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SPECIAL REPORT

**JOSINGFJORDEN, RAEKEFJORDEN
AND
A/S TITANIA MINES**

INTER-SERVICE TOPOGRAPHICAL DEPARTMENT

4 February, 1943

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SPECIAL REPORT

(submitted to the Department of the Army)

ON

JOSINGFJORDEN, RANKEFJORDEN

and

A/S TITANIA MINES

REPORT

Inter-Service Topographical Department
4th February, 1943

1.S.T.D./2/134

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4. Coastal road at head of Jörsingfjorden
5. 1/2 Titania mines and ore-dressing plant

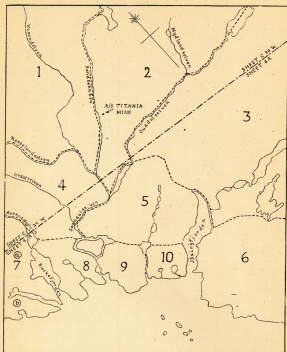
AERIALS

(Enlargements of single contacts)

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SOGNDAL DISTRICT

KEY TO TOPOGRAPHICAL REGIONS

BOUNDARIES OF TOPOGRAPHICAL REGIONS - - - - -

NUMBERS OF TOPOGRAPHICAL REGIONS 1—10

SCALE OF MILES

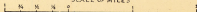


FIG. 1.

1. TOPOGRAPHY

(Fig. 1, Plan 1, Aerial 1)

INTRODUCTION

The topography and scale shown on Plan 1 should be treated with caution. The plan is based on three main sources, viz. maps, air cover and Admiralty Chart 3011.

The maps used were small parts of Sheet C 39 W, and of Sheet 4 A, O.S.O.S., Spruce No. 1090. Sheet 4A is contoured and carries a fair amount of information. But Sheet C 39 W, being merely an enlargement of the Norwegian 1:200,000 last map of 1928 and 1928, includes little information. More form lines give the sole indication of relief. Important names have been omitted, and considerable research has been necessary to establish the names of some inland features (lakes, rivers, etc.). These names cannot be guaranteed.

Although drawn to the same scale, the appropriate parts of Sheet C 39 W and of Sheet 4 A did not fit, so that an accurate map could not be made. The result is a compromise in which the coastline has been drawn mainly from part of Admiralty Chart 3011. Whenever possible the whole plan has been checked against aerial photographs. But the available photographs were small in scale, very cloudy in parts and mainly confined to coastal districts.

For the purpose of this report the region mapped is called the Sogndal district. It covers an arbitrary area about $\frac{1}{2}$ miles broad and (including coastal waters) about $\frac{3}{4}$ miles in depth.

The Sogndal district is mountainous, but nowhere does the land rise much above 1,000 feet. The general slope of the surface is downwards from all directions towards Hauge and Hansberg. The whole district may be considered as saucer-shaped, with major chips in the saucer rim at Rackerjorden and Jbeingjorden, and a smaller chip at Sogndalsstrand.

The bare rocky mountains are separated by narrow irregular valleys. Past bogs and lakes are numerous along the valley floors, and increase in size and number towards the south-eastern part of the Sogndal district.

Soil cover is present only on the lowest land. Along the major rivers the soil usually consists of sandy alluvium. But elsewhere any soil that does exist has a considerable admixture of peat mould. The many bogs and marshes of the Sogndal district consist almost entirely of peat. Along the lower course of Sogndalselven the more level land is very hard and stony.

There is little forest land in the district. Scattered birch woods occur in the lower and more sheltered valleys, but there are few trees of the coniferous type. A few pine or fir woods have been planted within the last century.

The amount of cultivable land is small even when judged by Norwegian standards. It is doubtful whether as much as 15 per cent. of the Sogndal district is under cultivation.

The main cultivated area lies around Hauge and Hansberg. Here tillage is fairly widespread, but there is also a fair amount of meadowland. Cattle, barley and roots form the usual crops. Fields are usually separated by fences rather than walls and there are only a few straggling hedges.

DRAINAGE AND CULTIVATION

Since the main drainage system of the Sogndal district cuts across the topographical regions described in the next sub-section, it is better treated as an entity.

Five streams, the courses of which are shown on Fig. 1 and Plan 1, rise in lakes to the north of the mapped area and combine to form Sogndalselven. A sixth stream, Urdalselven, rises in Snottfjeld, north-west of the area, and joins Sogndalselven below the confluence of its two main tributaries, Vasundselven and Gaddalselven. Farther west Rackerdalselven rises in Ragnidalsfjeld and reaches the sea at the head of Rackerjorden.

Except for narrow strips along the banks of Vasundselven and Rackerdalselven, cultivation begins in the valley of Gaddalselven at the point where it broadens out to form a lake 900 yards long and 70 yards broad (Aerial 1). Along the whole length of the northern shore of this lake there is a cultivated strip about 60 yards wide. Between the lake and the confluence with Vasundselven this strip broadens out to a maximum width of 200 yards, and on it there are five fairly large farms. There is also a very narrow cultivated strip along the left bank of Vasundselven, south of the point where it is joined by Sandbakkåsen.

Below the main confluence the valley of Sogndalselven broadens out, and on both sides of the river there is cultivation, which reaches its widest extent on the left bank in the head opposite Hauge village. Here there is carefully tilled farmland with a maximum length of 1,300 yards and a maximum width of 1,000 yards. The branch

road from Prestthro (at the confluence of Vagendalven and Sagdalsalven) to Sagdalsstrand passes through this area (see III, Roads, Route 2), and adjoining it are several farmsteads. The main group of buildings, consisting of three farmsteads, is at Årstad where the road turns southward. Cultivation is mainly in the form of long, narrow fields, running at right-angles to the road and enclosed by fences, but there are a few thin hedges. There are some scattered trees in the extreme south of the area, but elsewhere the land is under tillage. There is also a fair proportion of meadowland.

On the right bank opposite this area there is less cultivation but closer settlement. A cultivated strip 800 yards long, with a maximum width of 150 yards at its western end, is bordered on the north by the main road (see III, Route 1) and by the straggling farmsteads of Bråland. West of this strip the road approaches Sagdalsalven more closely, and between Hauge village and the river bank there is little space for cultivation.

The valley of Brådal, along which the main road runs, broadens out as it nears Sagdalsalven, and west of Hauge village there is a cultivated strip 400 yards long and 200 yards wide.

Below Hauge village the river turns south, and on its right bank there is a cultivated area about 500 yards square. Here intensive tillage is mainly confined to a narrow strip along the river bank. To the west and south the ground rises gently and becomes rather rocky, and tillage is largely displaced by rough pasture. The main farmsteads border the roads which skirt the northern and western sides of this area.

South of the two main cultivated areas described above, the river divides into eastern and western arms, enclosing the island of Årstad. East of the island the eastern arm broadens out into a lake about 450 yards long and 350 yards wide.

Årstad has a maximum length of 900 yards from east to west and a maximum width of 600 yards from north to south. It is a rather rocky island, with two hill groups carrying scattered birch-wood; the more westerly hill has a steep scarp on its southern side, overlooking a marshy area. At the eastern end of the island there is a strip of cultivated lowland, with one large farm, and on the north side there is a smaller farmstead with a few cultivated fields adjoining it. These cultivated areas are served by a track which bridges both arms of Sagdalsalven (see III, Roads, Km. 1.2 of Route 2).

The river valley for the remaining 1,000 yards below Årstad is narrow and rocky, but there are a few cultivated strips and scattered trees. Along the right bank houses are strung together for a distance of 400 yards from the sea. But the actual village of Sagdalsstrand, on the left bank, is more localised.

Below Prestthro, Sagdalsalven varies considerably in width, but 20 to 25 yards may be considered as a fair average. In common with the other rivers of the Sagdal district, Sagdalsalven is fairly shallow, and it should be possible to ford the river at many points along its lower course.

TOPOGRAPHICAL REGIONS

The Sagdal district is divided into 10 topographical regions. It has not been found possible to give each topographical unit a characteristic regional title; each region is therefore denoted merely by the number shown on Fig. 1.

1. This roughly rectangular region is about 2 miles broad and 3 miles long. To the south-west it is bounded by Kossandalalven, to the south-east by Sandbakkalven and elsewhere by the limits of the map. The region is crossed almost diagonally by Vagendalven. This river flows from Brådal and joins Kossandalalven in the extreme south of the region near Lindland.

Much of the region is rocky and barren. But the amount of lowland is greater than in Region 2 to the east. There are narrow strips of cultivated land along the valleys of Kossandalalven and Vagendalven, and farmsteads are fairly numerous. Sakke, Ekeland, Erane, Lindland and Kossland are the main inhabited places. Of these Lindland, at the confluence of Kossandalalven and Vagendalven, is the largest. 2. This triangular region measures $\frac{1}{2}$ miles by $\frac{3}{4}$ miles by 1 mile. It is bounded to the south by Gaddalsalven and to the north-west by Sandbakkalven. It includes the 1/3 Titania mines, situated in the valley of Sandbakkalven about a mile from its confluence with Vagendalven.

The northern part of the region is occupied by two mountain blocks. Between the 1/3 Titania mines and Gaddalsalven a furrow $\frac{1}{2}$ miles in length runs east and west. At its eastern end this furrow runs into the valley of Gaddalsalven near the point where it is joined by Mylandalven. South of this furrow the remainder of the region is occupied by a low and deeply dissected plateau.

The whole region is rocky and barren, but in the south, i.e. just southward of the 1/3 Titania mines, there are scattered birch trees. There is a fair amount of marsh and peat bog throughout the region, and little cultivation except on a strip of farmland along the lower Gaddalsalven valley (see above, p. 2).

The A/S Titania mines are situated on the left bank of Sandfjorden. This stream flows down a very narrow valley which carries both a road (see III, Roads, Route 5) and a mineral railway. In the extreme south of the region another mineral line runs along the Gaddalselven valley to the abandoned Blafjeld and Ørland mines. 3. This region is bounded to the north by Gaddalselven, to the west and south by the main road, and elsewhere by the map limits. The area has an average length of 2½ miles and an average width of 2 miles.

The whole region forms a lake-studded plateau which reaches its greatest height in the broad mountain group running parallel to and overlooking Tøllenesvannet. Husebergshøien (303 m.) and Kirkefjeld are other high mountain groups in the region. Kirkefjeld lies to the south-east of Gaddalsvannet and Husebergshøien north-east of the head of Jåsingfjorden.

The long, narrow Tøllenesvannet (1½ miles x ½ mile) is the largest lake in the region, but little more than half of its total area is included within the limits of the map. To the west a smaller lake, Lønnervannet, is linked to Tøllenesvannet by a stream. To the south of Tøllenesvannet is Møllervannet (900 yards x 300 yards). Other lakes in the region include Stuvannet, Stamtjern, Søre Støltjern and Oddevannet.

The whole region is barren, desolate and rocky. There are few trees. Around the lake margins and in the hollow marsh and peat bog are frequent. Farm houses scarcely exist, and there are few paths.

4. The boundaries of this region within the limits of the map are formed by the river system, except in the south where it is bounded by the depression running from Tøllan on Raskofjorden to Skarv on Sagdalselven. This depression is about a mile in length.

The whole region forms a mountain block about two miles square. The grain of the country is north and south, and the area is crossed by Raskdalselven and Urdalselven. Between these streams Nonfjeld* stretches southward. This high ridge increases in altitude towards the south and reaches its greatest height just to the east of the head of Raskofjorden.

The southern end of Nonfjeld, overlooking Raskofjorden, has a steep western scarp bounding the eastern shore of the fjord. But this scarp decreases in height to the north, i.e. towards the headwaters of the Urdalselven.

The Nonfjeld is not nearly as steep on the eastern side of the ridge as it is to the west. Its eastern slopes are wooded with scattered birch and other deciduous trees, e.g. mountain ash.

Urdal carries the main road (Route 1) from Hauge to Raskeland (outside limits of map). In places the Urdal road is bordered by strips of flat cultivated land on which there are a few isolated farm houses.

Urdal is bounded to the east by the steep, scarped and wooded slopes of an extensive mountain block which slopes gradually on the south towards Hauge and on the south-east towards Vassdalsvannet. The surface of this highland is rough and irregular but the lower southern and eastern slopes are wooded. Near Hauge the woods are displaced by cultivated land (see above, p. 1).

The country immediately to the west of the upper valley of Raskdalselven is occupied by the southern extension of Skotfjeld. This highland consists of a succession of rough mountain blocks furrowed by transverse gorges. These gorges run at right angles to Raskdalselven and usually carry small streams. Parts of this northern division are wooded, and where the higher parts of the mountains are flat there is a thin soil covering. Even on the higher mountain slopes there are some isolated farm houses.

5. This fairly extensive tract of country stretches from Sagdalselven to the western shores of Jåsingfjorden, and is roughly two miles square. To the south it is bounded by an ill-defined series of depressions, in the centre of which is the Knudshol lake. South of the cultivated area along the left bank of Sagdalselven (see above, p. 2) the land rises to a rugged mountainous area with an average height of nearly 1,000 feet.

This highland is deeply dissected and furrowed. Three main furrows run north and south. One furrow, forming the eastern boundary of the region, carries the main road from Prestbø to Jåsingfjorden. The centre furrow carries two lakes, and the westernmost furrow has three small lakes along its floor.

Between these main north-south furrows the mountains are scarred by numerous gorges which have no definite general direction. The whole region is barren, rocky and uninhabited apart from a few farmsteads along the main road.

6. This region is a deeply dissected plateau bounded on the west by the eastern shores of Jåsingfjorden. For the most part the fjord coast is low and is backed by a low ledge all along Jåsingfjorden except around the promontory north-west of Ba.

* This name ("Non Mt." at U220 on G.S.G.S. Sheet 3 39 W) is considered improbable by Norwegians, but no more authentic version of it has been found.

Behind this coastal platform the land rises very abruptly to rugged mountain summits, most of which are over 1,000 feet in height. But the land between the mountains is cut down almost to sea-level by numerous gorges and gullies running at right angles to Jådingfjorden. A few ravines cross these gullies at right angles.

Apart from the general rugged nature of the region the land surface is very rough. Except for small areas south-east of the Holmen factory and to the north of Surrodden, there is little level or cultivated land. Even the lowest areas are rocky and boulder-strewn.

Marshes and peat bogs are numerous along the gully floors, and most of the region is devoid of trees. But there is one patch of woodland (600 yards x 200 yards), consisting of scattered birches, south-east of Holmen factory. On the mountains there is no vegetation on the highest summits, but there is some heather and moss on the lower slopes.

The region is drained to the south. A small stream flows south from the lake near Dylland. About 250 yards from the coast this stream is joined by a tributary from the east. To the east of the region Store Melkøved is drained by another stream which reaches the sea close east of the inlet of Træskeløkke.

Of the numerous lakes in the region Store Melkøved is the largest. This lake is about half-a-mile square and contains several islands. Lille Melkøved, to the south of Store Melkøved, is about 400 yards long and about 200 yards broad. The Dylland lake is about 450 yards long and 250 yards broad; Torsøved, in the north-west of the region, is 180 yards long and 35 yards broad. Most of these and the other smaller lakes of region 6 are irregular in shape and have high rocky shores.

There is little or no cultivation carried on in the region. Apart from a few houses at Lå, Dylland and Saeg the population is mainly confined to the shores of Jådingfjorden.

7. This region consists of two almost separate parts:-

- (a) a triangular tract of country along the western shores of Ræskfjorden, terminating in a narrow peninsula north-east of Nordfjorden, and
- (b) a narrow peninsula south-east of Nordfjorden.

(a) This roughly triangular division has sides of $1\frac{1}{2}$ miles, $1\frac{1}{2}$ miles, and 1 mile.

Its northern part, i.e. north of Ymerstein, rises fairly steeply from the western shores of Ræskfjorden to form three mountain blocks about a thousand feet in height and separated by two fairly wide V-shaped valleys. Of these three mountain blocks the southernmost, overlooking Ymerstein, is the highest and most extensive. All three mountains are rugged and craggy. There is little soil cover, but the lower slopes carry a few scattered trees.

East of Ymerstein there is a triangular stretch of lowland which broadens westward for a distance of half a mile towards the head of Nordfjorden. The northern strip of this low-lying area is flattest and carries the Ymerstein - Vatland road (see III, Roads, Km. 1 of Route 4). Just to the north of this road there is a narrow stretch of cultivated land extending for 300 yards. South of the road there is scattered woodland. The extreme west of the low-lying area overlooking Nordfjorden is rather rough and uneven. The peninsula between Nordfjorden and Ræskfjorden is about 1,400 yards long and 800 yards broad at its base. Between Trædal and Nordfjorden this peninsula is crossed by a narrow gorge about 500 yards in length. To the north of this gorge there is a high and rocky rectangular mountain block. To the south of the gorge the mountain mass is lower and descends gradually towards the southern end of the peninsula.

The western slopes of both these mountain blocks carry scattered trees, but elsewhere the surface is bare and rocky. Cultivation is very scanty, and is limited to the farms of Meltesen, Midthagen, Trædal and Dalen.

(b) This peninsula is about 1,300 yards long and 900 yards broad, and has a deeply indented coastline. At the root of the peninsula a rocky gorge, 900 yards long, runs from the head of Nordfjorden south-westward to the coast.

The north-eastern half of this transverse gorge has a rough uneven floor carrying a few scattered trees. Here the lowest part of the gorge is rather marshy. Near the coast the gorge opens out on to the north-eastern shore of a lake (200 yards x 150 yards).

To the east of the transverse gorge the surface of the peninsula gradually increases in height, reaching a maximum of just over 200 feet about 300 yards from the eastern end of the peninsula.

Two deep ravines cross the peninsula from west to east. Both have marshy floors.

The peninsula as a whole is bare, rocky and almost treeless. There is no cultivated land and only one dwelling.

8. To the north this region is bounded by the depression, one mile long, running from Volden near the head of Raskofjorden to Skurås near the western end of Årstadøy. This depression carries the road (see III, Roads, Route 4) and mineral line from Hauge to Volden and is flanked by narrow strips of cultivated land and scattered woods.

Between this northern depression and the lake called Hollevand on Plan 1 (the name is uncertain) there is a triangular block of upland. In the west this upland rises to a ridge some 1,200 yards long and about 300 feet high overlooking the eastern shores of Raskofjorden. Along the fjord the ridge is flanked by rather steep scarped slopes. But from this western crest the upland block slopes gradually eastward to Sogndalselven. Just to the west of Skurås the eastern and lower slopes carry scattered trees and rough pasture.

South of this upland block another depression some 1,200 yards long runs right across the region from Øveddén on Raskofjorden to Todhammer near Sogndalselven.

This central depression is lowest in the east where it reaches Sogndalselven, and maintains an almost level course for 500 yards as far as Hollevand (400 yards x 280 yards).

West of Hollevand the central depression continues for a further 500 yards to Raskofjorden. This western part of the depression rises rather steeply until it reaches a point about 130 yards east of the fjord. From this point the floor of the depression falls rather abruptly to the fjord shore at Øveddén. The depression carries a minor road (see III, Roads, Km. 2 of Route 5) from Todhammer round the southern end of Hollevand as far as Landland. But the latter settlement is situated on the hillsides above the floor of the depression.

At the southern end of Hollevand the Øveddén - Todhammer depression is joined by another trough running at right-angles to it. This latter depression runs from Hollevand to the head of Hellevik, a distance of some 500 yards. The floor of this north-south depression is fairly low, but its floor surface is rather rocky.

To the west of the Hollevand - Hellevik depression the land is mainly occupied by three parallel ridges about 350 feet high and running north and south for a distance of 700 yards. The easternmost of these ridges, i.e. that overlooking the Hollevand - Hellevik depression, is the longest and most continuous. All three ridges carry a fair amount of scattered woodland mainly composed of birch and mountain ash.

South of this wooded upland a low valley, 500 yards long, runs from south-east to north-west between Lågøvik and Raskofjorden. Near its north-eastern end this valley is blocked by low tree-covered hills, but its south-eastern end is cultivated and there are a few farmhouses. Cultivation disappears about 250 yards westward along the valley.

Farther south is a rocky peninsula some 700 yards long and 500 yards broad, lying between Lågøvik and the mouth of Raskofjorden. The grain of this rocky peninsula is north and south, and it has an average height of about 200 feet. The hills are deeply scarred and are devoid of acacia, trees or habitation.

To the east of the Hollevand - Hellevik depression is an upland block over 200 feet high and stretching north and south for a distance of 1,500 yards. This upland block culminates in one main ridge which has more gentle slopes to the west than to the east. Along the right bank of Sogndalselven there is a narrow cultivated strip about 1,000 yards long. As the central slopes of the upland block are reached, cultivated land is displaced by rough pasture. Somewhere the upland block gradually narrows until it is only 200 yards wide.

9. This region is bounded on the north-east by a depression running for a distance of 1,500 yards from Sogndalselven to the Krabedal Lake. To the south-east the regional boundary coincides with the deep ravine followed by the Krabedal stream running south-west for 700 yards from the Krabedal lake. The southern scoured margin stretches for 900 yards and the western boundary along the coast and Sogndalselven is about a mile long.

The floor of the northern depression from Sogndalselven to the lake is far from level, and is highest in the neighbourhood of Øvre Løvå. This depression is followed by a track, but does not carry a good road (see III, Roads, Route 2).

The Krabedal lake (400 yards x 330 yards) has an irregular oval shape. Its shores are low except to the south-east. At Krabedal there is a small area of cultivated land and a few houses. The Krabedal stream, issuing from the lake, follows a rather winding course, keeping close to the eastern side of its valley gorge.

Most of the region is occupied by hill country rising to over 550 feet along its eastern boundary. The surface is fairly regular when compared with Region 10, for example, and the general slope is downwards to the west from the high western wall of the Krabedal stream gorge. In the west of the region the lowland is broken

by a few craggy hills just to the east of Sogndalselven and the coast. Much of the hill country is bare, but in the north-west there is some scattered woodland of birch and mountain ash.

10. This region is about 1,300 yards square and lies between Region 9 and Jösingfjorden. Like Region 9 the present area mainly consists of hill country over 550 feet in height. But the surface of Region 10 is much more irregular than that of Region 9.

The hill country of Region 10 is highest in the centre and south, sloping towards the Krabodal stream. The slopes towards Jösingfjorden and the south-west coast are very craggy and steep (over 1:7). Almost everywhere throughout the region the rock surface is deeply fissured and fractured. In the southern part of the region there are two small lakes, the more westerly measuring 130 yards by 70 yards and the irregular T-shaped lake to the east 260 yards by 250 yards.

There is little or no vegetation, and the region is almost uninhabited apart from a few houses at the entrance to Jösingfjorden. There are no roads or tracks.

II. COAST REPORT

(Chart 3011)

JÖSINGFJORDEN

(Plans 1 and 2, serials 1 and 2, photographs 1-7, 18)

(1) General Description

Jösingfjorden extends inland for about 1½ miles from a treeless, steep and rocky coast, fringed in most places by rocks lying close off-shore.

The entrance, between Östre and Vestre Kvalen, is about 160 yards across, and the sides of the fjord are everywhere very steep. The north-western side of the fjord is sheer or strewn with boulders and, except at its extreme northern end, is uninhabited. The south-eastern side is uninhabited between Östre Kvalen and Halsen except for a few cottages at Vintorøst. Halsen is a rocky promontory about half way between Östre Kvalen and Jösinghamn near the head of the fjord; here there is a wharf serving a disused herring oil factory (photographs 2-4) with a tall chimney which, however, is not visible from seaward. Close behind the factory, in a house close to the main road, there is a telephone and telegraph office.

The A/S Titania quay is at Jösinghamn (photograph 18); there is another loading point for these mines at the head of Kækerfjorden (see IV, Resources).

At Nævre Hølløven, at the head of the fjord (photographs 2, 3, 6, 7), is a zinc factory, which has not been used for 20 years, and a power station supplying power to the titanium mines.

The old zinc factory wharf is near the head of the fjord, on its eastern side.

(2) Ice

The head of the fjord and the inlet north-east of Halsen may become ice up in February.

(3) Anchorages

Anchorages are as shown on the chart: the best is in about 28 fathoms, clay, 300 yards north of Halsen.

(4) Tides

Spring rise about one foot.

(5) Quays

(a) Jösinghamn A/S Titania quay

Concrete. About 80 feet long; 40 feet wide; deck level 6 feet above high water. Depth alongside is more than 30 feet.

There is a buoy close to the south-westward of the quay to assist in berthing. Ships securing to the quay put a line out to the buoy and, turning with bow south, drop alongside the head of the quay. There are mooring rings or bollards ashore both north and south of the quay.

Ore from the titanium mines at Sandbekk is conveyed to the quay in buckets by an overhead cable from the other side of the fjord. The terminal is a building built into the cliff-side above the quay; a chute and a conveyor, the outer end of which is movable, convey the ore from the buildings to the ship.

The main coastal road (see III, Roads, Km. 40 of Route 1) passes immediately behind the quay and beneath the ore chute (photograph 18).

(b) Halsen herring-oil factory wharf

Wooden, in a state of disrepair, and incapable of supporting any appreciable weight. Berthing is at the western side. About 150 feet long, 35 feet wide at north end and 50 feet wide at south end; deck level 5 feet

above high water. Depth alongside 18 to 20 feet. There is a small cut in the northern end of the wharf where small boats can secure: no steps. At the southern end there is a chamber for rowing boats, on the southern side of which there are several very small wharves for fishing craft.

In March, 1940, the warehouses and sheds on the wharf were in fairly good repair, but no care was being taken of them; nothing was stored in the warehouses, and it is probable that the Germans have removed the boilers from the sheds.

There is a telephone on the wharf.

Road connection from the wharf to the main coastal road (see III, Roads, Km. 10 of Route 1).

(c) Nedre Hallaren: zinc factory wharf

Wooden. In disrepair. About 200 feet long and 25 feet wide. The depth alongside is not known but is probably about 12 feet.

Immediate access to the main road (see III, Roads, Km. 12 of Route 1).

(6) Landing-places

Between Holmen and Nedre Hallaren the main road, besides being accessible from the wharves and A/S Titania quay, is also accessible from the fjord. It is from 6 to 8 feet above high water, and to reach it a short steep scramble over rocks would be necessary.

Landing is also possible in Vinterstø, 500 yards south-west of Holmen; here again the rocky coast would necessitate a scramble landing. A track leads from Vinterstø to the main road south of Holmen (see III, Roads, Km. 9.5 of Route 1).

At Km. just outside the fjord, and 400 yards east of Østre Kvalen, there is a small fishing settlement with a shelving beach up which small boats can be hauled. There is, however, no road connection.

(7) Road exits

From Holmen the coastal main road (see III, Roads, Route 1) winds south and east across hilly country to Lønsdal and Flakkefjord.

From Nedre Hallaren it follows the valley for about 500 yards, passing close to the power station; it then climbs the rocky hill face which forms the north-western side of the fjord. Above Nedre Hallaren it passes through tunnels about 120 yards long, and then turns north and west to Prestbø and Sæge, whence branch roads give access to Sogdalsstrand, Rækefjord and the A/S Titania mines (see III, Roads, Routes 1-5).

COAST BETWEEN JØRINGFJORDEN AND RÆKEFJORDEN

(Plan 1, aerial 1)

Jøringfjorden to Sogdalsstrand

Between Østre Kvalen and Sogdalsstrand, $1\frac{1}{2}$ miles to the north westward, the coast is steep, rocky, and almost black in colour. It is nowhere suitable for landing operations. There are several rocks lying close ashore, and three rocky and uninhabited islets lie to the southward of Sogdalsstrand; they are fairly low-lying and comparatively flat-topped. Langholmen, the most southerly one, is the highest of the three; it is about 330 yards long and 100 yards wide.

Sogdalsstrand

Sogdalsstrand, a fishing village with a population of not much over 200, lies at the mouth of Sogdalselven. This village, together with Rækefjord village, constitutes the borough ('by') of Sogndal, with a total population of just over 300. This is one of the smallest boroughs in Norway, and is administratively distinct from the rural district ('herred') of Sokndal, whose main centre is Sæge village.

The main entrance to the harbour is through Væbelsundet, between the mainland and Langholmen. The harbour can also be entered from the westward through Skitløp, but this channel is very narrow, and as there are rocks in the entrance, local knowledge is required for its passage.

The harbour, which has depths of from $1\frac{1}{2}$ to $5\frac{1}{2}$ fathoms, is seldom used: it is exposed to southerly winds in winter, and in spring and autumn, after heavy rains, the tidal stream sets strongly out from Sogdalselven through Væbelsundet. There are mooring rings in the small bay on the eastern side of the harbour.

A small dog-legged jetty projects southward from the western side of the mouth of Sogdalselven: it is suitable for small boats only, and the approach to it is foul.

The village itself is more compact than Rækefjord; it lies on both sides of Sogdalselven, and is connected by a bridge. The houses on the eastern bank of the river are compactly grouped; those on the western bank are more numerous, but are strung along the river side. There is a telephone and telegraph office and a few shops in the village.

On both sides of the river motorable roads run northward to join the coastal main road, which is here about $1\frac{1}{2}$ miles inland at its nearest point (see III, Roads, Routes 2 and 3).

Sogndalsfjord to Rækkfjord

This stretch of coast is again steep and rocky, and there are many rocks and islets close off-shore: the largest of these is Tyvholmen, which is rocky, steep-sided and uninhabited.

The only possible landing-place is a very small inlet forming the head of Iågvik, half a mile north-west of Sogndalsfjord; the foreshore here is probably gravel and there are several fishermen's cottages. A narrow road leads north-westward to Rækkfjord (see III, Roads, under Route 4). The approach to the inlet is from either side of a rocky patch which lies off the entrance.

RÆKKFJORDEN

(Plans 1 and 3, serials 1 and 3, photograph 8)

(1) General description

Rækkfjorden extends inland for about a mile: the sides of the fjord, though high and steep, are not as sheer as those of Jålingfjorden. The narrowest point in the fjord is at Gævingdalen, about a quarter of a mile within the entrance, where it is about 80 yards wide. It is impossible to enter the fjord with strong southerly or south-westerly winds.

Rækkfjord village is a port of call for coastal steamers, and consists of a number of scattered cottages along the north-eastern side of the fjord. There are a number of cottages on the northern and north-western sides of the fjord also, and the population of the whole area is probably about 200.

The A/S Titania jetty is at the head of the fjord, at the northern end of the village.

The steamship quay is at Gveodden, a small promontory near the southern end of the village.

There are also small wharves close to the eastward of Stålovik and at Måthagen.

In the village there are a few shops, a chapel, and a telephone and telegraph office: the latter used to be about 450 yards north-east of the steamship quay, but it is possible that it has been moved.

Other buildings are a fisherman's storehouse, ('ajhus'), on the point north of Gveodden, and a very small crab canning factory near the steamship quay. The latter is open only during the crab season (from the end of August until November).

A pilot, whose section of the coast is from Rækkfjord to Stavanger, is stationed at Rækkfjord: his house, to which is attached a small general store, is on the eastern side of the fjord near its head.

A house known as Slottet ('castle') is a conspicuous landmark close northward of Stålovik wharf (serial 3, photograph 8).

The nearest hotel is Janssens Hotel (21 beds) at Hauge, about a mile to the eastward of the head of the fjord.

(2) Ice

Drift ice enters the fjord in winter and may at times prevent small craft from berthing alongside. February is the worst month.

(3) Anchorage

Ships can anchor in 13 fathoms off Tyvhol, on the western side of the fjord, where there are mooring rings. Small ships can anchor further in, off Rækkfjord village or Rødhellen; the bottom is clay.

(4) Tides

Spring rise: about one foot.

(5) Quays

(a) A/S Titania jetty (head of fjord):

Wood. About 200 feet long; 20 feet wide; deck level about 10 feet above high water. Depth alongside about 18 feet.

Berthing is on the western side of the head of the jetty, which lies at an angle to the northern and shallowest part of the jetty. Berthing length is about 80 feet. The eastern side of the jetty is shallow. Ships anchor close to the northward of the inlet about 150 yards south of the jetty, and drop astern alongside the jetty with bows south.

The jetty is served by a light railway from the titanium mines at Sandvick; loading is carried out by conveyor. There is a large building for storage of magnetite concentrates.

The jetty leads onto a good road running north and south (see below, 7, Road exits).

(b) Steamship quay (east side of fjord):

Stone. About 120 feet long, 25 feet wide, deck level about 4 to 5 feet above high water. Depth alongside 18 to 20 feet. There is a small and low store shed at the northern end of the quay and on the northern end there is a two-story private house owned by the steamship agent ('arspelit'). The ground floor is an office; the living quarters are on the first floor. Telephone.

A good road runs north from the quay to the head of the fjord; a narrower road leads south to Høyen and thence south-east to Lågervik (see below, 7, Road exits).

(c) Wharf for fishing craft (east side of fjord):

Wood. About 60 feet long and 12 to 15 feet wide; depth alongside 10 to 12 feet. Suitable for fishing craft only. Situated alongside the road which runs through Raskofjord village (see below, 7, Road exits). There is a small shop on the wharf.

(d) Stålerik wharf (west side of fjord):

Three-quarters concrete, one-quarter wood. About 65 feet long, 10 to 15 feet wide, deck level 4 to 5 feet above high water. Depth alongside about 12 feet.

There is a general store on the concrete part of the wharf.

Near this wharf there is a tank for gas oil, capacity 65 cubic metres. Immediate access to the road following the west side of the fjord (see below, 7, Road exits).

(e) Midthagen wharf (west side of fjord):

Wood. About 60 feet long; 10 to 15 feet wide. Depth alongside about 12 feet. Narrow road to Ymerstein, thence westerly road to the head of the fjord (see below, 7, Road exits).

Twisted, close south of Midthagen, used to be a place of export for live and salt fish. Fish were loaded by fishing craft berthed alongside the natural rock. It is not known whether this is still the practice.

(6) Landing-places

The road between the steamship quay and the A/S Titania jetty, besides being accessible from both these points and from the fishing craft wharf, is also accessible from the fjord. It is about 8 feet above high water, and to reach it a short steep scramble over rocks would be necessary.

Access to the narrow road between Midthagen and the head of the fjord can also be had by a short scramble over rocks except at Ymerstein, where a muddy foreshore gives access to a narrow strip of grassland behind which the land is high and rocky.

(7) Road exits

(a) East side of fjord: from the steamship quay at Oveclien a good road (see III, Roads, Route 4) closely follows the shore northward through Raskofjord village, and passes close behind the A/S Titania jetty. At the head of the fjord it turns eastward to Høyen, the main focus of routes in this area.

Southward from Oveclien a narrow road, probably not suitable for motor traffic, follows the shore to Høyen, whence there is a narrow road or track across the peninsula to the head of Lågervik.

(b) West side of the fjord: from the wharf at Midthagen a narrow road, probably not suitable for motor traffic, follows the shore northward and westward to Ymerstein. From Ymerstein a narrow but motorable road runs westward to Vatland and northward along the shore to the head of the fjord, passing close behind the Stålerik wharf. At the head of the fjord it is joined by a bridge to the Raskofjord - Høyen road described above.

NOTES ON THE

This shallow and narrow, steep-sided fjord lies immediately west of Raskofjorden; it extends in a north-westerly direction for about three-quarters of a mile, the inner 600 yards of which dries out at low water. It is about 100 yards wide at its narrowest part and is nowhere suitable for landing operations.

Præsteskjærene are two low, bare, and rocky islets which form the eastern entrance point to Raskofjorden and the western entrance point to Raskofjorden. The two islets are joined together by a small bridge; another bridge joins the larger of the islets to the mainland. The lighthouse is on the smaller of these islets (30 yards x 20 yards). The larger (300 yards x 150 yards) is uninhabited.

The fjord is normally used by a few small fishing craft, but in winter it is liable to become filled with drift ice.

A narrow valley runs eastward to Ymerstein, on Raskofjorden; to the westward the land is barren and rocky. The Ymerstein - Vatland road passes through this valley and close round the head of the fjord, see above under Raskofjorden, 7 (b).

III. ROADS1. GENERAL DESCRIPTION OF SYSTEM (Plg. 2)

The coastal main road from Flakkefjord to Egersund (State Road No. 40) passes through the area covered by this Report at distances of from three-quarters of a mile to $2\frac{1}{2}$ miles inland. The relevant portion of this road is described below as Route 1.

Only in the inner part of Jßeingfjorden, along its eastern shore, is there direct access to this road from navigable waters (see above, pp. 15-16). Two secondary roads giving access to it from the coastal settlement of Segndalstrand are described below as Routes 2 and 3. It can also be reached from Rækkelfjord village, on the eastern shore of Rækkelfjorden (see above, pp. 7-9), by the secondary road described below as Route 4.

The inland main road from Flakkefjord to Stavanger (State Road No. 140) passes behind the area covered by this Report at distances of from 10 to 15 miles inland. Secondary roads giving access to it from the coastal main road are described below as Routes 5 and 6.

The main focus of routes is in the neighbourhood of Hauge village. Routes 1-5 all converge on the road junctions of Hauge and Presttve, which are only one mile apart (see miles 11 and 12 of Route 1).

The Flakkefjord - Stavanger Railway closely follows the course of the inland main road. There are stations on this line at Moi, Eide and Helleland, the terminal points of Routes 3 and 6 and of the north-westward branch from the latter.

ROAD REPORTSROUTE 1.

Part of State Road No. 4

ÅSENES - RAGDAL(14 $\frac{1}{2}$ miles - 22.9 Km.)

via Hølsen (Jßeingfjorden) - Hauge (Segndal)

Category: D 3

Plans 1, 2, 4; Aerials 1, 3, 4; photographs 2, 4,
5, 6, 7, 9, 16.

S.S.S.S. 4090 (1:100,000): 4A and C 39 N.

This is part of the coastal main road between Flakkefjord and Egersund. All overland traffic to the Jßeingfjorden - Segndal area has to pass through one or other of these two towns, either by the coastal main road or by the inland main road which also connects the two towns. From this inland main road there is access to the Segndal district by three secondary roads which branch off at Moi, (Route 3), Eide (Rækketst) (Route 5), and Helleland (branch road joining Route 6 at Km. 11.1).

CONSTRUCTION

Sand and gravel on stone foundation. Width in 1939, 8 $\frac{1}{2}$ - 13 ft., with several passing places. The stretch between Flakkefjord and Egersund has been reconstructed since the invasion, and it has been reported that this work was completed in the summer of 1942, and that the road for its whole length can take two-way traffic. This has not been confirmed, but is believed to be probable except for the stretch through cuttings and tunnels around the head of Jßeingfjorden.

CONDITION

Well maintained in summer 1942.

BRIDGES

Km. 0

ÅSENES bridge (A 4/113403).

Steel lattice girder with concrete surface; span 210 ft., track 14 ft. 1 in. This bridge belongs half to Ragdalen county and half to Vest-Agder county.

According to official plans from the former the carrying capacity is 12 tons, the latter states only 5 tons. It is known that 10-ton loads have passed across the bridge.

Km. 0.4

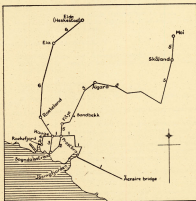
HØLSESTØEN (A 4/113403).

Iron girders with concrete surface; span 19 ft.; width 9 ft. 2 ins.; carrying capacity 12 tons; built 1929.

SOGNDAL DISTRICT : ROADS

Key to Route Numbers

—SCALE—



- Km. 2.2** **LOKSENGEN** bridge (L A/101124).
Stone arch, span 16 ft. 5 ins.; width 9½ ft.; carrying capacity unknown; built 1917.
- Km. 12.12** **JØSSINGHUS** bridge (L A/068153).
Concrete plate construction, ('platebro'); span 15½ ft.; width 14½ ft.; carrying capacity 12 tons; built 1927.
- Km. 12.20** **HEILESENHØKEN** bridge (L A/068154).
Concrete plate construction ('platebro'); span 16 ft. 5 ins.; width 16 ft.; carrying capacity 12 tons; built 1927.
- Km. 17.6** (a) **Nær FRESTING** (L A/068175).
Not marked on map, but see aerial L. No details, but it is both longer and wider than the old bridge.
(b) **OLD FRESTING** (L A/067174). Marked on map. Two spans: one stone arch 52½ ft. (built 1902), one iron girder with wooden surfaces, 36 ft. (extension 1910); width 8½ ft.; carrying capacity unknown.
- Km. 22.0** **RÆKELAND** bridge (approx. C 39 W/08-108). Culvert type, covered by slabs; span 7½ ft.; width 16 ft. 5 ins.; carrying capacity 12 tons.

On the road from Sandra eastward to Flakkefjord - 19.4 Km. (12 miles) - there are 7 bridges, the largest of 27½ ft. span. Two of the smaller bridges have a carrying capacity of only 3 tons, but during the invasion the Germans drove across with guns as well as large tank lorries. The railings of these two bridges were taken away, as they were too narrow to allow the lorries to pass.

On the road from Rækeland westward to Egersund, 27.5 km. (17 miles), there are 5 bridges, the largest of 33½ ft. span.

FERRIES

There are no ferries on this stretch.

GRADIENTS

- Km. 8.5** **STERNVÅG** Lake: road descends steeply to Halsen (L A/061142).
Km. 12.2 Road ascends steeply from Hølleren and runs through galleries and tunnels.

SHARP TURNS

- Km. 1 - 10** Road runs in curves.
Km. 12.2 Hairpin bend in ascent from Hølleren.
Km. 22.9 At Rækeland road junction the main road turns sharply.

VULNERABLE POINTS

From about Km. 11½ to about Km. 13 the road is extremely vulnerable and can easily be blocked.

Plan L shows this part of the road, which first goes through a tunnel 66 m. (217 ft.) long, then winds uphill through galleries protected against snow and landslides and through tunnels of a total length of 113 m. (370 ft.). The longest of these tunnels is 80 m. (262½ ft.) and the inside was originally chalked white to facilitate traffic. The type of tunnel is illustrated by photograph 3.

The whole stretch of road around Jøisingfjorden has been curbed.

AIR COVER

The road runs practically for its whole length through open wooded country, giving no cover against air observation.

SEASONAL VARIATIONS

The road is kept open in winter by snowploughs fixed to trams. During the spring thaws of April, 1940, the road was very soft, but the Germans brought up guns and heavy tank lorries from Egersund to Flakkefjord.

ITINERARY

Miles	Km.	Altitude in ft. less than 100 ft. marked thus	ROUTE
			(Main road from Flakkefjord to Åmås bridge, 19.4 km. (12 miles) goes up and down hill between gorges and ridges. There are some woods along the first part of the road; the remainder passes through treeless country except for the area around Åmås bridge, where the land is wooded again).
0	0	-	Bridge across Åmås (L A/115103).
		600	Road crosses two bridges at Km. 0.4 and Km. 2.2 (see above, Bridges), and climbs gradually up to about 600 ft. Many curves. Road runs through an undulating, desolate and treeless mountain district. (On G.S.S.S. 4090, Sheet 1A, second edition, the main road is shown to divide at 098127 and re-join at 068157. This is wrong, as there is only one road, which runs as the one shown to branch left (the more southerly), and takes the longer of the two routes shown at the head of Jåsingfjorden).
5½	8.5	492	Storvål Lake (L A/068140). Road descends steeply, and goes through a little wood to
6	9.5	197	DYDLAND road junction (L A/060140). Keep right. (On left, narrow, winding road about 1.5 km. to Dydland farm (L A/056123) whence a new road, about 1.5 km. (not marked on sheet 1A), has been built to the German gun positions at Ruvoråsen (L A/045128)). Road winds down through the wood (photographs 2 and 4), and before it reaches Jåsingfjorden a narrow road or track branches left to Vinterstø (L A/057142).
6½	10	-	HELAN (L A/061142). Small settlement on eastern shore of Jåsingfjorden. Keep right. (On left, two side roads to the wharf; see above, pp. 16-17). Road follows eastern shore of Jåsingfjorden (photographs 2 and 4) passing under chute between 1/3, Titania quay and storage installation at Jåsingfjorden (photograph 18). Close behind the disused zinc factory wharf it enters a tunnel 217 ft. long. (Plan 4, photographs 5, 9, 18.)
7½	12	-	HEIDE HELLEREN Factory and power station (photographs 2, 3, 6, 7). Road crosses bridges at Km. 12.12 and Km. 12.20 (see above, Bridges). Road makes winding ascent across Hølland valley, passes through rock galleries with covers and through tunnels of a total length of 570 ft. A curb is laid along the road on this stretch. (Plan 4, photographs 4, 7, 3).

Miles	Km.	Altitude in ft. less than 100 ft. marked thus -	ROUTE
		492	Road reaches about 492 ft., then descends past Stentjern lake and turns westward to follow left bank of Gaddalselven. The whole stretch is practically treeless.
11	17.6	-	PRESTERO road junction (4 A/049175). Keep straight on over the new bridge (see above, Bridges) across Bogdalselven at the confluence of Gaddalselven and Vasendalven. (On right, narrow bridge (not marked on sheet 4A), probably only a footbridge, across Gaddalselven just above the confluence of this river and Vasendalven. On the opposite bank there is a short narrow road to Kest farms (4 A/053176). Here the road joins the narrow-gauge railway from Rækkjærd along Gaddalselven to the disused mine workings at Hårfjeld and Ørland. The track of this railway may have been removed from about Kest, so that it can possibly be used as a road to the mines). (On left, Route 2 to Bogdalsestrand). Road on right bank has been reconstructed (aerial 4) and runs direct to
11½	17.8	-	FRILAND road junction (4 A/046176). Keep straight on. (On right, Route 5 to Sandbak and Mol.) (On left, old main road to crossing by the old Feather bridge). Road crosses narrow-gauge railway about 150 yards further on, passes the straggling farmsteads of Friland and ØB, then turns left at Bogdal church to
12	19.4	-	HUKE village and road junction (4 A/031477). Turn right. (On left, a short distance above this road junction, a narrow bridge - probably only a footbridge - crosses Bogdalselven at 4 A/038176, whence a short narrow road runs to Krested on Route 2. (Neither the bridge nor the road leading from it is marked on sheet 4A, but see aerial 1)). (Straight on, Route 3 to Bogdalsestrand). Road runs along partly wooded Urdal valley, crossing a bridge (culvert type) at Km. 22.0 (not as shown on sheet C 39 U), to
12½	22.9	?	RØKKELAND road junction (C 39 W/021205). On left, main road continues to Egersund, 27.5 Km. (17 miles) away. A sharp turn at this junction. This road runs mostly through 'hed'-land (hills, gorges and lakes), with only scattered trees, reaches a height of about 660 ft., and descends to Gidlen. From Gidlen the road runs through open, well-tilled and rather flat country to Egersund. On right, Route 6 to Eide, with branch to Solleland.

ROUTE 2

SOGDALSTRAND - PRESTERO

(2½ miles - 3.9 Km.)

via Årstad

Category: C 5

Plan 1, aerials 1 and 4

S.S.G.S. 4090 (1:100,000): 4A

A parish road affording access from the coastal settlement of Sogdalsstrand to the coastal main road at Prestero bridge and road junction (Km. 17.6 of Route 1).

The road is narrow, but there are passing places and it is used for motor traffic.

ITINERARY

The road starts from that part of Sogdalsstrand village which is on the left bank of Sogdalselven just above its mouth. A bridge joins this part of the village to the part situated along the right bank (see above, p. 19), which is the starting point of Route 3.

At about Km. 1.2 (AA/035164) a track branches left and crosses a narrow bridge (probably a footbridge) across the eastern arm of Sogdalselven on to Årstadby. The track continues across the island and crosses the western arm of Sogdalselven by a similar bridge at AA/035169 to join Route 3 close west of Hauge village.

The road then takes an eastward bend to avoid the lake east of Årstadby. From the Nævre Laurås group of farms, on the eastern side of the lake (AA/035164), a track branches south-eastward to the farms of Øvre Løyde and Knektedal. The road then proceeds northward through cultivated land to the Årstad farms (AA/035174). (See side road from this point see Km. 19.4 of Route 1).

From the Årstad farms the road turns eastward and approaches Sogdalselven. At about Km. 3.8 the old Prestero bridge crosses Sogdalselven on the left, carrying the old main road which rejoins Route 1 at Km. 17.8.

Route 2 then follows the old main road for the remaining 100 yards to its junction with Route 1 at the new bridge (aerial 4).

ROUTE 3

SOGDALSTRAND - HAUGE

(1½ miles - 2.8 km.)

Category: C 5

Plan 1, aerials 1 and 4

S.S.G.S. 4090 (1:100,000): 4A

A County road giving access from Sogdalsstrand to the coastal main road at Hauge road junction (Km. 17.8 of Route 1).

This is a better quality road than Route 2, and may be capable of taking two-way traffic.

ITINERARY

The road starts from the southernmost point of that part of Sogdalsstrand village which is on the right bank of the river. A bridge joins this part of the village to the part situated on the left bank (see above, p. 19), which is the starting-point of Route 2.

At about Km. 2 (Tofthammer road junction, AA/035168) a narrow road branches left and winds across country to Høyen, on the eastern shore of Røkkfjorden, thence along the shore to Øveolien (AA/046169), the starting-point of Route 4.

Beyond this point the road skirts a patch of cultivated land north-west of Årstadby, passing through the Skarås group of farms.

At about Km. 2.4 (Tyrneskogen road junction AA/037174) the road is joined by Route 4.

From this junction the road runs eastward to Hauge village, where it joins Route 1 at Km. 19.4.

Just before this junction it is joined by the track crossing Årstadby from Km. 1.2 of Route 2.

ROUTE 4

RASKEDAL - HAUGE

(2 miles - 3 km.)

Category: C 5

Plans 1 and 3; aerials 1 and 3

G.S.G.S. 4090 (1:100,000): 4A

A County road giving access from the eastern shore of Raskedfjorden to the main forms of routes at Hauge.

This road is of much the same quality as Route 3, and may be capable of taking two-way traffic.

ITINERARY

The starting-point of the County road is the steamship quay at Øresiden, at the southern end of Raskedfjord village (see above, pp. 20 - 2).

Southward from Øresiden a narrow road, probably not suitable for motor traffic, follows the eastern shore of Raskedfjorden to Høyen (44/016164), whence a track or narrow road crosses the peninsula to the farms at the head of Løgvik (44/019160). (See also Km. 2 of Route 3).

Northward from Øresiden the County road runs through Raskedfjord village and along the rocky eastern shore of Raskedfjorden.

At about Km. 1 a road branches left over a bridge across the mouth of Raskedalselven (44/017178). This is a parish road, narrow but suitable for motor traffic, which follows the western shore of the fjord southward to Stålevik and Tamarstein, then crosses the peninsula to the head of Nordfjorden, and continues westward to Vatland (3 D/973195). From Tamarstein there is a short narrow road, probably not suitable for motor traffic, along the coast to Midthagen (44/012168).

At Vatland, a short distance beyond the bridge mentioned above, Route 4 turns eastward along a ravine, which broadens out into a valley, and proceeds to Tynneskogen road junction (44/027171), where it joins Route 3 at Km. 2.4. This junction is about a quarter of a mile from Hauge road junction, where Route 3 joins Route 1.

The only side road on this stretch is a narrow one which branches left at Vatland road junction (44/019180), just before the entrance to the ravine, and follows the valley of Raskedalselven to the Raskedal farms only.

ROUTE 5

HIGHLAND ROAD JUNCTION - SANDBEKK - MOI

(18½ miles - 29.8 Km.)

Category: C 5

Plans 1 and 3; aerials 1 and 4

G.S.G.S. 4090 (1:100,000): 4A and C 39 W.

A parish road linking the coastal main road (Route 1) with the inland main road from Fiskefjord to Storanger.

This is a narrow road, and allows only one-way traffic with occasional passing places.

There are some very hilly stretches, and many curves.

ITINERARY

Miles Km.

0	0	HIGHLAND road junction (44/046176). Road branches northward from Km. 17.8 of <u>Route 1</u> , skirts west side of a wood then turns north-eastward and bridges Vasendalselven just before.
1	1.5	MOI road junction (C 39 W/081191). Keep right. (On left, side road to Båke and Groland, C 39 W/083110, 3.7 Km.) Road turns east towards the right bank of Sandbekken, which it follows north-eastward.
2.2½	2.3.5	(On right, at C 39 W/061196 (plan 5, aerial 4), two bridges across Sandbekken to A/S Titanis mines at Sandbekk). Road continues along right bank of Sandbekken, bridges the river at C 39 W/086225, and runs north-eastward past Algfjord farms to

Miles	Km.	
5½	8.6	Road junction at C 39 W/010233. Keep right. (On left, side road to Grestad and Viken, 3.7 Km.) Road winds eastward through the Mykland group of farms, swings southward to skirt Bredalsfjeld, then runs north-eastward to reach the west shore of Lundevand at
16½	26	SKÅLAND road junction (C 39 W/201240). Keep left. (On right, a parish road runs southward along the west shore of Lundevand. This road has not yet been extended as far as Rensire). Road continues northward along west shore of Lundevand to join the inland main road at
18½	29.8	MØI (C 39 W/205270). Station on the Flockefjord - Stavanger railway.

ROUTE 6

County Road No. 471

BARRELAND - EIDE
(14 miles 17.6 Km.)

via Eia

Category: C 5

G.S.G.S. 4090 (1:100,000): C 39 W

A County road linking the coastal main road with the inland main road from Flockefjord to Stavanger.

This is a good motor road, narrow but with many passing places. The road is somewhat hilly.

ITINERARY

Miles	Km.	
0	0	BARRELAND road junction (C 39 W/021205). Terminus of Route 1. Road branches northward from coastal main road and follows Urdal valley.
1½	2.3	Road junction at C 39 W/025232. Keep straight on. (On left, side road to Goutland C 39 W/018242). Road passes to left of Barrestad village and Barstadvand.
3½	5.5	Road junction at C 39 W/030247. Keep right. (On left, side road to Refsland C 39 W/013273, 3.8 Km.)
7	11.1	EIA road junction (C 39 W/058297). Keep right. (On left, a fair motor road, category C 5, to Helleland C 39 W/002400, 13 Km., on the inland main road and railway).
8	12.8	Road junction at C 39 W/071299. Keep left. (On right, side road to Steine C 39 W/076253, 1.3 Km.) Road winds north-eastward between a series of small lakes.
9½	15.6	Road junction at C 39 W/086307. Keep right. (On left, side road to Dybing C 39 W/084340, 3.6 Km., and Mykland C 39 W/082342, 3.1 Km.). Road continues on north-west side of Eidevand to join the inland main road at
11	17.6	EIDE (HEKKESTAD) (C 39 W/100314). Station on the Flockefjord - Stavanger railway.

IV. RESOURCES(1) INDUSTRIES

Except for the 1/3 Titania mines and ancillary installations which are described in detail below there are no industrial establishments of any importance in the area. Four small establishments are reported; the available particulars of these are summarized at the end of the present section.

1/3 TITANIA TITANIUM AND IRON ORE MINES (Admiralty Chart 3011 at 58°21'50"N 60°20'10"E approx.; G.S.G.S. 4090 Sheet C39W at 0619)

General

The mine, which is operated by 1/3 Titania (owners: Titan Co. 1/8, Fredrikstad; American and Norwegian capital; head office at Øra, Fredrikstad) produces titanium

iron ore, which is processed to ilmenite and magnetite concentrates. The mine is about 28 miles north-north-west of the head of Jödingfjorden, close south of Sandbakk farm. It lies in a little valley on the east side of Sandbakk, one of the tributary streams which meet to form Sogndalselven (see Fig. 1). Adjoining the mine is an ore-dressing plant. A narrow-gauge railway (for transport of magnetite concentrate) connects the ore-dressing plant with the storage installation (2,400 tons capacity) and shipping point at the head of Rudefjorden; an aerial ropeway (for transport of ilmenite concentrate) connects the ore-dressing plant with the main storage installation (20,000 tons capacity) and shipping point on the east shore of Jödingfjorden about a quarter of a mile from the head of the fjord.

The mine and adjoining installations, the railway, the overhead cable way and the storage and shipping points are dealt with separately below.

The mine is the largest producer of ilmenite in Europe and the chief supplier of this mineral to Germany and Italy. Ilmenite is an important source of titanium oxide; it is used in the manufacture of titanium white, a substitute for white lead in paint.

It is also known that the Germans intend to make use of titanium ore from this mine to produce ferro-titanium at Messner Ferro-alloy works (Nord-Trøndelag) and in Germany, to be used in special steel for armaments. The bulk of the ilmenite is believed to be shipped to Germany. The post-war consumers are stated to have been:

- (a) I.G. Works at Leverkusen;
- (b) Soc. de Ferros Karas at Thann near Strasbourg;
- (c) the Montecatini factory at Bovegno, in Northern Italy.

The rest of the ilmenite was consumed in Norway (? after prior treatment elsewhere) by A/S Titan Co.'s factory near Fredrikstad, producers of "Kronos" Titanwhite (titanium white for white paint) and "Tasla" Stribeslud (ship's paint).

Titanium tetrachloride is produced from titanium oxide and chlorine, and has been used for making smoke screens. Less important uses of titanium oxide are for the paper, rubber, and artificial silk industries. The magnetite, which is reported to contain about 0.5 per cent. vanadium, is sent partly to A/S Brønnøysund Kraftverk's pig-iron works at Brønnøysund (Sogn og Fjordane) and partly to Kristiansund Spikerveik (pig-iron works and rolling mills), Oslo. Production figures in recent years have been as follows:

	1938	1939	1/1/42 = 30/9/42
	tons	tons	tons
Ore	159,183	187,180	-
Ilmenite concentrate (44% TiO ₂ , 35% Fe.)	49,481	55,027	43,787
Magnetite concentrate (65.50% Fe., 3.35% TiO ₂ , 0.3% approx.	13,543	13,179	9,408

On the basis of the production figures given in column 3 for the first nine months of 1942, production in 1942 would be about 98,300 tons ilmenite concentrate and about 12,590 tons magnetite concentrate.

The Germans are known to be greatly interested in raising the production of the mine, and in 1941 labour was released from German defence works and sent back to the mine. The mine is also included in the list of industrial undertakings important to the German war economy coming under the German forced labour order, of the summer of 1941.

From 1939 statistics it is clear that, at the beginning of 1940, there were underground stocks of about 150,000 tons of ore, which was already mined and lying in the stopes above the main haulage drive. This, and the relatively easy method of working the mine, should make it possible to raise the production to 60-70,000 tons of ilmenite concentrate per year. The full capacity of the ore-dressing plant is reported to be about 100,000 tons of ilmenite concentrate and 20,000 tons of magnetite concentrate. Normally about 40 hands are employed underground and about 80 hands in the ore-dressing plant and surface workings.

The mine and adjoining installations

The layout of the mine and adjoining installations, the ore-dressing plant, the starting point of the narrow-gauge railway and overhead cableway, etc., are shown in detail on plan 5, aerial 5, and photographs 10 to 17.

The text below describes the working of the mine and the flow-sheet of the ore-dressing plant, and should be referred to in conjunction with the above-mentioned plan, aerial and photographs. The numbers in the text refer to numbers on plan 5.

The ore is mined both by underground and surface workings. In 1939, 33 per cent. of the ore mined came from the surface workings.

All the ore, including the ore from the surface workings (1) is hauled through the main drive, which lies about 220 ft. above sea level and probably enters the mine in a south-easterly direction at 2. The ore is drawn from the stope in the mine and carried out of the drive by tipping wagons (which are probably driven by storage battery locomotives) to the primary crushing installation (for crusher) (3). The ore is then carried by a conveyor (4) to the intermediate crushing installation (5 and 6), which is equipped with a small ore bin (5) for regulating the flow to the cone-crusher house (6), thence by conveyor (7), to another regulating bin (8) which contains sufficient ore for 24 hours production. From this regulating bin the ore is transported by conveyor (9) to the grinding and concentration plant (10). In this building the ore is ground in rod mills, and the pulp is then passed on to Wilfley vibrating washing tables, and to magnetic separators; the concentrate is dried in an oil-heated rotary drier, and again passes through magnetic separators which separate the magnetite concentrate from the ilmenite concentrate. The sand is carried probably by a subsidiary aerial ropeway running parallel with the main ropeway, and tipped at the waste dumps above the mine. The concentrates are reported to be stored in a bin, thought to be at 11, containing seven compartments of 1,000 tons capacity each. From this bin the concentrates are thought to be distributed to the dispatching points (railway and ropeway terminals) by a conveyor system (12).

The workmen and officials are quartered in dwelling scattered about the surrounding area; about 200 yards upstream from the dressing plant is the main building of Sandbekk farm, where the workshop foreman and his family live, and where there is a building housing 20 to 40 workmen. A few hundred yards further on there is reported to be a group of 5 or 6 workmen's dwellings.

Details are lacking on the following important points:

- (1) Water conditions in the mine; none of the available reports gives any indication as to whether the mine is a wet or dry one, or what pumping equipment, if any, exists. Similarly, there is no information regarding the water supply system for the dressing plant.
- (2) Location of mine entrances; photograph 12 shows the entrance to the main haulage drive, which is thought to be at 2 on plan 3, but this is not confirmed. There are undoubtedly other means of access to the underground workings.
- (3) Explosive stores; no information as to location.
- (4) Compressor plant; this may be at the point shown on photograph 12 and at 20 on plan 3, but this is not confirmed. The compressed air line is shown entering the main haulage drive on photograph 12.
- (5) Battery charging station; as stated above, the wagons carrying ore from the mine are hauled by locomotives thought to use storage batteries (see photograph 12). There is no information as to the location or equipment of the plant for charging these batteries.
- (6) Transformer station(s); no information.

It may be noted that the air reconnaissance available of the mine and immediately adjoining area is limited to a single photograph which is reproduced as aerial 4.

Aerial ropeway to Jellingfjorden.

From the terminal (13 on plan 3) near the concentrates bin the ropeway runs south-south-east across the mountainside. It is carried on pylons, the construction of which is seen on photographs 14, 15, 17 and 18; the last pylon before the long span across the head of Jellingfjorden can be seen to be of steel, but other pylons are believed to be of wood.

The total length of the ropeway is about 2½ miles. A subsidiary ropeway is thought to be used to carry waste from the dressing plant to the dumps shown on aerial 4.

The ropeway uses electric power, but no details are available as regards the driving machinery.

Concentrate storage and shipping installation at Jellingfjorden. (Plans 1 and 2; aerials 1 and 2; photograph 18).

From the terminal of the aerial ropeway the ilmenite concentrate is tipped from the buckets of the ropeway into a chute leading to a bin, blasted into the mountain side and roofed in by a sloping building.

From the bottom of the bin, the concentrate is automatically fed through a chute onto a conveyor, which leads out of the mountain side through a tunnel and is carried on a steel framework. The leading gear is reported to be very modern and efficient and to be able to load 600 tons per hour; the outer end of the conveyor is stated to be movable so as to facilitate even loading of ships.

Railway to Raskelfjord (Plans 1, 3 and 5; aerials 1, 3 and 4)

The railway is of narrow gauge; the method of traction is not reported. The magnetite concentrate is carried in small open wagons.

The line runs south-west from the dressing plant along the left bank of Sandbakkfjorden. At approximately 049176 on U.S.G.S. 4090 Sheet C 39 W., the line crosses Vassundelven just north of its junction with Gaddalselven; the bridge is of steel construction, on concrete foundations; the main span is reported to be 16 yards in length.

From this point the railway follows the north side of Sagrdalselven, passes the village of Henge, and, leaving the river (which here turns south) continues west through a gorge to reach the east shore of Raskelfjorden near its head; here the line turns south along the shore of the fjord to the storage and shipping installations at 017177 on U.S.G.S. 4090 Sheet 4 A.

Concentrate storage and shipping installation at Raskelfjord. (Plans 1 and 3; aerials 1 and 3).

The storage installation consists of a long narrow building partly of wood, and partly of concrete, housing bins which are filled direct from the wagons. A rubber conveyor, automatically fed from the bottom of the bins, carries the concentrates direct on board ship.

Power supply: see below (3) Electricity.

Minor industrial establishments

1. Raskelfjord Packing Co.: small crab and prawn factory, owner M. Skordal, situated near the steamship quay on the east shore of Raskelfjorden, approximate grid reference 017169 on U.S.G.S. 4090 Sheet 4 A. Normally during the season this factory employed about 30-35 hands.

Sagrdal Spinnveri og Væveri: small weaving and spinning establishment; site not located.

Herring oil factory: disused herring oil factory at Holmen in Jðalingfjorden, shown on plans 1 and 3, aerials 1 and 2, and photograph 2.

2. The Jðalingfjord Manufacturing Co.: this company, which is a subsidiary of Titan Co. A/S., owns the three hydro-power stations of Nedre Høllæren, Øvre Høllæren and Holmen and rents to power the A/S Titania mines. The old mine works at the head of Jðalingfjorden belong to this company, but the works were closed down and the machinery dismantled about 30 years ago.

(2) OIL STORAGE

There is reported to be one 65 cu.m. tank for gas oil at the wharf on the west shore of Raskelfjorden; (plans 1 and 3; aerials 1 and 3) opposite the A/S Titania shipping point. (Approx. 016177 on U.S.G.S. 4090 Sheet 4A).

(3) ELECTRICITY

The Sagrdal and Jðalingfjorden areas are not connected to any outside source of power; apart from that of the A/S Titania mines (Nedre and Øvre Høllæren power stations), there is no important electricity supply system. The inhabitants and the small local industrial establishments draw their power from 3 power stations, namely Låndalsfoss, A/S Vestlandske Kraftselskap and Holmen, which are all small. Apart from the power transmission lines shown on plans 1, 2 and 5, aerials 2 and 4, and photographs 10, 11, 14 and 15, there is no detailed information regarding power lines and transformer stations; the connections reported to exist are indicated in the description of the power stations below, but the exact course followed by the lines is not established. Details of the 5 hydro-electric power stations mentioned above are as follows:

Holmen

Position: Near Holmen on east side of Jðalingfjorden, approx. grid reference 063140 on U.S.G.S. 4090 sheet 4 A.

Installed capacity: 110 KW.

Head of water used: 320 ft.

Owner: A/S Jðalingfjord Manufacturing Co.

Consumers supplied: Jðalingfjorden area; A/S Titania installations.

The power station is reported to be situated on the Libakk river utilizing the water from Stensund lake. The water is regulated by 2 dams seen on plan 2 and aerial 2. The path of the pipeline can be very faintly seen on the above aerial looking from the dam at the end of the small lake below Stensund to a small house situated amongst the trees 440 yards east-south-east of the disused oil factory of Holmen. On photograph 2, pylons carrying a power line apparently connecting Holmen and the head of Jðalingfjorden can be seen on the hillside. No further details are known.

Ovre Hallaren

Position: About 600 yards due east of 1/8 Titania quay at Jönsinghamn, approx. grid reference 072148 on G.S.G.S. 4090 Sheet 4 A.
 Installed capacity: 1520 KW.
 Head of water used: 232 ft.
 Owner: 1/8 Jönsingfjord Manufacturing Co.
 Consumers supplied: 1/8 Titania mines and adjoining installation.

This power station, which is situated on the east shore of the water reservoir of Nedre Hallaren power station, utilizes the water from Tallenselven. The dam and pipe line leading down to the power house are all shown on plans 1 and 2 and serials 1 and 2. The power transmission line connecting this power station with Nedre Hallaren power station is believed to follow the path shown on the above plan and serial. No further details are known.

Nedre (Lower) Hallaren

Position: At the head of Jönsingfjorden, grid reference 068154 on G.S.G.S. 4090 Sheet 4 A.
 Installed capacity: 1538 KW.
 Head of water used: 420 ft.
 Owner: 1/8 Jönsingfjord Manufacturing Co.
 Consumers supplied: 1/8 Titania mines and adjoining installations.

The power station, which is situated at the head of Jönsingfjorden adjoining the disused mine works, utilizes the water from the water reservoir on Tallenselven situated about 300 yards to the east-north-east of the head of the fjord. The power station and pipeline (? two pipes) leading into it can be seen on plan 2, serial 2, and photograph 2. Nedre and Ovre Hallaren power stations, which are the chief source of power for the 1/8 Titania mines and adjoining installations, are crossing plant, aerial ropeway and landing arrangement at Jönsinghamn, are connected by an overhead power transmission line (6,000 volts), leading across the mountain to the ore dressing plant at Sandbakk. No details are known concerning the transformer installation.

Lindlandsfoss

Position: On Romsdalselven, between Berstadsvad and the confluence of Romsdalselven and Tamsdalselven.
 Installed capacity: 400 KW.
 Head of water used: 95 ft.
 Owner: 1/8 Sogn dal Elektrisitets Verk.
 Consumers supplied: 1/8 Titania mines and private consumers in Sogn dal.

No other details are known. A source states that in the past (1930) Lindlandsfoss power station, besides supplying power to 1/8 Titania mines, also supplied power to Gurall and Mol Hydrogen Gruber (Molybdenum mines), situated near Gurall about 10 miles north-east of Sandbakk, approx. grid reference 1823 on G.S.G.S. 4090 Sheet C 39 W. Statistics of recent years, however, never mention the mines as being in production, and no reports since the German occupation of Norway give any indication that the mines are worked.

1/8 Vestlandske Kraftselskap

Position: On Sandbakkfossen between Grestadsvad and Sandbakk.
 Installed capacity: 200 KW.
 Head of water used: 255 ft.
 Owner: 1/8 Vestlandske Vassdrags og Kraftselskap.
 Supplying: Private consumers in the area.

No other details are known.



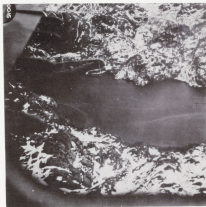
1. Jösingsfjorden, looking north-east.



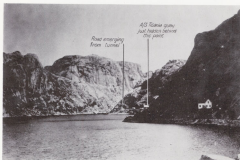
2. Jøsingfjorden; view from head of fjord showing old herring factory at Holmen (right) and Holmen - Nedre Hølleren road. The road to Hensire and Flekkefjord can also be seen behind Holmen. Left foreground: disused mine factory; immediately behind is Nedre Hølleren power station, with penstock on hillside. Old photograph, taken before construction of A/S Titania storage installation and quay.



3. Jösingfjorden: the head of the fjord, showing disused zinc factory, Nedre Helleren power station and workers' dwellings. Old herring oil factory at Holmen on extreme left. The rails seen in left foreground were used in constructing the coastal road to Holmen.



4. Jösingfjorden, 29.2.40: Disused wharf and herring oil factory at Holmen. "Altmark" beached the far side of the wharf.



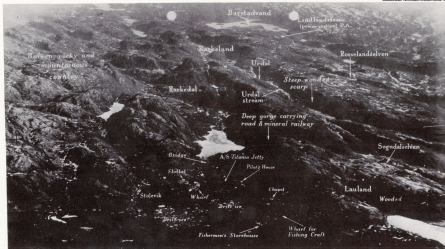
5. Jösingfjorden: view looking up the fjord from Holmen



6. Jösingfjorden (1937): view down the fjord from road north-east of Nedre Hølleren; taken when Sogndal road and tunnel (extreme right) were under construction.



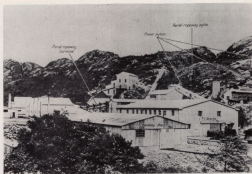
7. Jösingfjorden: view down the fjord from road north-east of Nedre Hølleren, showing on the right, Sogndal road and tunnels



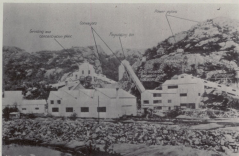
8. The head of Rekefjorden and surrounding country. 20.3.41.



9. Segndal - Ånsire road: sketch of tunnel and carbing on Jösingfjorden stretch.



10. Sandbekk: ore dressing plant: general view looking north-east. (N.B. Perspective much foreshortened.)



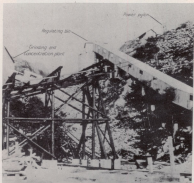
11. Sandbakki: ore dressing plant: general view looking east. Primary crushing installation (jaw crusher) is just off right-hand side of photograph.



12. Sandbakki: entrance of main haulage drive (exact site not located).



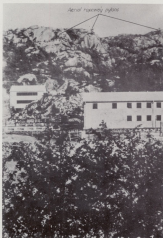
13. Sandbekk: Intermediate crushing installation; grinding and concentration plant in left background.



14. Sandbekk: left foreground: terminal framework of aerial ropeway; right: conveyor to regulating bin.



15. Sandbekk: grinding and concentration plant.



16. Sandbekk: subsidiary buildings south-west of dressing plant; serial ropeway in background. (The building on the right is the one thought to be the Stores, see photograph 10.)



17. Sandbekk: subsidiary building south-west of dressing plant; aerial ropeway in background.



18. Jödingfjorden: view of concentrate storage and shipping installations, looking southward from above the west side of the head of the fjord.





Gausdal Militærhistoriske Samling

Volden

Post, phone, railway, road and ferryway

Bridge

Århus Jolly

Stålevik

Ymmerstein

Low ridge 250 ft.

Steep Slopes

Rocky Ground

Steamship Quay

Oveadden

Lautland

Scorped Slopes

Klathagen

Narrow Valley

Tverdal

Scattered and main

Hallen

Dalene

Norway Valley

Canviggenden

Nordfjorden

Bridge

Gausdal Militærhistoriske Samling

Bare, rocky and deeply dissected

RAEKEFJORDEN TO JÖSINGFJORDEN

1-8-40

AERIAL 1.

Gaustdal Military-Historical Seming

