CHAPTER 9

OIL POLLUTION IN FRANCE AND GUERNSEY

From 18 to 25 June two members of the M.B.A. scientific staff visited Brittany and met many of those concerned both scientifically and administratively with oil pollution in France. They also visited polluted beaches on the north and west coasts of Brittany.

OIL POLLUTION AT SEA

The French coast was threatened at different times by two separate bodies of oil (Fig. 1). The first emerged after the original stranding of the 'Torrey Canyon' and drifted up-Channel in the manner shown in Fig. 32, where it was thought to be threatening the Channel Islands and Cotentin peninsula. Its course was tracked by sea and air reconnaissance from England, and it was also treated at sea with detergent. By 5 April when the oil mass lay close to Guernsey the British ships treating it were withdrawn and it was signalled to the French that they had emulsified all the oil they could, and that in consequence spraying operations had ceased.

Aerial observations by the French showed much oil remaining and, with the wind veering to the north-east, the coast of Brittany was threatened. Emergency precautions were begun by the French on 8 April, but owing to bad weather on 9 April, which prevented aerial reconnaissance, the first oil reached the Côtes du Nord almost without warning, between Les Heaux and the Bay of Lannion, on 10 April. Although hurried attempts were made to treat the oil at sea with sawdust and with powdered chalk, there was insufficient time to prevent the bulk of the oil (estimated at 15000 tons by the French), from coming on the shore.

The second mass of oil to threaten the French coast almost certainly issued from the 'Torrey Canyon' between 26 and 30 March. Its estimated course is shown in Fig. 36. This oil does not seem to have been reported to the French by the British, as the first warning received in France was from a French fishing boat which reported dense patches of floating oil in mid-Channel north of Ushant on 4 April.

First accounts were that it stretched over tens of miles and estimates of its quantity varied between 'over 50000' and 80000 tons, several times as much as was at that time drifting on to the Côtes du Nord. This oil would comprise all that released from the 'Torrey Canyon' after she broke up.

The most recent British estimate of the oil released immediately after the ship broke apart on 26 March was 48 500 tons (p. 162) and to this must be added any oil which was later released, but not burnt, when the ship was bombed on 28, 29 and 30 March.

The patches of oil were reported to be so dense and compact that vessels steaming into them were checked. The same oil was observed from R.V. 'Sarsia' on 12 April, about 20 miles north of Ushant (p. 33; Plate 7A).

From 11 April on the oil patches were reconnoitred and charted by the French Navy, with headquarters at Brest. The oil stayed at sea for a further five weeks (Fig. 37), during which it drifted to and fro off the west coast of Brittany. It was first treated by the French with sawdust, but from 18 April it was sprinkled with powdered craie de Champagne. This is natural chalk ($CaCO_3$) with about 1 per cent sodium stearate, which is normally added in the manufacture of blackboard chalk. In this instance the stearate seems to have made the chalk hydrophobic and oleophilic so that it was attracted to the surface of the oil, binding it into particles which sank after a few hours. The breaking up of the solid oil masses was facilitated by ships steaming through it, stirring up the mixture with their propellers. The French informed us that the 3000 tons used, if correctly applied, would sink 20000 tons of oil.

Because of the tendency of the dry chalk to choke the delicate machinery of the radar-operating gear and missile launchers of the larger warships it was found necessary to employ small but robust ships such as minesweepers and fishing trawlers to spread the powder on the oil.

In addition a 3000-ton coaster, the 'Petrobourg', was hastily adapted for pumping oil from the sea, and this came into service on 27 April. This ship had a hose with a special floating attachment for sucking oil from the sea surface. It was capable of collecting 1200–1500 tons daily, and operated by coming alongside an oil patch and allowing the wind to drift the oil against the side of the ship (causing the thickness of the oil to be increased to 60 cm), where it was held by a floating boom until sucked up. This method proved very effective when the layer of oil was sufficiently thick, but owing to the dispersion of the oil by the time the 'Petrobourg' was brought into use only 1200 tons in all were collected on the two days on which she was employed.

On 12 May R.V. 'Sarsia' steamed through the oil mass, which was centred at about 47° 58′ N., 05° 22′ W. The mass consisted of floating pieces of oil of varying sizes up to 'rafts' of some 100 square metres with a thickness of perhaps 10–15 cm and of the consistency of heavy grease (Plate 7C). It was estimated that at least 1000 tons of untreated oil was present in the area on that day.

The oil came ashore around the Pointe du Raz and the Crozon peninsula, south of Brest, on 19 and 20 May (Fig. 39), but the extent of beach contamination was small. One estimate was 300 tons in all, but the M.B.A. staff who visited certain of these beaches thought it might be much less.

It would therefore seem that the French were successful in preventing the bulk of this very large oil mass from coming ashore. This was possible because they had several weeks in which to apply the chalk and adapt a ship

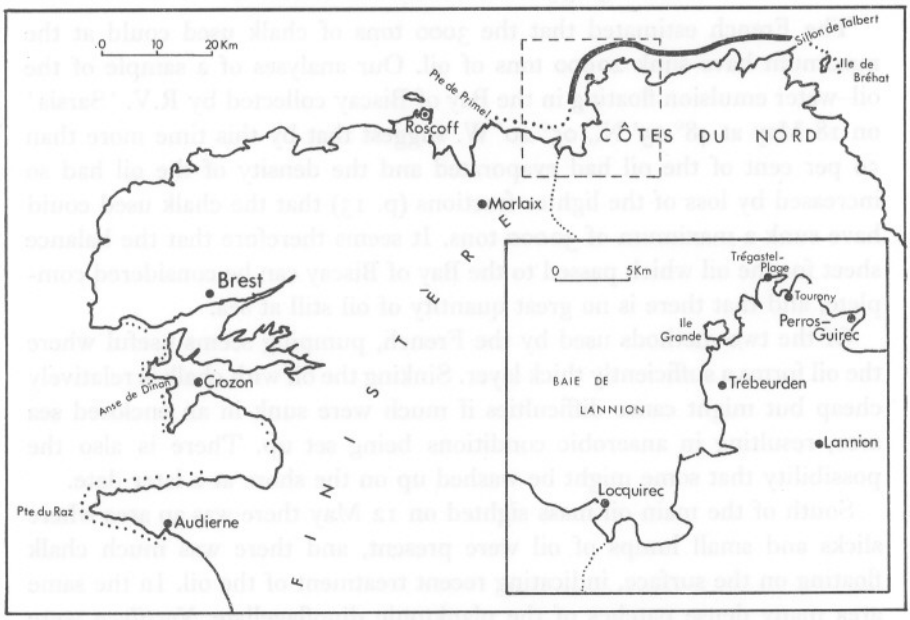


Fig. 39. Map showing oil pollution in Brittany, and some of the places visited by M.B.A. workers. The thick line shows the heavily polluted area on the Côtes du Nord. The dotted lines along the coast indicate slight or moderate pollution.

for pumping. Although the chalk would have sunk most of the oil it seems likely that in addition the remaining floating oil was broken up into small pieces which would soon become spread over a wide area and which, from the greater total surface area, would be more easily attacked by bacteria. An isolated patch of oil, still at sea on 18 May, is shown in Plate 7B.

Observations from 'Sarsia' in mid-May indicated that there was a large area where the surface of the sea was very slightly oily, resulting in smooth slicks, but not opalescence. This area stretched westward from the Ushant–Penmarc'h area to the continental slope south of La Chapelle bank. It seems likely that a lot of the remaining oil had by this time become dispersed in this region.

Taking an estimate of 50000 tons of crude oil initially released and passing to the west of Ushant, the 'balance sheet' seems to have been:

Lost by volatilization (and perhaps by biodegradation) of lighter components	25000 tons
Pumped by 'Petrobourg'	1200 tons
Stranded on coast	300 tons
	26500 tons

Leaving 23500 tons to be accounted for.

The French estimated that the 3000 tons of chalk used could at the maximum have sunk 20000 tons of oil. Our analyses of a sample of the oil–water emulsion floating in the Bay of Biscay collected by R.V. 'Sarsia' on 18 May at 48° 05′ N., 05° 20′ W. suggest that by this time more than 50 per cent of the oil had evaporated and the density of the oil had so increased by loss of the lighter fractions (p. 13) that the chalk used could have sunk a maximum of 30000 tons. It seems therefore that the balance sheet for the oil which passed to the Bay of Biscay can be considered complete, and that there is no great quantity of oil still at sea.

Of the two methods used by the French, pumping seems useful where the oil forms a sufficiently thick layer. Sinking the oil with chalk is relatively cheap but might cause difficulties if much were sunk in an enclosed sea area, resulting in anaerobic conditions being set up. There is also the possibility that some might be washed up on the shore at a later date.

South of the main oil mass sighted on 12 May there was an area where slicks and small lumps of oil were present, and there was much chalk floating on the surface, indicating recent treatment of the oil. In the same area many dense patches of the planktonic dinoflagellate *Noctiluca* were seen, producing a 'red tide'. It is not known if the appearance of *Noctiluca* in the same area as the treated oil is anything more than a coincidence, but it is possible that conditions favourable to the rapid multiplication of *Noctiluca* were created by the presence of oil or by its treatment with chalk.

Details of the red tide were as follows. Red tide was first seen as R.V. 'Sarsia' was steaming towards the polluted area, at 15.15 hours G.M.T. on 12 May. The first patches seen were right at the surface, but from 17.57 hours on they were described as submerged just below the surface. Only one patch was seen after 18.57 hours, suggesting downward migration or dispersion in the evening.

Meteorological details at 15.00 hours were: wind S., force 1–2; bright; 6/10 cloud; smooth sea, very slight swell; barometer 1007; shade air temperature 17 °C.

At a hydrographic station at the edge of the polluted area sea temperatures were: at 5 m, 13 °C; at 50 m, 11 °C; depth 124 m.

The patches of *Noctiluca* occurred over an area estimated as eight miles from west to east and three miles from north to south, with centre at 57° 55′ N., 05° 16′ W. (about 22 miles off Pointe du Raz).

Individual patches of *Noctiluca* tended to be elongated, with long axis south-west to north-east. A typical fairly large patch was estimated as 3 × 30 metres, but some formed elongated streaks 100 metres or more long and a metre or two wide. Patches were orange-red in colour (Plate 28A, B) thinning to white at the edges, and were often associated with small pieces of floating oil or chalk. The *Noctiluca* was concentrated near the surface of the sea, except in the evening, when it submerged. The association between *Noctiluca* and floating oil or chalk is probably due to 'convection cells' as described for plankton patches by Bary (1953). These would tend to concentrate plankton and floating particles into bands or streaks at the surface during calm weather. This red tide was evidently non-toxic, as no dead marine animals were seen.

Information on the outbursts of dinoflagellates and other organisms causing red tides has been summarized by Rounsefell & Nelson (1966). Outbursts occur in calm weather, mainly in warm waters, and after diatom blooms have impoverished the water of nutrients. They often occur in coastal regions subject to run-off from the land. Surprisingly enough the level of phosphorus in sea water within the red tide area may be very high, as much as ten times the normal level, but whether this is a cause or an effect is not clear.

Without further information it is difficult to speculate about possible causes of the red tide observed around the treated oil. The chalk or the oil might be a source of substances favourable to *Noctiluca*; partially anaerobic conditions may have been produced through bacterial action on the oil masses (aided perhaps by the breaking up of the oil by the chalk, so increasing its surface area); or the *Noctiluca* may have been feeding on micro-organisms which were themselves attacking the oil.

One possibility seemed to be that the chalk was a source of phosphate, but an analysis showed a content of only 300 ppm.

Some laboratory experiments were carried out, oil and chalk being added to *Noctiluca* cultures. These failed to show that these substances appreciably affected the rate of multiplication of *Noctiluca* in culture.

BARRAGES AND BOOMS

The French had some success with booms, and the M.B.A. scientists had an account from M. Cabioch, sous-Directeur at Roscoff, of the booms set up to defend the harbour and laboratory foreshore at Roscoff. Some of the

oil from the Côtes du Nord, some 20 miles to the east, later drifted towards the Gulf of Morlaix and Roscoff, where it was under constant surveillance by local boats. The first boom was constructed in a great hurry, using straw covered with jute fibres buoyed up at intervals with tractor inner tyre tubes. The second boom had an expanded polyurethane core, surrounded by straw tied on, and a final covering of jute fibres. This boom was heavier, and according to M. Cabioch, less successful as a protection against oil. By means of these booms Roscoff was kept free of the oil, which for a time drifted in between the Ile de Batz and the mainland. The Biological Station at Roscoff is publishing an account of their experiences in a forthcoming number of the *Cahiers de Biologie Marine.*

CONDITION OF THE BEACHES

North coast

The beaches of the north coast of Brittany received about 15–18000 tons of oil, which arrived on 10–12 April over about 60 miles of coast on the Côtes du Nord, between Trébeurden and the Sillon de Talbert (Fig. 39). Lesser amounts came ashore west of Trébeurden, and in Finistère as far west as Roscoff. There was a significant quantity on the shores of Finistère between Locquirec and the Pte de Primel, but very much less than in Côtes du Nord. Scientists from Roscoff were familiar with the beaches in Finistère both before and after the arrival of the oil, but had scarcely visited the polluted areas of Côtes du Nord, where the fauna was considered to be less rich.

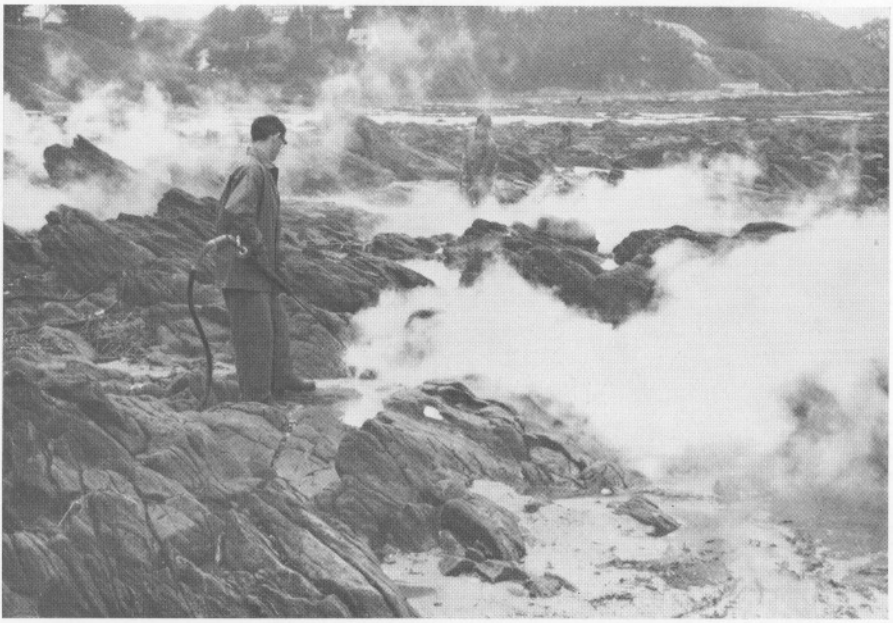
From Trébeurden north and eastward to Perros-Guirec the M.B.A. scientists visited a number of beaches which were uniformly polluted, showing a dark brown-black band of oil about a metre wide on the rocks at high water for many miles. The oil had arrived in calm weather, so this band was quite level. The coast in this region is mainly rocky with large pink granite boulders, up to 15 metres or more across, and unlike Cornwall is readily accessible as there are no high cliffs. There are also stretches of sand or gravel between the rocks.

Little or no attempt had been made to clean most of the shoreline, so that its condition contrasted with that of Cornwall which had mostly been sprayed with detergent. In mid-June the oil on the rocks was almost black (Plate 27B). We were informed by M. Cabioch that it came ashore

PLATE 29

A, Steam-cleaning of oily rocks at Locquirec, Finistère, 20 June. **B**, North end of Trégastel-Plage (Côtes du Nord), 21 June. Troops wearing gasmasks spraying oily rocks with detergent.

PLATE 29



A

B

(*Facing p.* 168)

reddish brown in colour but after two days' exposure to the sun during neap tides it became blackened. The sandy regions had been to some extent treated with detergent and by mechanical means, but where they had not been so treated the surface of the sand was a dark blackish brown, sometimes with a thin hard crust of oil, with lighter brown oil in the top 10 cm of the sand (Plate 27c).

At Ile Grande such an untouched beach of coarse sand showed some evidence of biodegradation of the oil in the sand (p. 81), as under some patches of oil a thin grey layer was present. Farther east near Trégastel, in a similar coarse sand beach, the layer of sticky brown oil showed no evidence of biodegradation at the time.

In general the impression was that pollution had been overall heavier than in Cornwall, although at some places, such as Sennen and Porthleven, worse conditions had been observed. It is likely that an earlier visit, when conditions would have been comparable to those first seen in Cornwall, would have suggested that pollution in Brittany was everywhere worse than in Cornwall, where a rather smaller quantity of oil was spread over a much longer coastline.

West coast

South of Brest, beaches polluted by oil which came ashore about 20 May were visited on 23 June. Beaches on the west coast of the Crozon peninsula were inspected, but not those around the Pte du Raz, where pollution on a similar scale has been reported. Estimates of 300 tons as the total for the western beaches suggested that pollution was light, and the oil which was found was more or less confined to the northern end of the beaches. Oiled rocks were black, and at one or two places were covered by up to 5 cm of thick viscous oil. At the north end of the Anse de Dinan, in addition to this type of pollution, there were small lumps of brownish oil on the strand line evidently drifted in at a later date than the main pollution. None of these beaches had been treated with detergent, but one beach had been treated mechanically by bulldozing, and at another some troops were collecting and burning small lumps of oil and driftwood.

The quantity of oil on each of these beaches appeared to be less than a ton, so that 100 tons may be a more realistic figure for the total drifted ashore from an original mass of over 48000 tons.

METHODS OF TREATMENT

The following notes apply mainly to the north coast of Brittany.

Gorse and straw

Some sandy beaches had been cleansed of oil by laying a line of gorse or straw on the beach at low water. As the tide rose, these materials rolled up the beach and collected oily sand. They were then picked up and burned, and the process repeated. Repetition of this process over a month was said to be most effective, and the sandy part of the beach at Locquirec, for example, where this method had been used, was clean. Sawdust (of which there were traces on many beaches) was also tried in this way, but was not found to be effective.

Removal of upper layers of sand

When the oil arrived on sandy beaches it was reported to have sunk to about 15 cm below the surface. Cores taken at Ile Grande showed oil (in an untreated beach) in the top 10 cm. Since the beaches are mainly accessible to vehicles it had been feasible to bulldoze off the upper layers, repeating the process until all the oiled sand had been removed. In addition to bulldozers, two large machines flailing sand into a hopper were seen at Trégastel, the sand being carried away and dumped to aid land reclamation nearby (Plate 28C).

Steam cleaning

On 20 June the M.B.A. scientists attended an experimental cleaning of oiled rocks at Locquirec (Finistère) under the direction of M. Daniel (head of Civil Defence for the department). Troops were using small trailer-mounted steam-cleaning equipment of the same kind as is used to clean the underside of vehicles (Plate 29A). Steam at 140 °C and 8 kg/cm^2 was being delivered from small nozzles at the end of pipes held by the operators, who were equipped with oilskins and gasmasks (the latter not in use). A small quantity of Teepol (1 l. Teepol to 300 l. water) was added to the cold water used for rinsing the rocks after the steam treatment, and this produced a white foam around the treated areas. By this method 30 square meters of rock surface could be cleaned per hour per machine. An ample supply of fresh water, around 2000 l. per machine, was required.

The treated area was at high-water mark with few animals on it, and the steam treatment seemed to clean the rocks effectively. Below the treated reef, streams of water ran down through the sand, and in places the black sulphide layer in the fine sand had been washed up to the surface. It is

possible that this may have resulted from previous mechanical removal of sand, which had begun on 10 April, as soon as the beach had been polluted.

There was no evidence of plant or animal mortalities on this beach, although anything subjected directly to steam treatment would naturally be killed. The ultimate fate of the oil removed by steam treatment and washed down the beach is not known.

No detergents were being used for beach cleaning in the department of Finistère. Because of the important inshore oyster beds and shellfish industry of the area the civil defence authorities had been strongly advised against the use of detergents by scientists at the Roscoff Marine Biological station. A few miles to the east, however, in Côtes du Nord, detergents were being used for beach cleaning.

Detergents

Detergents were being used to clean rocky shores at various places on the coast of Côtes du Nord, the coast being much more heavily polluted than in Finistère. Detergent treatment began on 24 May and continued until the beginning of July. During this period some 2300 tons of detergent were reported to have been used. At the time of our visit detergents were being used more or less on an experimental basis under the direction of two experts from the Institut National de Recherche Chimique Appliquée, seconded to Roscoff from the Laboratory of the Ecole Polytechnique.

The chief detergents used were Oxane and Fina-sol, the latter being a dark red liquid, non-ionic, with a much less pronounced smell than BP 1002. The chemists from I.R.C.A. had been sent more than sixty types of detergent, of which Fina-sol had proved to be the least toxic. Toxicity tests carried out by M. Audouin of the Fisheries Laboratory at Roscoff confirmed the opinion earlier put forward in this report that the more efficacious the detergent the more toxic it is. Some experiments had been carried out upon emulsion stability, the conclusion being that few brands were capable of forming a stable emulsion of oil in sea water.

Drums of detergent were pumped into small trailers at the army camps, and these small trailer tankers were then moved by lorry to different sites, where spraying was carried out (Plate 29B). A number of commercial tanker lorries were also employed. Operations were on a smaller scale than in Cornwall, spraying being from small nozzles by operators dressed in oilskins and wearing gasmasks. Only a limited area was treated at one time, the operators then moving elsewhere. On the badly polluted beach of Trégastel, spraying on the rocks produced sufficient detergent to form a white patch in the water which gradually filled the harbour (Plates 22B, 28C). The sand became impregnated with detergent from the water: it was

not sprayed directly. On this beach, dead limpets, other gastropods and crabs were found. Spraying had been carried on there for some time prior to the visit. At this site alone of those visited, oil layers were found buried below clean sand.

Despite the fact that the oil being treated by detergent was some two months old and had become black, the spraying seemed to be efficient at removing it. Fresh brown patches of oil (Plate 6A) some metres across were observed at Trégastel on the water in the harbour perhaps resulting from de-emulsified oil returning. Similar small patches were observed on the strand line near Ile Grande (Plate 6B). At other beaches, such as Perros-Guirec, detergent had been used, and a sulphide layer, 1 cm below the sand surface, smelt of detergent. An iridescent oil film was present on the water-table. In the harbours of Ploumenac'h and Tourony nearby the water was milky white and the sand smelt of detergent. Dead crabs were floating there, and a local resident reported that dead congers had been found. Although the lagoon of Tourony dries out at low tide, and although detergent-spraying had stopped there five days prior to our visit, the water was still milky with detergent at high tide. Spraying had been carried out here for the past month.

The general impression gained was that at Trégastel and certain other beaches much detergent had been used, and that similar effects to those observed in Cornwall were either observed or could be expected. It seemed probable that more detergent would be used.

No evidence was obtained of any effects of detergent upon the important lobster fisheries of the Côtes du Nord, but, if spraying were carried out elsewhere in the same manner as at Trégastel, it seemed likely that toxic effects would be observed.

OIL POLLUTION IN GUERNSEY

The following notes on oil pollution in Guernsey were made by a member of the M.B.A. scientific staff who visited the island on 10 and 11 July. He is indebted to Mr Guillaumette (States Supervisor), Mr Bichard (Department of Public Works) and Capt. Walker (Fishery Officer) for information and assistance.

Guernsey, the only one of the Channel Islands to suffer pollution, received a severe but localized shore fouling on 6 April. Shortly afterwards the very large mass of oil which later went ashore on the Côtes du Nord of Brittany (Fig. 34) passed very close to the Channel Islands and much of it was blown southwards through the channel between Guernsey and Sark.

The only badly affected area was a two-mile stretch of the west coast of

Guernsey from Saumarez Fort to the south end of Vazon Bay (Plate 27A). The intertidal reefs in this area are very extensive, up to half a mile wide in places, forming small north-facing bays and fortunately one of the least popular spots for holiday visitors. While the wind stayed onshore the most effective means of disposal was found to be the direct pumping of oil from the sea surface at high water and just after. Up to seventeen sewage tankers of 800–1000 gallon capacity were available and, fortunately, good access to the shore was possible from several slipways. A minimum thickness of oil of about 2 inches was necessary for successful pumping; so long as the wind stayed fresh the depth of oil built up at times to 4 inches. If the wind dropped or changed, pumping had to stop. Pumping was carried on until 24 April when the wind changed to south-east for less than a day, but the remaining floating oil was carried away to the south.

Some of the oil pumped from the sea was delivered through a large (4 inch) suction pump into a pit or tank from which the tankers filled up later, and small amounts of oil were pumped from pools with portable pumps. The total quantity of oil removed directly was 866000 gallons (*ca.* 3000 tons).

Steam-cleaning plant was tested on oil-covered walls but was found to be very slow compared to light detergent spraying coupled with pressure jets of water from a fire-hose.

The use of detergent was very strictly limited (it had to be paid for at 6*s*. per gallon) and was generally confined to slipways and sea-walls. Very extensive rock areas around the level of high-water neaps were still blackened on 10 July and will be left. The oil residues on the rock surfaces were dry to a light touch and slightly powdery. The oil took many days to adhere to the rock and did not affect lower parts of the shore.

Natural banks of broken kelp above high water absorbed the oil and cut weed was used deliberately to a small extent to absorb it.

Rock pools in the most heavily polluted reefs contained a normal fauna, including blennies, sea anemones, winkles, limpets, etc. Nearby several live ormers (*Haliotis*) were found during a short search just below low-water springs at Le Jaune Pont.

The total cost of the oil clearance work in Guernsey was estimated to be about £30000 (working out at roughly £10 a ton).