Fig. 1 Eastern Flevoland. View from the South on Lelystad with workharbour and lake-dyke in Northern direction.

Royal visit to Eastern Flevoland and North-East Polder

During the few crowded days of the visit of the royal guests from Luxembourg to the Netherlands, a view was taken of the partially completed Flevo Polder, the new museum at Lelystad and the Laboratory of Watercourse experts at De Voorst. The Zuyderzee works and the plans in connection with the regulation of the Zealand waterways greatly interested the royal visitors.

The car trip over the 25 km. long Knar-dyke to Lelystad provided opportunity for them to observe the enormous effort of the Dutch people in their struggle against the sea. The expert explanations, also, of ir. J. F. R. van de Wall, chief engineer and director of the Service of the Zuyderzee works, about the interesting museum at Lelystad, where all drainage schemes of the district, beginning with those of Kloppenburg and Faddegon of 1848 are graphically pictured, enjoyed the full attention of the visitors.

In the laboratory of watercourse experts "De Voorst," where Prof. ir. J. F. Thysse did the honours, the projects of the waterways *Nieuwe Waterweg* and *Haringvliet* were inspected, and the visitors were able to witness the unique experiments to assist the study of the currents in the Netherlands inlet of the sea as they will arise after the closure by dykes. For the benefit of our readers, we give a few details of the laboratory and its workings.

Essential requirement

The growing need for larger models was the reason that the watercourse laboratory experts decided to build models in the open air. The principal requirements in respect to the ground were:

a. space, without detriment to valuable agricultural ground,
b. a good supply and drainage of water,
c. sound foundation,

Visit of Her Majesty Queen Juliana to Lelystad and Ir. J. F. A. v. d. Wall, chief engineer and director of the Service of the Zuyderzee Works

d. afforestation to afford the necessary protection against wind.

An extremely suitable ground was found in the North-east Polder, in the neighbourhood of "De Voorst". The ground of this part of the polders consists of sand and boulder clay, and immediately after the polder dried this corner was utilized by the management of the States Forests to appoint a few parcels of land for afforestation. The watercourse laboratory now has 65 ha. of this forest in use and later this year a further 24 ha. will be taken into use. Moreover, if necessary, another 48 ha. can be added to the ground.

"De Voorst" is a name for the salient angle in the old coast line, north-west of the province of Overysel. This district is a spur of the hilly Ambt-Vollenhove district. During the glacial age the ultimate end of a glacier lay on this spot and pressed the soil closely together, with the result that now no fear need exist that any of the models may sink and expensive foundation constructions are not required. Finally, the ground is situated most favourably for a supply of water because it lies in the corner between the border lake (Vollenhove canal) and the canal Zwolse Vaart running through the polder. The level of the water in the border lake is about N.A.P. and that in the canal *Zwolsevaart* about N.A.P. — 4.5 m. The ground itself is N.A.P. — 1.5 m., so that there is a sufficient fall available for the inlet of water (which takes place via an inlet culvert), and when the water has passed the models, it flows off to the much lower lying canal Zwolsevaart.

Further construction

The adjacent pumping station "De Smeenge" pumps this water back again to the border lake. The ground is divided into a number of lots, the long sides of which lie at right angles to the Zwolse Vaart canal, and in the centre of each lot a draining ditch is set which ensures the supply of water to the models. The existing ditches between the lots have been broadened and serve for the drainage of the water to the canal Zwolse Vaart. In consequence, the models are lying on the strips of ground between the newly-cut supply ditches and the broadened lot ditches.

On a tract of ground between the Repelweg road and the border lake a large building is going up, in which

Visit of Her Royal Highness Grand duchess of Luxembourg to "De Voorst" and Prof. Ir. J. F. Thijsse, director of the Hydraulic Laboratories in the Netherlands

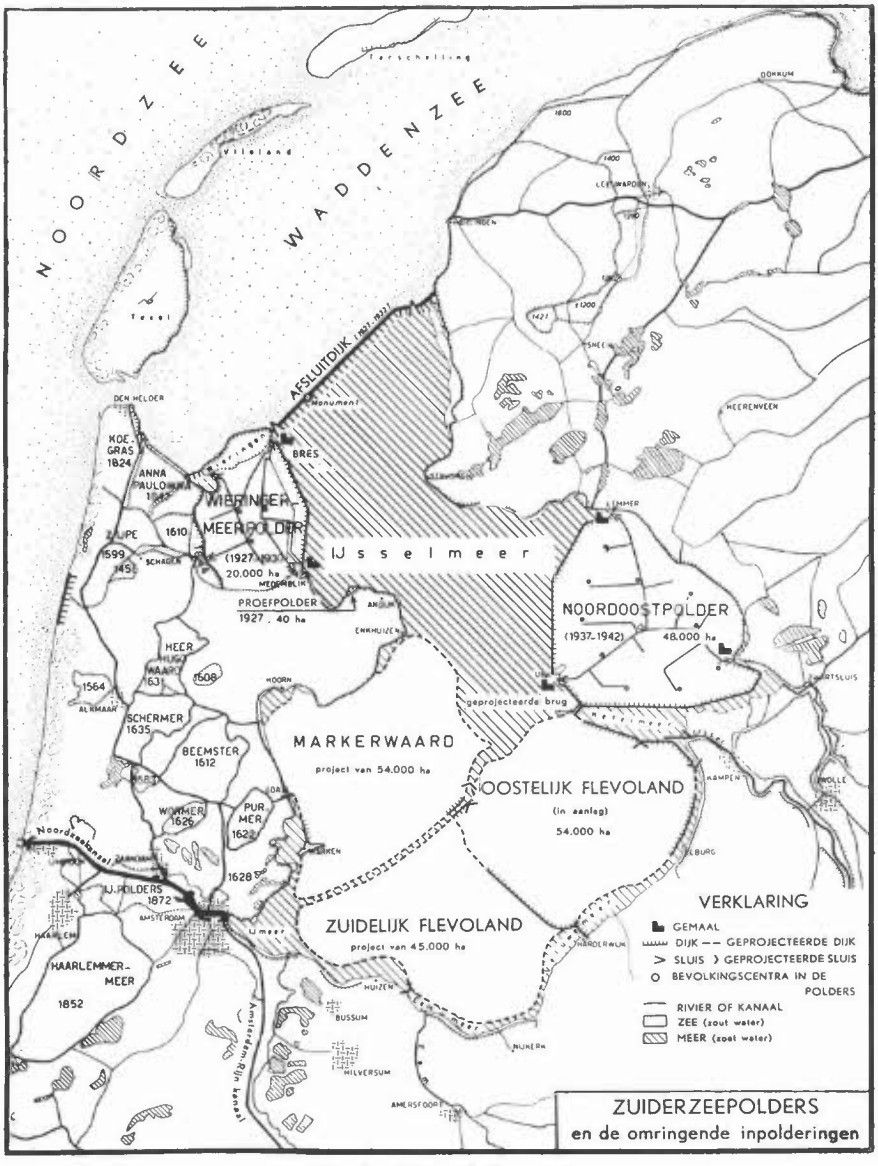

Fig. 2 Plan of the area

two long concrete trenches will be installed, through which water can flow at great speed. One of these trenches will be so constructed that a strong wind can stir over the surface of the water via a closed circuit. In this wind trench, or wind tunnel, tests will be taken wherein waver will play a great part, while in the adjacent current trench, a.o. tests can be carried out in the field of sand transport. Both trenches will co-operate in solving many questions which arise in executing the Delta works.

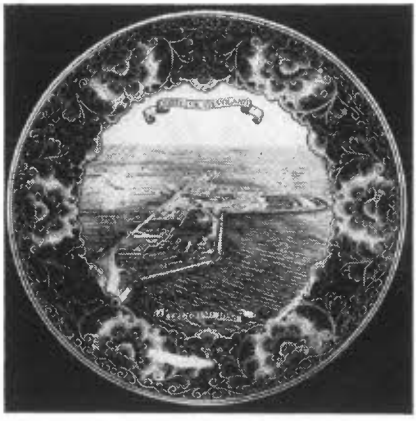

Fig. 3 Delft plate from the art pottery Schoonhoven, painted with a bird's eye view of Lelystad, which was offered to the royal visitors as a permanent memento. It is inscribed on the reverse: "Offert par le Service des Travaux du Zuyderzée à son Altesse Royale Madame la Grande Duchesse de Luxembourg 6 juin 1956

Other model undertakings

At present the models below are in operation:

Rotterdam Waterway (part Kralingen-Parkhaven) the waterway from Rotterdam to the sea).

Idem (part Vlaardingen-Poortershaven).

Lower Rhine near Maurik.

Entrance to the harbour St. Anna Bay (Curaçao).

Harbour of Lagos.

Discharging sluices in river Haringvliet (Delta plan).

Current over stone dam (Delta plan).

Building enclosure for discharging sluice in river Haringvliet (Delta plan).

Rubber wood sluices (Zuyderzee works).

Sluices at Kornwerderzand (Research work for Delta plan).

Model of Rotterdam Waterway

The building of the Rotterdam Waterway model was started in the autumn of 1954, and in September 1955 was in such an advanced state that tests could be started with the parts Kralingen-Parkhaven and Vlaardingen-Poortershaven. The model is so built that all longitudinal dimensions are to a scale of 1 : 75 and all vertical dimensions to 1 : 375 and the scale of the current speed is about 1 : 6, so that the water in the model is flowing six

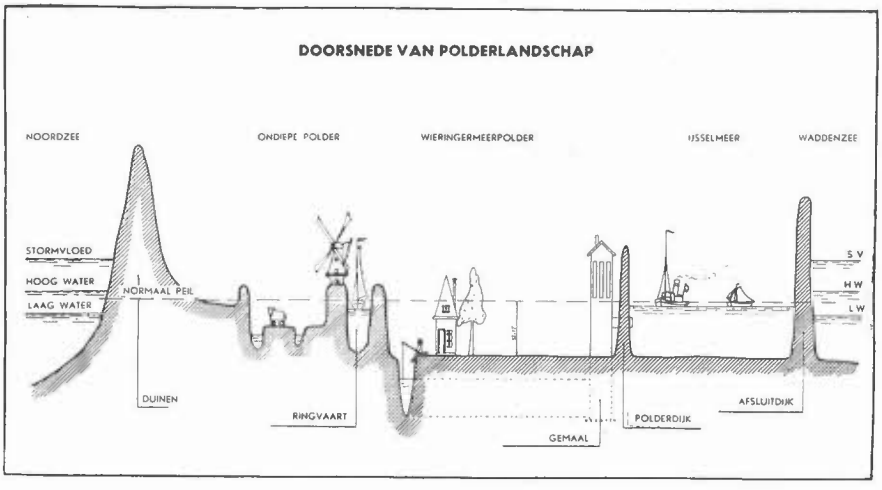

Fig. 4 Section of Polder-landscape
Noordzee = Northsea; ondiepe polder = shallow polder; stormvloed = storm flood; hoog water = high water; laag water = low tide; duinen = dune; ringvaart = ring canal; polderdijk = polder dike; afsluitdijk = barrage dike; gemaal = pumping station.

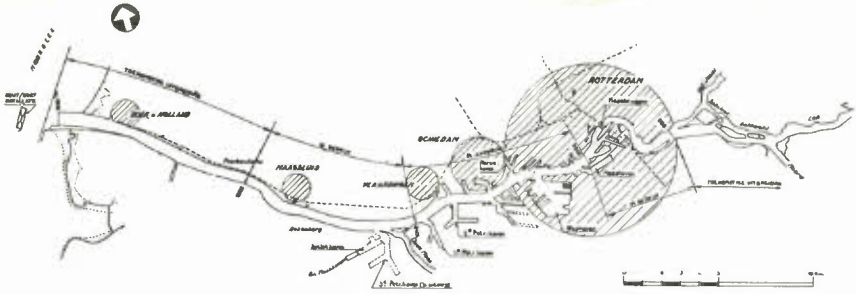

Fig. 5 Model of Rotterdam Waterway

times slower than in reality. It is executed in such a way that both models so far built can flow quite independently from the other, either with ebb or with flow current, and consequently the various points of research can be approached at the same time, and they are situated in such a way that in future, by building on the section lying between them, one long model can be obtained.

The whole model is surrounded by a dyke, which makes it possible to inundate it during a long period of frost. The waterlayer, ± 50 cm. in thickness, prevents frost seeping into the ground and affecting the model. Further, along both sides of the model a total of 1,000 poplars have been planted, which will provide the necessary protection from wind when in the future salt-fresh water tests are taken.

Vlaardingen-Poortershaven model

Model tests on this section consist of:
a. research on the form of the 3rd Petroleum harbour mouth,
b. research on the necessary measures to be taken to improve the curves of part of the river near Maassluis.

Until the present tests only the shape of the harbour mouth was considered, but it must now be executed in such a manner that: ships can easily sail in and run out; the deposit of sand and clay must be limited as much as possible; and the annual dredging work must be very slight.

The silty deposit of a harbour in a lower river, which is subject to tide is caused by the three factors: (1) The basin filling. Between low and high tides the surface of the water is rising in the harbour basin. This can only happen when water is flowing from the river into the harbour. This quantity of water depends on the surface of the harbour basin, and therefore cannot be altered.

(2) Horizontal interchange. Some of the water running along the harbour enters the harbour and at another part of the mouth flows out again. In the model a form of mouth must be sought whereby this interchange is as small as possible. By keeping this interchange to a minimum, less silt is transported and there is a reduction in the change of silty deposit.

(3) Vertical interchange. This is caused by tidal water with a larger salt content than that of the harbour running along the harbour mouth. Through this difference in specific gravity, salt water flows into the harbour along the bottom and fresh water leaves along the surface. This interchange will be smaller as the bottom is at a higher level in respect to the river bottom. In this instance, where it concerns a harbour which must be navigable for larger tankers (ships with larger draught), very little can be done to this vertical interchange.

The research thus relates principally to the horizontal interchange, in which the nautical aspect is of the greatest importance. For this reason, in the model the rate of flow in the harbour mouth (shipping) under various circumstances is being measured and also the horizontal interchange (risk of silty deposit) defined. This research is still in progress.

Kralingen-Parkhaven model

In this section two problems require solution:
a. the influence of new cross river connections on the river bottom,
b. the changes in the new harbour complex between Leuvehaven and Bethesda.

The measurements dealing with "a" will soon be taken in hand, whilst those concerning "b" are in progress.

At present the progress of the work in this inner harbour complex is such that the current running through the harbour is strong enough to stop the silty deposit.

After the Maasstation (Meuse sta-

tion) has disappeared it will be possible to build a boulevard along the northern bank. This will mean that the openings by which the inner harbours are connected with the river will then be partly closed and a number of bridges will be replaced by floodgates.

The size and situation of the new engineering works must, however, be such that in future the current through the inner harbours remains sufficient to avoid silty deposit. Moreover, the floodgates must be navigable for inland vessels wanting to use the inner harbour.

So it was that this fascinating visit gave the guests a striking picture of the importance of the large works at present in preparation.

Reclamation of the Zuyder Zee

On 13 September last the 90-kilometre (56-mile) dyke enclosing the East Flevoland polder in the former Zuyder Zee was closed in the presence of Her Majesty, the Queen of the Netherlands. The polder will cover an area of 54,000 hectares (133,440 acres).

A start can now be made with the drainage, for which purpose three pumping plants with a total capacity of 4,200 cu.m. (148,300 cu.ft) per minute will be in operation. The Queen herself started up one of these pumping plants. The drainage will take about eight months. As soon as the highest areas of the polder have been drained, the work of preparing the new land will commence, and consist of digging ditches and canals and constructing roads. When this has been completed, the polder will be reclaimed and put under cultivation in annual quotas of about 6,000 hectares (14,800 acres). This project will thus take about nine years.

East is the third large polder, after the Wieringermeer of 20,000 hectares (50,000 acres) and the North East Polder of 48,000 hectares (120,000 acres), in the area of the former Zuyder Zee.

Closing of four estuaries in South West Holland

The Netherlands Government has submitted to the Second Chamber of the States General a Bill — the so-called Delta Plan — which envisages the closing of four estuaries in the south west of the country and the reinforcement of various defences against high water to protect the country against storm-engendered floods. The duration of the execution of all these projects is put at, roughly, twenty-five years, while the cost is estimated at some 25,000 million guilders.

It is the intension to close the estuaries situated between the West Scheldt and the Rotterdam Waterway by dykes connecting the islands of Walcheren, North Beveland, Schouwen, Goeree-Overflakkee and Voorne. Moreover, in this area as well as further along the Netherlands coast (including the Wadden Zee islands) the retaining dams along the sea will be reinforced, as also will be those along the West Scheldt and the Rotterdam Waterway and the waters in open connection therewith. Both the West Scheldt, which connects the Belgian city of Antwerp with the sea, and the New Waterway, which connects Rotterdam with the sea, will remain open.

The "Delta Plan" has not been devised for reasons of safety only. The estuaries which now stretch far inland impart an excessive salt content to large tracts of the agricultural and horticultural soil of most of the islands of the Province of Zealand. It will be possible to prevent this excessive salt content by the formation of large fresh-water reservoirs behind the new dykes. In the mouths of the Rhine and the Maas the borderline between fresh and salt water will be made to recede many miles. The imminent danger of an excessive salt content in a large part of the Province of South Holland will be curbed for ever.

The reclamation of some land can be counted upon, while it will be possible to construct roads, so that land traffic will be considerably improved. Better and more rapid connections between Belgium, the Province of Brabant and the west of the country thus come into being. Inland navigation will benefit from the enclosure of the estuaries, as the absence of high and low tides will render traffic more rapid and safer.

Prior to these Delta projects, the so-called three-island plan will be carried out. It comprises the construction of two dams between, on the one hand, the islands of Walcheren and South Beveland (already connected) and, on the other hand, the island of North Beveland. Of the stretch of water of 3,600 hectares (9,000 acres) which will then be enclosed, about 2,000 hectares (5,000 acres) come under consideration for reclamation. The most westerly dam, the one between Walcheren and North Beveland, will at the same time be the first of the four enclosing dams. Preparations for the execution of this plan have already been started.