

108 ft., the guiding speed of the star image at the focal plane is one three-hundredth inch per second.

The engineering and mechanical problems involved in designing and constructing a telescope of such proportions and accuracy are apparent only when an appreciation is had of the fineness of astronomical work. Accuracy in astronomy is illustrated by the study which accounts for the motion of the perigee of the moon within 1-300,000 per cent. Also by the fact that astronomers are searching for the cause of a monthly change of less than 1-1,000 of a second in the length of the month.

SARNIA, ONT., SEWAGE DISPOSAL.*

THE city of Sarnia, Ontario, is situated on the St. Clair River, practically at its source. It is opposite the central portion of Port Huron, and is separated from the shore of Lake Huron by the small village of Point Edward. It is connected with the east and west by the Grand Trunk and Pere Marquette railroads, and possesses a fair amount of industrial development, including important oil refineries and brass works.

The city is somewhat more rugged in contour than many of the cities on the Michigan side, with fairly high ground in the southern part and to the south thereof, outside of the city limits.

Most of the existing sewers which discharge near normal river stages have their outlets fairly close together, and a relatively short distance from a vacant tract of land near Devine St., which is suitable in size and location for a treatment plant.

The population was 6,700 in 1891, 8,200 in 1911, and is estimated at about 11,500 for 1915. This indicates a good, healthy growth, and there is no reason to believe that it will not be continued, or even increased, in case the Ontario oil fields should become of increasing importance in the future. It seems entirely possible that the population will reach 25,000 within the next 25 or 35 years.

The water records, after making allowance for railroad use, indicate a daily per capita consumption of about 350 United States gallons. According to the waterworks superintendent, there is a very great waste through leaky mains and fixtures and continuously running closets and faucets. In fact, the consumption was at one time cut down by careful inspection to about 175 United States gallons per capita daily. It seems reasonable, therefore, to presume that the consumption may again be reduced, and for the purpose of this study it has been assumed that the daily per capita consumption will be limited to 180 United States gallons, of which 80 per cent., or 144 United States gallons, has been considered as the sewage contribution. An additional allowance of 1,500 gallons per acre for ground water has also been made.

The existing system of combined sewers is so constructed that they are quite shallow at Russell St., making it impossible for them to collect sanitary sewage much above that street. At some future time, therefore, an interceptor will be required in order that the area to the east may be properly sewered. This interceptor should be built in or near Mackenzie St., and should be

designed to carry sanitary sewage only. The storm water from this area and the rural district, which drains through the city, should be taken care of by a storm-water sewer in Confederation St.

The interceptors, which have been designed to serve the present sewerage system, and the above proposed future interceptor as well, on the basis of the increased population previously mentioned, are two in number. The main one begins at Cromwell St. and follows Front and Christina Sts. to Devine St., where it is joined by the smaller one, which follows Christina St. from Clifford St. From the junction point the course is along Devine St. to the railroad tracks, where it turns south and proceeds to the pumping station located at the proposed treatment plant.

As an alternative plan the treatment plant might be located at a point farther downstream, near where the Grand Trunk tunnel passes under the St. Clair River. This location would call for a somewhat greater first cost and a greater pumping lift.

It should be observed that no ground level or sewer level data was obtainable at Sarnia, and that consequently the cost estimates presented herewith are necessarily very approximate. Indeed, the entire study should be considered as incomplete for the same reason. The interceptor is designed for 25,000 persons and based on an assumed average cut of 20 feet for the interceptor and an assumed pumping lift of 20 feet.

Cost of Disposal Plant for Sarnia, Ont., 16,000 Population.

Item.	Unit price.	Cost.	Total cost.
3,000 feet of 10 and 12-inch sewer	*\$ 2.30	\$13,800	
3,200 feet of 24, 30 and 36-inch sewer	*8.00	25,600	
850 feet of outfall sewer	*11.00	9,350	
Appurtenances		1,000	
			\$49,750
Pumping station:			
Buildings		\$ 4,500	
Machinery		3,800	
			8,300
Treatment plant, including Imhoff tanks, sludge beds, grit chambers, and disinfection apparatus	†\$ 2.45		\$30,200
Land			3,000
Total			\$100,250

*Per foot. †Per capita.

The total of the annual charge which results from the estimate given above, and the cost of operation, is estimated at \$6,000 per annum.

*From report of H. C. McRae, district engineer, to Prof. Phelps, consulting sanitary engineer to the International Joint Commission.

Allen Hazen, in his presidential address to the New England Waterworks Association, urged that "dead-heads" be abolished in connection with city waterworks, stating that the dead-head takers are in general those who waste the most water and those whom it costs the most to take care of. He suggests that fire departments and all other users be billed for the cost of the water used by them, this charge to be transferred in turn, in the form of a fire tax, to the buildings protected by the department, the tax being properly adjusted in proportion to the hazard.