section has thereby sustained will probably never be known, but unquestionably run annually into millions of dollars.

It is of higher importance than ever before that a reasonable duty of water be established, and that those responsible for irrigation projects, by the education of the farmers as well as by the enforcement of reasonable rules, see to it that such duty is observed. At present, the duty of water assigned by the State Engineers is seldom as low as 30 acre-inches; usually, much higher. It will be a living question, in view of what we are learning concerning the relation between water and crops, whether even 30 acre-inches shall be allowed for one acre of land when it might be made to accomplish so much more if spread over a larger area.

Spreading 30 acre-inches of water over four instead of one acre, the increase in yield for wheat, corn, sugar beets and potatoes was threefold; for alfalfa even more, and for timothy twofold. Increasing foodstuffs in this manner, two and threefold, simply means that from two to three times as many human beings may be maintained upon the irrigated area; and every lover of the West dreams of the day when populous commonwealths shall cover the "Great American Desert." Irrigation is for the many, not for the few.

Table No. 3.—The Crop-producing Power of 30 Acre-inches When Applied to Different Areas of Land

	Thirty acre-inches spread over.			
Crop.	1 acre.	2 acres.	3 acres.	4 acres.
Wheat (bush. of grain)..	48	91	132	166
Corn (bush. of grain)...	97	188	269	317
Wheat (pounds of straw)	4,533	7,908	10,356	13,204
Corn (pounds of stover).	10,390	16,558	18,021	28,756
Timothy (pounds of hay)	6,054	7,688	11,739	11,928
Alfalfa (pounds of hay)..	8,840	15,093	29,653	....
Sugar beets (tons)	21	39	56	65
Potatoes (bushels)	195	373	456	544

By a more intelligent use of the waters already impounded or diverted the irrigated area may be increased largely, perhaps doubled. It is certainly a subject worthy of consideration. True, under the new projects, not yet well settled, there is no scarcity of water; yet in developing the West by irrigation should not the growth be symmetrical? We hope that no completed project will long remain without settlers; should we not be equally anxious that every new settler, from the beginning, use water the right way? In our older sections, water already is scarce; methods for increasing the duty are sought after; in time the newer sections will be in the same condition. Let us learn good habits in our youth, so that we shall have less to unlearn in our maturity.

FORESTERS IN DEMAND.

We note in the Conservation Publication for February an article which we publish herewith. It should be of importance to all those choosing future work and occupation.

The remarkable expansion of forestry work in Canada during the past year is evidenced by the fact that all the men who will finish forestry courses next spring at the University of Toronto were offered employment months in advance of their graduation. If the class were several times as large there would still be no difficulty in finding employment in Canada. The organization of the new Forests' Branch in the Department of Lands of British Columbia and the natural growth of work in the Dominion Forestry Branch, Department of the Interior, are largely responsible for this situation. At the present time the supply of Canadian foresters is far below the demand and this condition will continue for several years at least.

SOME FEATURES OF MACADAM CONSTRUCTION.*

By T. R. Agg.†

Inasmuch as water bound macadam has been written about and discussed so frequently, it would seem that there would be little need to consider it at a time like this. Nevertheless, it is not uncommon to see water bound roads under construction where little attempt is being made to observe the simple and well-known principles of such construction, and that is perhaps sufficient reason for some discussion of those principles at this time.

The well-known characteristics of a properly constructed water bound macadam road are: A well-drained, carefully shaped and thoroughly compacted subgrade; properly shaped side roads and ditches to insure the removal of surface water, and a layer of thoroughly compacted, properly bonded crushed stone, the surface of which has been well keyed together by rolling so that it presents a compact mass of stone of sufficient size to bear the loads that will pass over it without crushing and in which the stones are mechanically locked together by rolling and held in place by means of the dust from the crushed stone which has been worked into the interstices between the stones by means of water and rolling.

In deciding upon the size of the pieces of stone to be used for the upper layer of the water bound macadam road, two things must be taken into consideration—the quality of the stone which is available for use, and the amount of traffic and the weight and character of the loads which will pass over that surface. A road surface carrying a medium or light traffic, of which a small percentage consists of motor-driven vehicles, can obviously be made of smaller sized pieces of stone than a road surface carrying traffic made up of a great many heavily loaded horse-drawn vehicles, together with a large number of motor vehicles.

If the pieces of stone in the surface of the road are so small that the wheels passing over them crush them, it is inevitable that rapid wear will result and that the road will deteriorate quickly. On the other hand, if the surface of the road is made of very large pieces of stone, the traffic will not crush them, nor even wear them with sufficient rapidity to supply fine material to fill the interstices between the stones and keep the voids filled, notwithstanding the action of the elements and traffic. In such a case, the road will become rough and uneven, the surface being made up of rounded stones, which project slightly and make it disagreeable to traffic.

If the road carries any considerable proportion of motor vehicles, the water bound macadam does not prove satisfactory, but a surface made up of fairly large pieces of stone will withstand the action of motor traffic better than one made up of small stones, though the former is less desirable from the standpoint of the user on account of its roughness.

Somewhere between these two extremes, lies the ideal size of stone to use, which is a size sufficiently large to sustain the loads that pass over the road, without breaking, but small enough so that the wear on the surface will furnish sufficient fine material to keep the voids between the stones filled with dust and chips, thereby maintaining a smooth surface.

In the work of the Illinois Highway Commission, it has been found that with the soft limestone available, the size ranging from 2½ ins. to ¾ in., is most satisfactory. When stone of such a size is used it is, of course, desirable to have

* From a paper read before ninth annual convention of American Road Builders' Association, held at Cincinnati, December, 1912.

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