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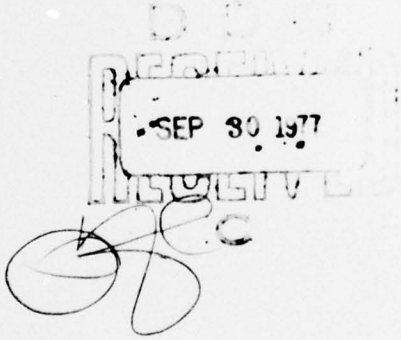
J. Wierzbicki



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The sewage from Ostrow Wielkopolski has been purified since 1911 by agricultural use on irrigated fields about 4km from the city, located near the village of Jelitow. This report discusses the method of sewage purification that they use.

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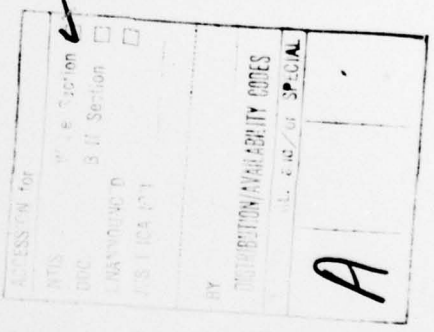

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SEWAGE FARMING AT OSTROW WIELKOPOLSKI

(Pola nawadniane m. Ostrowia Wkpl.)

Jan Wierzbicki, Dr. Eng.

The sewage from Ostrow Wielkopolski has been purified since 1911 by agricultural use on irrigated fields about 4 km from the city, located near the village of Jelitow.

A city of 35,000, the city has a distribution sewage system and the main discharge of sewage amounts to nearly 100 l/d per person. Only a small part of the waste water enters the sewage system: this is sewage (industrial) flowing from a few yards away through storm drain gratings. In addition water saturated with raw gas from the town gas plant is appropriately discharged into the sewage system. This amount of water is only a small fraction of the total sewage. Finally, waste water originating in a few wells, in addition to the town waterworks, and ground water that infiltrates the sewage conduits, flows into the sewers.

Of the total annual amount of sewage of about 1.17 million m^3, water discharged by the town waterworks constitutes 73% (0.85 million m^3, the yearly average). The rest (27%) is waste water, ground water, water from private wells and water saturated with gas, as was stated above.

A sewage pumping station built at the lowest point in the town receives all of the water. The average amount is 3,200 m^3/day. The water enters a tank that holds approximately 500 m^3. Before reaching the tank, the water is purified by a mechanical rotary sieve 4.0 m in diameter. Piston pumps, one with an electrical drive and the other with gas suction, force the sewage to the highest point of irrigated fields (135 m above sea level) through a circuit 400 mm in diameter and 4.0 km long. The pressurehead must overcome a height gradient of about 9 m and a pressure loss equal to about 16 m due to frictional resistance in the conduit. This loss depends on the throughflow intensity, whether one pump is working (40 l/sec) or two.

The sewage is conducted to the fields at 2 points, to small clarification tanks (about 10 X 10 m), and is then distributed to individual parcels. The original outlets on the ground, regular trenches with a slope inclination of 1:1, proved to be impractical because of the rank growth of weeds, bottom silting and the high costs of annual maintenance. The concrete channels (cement to aggregate ratio 1:5), made in 1 m segments (Figure 2) were introduced in 1922 and have proven to be very practical in use: they are easy to maintain in an efficient condition, are durable (after 20 some years of use they do not show much wear), have a small surface (top width is 0.45 m) even at 80% capacity flow rate (80 l/sec) that reaches the fields.

The total area of the irrigated fields is 42.3 ha, including 32.5 ha of meadow. The meadow is located on 96 plots with a mean surface of 0.34 ha (from 0.22 to 0.38 ha). The area of the individual plots was artificially limited: surrounded by dikes and containing a terraced portion inclined for the requirements of hillside flow irrigation. The amount of a single irrigation is about 250 mm. The meadows are irrigated at least 4 times. The amount of irrigation depends on local conditions, and here the permeability of the soil, the kinds of grass and the type of weather have a decisive effect. The

average amount of irrigation during the year is 2.0 m. The fields are irrigated in the Winter (9.8 ha), and the excess water can be diverted to a nearby town forest, which is rarely used.

The deep sandy soil of the irrigated fields is not very fertile. Only in the eastern part of the fields does clay occur in the soil. A typical soil sample taken from the edge of the road (original soil), with one from the central plots of the meadow, has the following composition:[1]

Particles with an average particle size less than 0.002 mm 2%

" " " " " " " " 0.002 - 0.05 mm 3%

Particles with an average particle size less than 0.005 - 0.1 mm . . 8%

" " " " " " " " 0.1 - 0.5 mm (fine sand) 81%

Particles with an average particle size less than 0.5 - 1.0 mm (average sand) 5%

Particles with an average particle size less than 1.0 - 2.0 mm (coarse sand) 1%

The Ostrow Irrigated Fields were drained without regard to the permeability of the soil. The individual conduits are 12 - 125 m long, chiefly about 50 m. The drains are spaced 8 to 9 m apart. Drainage depth is 1.20 - 1.40 m; the drain average is 5 cm, and the collection drains average 7.5 cm. Ceramic pipes 1 m long and 10 cm in diameter were used as outlets, set directly into the turf slopes of the effluent trenches. Figure 4 shows part of the drain system in the eastern part of the fields.

The drained water is directed toward the effluent pipes, designated on the map by arrows, continuing from there to the Olobok Stream, which flows into the Prosna River 20 km below Ostrow, as a left-bank tributary. The watershed of the stream at the point of drainage is only 76 km^2, but thanks to the good purification on the irrigated fields and to the small amounts of this water, not even the smallest degree of water contamination has been found in the stream up to now. As was already mentioned, drain run-off is not very large because of the high permeability of the soil and the transpiration of the verdant irrigated vegetation.

The best conditions for growing grasses irrigated by the sewage exist in the central and western parts, where deep and infertile sand occurs. The low permeability of the clay soil on the plots in the eastern part is the reason for the relatively poor yield.

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[1] Analysis made in October 1949 in the P.I.N.G.W. Laboratorium Melioracyjne (Drainage Laboratory) in Wroclaw.

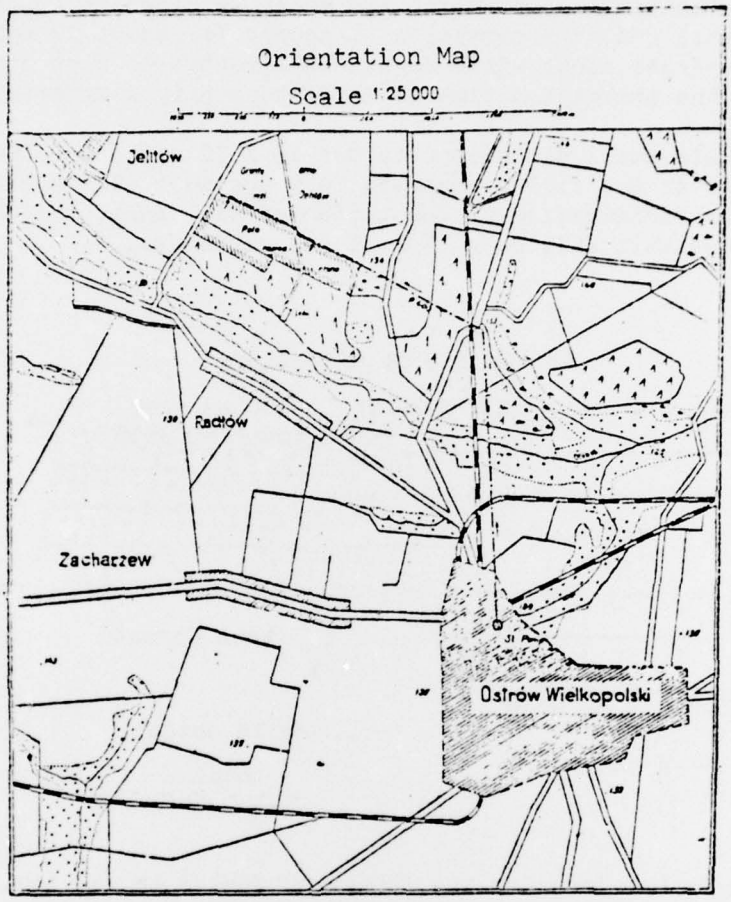

Figure 1.

Meadow areas (32.5 ha) form 77% of the total surface of the Ostrow irrigated fields. The first irrigation of the meadow begins at the end of February or the beginning of March, and lasts until December if severe frost does not prevent this. In the December - February period the sewage is purified on arable land (9.8 ha) using furrow irrigation. The sewage temperature (approximately +6°) makes it possible to distribute this water on fields even when there is frost.

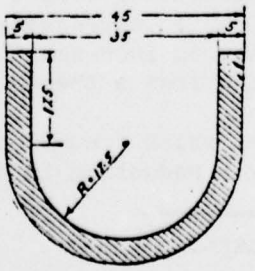

Figure 2. Cross-section of a concrete channel for outlets.

Irrigation is continuous; at night the water is directed to meadow plots or fields (in Winter) and no supervision is needed for about 10 hours of irrigation on a separate plot; where sewage is directed to 2 or more plots at the same time, the irrigation time is correspondingly lengthened.

In view of their small dimensions (about 10 X 10 each) the two tanks for applying the sewage to the fields separate only the most easily clarified suspensions. After fermentation at the bottom of the tanks, the residue is air-dried and enthusiastically bought[2] by local gardeners.

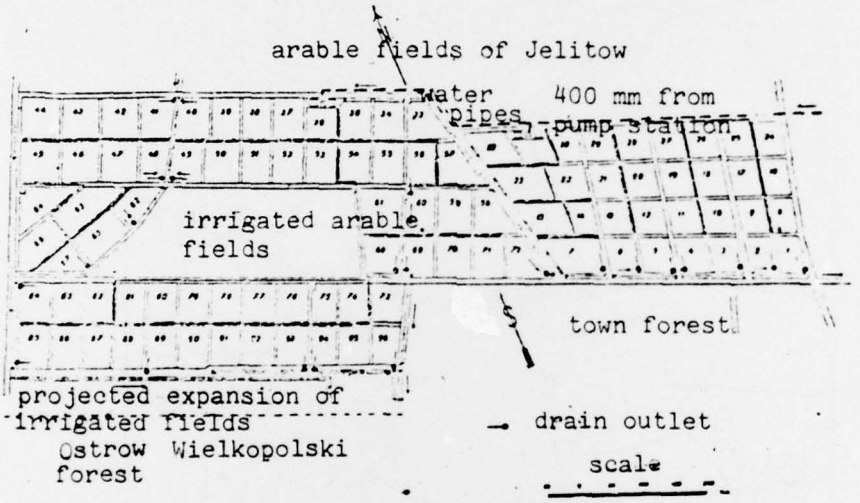

Figure 3. Map locating the irrigated fields in Jelitow.

Neither the fields nor the meadow irrigated with sewage receive additional doses of artificial fertilizers. Despite the light soil (sand), the yield obtained from the arable fields are very good, thanks to the sewage application: the sugar beet yield reaches 500 quintals per ha, and the weight of individual roots of the plants reaches 5 kg. The fields are irrigated by means of absorption and flow: furrows are made along the largest parts of the fields using plow horses, and a rather even soil humidity is produced by damming-up the furrows during irrigation.

The meadow irrigation is adapted to the vegetation period of grass and crops. There is no irrigation immediately before this or after the harvest. In the Summer, when plant transpiration increases, the amount of sewage is insufficient and it becomes necessary to increase the rate of irrigation: at that time additional water is drawn from a trench near the town slaughterhouse.

The phenomenon of stagnation, which occurs on all of the artificially established meadows, reflected by a reduction in crops and by the greater

[2]For 500 za per horsedrawn cart.

occurrence of mediocre grasses and weeds, occurs on the Ostrow irrigated meadows. After several years of use the meadow in a given parcel is plowed, cultivated and sewn with grass. If the sewing takes place in Autumn, the meadow is sewn with rye, as a cover crop. Oats are the cover crop during Spring sewing.

The most common mixtures sewn are: English rye-grass with cover grass, 20 kg/ha; cocksfoot with tall grass, 10 kg/ha, sometimes 30 kg/ha.

Under local soil conditions these grasses produce good crops. High yields are also obtained from Italian rye-grass, meadow grass, canary grass and wheat-grass. The latter, cultivated alone, creates a lush, dense growth.

The general occurrence of weeds[3] on fields irrigated by urban sewage is rare on the Ostrow fields. Because of the careful maintenance and partial plowing of the meadow along with the dikes, blow-balls occur only in a small number of parcels. This weed, although it has considerable nutritional value, is controlled on the Ostrow irrigated fields in an original manner because of the small amount of fodder it provides and because it suppresses the growth of more valuable species: in the places where blow-ball occurs, hay is made from rye-grass. Because of cover and the abundant sewing of the rye, blow-ball makes way for the rye-grass.

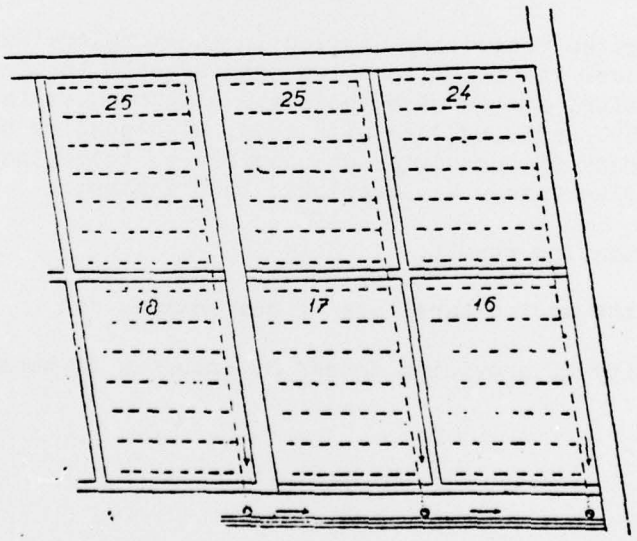

Figure 4. Detail map of part of experimental fields.

[3]Meadows, and famous Anthemis, tancy, blow-ball, black nightshade, tomatoes (from seeds carried in the sewage water), elder, thistles, etc.

The area is mowed 4 to 5 times. Three or four mowings are harvested for hay, and the last one for green fodder. Fermentation of the grass (silage storage) gives good results and animals enjoy eating the silage. A few percentages of beet leaves are added to the grass in the silo, and the ensilage process does not fail even in roots covered with earth.

The hay is excellent and in heavy demand in town. The average crop yield amounts to 100 - 120 quintals of hay per acre.

In a 37-year period (1912 - 1949) not a single instance of a harmful effect on the health of animals from feeding hay produced on the Ostrow irrigated fields has been noted. It should be stressed that there is no cannery in Ostrow Wielkopolski, thanks to which there is no fear of fodder infection by anthrax.

Small farmers lease grass harvests from the irrigated meadows for a 3-year period. If the area is cultivated in grass the lease period is extended to 6 years. The leasing rate depends on the fertility of individual parcels and varies within limits of 80,000 - 120,000 annually per ha.

Many leaser-users harvest and dry the grass carefully by hand so that the facilities (dikes, outlets) are not harmed, while frequent mowing helps to free the meadow of weeds.

The Ostrow irrigated fields are handled in an exemplary way from the technological and fodder viewpoint, provide considerable income for the municipal administration, and furnish the small neighborhood farmers with considerable benefits, by supplying them with good, high quality hay. It would be desirable for as many of our cities as possible to solve the onerous problem of sewage treatment like Ostrow Wielkopolski, thus achieving

1. a good purification result,

2. income from the agricultural use of the sewage, and

3. the possibility of providing dozens of suburban farmers with valuable fodder.