the quantity discharged and the available head, but also by the channel conditions; because, for a given quantity of water flowing and a given head or elevation of hydraulic gradient, there are two possible surface-water levels which we will call alternative stages. The upper stage is the normal level in an ordinary stream, and for very low velocities is practically coincident with the hydraulic gradient. The lower stage is that ordinarily taken by water discharged at high velocity from an orifice or below a spillway dam. This is the more unstable of the two levels, due to the friction of high velocity on the channel bed. In other words, it can be shown that in any open channel, except at controlling sections such as just referred to, there is, in addition to the existing water level, another level at which the same quantity of water might be flowing with equal steadiness and under the same head or elevation of hydraulic gradient.

As these two definite alternative stages are the only possible ones under the existing head for smooth undisturbed flow, the stream must stand at one of these two levels, that is, water flowing in a smooth channel of uniform section must continue to flow at its existing stage, whichever one that happens to be, until, either due to a change in the channel bed or after sufficient loss of head in friction, it encounters a controlling section where the two alternative stages merge into one, and the depth is two-thirds of the total head. Below this controlling section the two possible stages again separate. At such a point as this the water level may change, without disturbance or interruption of the steady flow, from upper to lower stage, or from lower to upper stage, or may continue at the same stage. For example, the water behind a spillway dam is approaching at the upper stage and just below the dam it flows away at the lower stage, the change occurring smoothly over the dam where the two stages were merged into one. On the other hand, if the dam is submerged by back-water almost as high as the up-stream pool, the surface may simply dip down locally at the dam where the depth is two-thirds of the head. In this case the upper alternative stage is maintained throughout, below as well as above the dam. It can also be shown that under certain circumstances the flow over a dam may theoretically be reversed, the dam facing down stream, and the water apparently running up hill—simply a case of passing from the lower to the upper stage smoothly, over a gradual controlling section where the depth is equal to two-thirds of the head.

In such phenomena the presence of the controlling section tends to eliminate any disturbance in passing from one level to the other, so that the existence of the two alternative stages is not noticed; but water flowing at the lower high-velocity stage and suddenly encountering obstructions which tend to destroy its velocity may rise suddenly, and with considerable disturbance and eddying, to the more stable upper low-velocity stage, and this phenomenon is the so-called "hydraulic jump," occasionally observed in open channels, and a common occurrence below spillway dams. It is merely the passing between the two alternative stages.

In this phenomenon the only energy loss is that due to the accompanying disturbance and eddying, the jump proper merely transferring kinetic into potential energy. Ordinarily, however, this hydraulic jump occurring below a spillway dam is accompanied by such violent disturbance and eddying that the total surplus energy in the water may be destroyed in this way. The jump proper, or the passing from lower to upper stage, does not involve energy losses, except incidentally, and it is doubtful if the ordinary formula for loss by "sudden expansion" applies in this case.

The author proceeds to establish a mathematical basis for the above conclusions, as indicated in the relation between depth, head and discharge, and maximum discharge at controlling section. He gives numerous examples of the two "alternative stages" and of the hydraulic jump. The destructive high velocity below spillway dams is also considered. He points out that the destructive energy due to the drop over a spillway dam is a definite, fixed quantity, regardless of the presence or absence of any hydraulic jump. The only destruction of this energy (conversion into heat) in the hydraulic jump is that due to the accompanying eddies and disturbances, and is measured by the drop in hydraulic gradient. If this drop is large, as over a high spillway dam, the disturbance is equally large, and unavoidable. The Bassano dam of the Canadian Pacific Railway Irrigation Project, is equipped, after the recommendation of Mr. John R. Freeman, with two staggered rows of "baffle-piers," shaped like snow-plows, pointed up stream, and designed to split up the high-velocity sheet of water before it can strike the bed of the stream, and throw one jet against another* so that the energy will be absorbed as much as possible by eddies within the body of the down-stream pool, and not by tearing the foundations. These baffle-piers, backed up by a water-cushion, give assurance that the jump will start at the toe of the dam. They themselves are not designed to destroy the energy by impact, but merely to start the necessary eddies, which act in the water-cushion below the baffle-piers and complete the hydraulic jump.

The paper calls attention to the existence of the two alternative stages in open-channel flow, and to their practical importance, in many cases, when the flow is at high velocity; it is also intended to identify the hydraulic jump as the passage from the lower to the upper stage. Below a spillway dam, it often happens that these two stages are so far apart that the jump cannot occur between them, until a considerable distance down stream and after enough energy has been destroyed in friction to bring the two stages near together.

*See page 423, *The Canadian Engineer*, for September 30, 1915.

NEW UNIVERSITY BUILDING, EDMONTON.

An important and singularly artistic unit has been added to the buildings of the Alberta University in Edmonton by the completion of the main administrative block. This building, officially declared open on Wednesday, October 6th, 1915, is to be devoted entirely to teaching and administration. The structure is a three-story one, built of brick, elaborately adorned with classical trimmings of Indiana limestone. It was designed by Messrs. Nobbs and Hyde, architects, Montreal, and was erected by Messrs. George W. Fuller and Co., Limited, of New York and Winnipeg, the cost being slightly over $600,000. Mr. Cecil Scott Burgess, A.R.I.B.A., Professor of Architecture in the university, acted as resident architect.

The university campus covers 258 acres, with a frontage on the River Saskatchewan of 2,100 feet, and an elevation above the river valley of 200 feet. A complete plan has been developed for its beautification, and for the arrangement upon a definite system of all future university buildings. This scheme is the work of several eminent Canadian architects and designers.