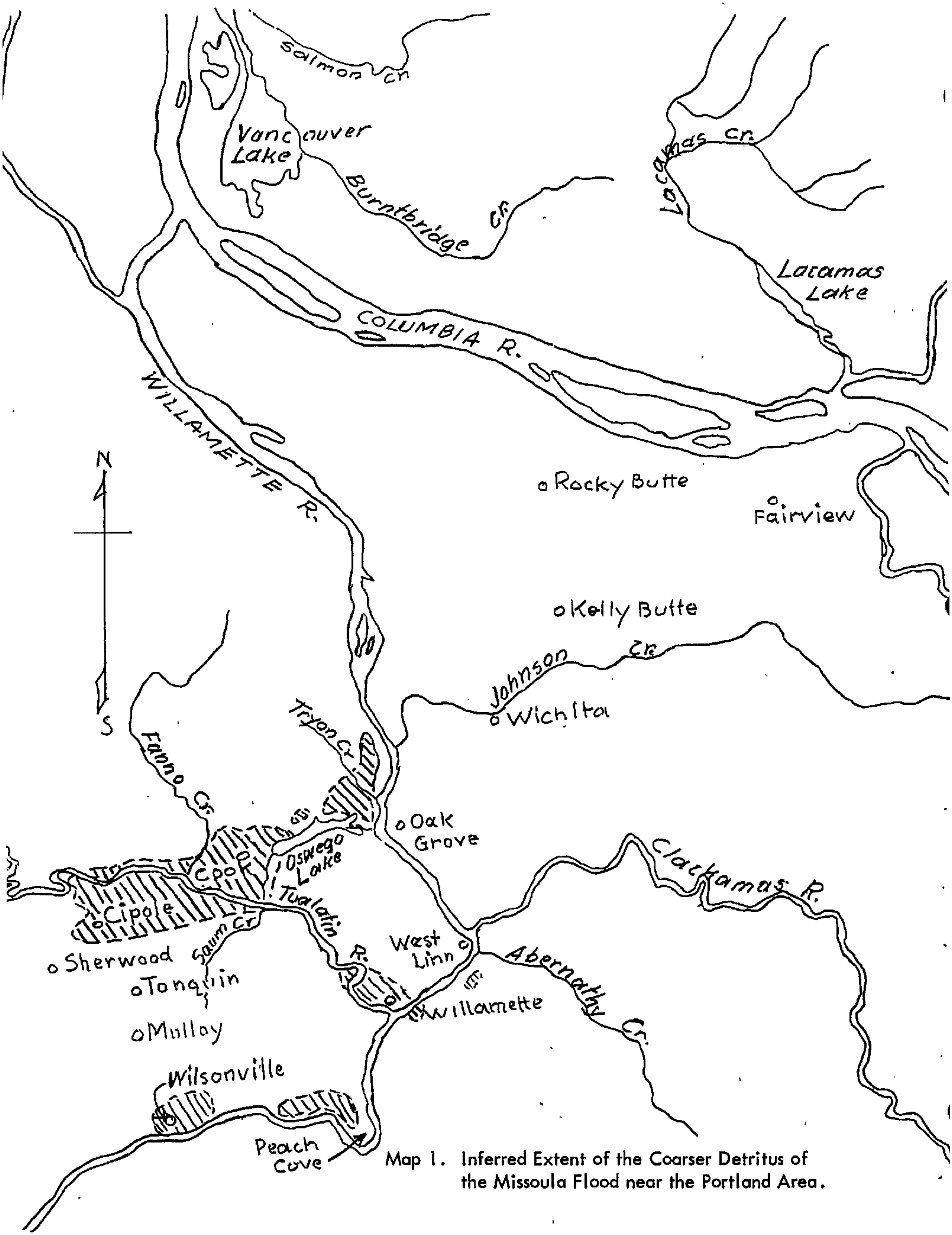

Map 1. Inferred Extent of the Coarser Detritus of the Missoula Flood near the Portland Area.

LATE PLEISTOCENE FLOOD DEPOSITS IN THE PORTLAND AREA

By

Dr. James Stauffer*

Reasonable objections to the theory that a late Pleistocene flood swept down the Columbia River and spread over the Portland area with devastating effects disappeared with the publication in 1933 of Allison's paper on the "New Version of the Spokane Flood" and with the accumulation of corroboratory evidence since then. Contrary to the belief of Bretz that the flood was responsible for the thick cover of sands and gravels in the Portland area, Allison showed that most of these, as well as similar deposits near Umatilla, Hood River, White Salmon, Lyle, and Carson, are older than the flood, and that only erosional features and scattered areas of fresher sands, gravels, and coarser materials are explicable in terms of the flood. Lowry and Baldwin believe the older deposit, variously known as the "Portland Gravels," and the "Portland Delta Gravels," was built by the Columbia River into a body of water that gradually flooded the Willamette Valley as a consequence of a eustatic rise in sea level accompanying the melting of glacial ice during Wisconsin deglaciation, and that the present elevation of this deposit is due to subsequent uplift. The younger erosional and depositional features, Allison suggested, could have resulted from flood waters released from an ice jam initiated by landslides in the Eagle Creek Formation in the vicinity of Stevenson, Washington. Since it is now recognized that the flood probably occurred after the Spokane Stage of glaciation, the older term, "Spokane Flood," may be considered a misnomer. Also the weight of evidence against the theory of the damming of the lower Columbia River, plus the finding by Pardee of evidence for unusual currents in glacial lake Missoula in Montana, led to the theory that the flood was due to the release of an unusually large body of water in the upper Columbia; therefore the name, "Missoula Flood," is now preferred by some. These flood waters, it is claimed, had an elevation of 2100 feet before reaching the Wallula Gateway; between the Gateway and The Dalles they may have attained 1600 feet and in the Portland area they fanned out at an elevation of about 500 feet. Some estimates are a little more conservative than these but at any rate there is general agreement that it was a flood of major proportions.

Both the Portland Gravels and the younger flood deposits contain erratic fragments of plutonic and metamorphic rocks similar to types found in the upper Columbia basin. Most of these were ice rafted into the area although some may have been tree rafted, similar to those of recent origin along the Columbia described by Sargent. Some of the erratics in the flood deposits are highly weathered and are probably redeposited from the Portland gravels, but most of them are relatively unweathered and doubtless were borne by icebergs that came down with the flood. Between the Wallula Gateway and The Dalles, erratics have been found at around 1100 feet altitude; in the Willamette valley they occur up to 400 feet. The picture we have, therefore, is that of a rumbling torrent of muddy water, carrying huge icebergs and debris of all sorts, plunging through the Columbia gorge, fanning out in the Portland area, rushing relentlessly up the Willamette and into its tributaries against the natural flow of these rivers, spending its energies and then surging out leaving a scene of havoc that thousands of years have not obliterated.

The present paper is an attempt to map and describe some of these flood deposits and to speculate on the effects of the flood in altering the drainage of the area. Following are the most conspicuous erosional and depositional features in and near the Portland area:

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Erosional Features

1. Lacamas Lake area in Washington
2. Portland City area
3. West Linn, Oregon City, and Oak Grove areas
4. Oswego and Riverdale areas
5. Tonquin area
6. Area north of Peach Cove

Depositional Features

7. Portland City area
8. Areas east and north of Oswego Lake
9. Area west of Oswego Lake
10. Wilsonville area
11. Oregon City Park area
12. Lower Tualatin Valley
13. Peach Cove

Map 1 (opposite page 21) shows the location of these features. No doubt there are many more; however, these alone are sufficient to indicate the nature of one of the most catastrophic events of late Pleistocene times. Let us discuss each feature separately.

Erosional Features

1. Flood waters swept through the Lacamas Lake channel in Washington, scouring out a wide depression 25 to 50 feet deep and several miles long northwest of the lake. Rushing toward Vancouver Lake and Salmon Creek, the waters cut "deep distributary erosional channels" in the 300-foot terrace.

2. Surging across the Portland area, flood waters cut a broad depression about ten miles long from Fairview to Wichita. A deposit of fine gravel and sand at Wichita was interpreted by Allison as having been left by the flood. The depressions to the west of Rocky Butte were scoured out of the 300-foot terrace by waters swirling around the butte and concentrating their energies there. Sullivan Gulch was probably largely formed by erosion from water draining out of these depressions. Flood-scoured depressions also occur west and north of Kelly Butte.

3. Numerous places once covered by a residual soil of Columbia River basalt, Boring lava, or Troutdale Formation have been stripped down to bare rock. One of many such places may be observed south of the West Linn High School, an area that lay in the path of flood waters as they funneled through the Oregon City Gorge. This typical scabland, extending southwest from West Linn to the Tualatin Valley, shows such features as depressions, quarried areas, completely denuded areas, and areas with little soil and bearing a growth of scrubby trees and shrubs. Just across the Willamette River from West Linn, between the Clackamas River and Abernathy Creek, is a low area that contains a number of fairly large depressions. It has been suggested that these were caused by the scouring action of a giant flood eddy formed in this cove, although it is possible that they are old meander scars. In Oregon City there are a good many places that have been stripped down to bare rock. Scabbing is also evident in the Oak Grove region a few miles north of Oregon City. Here the long ridge between the Willamette River and Kellogg Creek is composed of Troutdale Formation underlain by Columbia River basalt. Growths of scrub oak prevail along this ridge and, where new housing projects are under construction, Troutdale

gravels may be seen at the surface. Evidently the old residual soil must have been entirely stripped away by the flood.

4. The northeast end of Oswego Lake was originally a depression occupied by an intermittent pond that was not directly connected to the lake. It is believed this may be due to flood scouring in a Pre-Boring river bed. That flood waters, rushing across the Fairview-Wichita region, found the Oswego Lake gap a natural pathway is attested to by numerous scabbed areas around the lake. Denudation is evident in the Lakebay region, lying between the two eastern embayments of the lake. Several long, narrow depressions, characterized by a pond, swampy areas, and stripped areas, cut across the Oswego golf course from the northeast to the Southwest. These are in a direct line with the Fairview-Wichita channel. The golf course channels lead to Twin Point and Diamond Head on the north side of Oswego Lake. Here, as well as in nearby areas, the top soil has been almost entirely washed away and growths of scrub oak, madronas, and various shrubs alternate with rocky treeless areas. Just west of Diamond Head is a pond, now connected to the lake by a narrow passage, that was a swampy depression before the lake level was raised by damming. This was doubtless formed by the action of flood waters cutting across the present golf course and plunging down into the lake channel. Other depressions occur a short distance to the west near the Oswego Riding Academy. Denudation is also evident in places on the south and west sides of the lake, although the latter is mostly covered by flood sediments. In the Riverdale area a strip extending from that place to Dunthorpe has been partially denuded. It appears that material removed from here was carried to the Tryon Creek and Oswego region.

5. The Tonquin scabland is characterized by numerous depressions, surfaces stripped of soil, some with scarcely any or no covering of vegetation, and a number of channels from which rock has been quarried by a mighty force. The impressive channel just west of Tonquin and Mulloy has been named "The Tonquin Floodway" by Hodge, who recognized that this area was once the scene of a great flood. Until recently, however, there has been some doubt as to the direction from which the flood waters came into this area, some imagining that they entered from the south. That this is not the case is indicated by depositional features that will be discussed below.

6. Up the Willamette River, just north of Peach Cove, is an area of scrub oak growing in a very thin soil (Map 3 on page 29). Nearby, at a lower elevation, two elongated ponds, now virtually swamps, may be seen. These features were noted and interpreted by Rudolph Erickson. They will be discussed later in connection with the deposits at Peach Cove.

Depositional Features

A great many types of flood sediments occur, ranging from poorly to well-sorted ones. The deposits range in thickness from a few feet up to about 100 feet and show both vertical and horizontal sorting of materials. Most of the sediments have been derived from the following older rocks:

a. Portland gravels and sands.
b. Boring lava boulders, cobbles, and pebbles.
c. Troutdale formation gravel and sand.
d. Columbia River basalt boulders, cobbles, and pebbles.
e. Plutonic and metamorphic erratics from the upper Columbia basin.
f. Pieces of rock of unknown origin, some of which are probably from the Eagle Creek formation.

In general the materials have not been transported very far; in most instances a deposit can be traced in origin to an adjacent scabland, so that it is possible to readily determine the direction of each of the various flood paths through the region.

7. Not many sediments in the Portland city area have been definitely earmarked as flood deposits. Those west of Mt. Scott at Wichita have already been noted. Poorly sorted gravels near Rocky Butte are probably of flood origin; others have been reported along the base line north of Gresham. There was doubtless a widespread shifting of Portland gravels and sands from one place to another in the city. Moreover, the mantle of silt that blankets much of the area dropped from the waters as the flood abated. In contrast with the older Portland sands, those of the flood are considered to be looser and to slide more freely, although this is not always a reliable criterion. Down river from Portland, flood deposits have been reported near Scappoose and Deer Island; up river they are known from a number of localities, but it is not proposed to discuss these or scabland features along the Columbia River in this paper.

8. In the process of enlarging the Riverdale School playground some time ago, many large residual boulders, that do not appear to be in place, were uncovered. With them is the largest erratic the author has seen in the vicinity of Portland. Measuring about 6 by 4 by 3 feet, it is a porphyry containing large feldspar phenocrysts. These boulders are considered to be part of a flood deposit extending from this area to Oswego. Lower Tryon Creek is a deep, narrow cut through this flood deposit. Flood sediments may be seen at a good many places east and north of Oswego Lake. The following are typical:

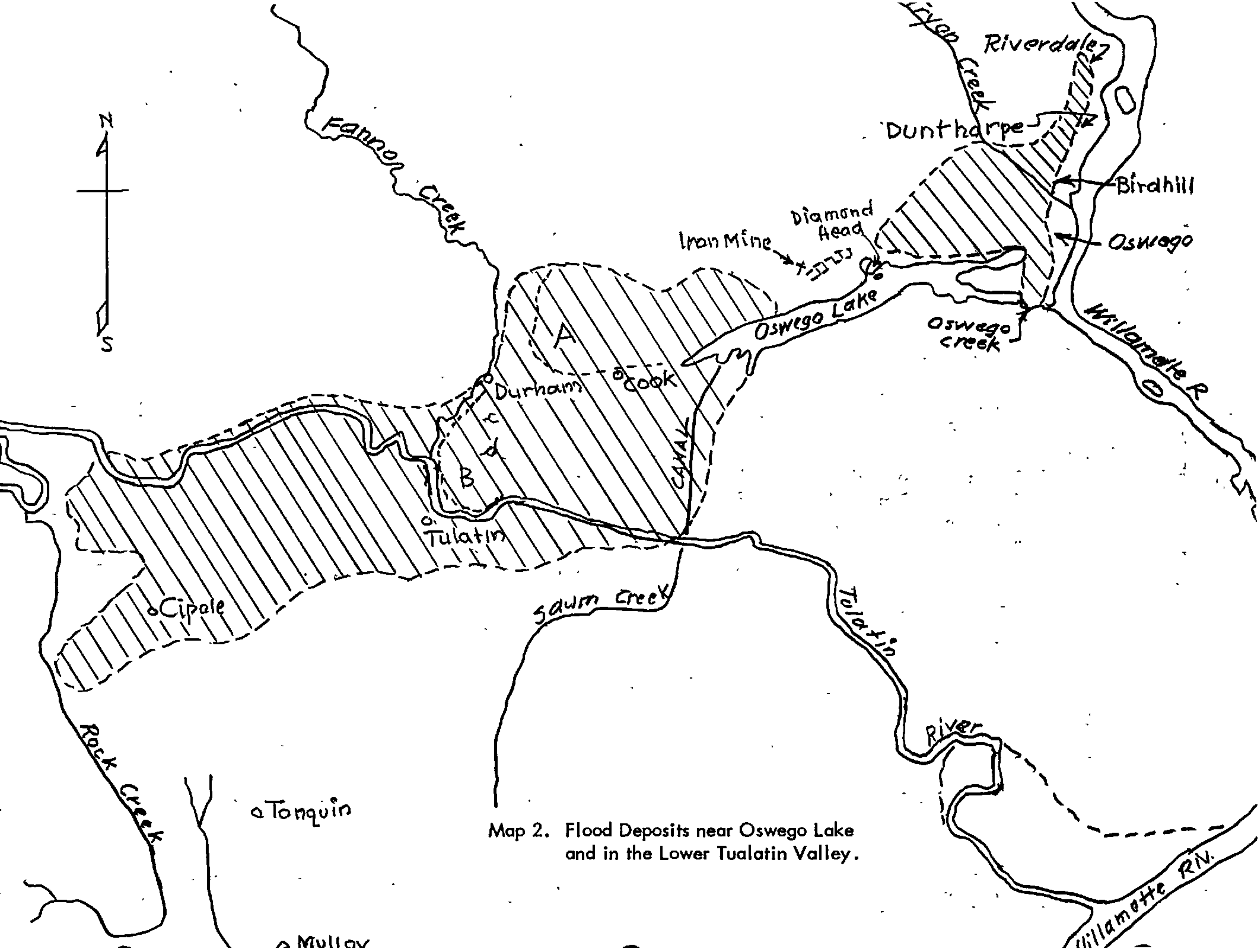
a. Just south of Tryon Creek at the northern entrance to Oswego.
b. On the east side of State Street just before reaching the Grade School.
c. Along the road leading from State Street around the south side of the Oswego Cement plant.
d. On the sides of Oswego Creek canyon and near the Oswego City Park at the junction of the creek with the Willamette River.
e. In the Forest Hills area and on both sides of Tryon Creek.
f. In the Birdhill and Dunthorpe areas.

The sediments composing these deposits vary from boulders and cobbles of different sizes through gravels and sand to silt. The deposit at the north entrance to Oswego offers the best section; it shows a gradation from around ten to twelve feet of a coarse mixture at the bottom to twelve to sixteen feet of sands, with five to six feet of silt on top. Excavations for basements reveal that this silt covers the older residential part of Oswego as well as the newer Forest Hills section and that, at least in the latter, it is underlain by a thick layer of micaceous sand that is probably reworked from the Portland gravels. A micaceous sand outcrops a short distance down Tryon Creek canyon beyond Tenth Street and is also found across the canyon to the north at a new cut, that was made for the completion of Terwilliger Boulevard Extension, as well as in Birdhill. Coarse material may also be seen in Birdhill above Boring lava along Highway 43. Excavation for a new house in Dunthorpe has recently revealed a top layer of silt resting on six to eight feet of sand, with coarser material - some of which is water-worn pebbles - below. It seems evident that this entire deposit is a lateral one made as flood waters swept up the Willamette and through the Oswego Lake channel, and that it once completely filled lower Tryon Creek canyon. Indeed it appears probable that the Willamette was temporarily choked with sediment near this region. Another lateral deposit of coarse materials lies north of the lake along Iron Mountain Boulevard. At the other localities east of the lake, boulders, cobbles, and gravels are the principal flood sediments. A discussion of the significance of these is reserved until later. Map 2 (opposite page 27) shows the above deposits as well as those west of the lake and in the lower Tualatin Valley.

9. The most extensive Missoula Flood deposit in the vicinity of Portland extends from the northwest end of Oswego Lake to some distance beyond Cipole. At "A", Map 2 (opposite page 27), there is an exposure of mostly angular rocks, sands, and silt that is similar to the Oswego deposit, and that was originally classified as Troutdale Formation by Treasher. It may be seen by walking out the railroad tracks beyond Cook Station. This deposit forms a sort of flat-topped dome around 250 feet in elevation, the southern border of which is an embankment that extends between Upper and Lower Drives in Lake Grove and curves around to the north as shown by the dotted line on the map. This may be interpreted as having been made by flood waters surging through the depressed area bordering the lake on the north. A greater surge through the lake channel proper swept flood debris to area "B," which is also a sort of low half-dome that drops sharply into the Tualatin River and Fanno Creek. The top of this dome has an elevation of about 200 feet. The steep embankment, indicated by the dotted line, marks the limit of the bouldery material but sands and fine gravels were carried farther to the west. The Tigard Sand and Gravel Company has scooped out several large, deep pits in deposit B near Durham. The following evidence obtained from these pits proves that the flood came from the east and passed through the Oswego Lake Gap.

a. Torrential bedding planes slope toward the west and southwest.
b. Numerous fragments of limonite are present, the only known nearby source of which is the Oswego Iron mine locality within the Oswego Lake Gap.
c. Numerous pieces of opal found in the pits are similar to opal found in place at Diamond Head.
d. Quartzite pebbles have been found within the pits. These must have been derived directly or indirectly from the Troutdale Formation, the nearest source being the area east of Oswego Lake.

The sizes of rocks from the gravel pits are truly impressive and furnish the most convincing proof of the energy of the flood. Basalt and breccia boulders larger than a car, portions of huge basalt columns, and a number of large erratics, all of which must have been transported several miles, are mixed with an assortment of smaller materials in almost utter confusion. Here and there one can see that deposition was so rapid that finer materials are completely lacking in the spaces between steeply inclined layers of tightly packed cobbles and boulders. One of the noteworthy features in the deposit is the presence of globular masses of clayey material, some of which are several feet in diameter. These are clearly not decomposed boulders. Because of their rather poor cohesiveness it appears highly improbable they could have been transported intact by the flood waters for any great distance. It is likely they are chunks of clay that have been scooped up a short distance to the east and rolled along to their present resting place. The thickness of the deposit at the site of the pit near the office of the gravel company is about 35 feet; in a pit a short distance to the south the thickness reaches around 75 feet (see Map 2, "C" and "D"). This is a significant fact that will be discussed later. Beneath the flood deposit is a blue clay which is probably the pre-flood residual soil. The border of the coarse Durham deposit may be observed by walking north up the railroad tracks from Tualatin toward Durham. The river here skirts around a steep bluff in which angular rocks may be seen. Paralleling the railroad tracks on the west side is an abandoned river bed which was likely the post-flood course of the Tualatin before it assumed its present position. To the west of the bluff finer sediments prevail. At Cipole there is a sand pit in an east-west elongated hill. Fine gravels are found here from which it is possible to pick up small fragments of limonite, opal, and granitic rocks similar to those found in the Durham pits. North of Cipole, along the north side of Highway 99W, there is an embankment of sand which is doubtless part of the same deposit. The inferred extent of coarse flood detritus west of Oswego Lake is indicated on Map 2. Here, as elsewhere, a foot or more of silt blankets the coarse materials and it is probable it covers large areas of the Tualatin valley into which the coarse sediments were not carried.



Map 2. Flood Deposits near Oswego Lake and in the Lower Tualatin Valley.

10. Recently a hitherto unreported flood deposit was discovered on the north side of the Willamette River near the bridge on the new Salem highway. This material is at present being removed for gravel so that it is possible to observe some excellent sections of it. In general it resembles the deposit at Durham, although no boulders as large as those at that locality were observed. Limonite and quartzite were not found but erratics are present. Most important is the fact that the torrentially bedded materials incline toward the south, revealing clearly that they were stripped from the Tonquin area by flood waters and transported to this place. It has been suggested that the work done in transporting these sediments was due to a back surge of water that had pushed up into the Tualatin Valley, but it is probable that both direct attact as well as back surge were responsible. Here again, even at this distant locality, one is impressed by the amount and nature of the debris that has been piled up and can imagine the fury of the waters. One might expect that the Willamette would have been blocked at this point, and indeed it may temporarily have been for it now swings in a gentle arc around the bulge of flood deposit.

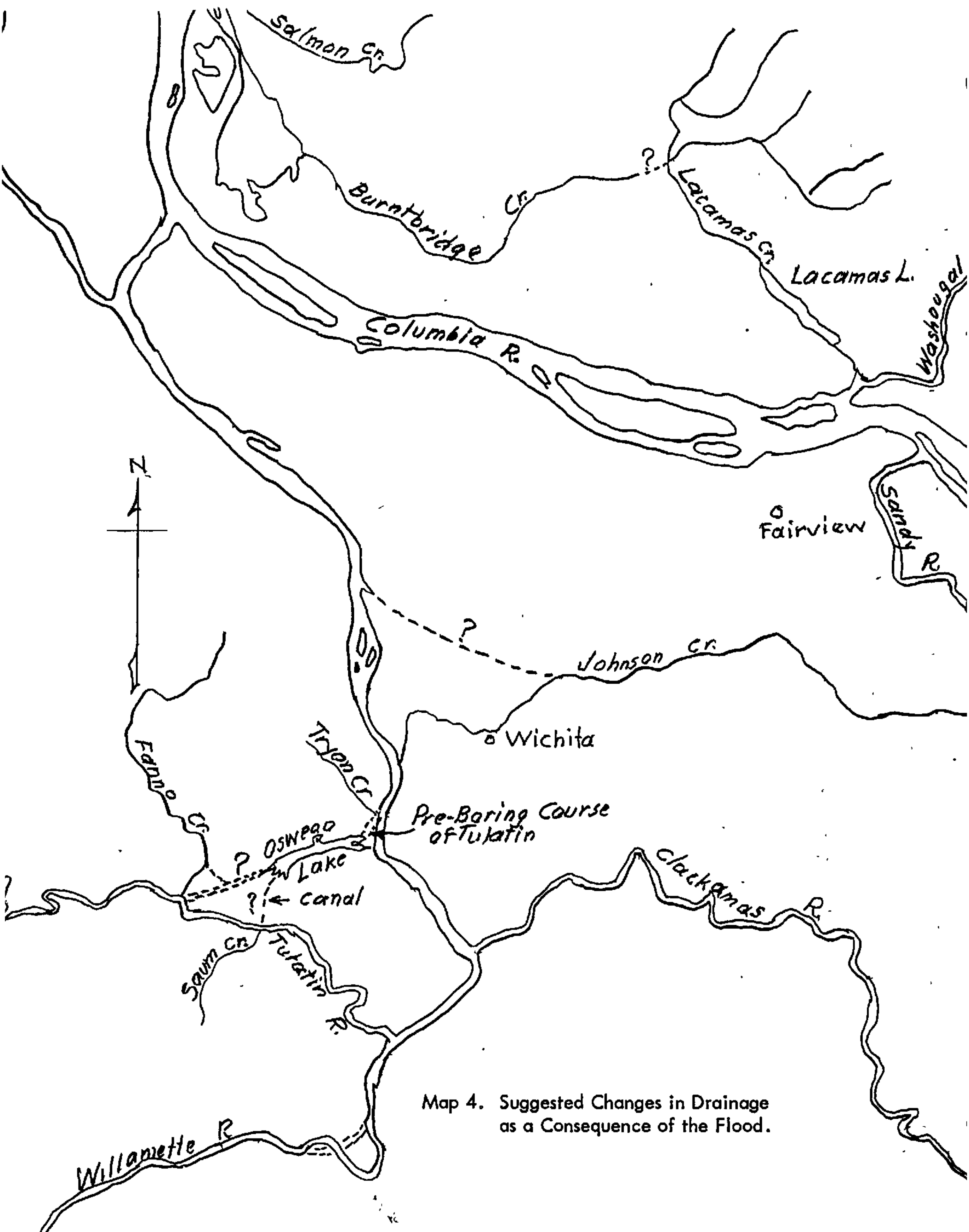
11. In the Oregon City Park area in the southern part of that city a chaotic mass of large boulders of gray basalt, torn from cliffs immediately to the north, presents mute evidence of the force of the waters that ripped through this region. The writer is indebted to Murray Miller for pointing out this locality and also the scabland at West Linn.

12. The Tualatin River has an unusual course near the town of Willamette. Just before reaching Field's Bridge it makes a large U turn, and then, after passing the bridge, flows through a canyon on the south side of the valley. Studies show that the mouth of the valley is filled with a sediment that is coarser near the Willamette River and grades into fine gravel and sand up the valley. In the process of enlarging the baseball field near the mouth of the Tualatin a couple of years ago, large boulders, some of which are erratics, were uncovered. On the other hand, up the river a loose, coarse sand and fine gravel may be observed in the road embankments near Field's Bridge. Since this deposit shows bedding planes that are inclined to the northwest it is inferred that it is part of the flood deposit that once completely filled the lower part of the Tualatin Valley, compelling the river to cut its way across and through it. Needless to say much of the sediment came from the scablands that extend from the valley to West Linn.

13. In the northwest part of Peach Cove there is a fairly high cuestalike ridge with a gentle slope to the east and a very steep slope to the river on the west. It is composed in large part of angular materials that evidently were not transported far. A number of erratics of various sizes and kinds are scattered about. The historical implications of this ridge will be discussed in the next section. It is believed the Peach Cove deposit may be continuous with one a mile upstream at the north end of the Canby Ferry. Here the high embankment along the river is composed of fine gravels and sand. This is possibly the last significant deposit made by waters surging up the Willamette.

Impaired Drainage

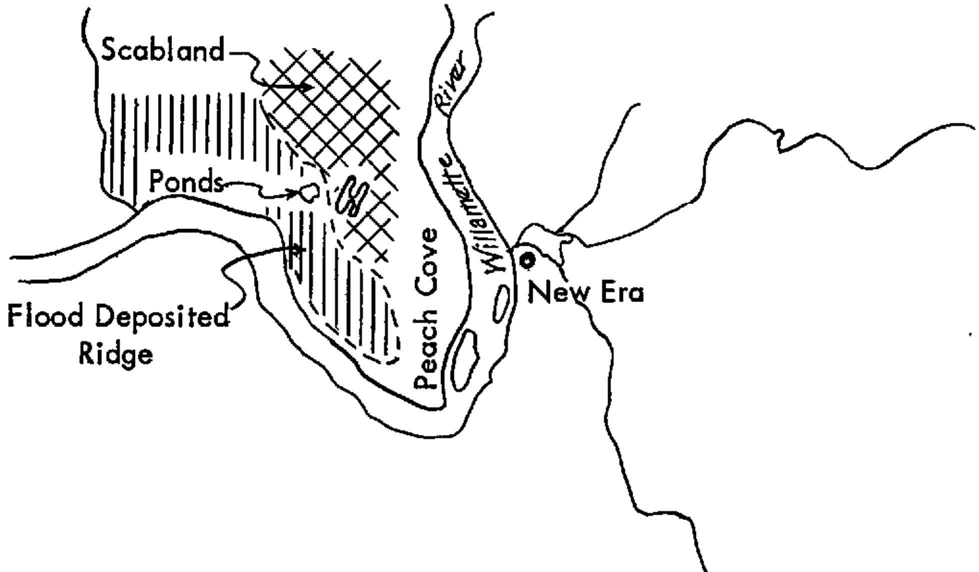
That a flood of such proportions should interfere with the drainage would be expected; however, except in a few instances, convincing proof of change is difficult to obtain. The following are mostly suggestions; additional studies need to be made to settle the various issues. The changes indicated are postulated: (see page 29)



Map 4. Suggested Changes in Drainage as a Consequence of the Flood.

A. Map 3 (below) shows that the Willamette River makes a large U-shaped bend around Peach Cove. In itself this is not particularly significant, but when it is considered relative to other facts known about this area an interesting bit of physiographic history comes to view. The following facts may be enumerated:

a. The existence of the already mentioned scabbed area (Map 3).
b. The cuestalike ridge composed of angular materials and containing erratics.
c. The U-shaped bend of the river around Peach Cove.



Map 3. Flood Features in the Peach Cove Area.

The history, as worked out by Erickson, appears clear. Formerly the Willamette cut across what is now the cove. Flood waters, channeled through the gap south of Oregon City, stripped soil and rocks from the area indicated as scabland on Map 3 and deposited them as a ridge that blocked the river and compelled it to make the large U-shaped detour. The flood-scoured channels, now intermittent ponds, are particularly impressive. At first glance it appears that they represent part of the old river bed, but closer study reveals that toward the north they are separated from the river by higher land. A small round pond west of these and on top of the ridge is probably due to slumping. It resembles kettle lakes the author has seen in glaciated areas of the north central states, and one is tempted to believe that a large iceberg may have become stranded at this point and that deposition around it, followed by melting of the ice, left a depression that subsequently filled with water. A somewhat similar but deeper pond is located in the northwestern part of the town of Tualatin.

B. Lacamas Creek (Map 4 on opposite page) flows in a westerly direction from the Cascade Mountains until it reaches a point a short distance west of Proebstel, where it makes an abrupt turn to the southeast and then flows through the previously mentioned flood-made depression northwest of Lacamas Lake. It is suggested that, before the flood, Lacamas Creek may have flowed in a westerly direction through Burntbridge Creek valley to the Columbia, and that the cutting of the depression by the flood formed a lower outlet for its waters.

C. Johnson Creek, before the flood, may have emptied into the Willamette River several miles north of its present junction. The anomalous nature of its course from Lents Junction to

Milwaukie and the barbed nature of its junction suggest this. It is postulated that its course was altered by the formation of the Fairview-Wichita flood channel.

D. As already mentioned, Tryon Creek was probably dammed by flood debris but did not alter its course. Its present lower course is in a deep canyon cut through sedimentary materials. There is some evidence that in Pre-Boring times Tryon Creek occupied a canyon slightly north of its present one and that its course was altered by a flow of Boring lava.

E. The Tualatin River and Fanno Creek appear to have altered their courses as a consequence of the flood. The following changes are suggested:

a. Prior to the flood the Tualatin River flowed through the Oswego Lake gap. There are several reasons for believing this was the situation. First, the greater thickness of the flood deposits at "d" (75 feet) compared with that at "c" (35 feet) on Map 2 (opposite page 27) may be interpreted as being due to the filling of the old river bed. Moreover near Cook, in a direct line with "d" and Oswego Lake, there are rather deep, swampy depressions, through which railroad embankments have been built, that are believed to represent the old Tualatin River bed, incompletely filled with flood detritus.

b. Flood deposits filled Oswego Creek canyon, the pre-flood outlet of the Tualatin. Evidence of this is the gravelly and bouldery materials found beneath the roots of large trees growing along the side of the canyon near the dam. At the same time sediments were deposited by the flood west of the Oswego Lake gap, filling in the old river bed and forming a high embankment north of Tualatin that effectively blocked the course of the river.

c. The consequence of these events was that the Tualatin River was forced to change its course and flow through an already existing partly structural and partly erosional valley which it still occupies. Erickson believes the Tualatin eroded its present valley first, was diverted and cut the Oswego Lake gap, and was then forced back into its older valley by flood deposits. This may have been the case; however, an alternative theory is possible, namely that the Tualatin originally flowed through the present Oswego district, cut the gap as late and post-Pliocene deformation occurred and was subsequently diverted by the flood into its present valley, which was a syncline occupied by a smaller stream.

d. Fanno Creek, which once joined the Tualatin River near Cook, was forced to detour around the previously mentioned low domes of flood sediment.

e. Saum Creek once joined the Tualatin near the west end of the lake. Saum Creek now has a barbed junction with the Tualatin. Its mouth is directly opposite the beginning of the canal and part of its original bed is now occupied by the canal that feeds water from the Tualatin River into Oswego Lake.

f. After the flood a lake formed in the gap cut by the Tualatin. Fed by small streams the lake would rise high enough in winter to spill over the flood deposit damming it and in time to cut through it, lowering the lake level. Before the present dam was built, the lake, known as Sucker Lake, was about half its present size, the west end being mostly mud flat and swamp. The present outlet occupies only the southern margin of the old mouth of the Tualatin.

A successful theory should be in accord with the known facts; moreover it should be possible to postulate consequences of the theory and to look for and find them. Inasmuch as this has been accomplished, it is now clearly evident that the flood theory, proposed by Bretz, modified by Allison and corroborated by widespread field observations, may be spoken of as an historical fact; and it is likely numerous other anomalies of erosion, deposition, and drainage in the Portland area and elsewhere that were caused by the flood will be discovered. It is to be hoped that eventually the date of the flood may be determined by radio-carbon analysis.

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MARCH FIELD TRIP

Sunday, March 25, 1956 -

Field trip to prospective building site of the Oregon Museum of Science and Industry. Meet at 2:00 p.m. at entrance to the new zoo on Canyon Road - roughly 1 mile west of Vista Bridge. Dr. Samuel Diack, President of Museum, will show us around. We shall take the opportunity also to study the geology of the Portland hills returning by way of Cornell Road.

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