lakes of considerable size have become greatly diminished, owing to evaporation and the clearing up of the country.

Surveys under the Dominion Observatory, Dr. King director, have assigned to them a number of field officers in various parts of the Dominion. Six officers are now engaged in precise levelling operations. These are Messrs. N. H. Smith in Alberta; D. McMillan in British Columbia; A. J. Rainboth in North-Western Ontario; H. P. Moulton in Central Ontario; G. F. Dalton in New Brunswick, and J. J. Dalton, D.T.S., who is conducting a boundary survey to the east of Rainy Lake on the Ontario-Minnesota boundary.

The British Columbia-Alberta boundary survey and the International boundary survey are also at work.

## COST PER FOOT OF WATER MAINS.

HE following table of comparative costs of water pipe of different diameters is from a paper by Nicholas S. Hill, Jr., newly elected president of The American Water Works Association. It is pointed out that in planning a pipe distribution system the engineer must decide upon the future period for which the improvements are to serve without duplication or enlargement. This period will bear no relation to the useful life of cast iron pipe, which depends largely on the service for which it is used and may exceed 100 years. It would be impossible to predict the amount or direction of a city's growth for so long a period as 100 years with any degree of certainty. It is possible, however, to predict with sufficient accuracy, both the extent and distribution of population growth, upon which the future demand for water will in great measure depend, for a period of 20 to 30 years to come.

The reasons for predicating estimates on results which are expected to obtain so far in the future are not that one can undertake to forecast the future with mathematical exactness even for this limited period, but rather because it is the safest and most rational way in which to make reasonable provision for future needs.

Failure to make such provision frequently results in a high capital investment in mains. It is cheaper to lay a main which is too large for present needs than to lay one which must be reinforced within a few years. To show the expense which a company or city incurs by pursuing such a policy, Mr. Hill presents Table I., which shows the comparative cost of different pipe sizes to give the same service.

The costs given in the table do not and, of course, cannot take into consideration the damage to improved streets, and the additional cost of maintaining them, which results from continual tearing up, nor can they take into account the inconvenience, annoyance and the disturbance of traffic which results from repeated removal of the street surface. They further do not include the additional cost of repairs due to the increased main mileage which results from duplication of mains and the increased liability of having to excavate for repairs, nor any consideration of the enhanced pumping costs ensuing from greater main leakage resulting from an increase in the number of pipe The table clearly shows that even where the joints. period of usefulness of the first main laid is 18 out of 26 years, the saving in favor of two mains in most cases is not sufficient to offset the other losses incurred.

	or of plan ediate in- arger pipe.	.l aslo	t of cost of t	In per cen	(11)	= (16) ÷(12)	-2.9 -11.7	14.9 2.7 6.7	25.7 12.9 2.0	
	Saving in fav 1,the imm stallation of 1	· foot.	ag saslod r	ıi tanomA	(16)	=(15) -(12)	\$ 0.43 0.14 0.57	0.38 0.07 -0.17	0.26 0.13 0.02	
	[		Total		(15)	=(13) +(14)	5 29 4.72 4.29	2.93 2.62 2.38	1.27 1.14 1.03	
B SIZES TO GIVE THE SAME SERVICE	annual cost lan 2. 	l annua ond pip (I when cent.	alue of tota foot of seco in Col. (1 sed at 5 per	Present v cost per ss givei sikriik	(14)	reduced to present	\$ 2.26 1.69 1.26	1.25 0.94 0.70	$\begin{array}{c} 0.54 \\ 0.41 \\ 0.30 \end{array}$	
	-Capitalized	foot o in Col	ual cost per e as given teniseaster	Total ann gig tarfi gigs)(11)	(13)	=(11) ÷.05	\$ 3.03 3.03 3.03	1.68 1.68 1.68	0.73 0.73 0.73	
	Plan 1.	foot as besilsti	ial cost per Col. (8) cap cent.	fotal anni given in at 5 per	(12)	=(8) ÷.05	\$ 4.86 4.86 4.86	2 55 2.55 2.55	1.01 1.01 1.01	
	tingle nine of	ollowed after in Col. (5) by of same size.	ısl cost per e pipe.	unns Istol no to toot	(11)	=(9) +(10)	cts. 15.14 15.14 15.14 15.14	8, 39 8, 39 8, 39	3.64 3.64 3.64	
<b>r</b> water pif	lowing plans. Plan 2.	col. (2) to be f period given	equired to capital in- capital in- st end for fe at 4 per	amortize smortize vestment cent. cent.	₹ (10)	=(4) ×.00274	cts. 0.79 0.79 0.79	0.44 0.44 0.44	0.19 0.19 0.19	
R DIFFEREN	foot under fol	size given in expiration of installation o	initial cost per 5 per	nterest on of one pi cent.	e 1	=(4) ×.05	cts. 14.35 14.35 14.35	7.95 7.95 7.95	3.45 3.45 3.45	· · · · · · · · · · · · · · · · · · ·
OMPARATIVE COST PER FOOT FOI	nual costs per	te installation of single size given in Col. (1).	Al cost per	otsi annu foot.	L (8)	=(6) +(7)	cts. 24.31 24.31 24.31	12.76 12.76 12.76	5.06 5.06 5.06	10-hour day.
	- Relative an Plan 1.		equived to ri latique ri latique ric at 4 per	annuity re amortize vestment 00 year lif cent.	(2)	=(3) × .00274	cts. 1.26 1.26	0.66 0.66 0.66	0.26 0.26 0.26	r at \$1.75 per
		Immedia pipe of	initialcoat cent.	no terest on 194 ov ter	11 (g	= (3) × .05	cts. 23 05 23.05 23.05	12.10 12.10 12.10	4.80 4.80 4.80	ing with labo
TABLE I. C	ring 1919	ars du f diam uffice.	amber of ye ingle <b>pip</b> e o s lliw (2) ,lo <sup>(2</sup>	na bəmuzə s s dəidw O ni nəviş	A (5)	2	6 12 18	6 12 18	6 12 18	medium digg
		nəvig 1	of diamete	eqiq elga in Col. (2).	is (V)	ē	2.87 2.87	1.59	0.69	325 per ton in
		nəviğ 1	of diamete	ngle pipe in Col. (I).	is (e)	10	\$ 4.61	2.42	0.96	C pipe, at \$
	299 28 25 .(	aller p service Col. (1	me to szie t smse svig o ni stizoqqo s	required t required t dig signis	N	(2)	2.05-18	2.05-12	2.05.6	ial cost, Class
	sts.	of 26 ye	piperequire for period	ameterof the service	Di	8	ins. 24	91	00	*Init