The foregoing discussion includes the most pertinent of our thoughts, conclusions, and recommendations regarding helicopter operations at this time. In summary, it could well be stated that it is our feeling that helicopters have made their place in snow surveys and that we would expect this position to expand.

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## HELICOPTERS - FROM THE FIELDMAN'S VIEWPOINT

By

Willard W. Dean[1]/

Travel on foot to isolated mountain snow courses and streamflow measuring stations has largely been made obsolete during the past 20 years by the use of mechanized over-snow vehicles for traveling over snow such as the Tucker Sno-Cat, the M-7, the Frandee Sno-Shu, the Weasel, the snow plane, the motorized toboggan, and others. Planes like the Supercub have been used at some locations where landings on skis are possible. From the fieldman's viewpoint, however, the helicopter is the best mode of over-snow transportation of this kind yet developed.

All of these vehicles have eased the work of the snow surveyor and stream gager. All have helped him to concentrate more on hydrologic data collection and less on the struggle over the snow to the point of measurement. Under the proper conditions the helicopter can now carry the fieldman and his equipment quickly to many stream gaging stations or snow courses with a minimum of effort on his part.

Use of the helicopter does not imply that snow tractors will soon be junked as many trips will continue to be made on the ground. Foot travel will be necessary on ground over which the snow tractor cannot operate or where the helicopter cannot land. In using any form of mechanical transport, the fieldman may some day find that mechanical failure forces him to proceed on foot.

Helicopters have been used in stream gaging from time to time since the late 40's when the Tacoma District of the Geological Survey began using helicopters for transport to snow courses and possibly there was some earlier usage. The Salt Lake City District is using a helicopter to go to remote gaging stations below 10,000 feet in the Wasatch Mountains. This year in California helicopters are being employed for the first time to carry hydrographers to 12 gaging stations operated for several cooperating agencies in the Kern, Kings, Stanislaus, and American River basins.

Helicopters have given very good results to date, and their use has been justified on an economic basis alone. The rather high cost of operation has been equalled by the saving in salary and per diem of personnel and operation costs of the snow tractor. Other gains such as improvement in the fieldman's morale and the better utilization of technical manpower are most important. No longer do hydrographers sometimes struggle in a snow tractor for three or four days to reach one or more gaging stations, and then need an equal amount of time to rest up before they are ready for field work again.

The Menlo Park District has chartered a Bell G-2 model helicopter with a 260 horsepower Lycoming engine. The cost is $100 per hour of flying time. The district guarantees a minimum amount of flying time and no charge is paid for standby time. A charge of 25 to 32 cents per mile each way is paid for moving the ship by trailer from airport to the operating base - the point on a plowed road nearest to the group of gaging stations.

By using Weather Bureau short range forecasts little trouble has been experienced with weather conditions. A tentative day is scheduled for flying and firmed up 24 hours in advance. Good flying weather is essential.

The winter is usually a comparatively slack period for agricultural helicopter work and there

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has been little difficulty finding a ship and pilot available. Particular attention is given to get a pilot with many hours of mountain flying experience. If the pilot is not familiar with our work, a preliminary flight is made over the area.

Landing spots are chosen in advance and natural sites are used as much as possible. Sites are cleared if necessary. An area 100 by 400 feet in timber had to be cleared at one station on the Middle Fork American River, where trees made it necessary to climb from the river immediately after takeoff. Some streams are open enough to allow flight up or downstream after takeoff.

A helicopter obtains maximum efficiency by distributing power between forward motion and lift. Vertical climb is very inefficient at all altitudes and often impossible at high altitudes, because the rotor is operating in disturbed air, obtaining less lift. Upward air currents found on a hill top or exposed point make takeoff easy; unfortunately these spots are not usually found near stream gaging stations.

A few statistics on the operation of a G-2 helicopter are:

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| CAA maximum loaded weight allowable (pounds) | 2,450 |
| Light weight stripped for high altitude work (pounds) | 1,600 |
| Maximum weight possible for gas, pilot, passengers and equipment (pounds). (This must be restricted under certain conditions) | 850 |
| Regular gas tank capacity (gallons). (Five-gallon cans can be carried for extending the range, 1/ within weight restrictions) | 41 |
| Gas consumption (gallons per hour) | 15 |
| Speed about (miles per hour) | 60 |
| Practical operating ceiling about | 10,000 |

1/ A better solution to the range problem is to cache drums of gas at selected locations before winter.

One ship that the Survey and the California Department of Water Resources charter has taken off from the top of Mount Whitney, but with only the pilot. Carrying two passengers, minimum equipment and 20 gallons of gas, a helicopter has taken off from The Tunnel airstrip at 9,000 feet. In more restricted locations or at higher altitudes takeoff with only one passenger is possible.

Stocked emergency shelter cabins have been established near all gaging stations in California where helicopters are used. This implies no lack of faith in the helicopter, but mechanical failure is always possible. The cabins are needed more for operations by helicopter than by snow tractors, even though the cabin may never be used. Only minimum survival equipment is carried in the helicopter because the extra weight limits the performance, whereas the snow tractor is usually stocked like a country store. Experience has already backed up this decision on cabins at Monache Meadows last January, where spark plug electrodes iced over at 10 degrees below zero and the battery gave out. Many of you read the resulting adverse publicity about the "rescue".

In conclusion, the use of helicopters appears to be an important improvement in field work at remote gaging stations and snow courses. It would appear that those responsible for conducting this work should explore the possibility of using helicopters.