SUPPLEMENTAL FLOW AND SEDIMENT TESTS OF CAPITOL LAKE HYDRAULIC MODEL

1976

COLLEGE OF ENGINEERING
RESEARCH DIVISION

SUPPLEMENTAL FLOW AND SEDIMENT TESTS OF CAPITOL LAKE HYDRAULIC MODEL

for

Department of General Administration
Olympia, Washington

by

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May 26, 1976

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BACKGROUND INFORMATION

The three basins of Capitol Lake act as a sedimentation trap for the Deschutes River. In recent years, the upper basin has rapidly approached its limit as a sedimentation trap, thereby causing increased deposition of coarser materials of sand size in the middle basin. A study of the sediment problem produced the recommendation as one alternative to restore the lake, that the existing islands in the upper basin be combined into one, and a new sedimentation trap dredged behind it.(1) With these changes, the secondary channel tends to fill with sediment early in flood periods. River flow will then be diverted through the trap area behind the new island where most of the coarser material will be deposited.

To increase accessibility of the lake and size of the recreational areas along the shore, it has been proposed by CH_2M-Hill that certain shoreline areas be filled (Fig. 1). To improve circulation in the swimming area in the lower basin, a new island in the lower basin has been proposed.

This report is of the additional hydraulic model tests to determine the effects of proposed shoreline fills and the new island on circulation patterns in the total lake. The specific items tested are:

1. Upper Basin: Test the effects on sediment deposition pattern of a new larger groin upstream of the combined island.
2. Middle Basin:
    a. Confirm the suggested configuration of the large fill in the southwest corner.
    b. Test the effects of the fills in the vicinity of Percival Cove outlet on the circulation pattern.
    c. Test the influence of fills in the vicinity of the upstream side of the railroad bridge.

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(1)"Hydraulic and Water Quality Research Studies of Capitol Lake Sediment and Restoration Problems, Olympia, Washington," by J. F. Orsborn, W. C. Mih, et al., College of Engineering, Washington State University, Sept., 1975, 315 pp.

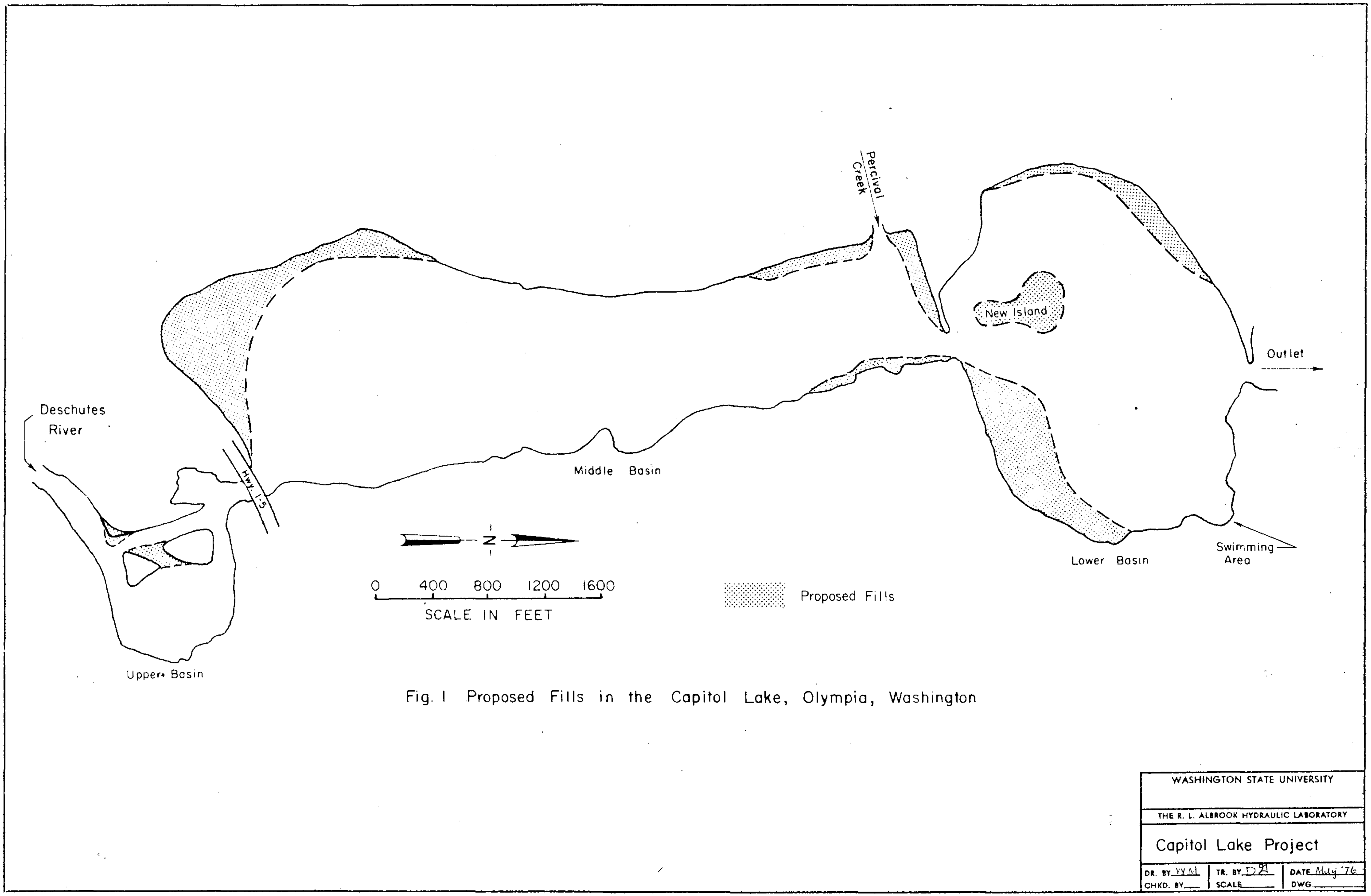

Fig. 1 Proposed Fills in the Capitol Lake, Olympia, Washington

3. Lower Lake:
   a. Test the effects of the new island just northwest of the railroad bridge on circulation patterns.
   b. Test the effects of the fill in the southeast part near the railroad yards on circulation with and without the new island.
   c. Test the effects of the fill on the west side on circulation.

TEST CONDITIONS

A detailed description of the hydraulic model and hydrological information of this lake can be found in the report of the previous comprehensive study.(1) Briefly, the horizontal scale of the model is 1:200 and the vertical scale is 1:20. The time ratio in the model is 1:44.7; therefore, a one-hour run in the model is equivalent to almost two days in the prototype. In the Deschutes River, the flood with one-year recurrence interval is about 3000 cfs, and the 5-year flood is about 5000 cfs. While operating the model at the corresponding flows of 100, 500, 1000, 3000, and 5000 cfs in the prototype, it was observed that the flow circulation patterns are generally the same. Hence, for the purpose of comparing the effects of new fills, most tests are run at 3000 cfs.

SEDIMENT DEPOSITION TESTS

The upper basin of the model was modified with new groin and combined island according to Fig. 1. The river flow was set at 3000 cfs over 6 hours (equivalent to 12 days in the prototype) during which time Delmonte sand was added. Delmonte sand was used also in the previous study.(1) The sediment deposition patterns after the 6-hour run are shown in Fig. 2.

Figure 2 shows that the heavy sediment deposit areas are: (1) near the junction of the Deschutes River and upper basin; (2) at the east side of the combined island; (3) in the secondary channel along the west side of upper basin; and (4) in the middle basin north of Highway I-5 bridge.

The deposition in the secondary channel slowly constricts the channel so that the flow in it is significantly decreased. At the beginning with 3000 cfs in the river, about 25 percent of the flow passed through the secondary channel.

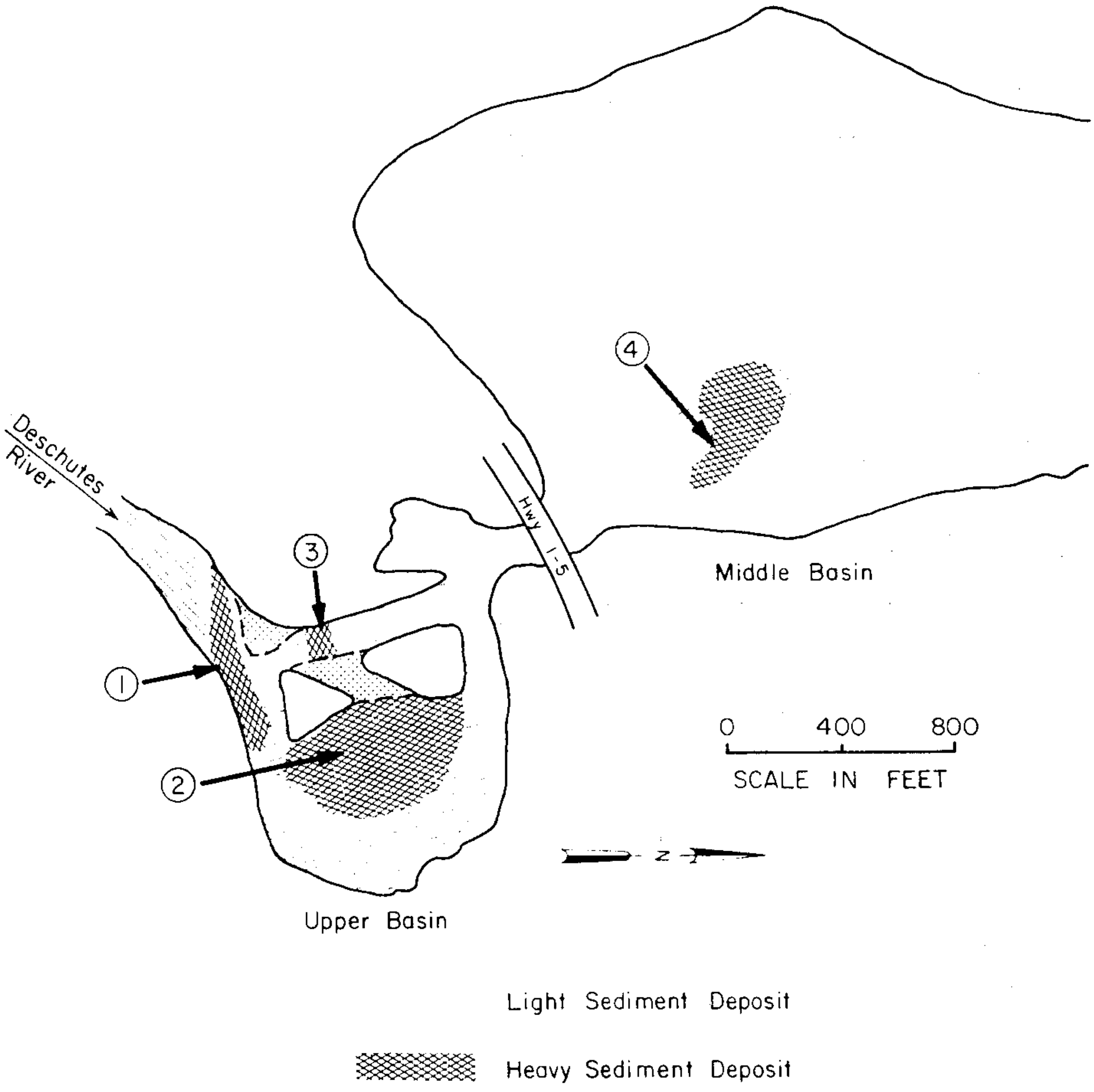

Fig. 2 Sediment Deposition Pattern in the Upper and Middle Basins of Capitol Lake Model (After 6 Hours of 3000 cfs Flow with 0.2% Delmonte Sand)

At the end of two hours with sand being added to the flow, the flow in the secondary channel decreased to 20 percent and at the end of four hours, it decreased to 10 percent of the river flow. At the end of six hours (equivalent to 12 days in the prototype) the flow through the secondary channel was only 3 to 5 percent of the total. The rate of flow decrease in the secondary channel with the new groin is slower than without the new groin.

FLOW PATTERN TESTS

With the lake at present conditions except for the new groin and combined island in the upper basin, the flow pattern was observed and recorded with the aid of dye and small float tracers as shown in Fig. 3. Note the large stagnant area in the southwest corner of the middle basin, and the weak vortex in the swimming area in the lower basin, even at this high flow.

With the new fills and new island in place, the flow pattern was as shown in Fig. 4.

Comparing Figs. 3 and 4, the new island in the lower basin does deflect flow towards the swimming area. The large fill area in the southwest corner of the middle basin eliminates most of the stagnant area and improves the flushing capability of the flow. However, there is still a small stagnant area and a small vortex in front of the large fill which can be eliminated by reducing the north end of the fill as shown in Fig. 5.

The fills near Percival Cove and along the railway in the middle basin also help the circulation at the outlet of Percival Creek. These fills were modified slightly to have a more smooth shoreline as shown in Fig. 5. In Fig. 5, the new island in the lower basin was removed to test the effects of proposed fills without the island. From the flow pattern with the new fills in the lower basin, it appears that the large new fill at the southeast part of the lower basin deflects the flow away from the swimming area. To further improve the circulation near the swimming area, the large southeast fill should be reduced and the new island should be changed to a vane shape for directing more flow to the east toward the swimming area.

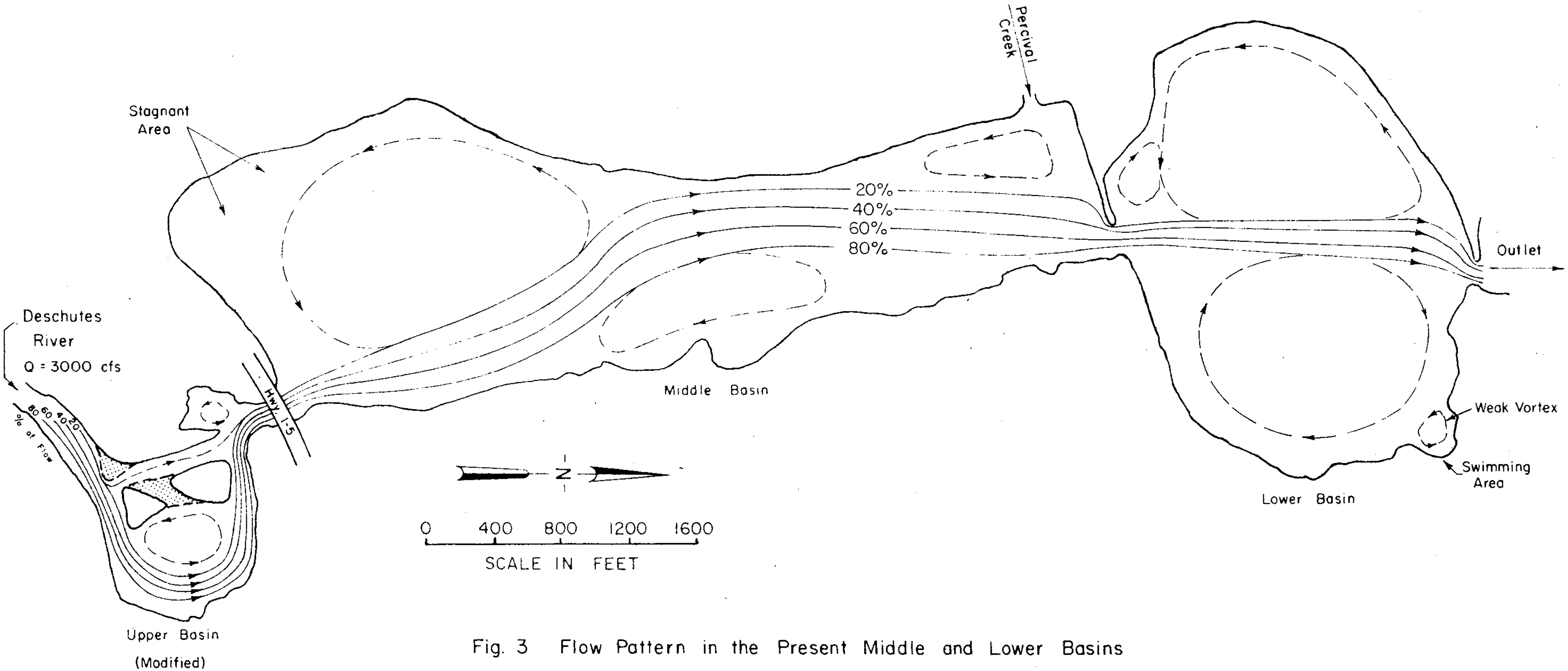

Fig. 3 Flow Pattern in the Present Middle and Lower Basins of Capitol Lake

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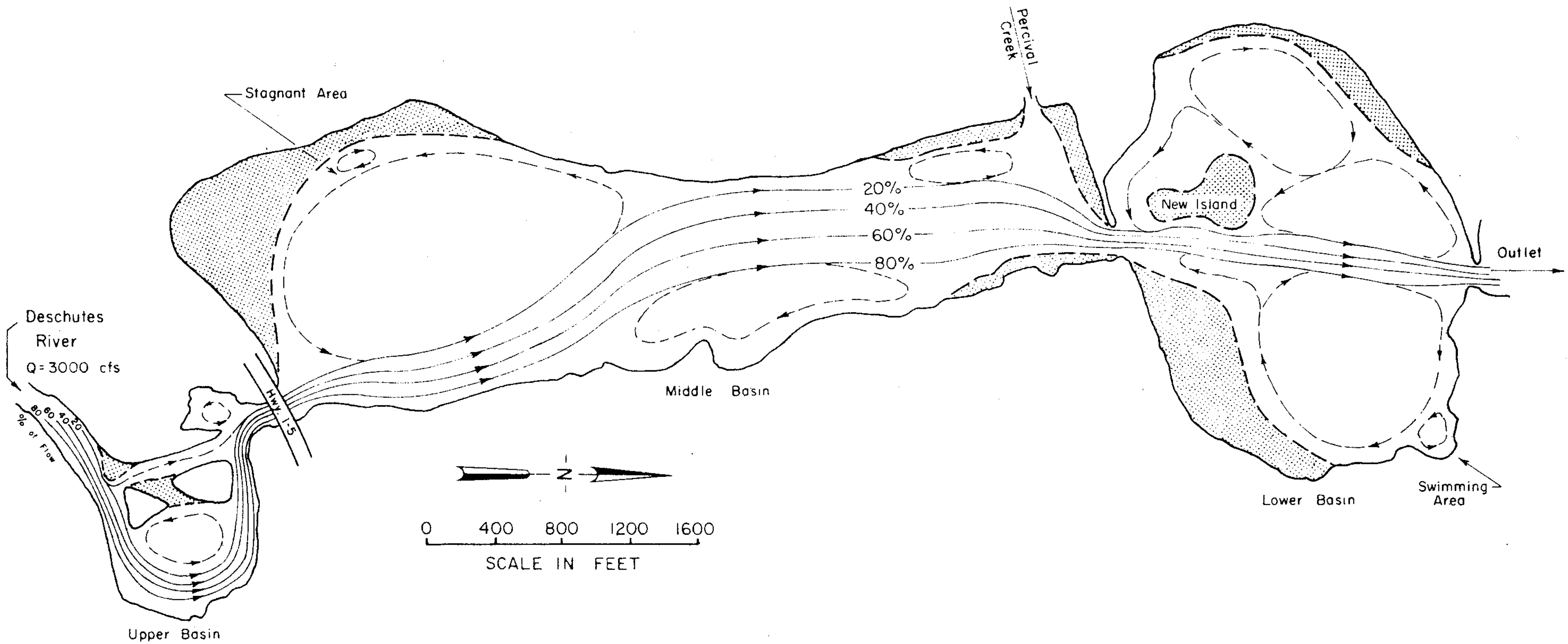

Fig. 4 Flow Pattern with Proposed Fills in Capitol Lake

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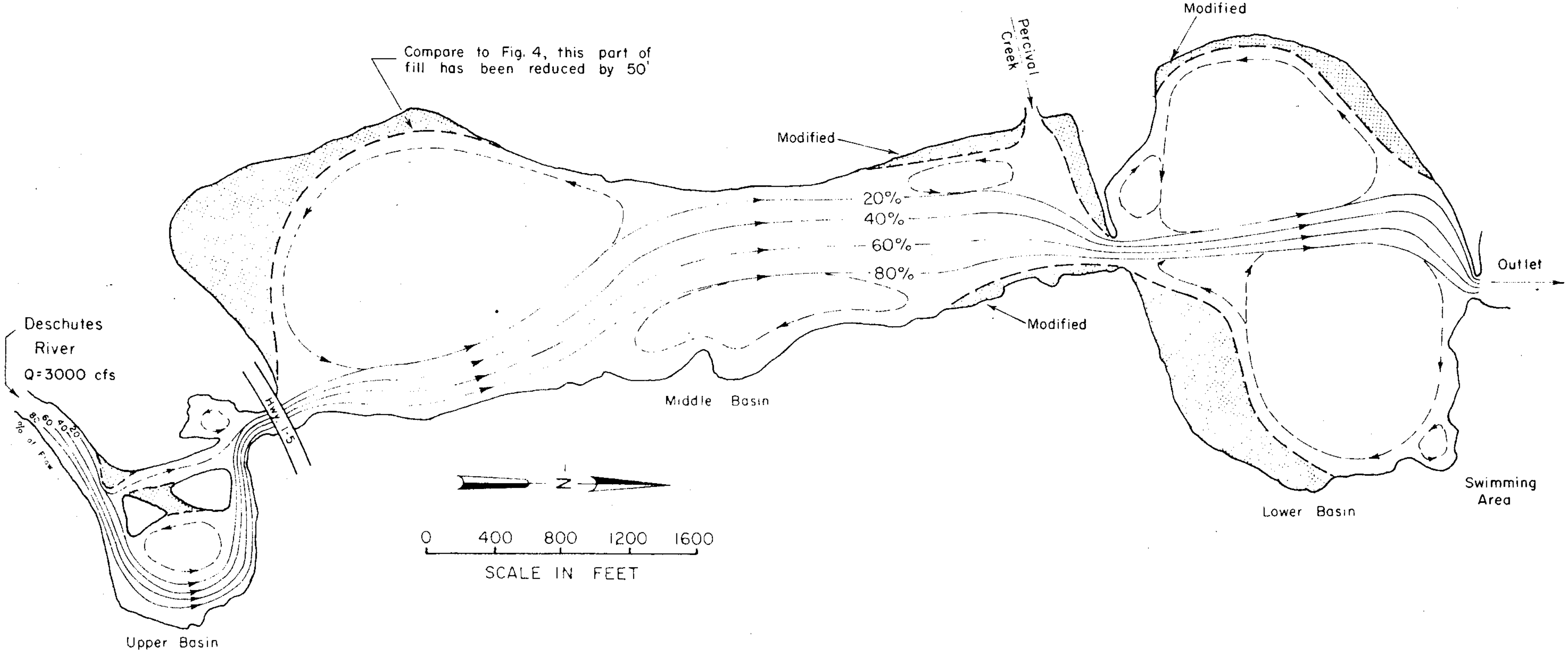

Fig. 5 Flow Pattern with Modified Fills in the Middle Basin and No Island in the Lower Basin

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After six trial arrangements for a new island and fills in the lower basin, the one that has the most circulation at the swimming area is shown in Fig. 6. The detailed location and configuration of the new island area at the normal lake level is shown in Fig. 7.

The flow patterns in the lake with given configurations are the same for high and low flows. However, the velocity at given points in the lake is proportional to the river discharge, hence the flushing ability of the lake varies with the discharge. Thus, the flushing effect will be small during low flow periods, and especially so in the swimming area in the summer. Compared to no island in the lower basin, the new island will improve the flushing action in the swimming area in high and low flows.

Changing the location of the river channel in the lower basin as an alternative means of improving circulation in the swimming area was considered. However, guiding flow with a bottom channel in the lake will not improve circulation since it guides only the slower bottom velocity layer, while higher velocity near the surface is not guided. Also a new deep channel in the lower basin would be difficult to maintain.

SUMMARY OF TEST RESULTS

1. Upper Basin: With the new larger groin and combined island in the upper basin, the secondary channel along the west side of the basin tends to fill with sediment in flood periods. River flow will then be diverted through the sediment trap area behind the combined island. With the new groin in the upper basin, the rate of sediment deposition in the secondary channel is slower than with the smaller original groin.

2. Middle and Lower Basins: To eliminate the stagnant area in the middle basin and to improve circulation in the swimming area in the lower basin, the new fills and new island should be changed to the configuration as shown in Figs. 6 and 7.

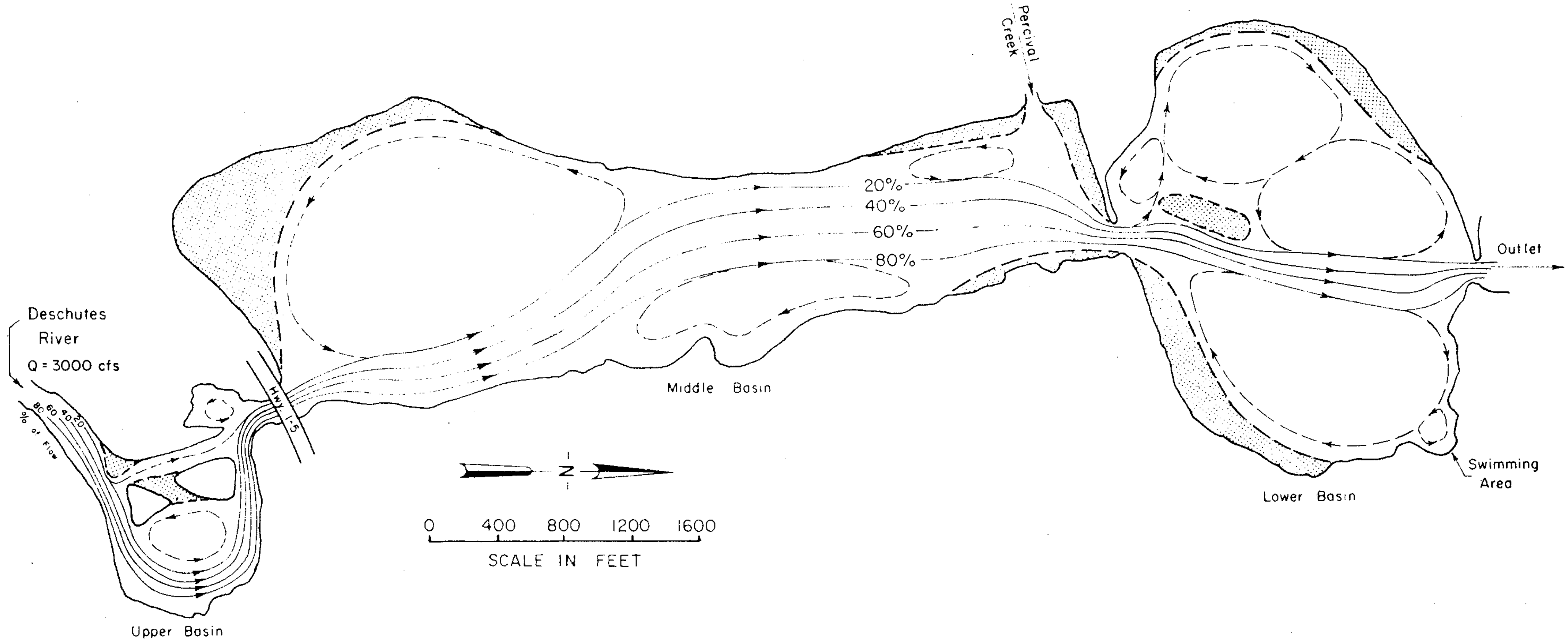

Fig. 6 Flow Pattern with Modified Fills and Island in the Capitol Lake

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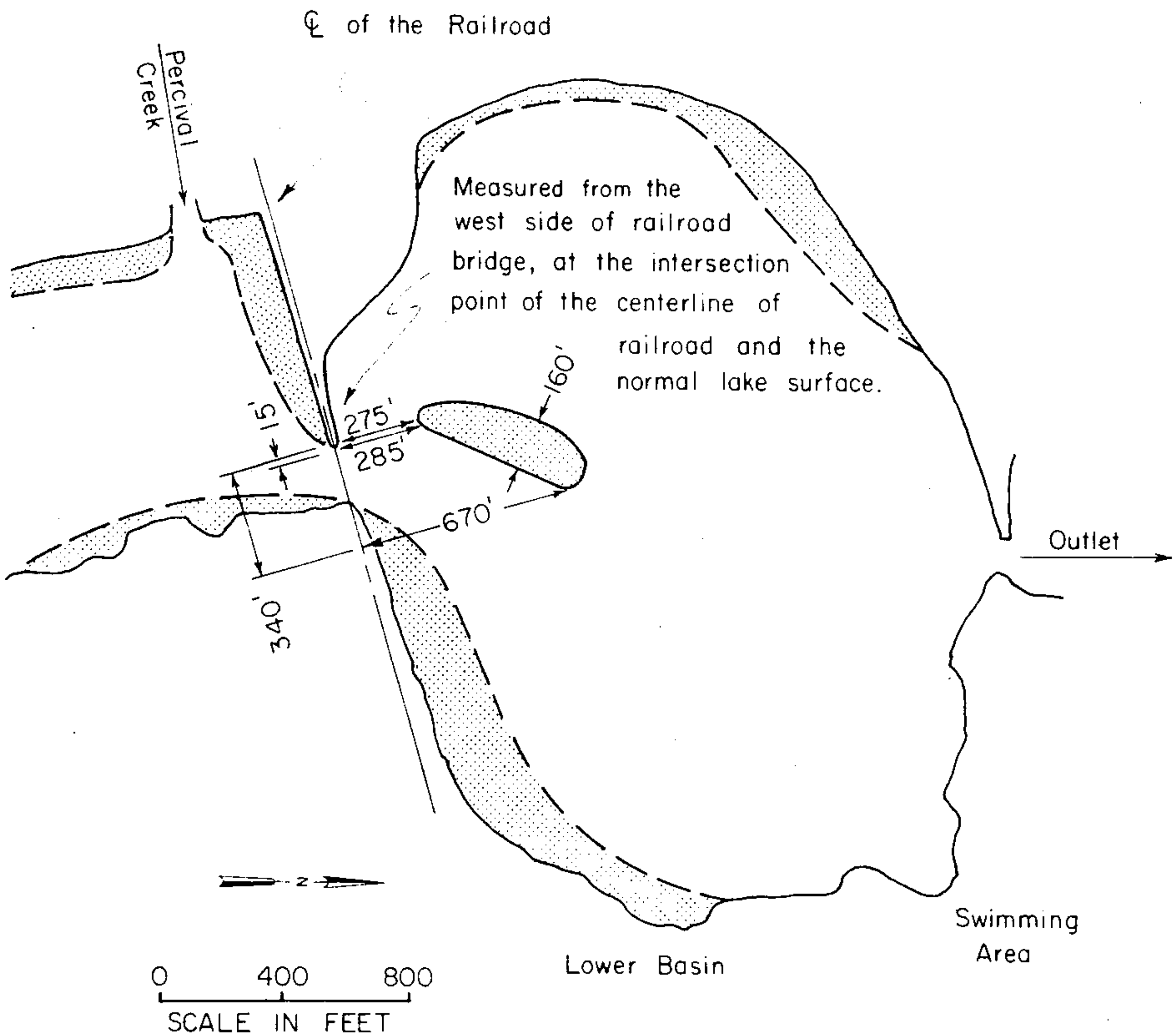

Fig. 7 Details of the Suggested New Island in the Lower Basin of Capitol Lake