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Growing Transportation Bottlenecks Threaten West Siberian Energy Development

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A Research Paper

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A Research Paper

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Summary

Information available as of 31 October 1988 was used in this report.

Increasing oil and gas output from West Siberia's vast energy wealth is the linchpin in the USSR's master plan to keep national output of these fuels stable or rising through the end of this century. So far, West Siberia has generally met its energy production targets, but an apparent decision to develop producing fields before the transport infrastructure is fully in place has created many difficulties.

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To sustain sharp growth in gas output and marginal gains in oil production in the 1990s, the Soviets must develop fields that substantially increase demands on transport services:

- To offset declining output from West Siberia's handful of aging giant oilfields, the Soviets plan to develop 94 relatively small fields during the period 1986-90 and to bring on line a larger number of even smaller fields in the early 1990s. This creates escalating demands on transport construction, particularly since the new fields are located farther from established supply bases than were fields developed before 1986.

- Gas production is moving north; the Soviets count on the giant Yamburg field to provide nearly all the increment in national production during 1986-90. They plan to sustain growth in the 1990s by developing the Bovanenko and Kharasavey deposits on the Yamal Peninsula. These fields also are located farther from established services than were their predecessors and challenge the Soviets with more inhospitable development conditions.

Soviet development plans and continuing obligations to serve established oil and gas fields suggest that overall transport demand to meet the needs of the West Siberian energy industry will rise at least 50 percent during 1988-93.

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Soviet transport is not prepared to meet these demands. In the early 1980s, Moscow slowed the development of transport services, and Soviet press reports indicate this has led to increasingly frequent transport shortfalls since 1985. More ominous, delays in river dredging and in construction of port facilities, roads, and especially railroads threaten to retard development of the new fields. We cannot accurately project the extent of likely delays to individual projects because we are uncertain how Soviet authorities will ration strapped transport services and to what lengths they will go

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to try to overcome the shortfalls. Nevertheless, given current development priorities and transport programs, we believe each of the following major programs is a candidate for delay, in *increasing* order of likelihood and severity:

- Transportation problems could cause a limited delay in bringing the giant Yamburg gasfield up to full capacity. Poor track conditions have severely restricted rail deliveries to the project and will hinder efforts to meet plans for increased shipments needed to complete construction. Rivers and the northern sea route will not be able to compensate fully for rail shortfalls. Moscow could offset delays in developing Yamburg with continued overproduction from the Urengoy gasfield, but this would reduce ultimate gas recovery and cause a faster-than-expected output decline—a concern expressed by Gorbachev in his September 1985 speech in Tyumen' Oblast.

- Chances are better than even that the transport infrastructure will not be able to meet the demands of exploiting smaller and more remote oilfields as well as the increasing requirements to maintain existing wells. Dredging the small rivers to a navigable depth to support development of these fields will not be complete, and truck transport cannot be adequately developed because of the high costs and long leadtimes necessary to build an integrated road system. This increases the likelihood that oil production in West Siberia, and hence national output, will fall in the 1990s. The extent of any national decline, however, will depend on how rapidly the Soviets can bring new production from the Pre-Caspian Basin on line.

- Transportation problems probably will set back plans to develop the Bovanenko and Kharasavey gas deposits on the Yamal Peninsula in the early 1990s. A several-hundred-kilometer rail line needed to deliver the enormous volume of freight required is presenting the Soviets with unparalleled challenges and high costs. It is already considerably behind schedule. To meet plans to expand gas production in the 1990s, the Soviets must first make substantial improvements in transport infrastructure on Yamal. If they do not, growth in West Siberia's gas output will probably slow.

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Although the Soviets may be able to moderate the severity of transportation bottlenecks, the cumulative shortfalls, especially when contrasted with the ambitious energy development plans, are so great that some disruptions are likely. Moscow will need to closely monitor progress in providing transport support to West Siberian energy development in order to prevent a serious setback to energy production in the mid-to-late 1990s. Moscow may also need to accelerate development of oil and gas deposits in other parts of the USSR, such as the Pre-Caspian Basin, and step up conservation efforts to moderate growth in energy demand.

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Scope Note

Increasing transport bottlenecks in West Siberia threaten ambitious oil and gas development plans for the region. This paper attempts to gauge the impact that such bottlenecks will have on future energy development. It focuses on the land, water, and air transport systems that deliver the equipment and supplies needed for development but does not address the ability of the pipeline systems to deliver oil and gas.

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Growing Transportation Bottlenecks Threaten West Siberian Energy Development

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The Transportation Challenge

Development of the West Siberian region of the USSR has been driven by its vast energy wealth.[1] Gas was first produced in the region in 1963, and oil production began in 1964. By 1987 the region was contributing 65 percent of the USSR's total production of crude oil and gas condensate and 63 percent of its natural gas (see inset and figure 1). Together these two fuels provide nearly three-fourths of the country's total energy production. Continued development of West Siberia, which contains roughly two-thirds of national oil and gas reserves, will be the main driver of national energy output through the end of this century.

Development of transport, in turn, has underpinned energy development in West Siberia. Virtually the entire area, which is roughly one-third the size of the continental United States, was uninhabited wilderness before oil was discovered in 1960. In the 1960s the Soviets had to bring in laborers, equipment, and materials to construct new towns, housing, and facilities to supply electric power and other services. Since then, the construction of infrastructure has steadily grown—for example, in the 1986-90 period housing construction is to be 80 percent higher than in 1981-85, and construction of electrical generating capacity is to double. These efforts have largely met demands for basic services but have not supported development of an industrial base capable of supplying the region's own needs for equipment and materials for energy development.

Transport services, therefore, must also support the surges in demand for freight associated with the development of oil and gas fields. The largest volume of freight is delivered during the first five years after field development begins. In the next five to 10 years, the field is in its prime production period, and demand for transport services is generally much lower. When output levels off and begins to drop, freight volumes often increase again because more equipment and other supplies are needed to perform well workovers, install new and replace broken pumping equipment, expand water separation and injection facilities, and replace gathering lines weakened by corrosion.

Meeting demands for infrastructure and energy development is complicated by the severe climate, swampy terrain, and permafrost that make West Siberia one of the most forbidding areas of the world:

- Winter temperatures—averaging −20°C—impair or in extreme conditions halt outdoor labor, reduce the service life of machinery, and increase the demand for materials and spare parts.

- Climatic swings require juggling of transport services. In winter, navigation on the rivers and the northern sea route is shut down for six to 10 months each year. In summer, extremely muddy, boggy conditions make cross-country movement nearly impossible and construction difficult. At least one-third of the region consists of marshes.

- Permafrost conditions require roads and railroads to be built on fill that is stable enough to resist the settling and erosion associated with the annual cycle of freezing and thawing (see inset). Subsequent maintenance is often more expensive than initial construction.

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The ambitious development programs and forbidding conditions combine to create enormous demands for freight. Soviet writings indicate that roughly 40 million metric tons of freight—equipment, pipe, ballast, construction materials, and other supplies—was brought into the region in 1987 to support West

[1] In this paper, the West Siberian oil and gas region includes the area in Tyumen' and Tomsk Oblasts north of 58 degrees north latitude, west of 82 degrees longitude, and east of 62 degrees longitude

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West Siberian Energy Production

West Siberian oilmen attained the enormous production increases of the 1970s by rapidly developing a small number of large and highly productive fields. Three giant fields—Samotlor, Mamontovo, and Fedorovo—accounted for nearly 70 percent of oil output from the region in 1975. In 1980, Samotlor alone accounted for about one-fourth of national production. Despite the introduction of 20 to 22 new oilfields in 1981-85, most of the region's output still came from the handful of oilfields brought on line in the late 1960s and early 1970s. Output from the aging oilfields began to drop in 1984, and this caused national oil production to decline in 1984-85 for the first time in nearly 40 years.

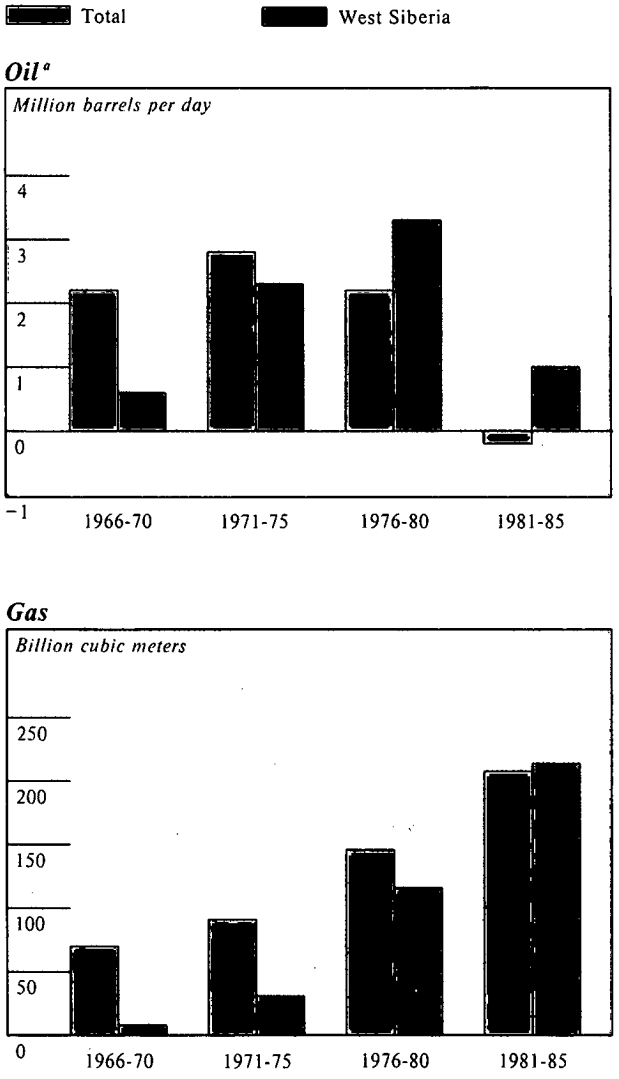
Since the mid-1970s, West Siberia has been the main base for expansion of national gas output. Since its startup in 1978, the huge Urengoy field has provided most of the increase. The Medvezh'ye, Vyngapur, and Urengoy fields together accounted for over 50 percent of Soviet gas production in 1985.

Siberian energy development. This compares with 25 million tons in 1980 and nearly 15 million tons in 1975.

Development of Transport Services

To support oil and gas development in West Siberia, Moscow's strategy since the 1960s has concentrated on gradually building an integrated rail and water transport system and associated support bases. Soviet transportation experts have long acknowledged that railroads are the most practical and cost-efficient way to move large freight volumes over long distances to and within the region. Railroad construction, nevertheless, is more costly and time consuming than construction of other transport modes. According to Soviet figures, average construction costs in the region are more than 1 million rubles for 1 kilometer of rail line, compared with only 1,500 to 8,000 rubles to

Figure 1
USSR: Growth in Annual Oil and Gas Production



[a] Including gas condensate.

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Building a Road in West Siberia

The Soviets must dig a trench, fill it with rock and sand, and lay a raised surface over the fill. Some of these trenches are as deep as 11 meters, and the road surface lies several meters above the level of the surrounding terrain. Since the cold climate prevents the pouring of concrete except by using special warming techniques, prefabricated slabs are used to build roads. In some areas entire marshes must be drained and filled with sand. Without adequate preparation, roads will disappear into a bog or marsh. 25X1

Marshy terrain near Urengoy gasfield 25X1

deepen 1 kilometer of river. Construction of a major hard-surfaced road costs 800,000 to 900,000 rubles per kilometer; winter (ice and snow) road construction costs about 50,000 rubles per kilometer.[2]

Getting Freight to West Siberia

Railroads provide the lifeline to the region because of the very long shipping distances and large freight volumes. The lion's share of rail freight is transported to the city of Tyumen', which serves as one of the region's main supply bases. Some freight is also delivered for transshipment via the Ob' River to railheads at Salekhard and Sergino (see figure 2). 25X1 Although air transport provides less than 5 percent of the cargo moved into the region, it is particularly important because it can be used when other modes of transportation are unavailable and is essential for

[2] A winter road is built either by spreading water over the ground and allowing it to freeze or by compacting snow. 25X1

Key Settlements in West Siberia

Labytnangi *(66°39'N/66°21'E). Population: estimated 11,000. From this railhead on the lower Ob', cargo is transferred to river craft at the port of Salekhard for shipment to gas exploitation areas.*

Mamontovo/Pyt'-Yakh *(60°46'N/72°47'E, 60°45'N/72°50'E). Population: estimated 10,000. Housing and storage areas at Mamontovo and the adjacent Pyt'-Yakh rail station support the Mamontovo oilfield.*

Megion *(61°03'N/76°06'E). Population: estimated over 10,000. Provides housing and logistic support for surrounding oilfields. All-weather roads lead to these fields and to Nizhnevartovsk.*

Nadym *(65°32'N/72°32'E). Population: estimated 50,000. One of the largest urban centers in the northern gas development area, it has schools, stores, and community services for workers of the surrounding gas region.*

Nefteyugansk *(61°56'N/76°38'E). Population: 86,000. This is the primary port and supply base for the Mamontovo and Ust'-Balyk oilfields. It is linked to them by all-weather roads.*

Nizhnevartovsk *(60°56'N/76°38'E). Population: 212,000. Supports the Samotlor oilfield and smaller fields nearby. It has extensive port facilities on the Ob' River, a rail tie to Surgut, all-weather roads, and an airport.*

Novoagansk *(61°57'N/76°41'E). Population: estimated 7,000. Located at the western edge of the Var'yegan oil-producing area, Novoagansk is a support base for oil exploitation and transport.*

Novyy Urengoy *(66°06'N/76°35'E). Population: 79,000. Served by rail and air, this is the main support city for the Urengoy natural gas field. Industries and high-rise apartments are being built.*

Noyabr'sk *(63°08'N/75°22'E). Population: 77,000. An urban center for the Kholmogor oilfield and other oil and gas exploitation. It has a rail-served storage area covering 3.5 square kilometers (km).*

Pangody *(65°51'N/74°30'E). Population: estimated 6,000. The supply base for the Medvezh'ye gasfield.*

Raduzhnyy *(62°06'N/77°31'E). Population: estimated 5,000. Supports nearby oilfields and is the terminus of an all-weather road from Nizhnevartovsk, 140 km to the south.*

Sergino *(62°30'N/65°38'E). Population: estimated 6,000. Rail terminus where cargo is transferred to river craft or to trucks traveling the winter road to the Urengoy gasfield.*

Staryy Nadym *(65°35'N/72°42'E). Population: estimated 2,000. This expanding port serves the city of Nadym (11 km southwest) and the Medvezh'ye and Urengoy gasfields.*

Strezhevoy *(60°42'N/77°34'E). Population: estimated 10,000. This port, 60 km southeast of Nizhnevartovsk, supports the Sovetskoye oilfield and new oil exploration along the Vakh River.*

Surgut *(61°14'N/73°20'E). Population: 227,000. The key housing, industrial, and supply center of the middle Ob' oil region. It has large mechanized port facilities, an all-weather airport, and rail facilities.*

Uray *(60°08'N/64°48'E). Population: estimated 20,000. Supports an oil exploitation area west of the Ob'. It is served by river craft and an all-weather airport; a dirt road connects it to a railhead at Mezhdurechenskiy.*

Urengoy *(65°58'N/78°25'E). Population: estimated 9,000. Development of Urengoy gasfields stimulated construction of port facilities and storage areas. These facilities are expanding along the left bank of the Pur River to the site of the rail yard and projected city of Tikhiy.*

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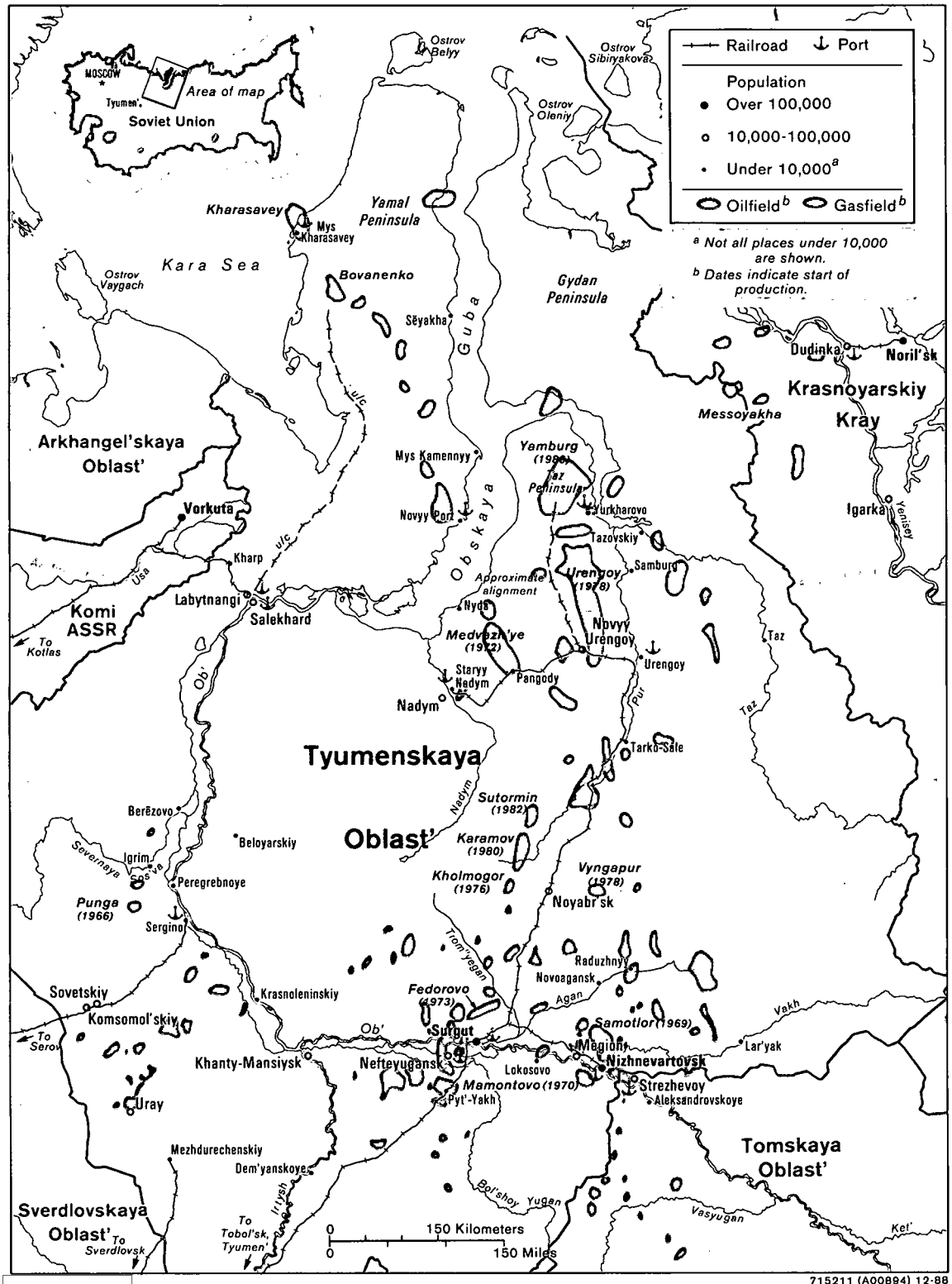
Figure 2
Major Transportation Links in the West Siberian Oil and Gas Region



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transporting people and priority freight.[3] Less than 5 percent of the total freight volume (mostly imported large-diameter pipe) is transported along the northern sea route by freighter from Nakhodka and Murmansk to the Yamal and Taz Peninsulas.[4]

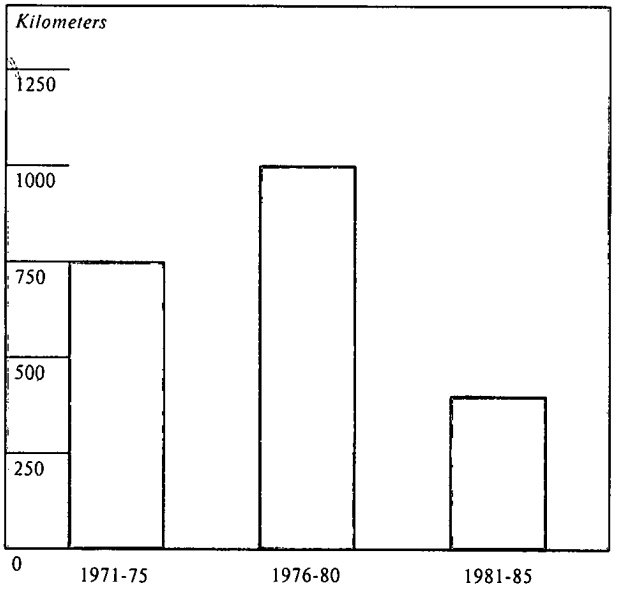
Most settlements developed along major waterways as ports and supply bases for the region's early oil and gas exploration and development. Many became major supply and housing centers on the road and rail systems that later penetrated the region. They now serve as hubs of the region's expanding pipeline and petroleum-processing facilities.

Moving Freight in West Siberia

Despite the short navigation season, rivers move most of the freight traffic (in terms of ton-kilometers) within West Siberia. Soviet statements indicate that planners realized early on that the extensive river network provided an opportunity to add transport capacity at a relatively low investment cost. In 1981-85, more than 6,000 kilometers of the region's 20,000 km of navigable waterways were deepened, and the ports of Nadym, Urengoy, Labytnangi, and Sergino were improved to increase their transshipment capacities.

West Siberia's 3,000 km of primary rail lines carry roughly 40 percent of the region's freight traffic. They consist of one main trunk line—from Tyumen' to the Taz Peninsula—and only two major rail spurs—one to Nizhnevartovsk and the other to Staryy Nadym. The pace of primary rail line additions rose steadily through the 1970s but fell dramatically during 1981-85 (see figure 3). Information on rail construction plans for 1986-90 is sketchy, but the length of primary rail lines to be built appears to be roughly the same as that put in place during 1981-85. Nearly all of the construction during the period will be on the

Figure 3
Estimated Length of Primary Rail Lines Put Into Operation in the West Siberian Oil and Gas Region[a]



[a] Does not include construction of secondary rail lines—mostly sidings, spurs, and track at yards and stations.

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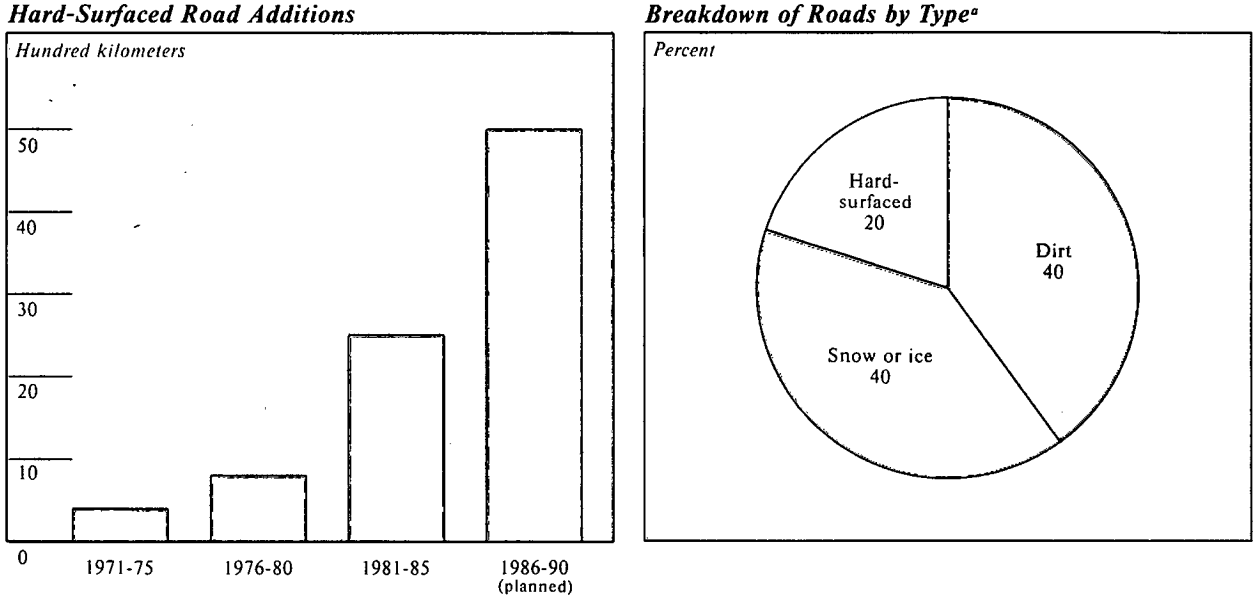
Yamal Peninsula. A 540-km rail line that will link the Bovanenko gas deposit with the city of Labytnangi is under construction.

Roads account for only about 5 percent of total traffic, despite a large surge in road construction during the 1980s (see figure 4). At the end of 1987, the region was not connected by an all-weather road system to the industrialized parts of the USSR, the key regional cities were not interconnected, and no major pipeline had a parallel all-weather road. Only about one-fifth of the region's roads are hard-surfaced, and the proportion is much less in areas where

[3] Year-round air links have been established between major Soviet cities, such as Moscow and Chelyabinsk, and the larger cities of the region—Surgut, Nefteyugansk, Nizhnevartovsk, Strezhevoy, Novyy Urengoy, and Nadym. In 1985, the Nizhnevartovsk and Surgut airports served a total of about 1 million passengers. During 1986-90 the Soviets plan to build eight new airfields at oil and gas deposits.

[4] The Soviets claim that use of the northern sea route shortens delivery time to the far north to about 45 to 50 days compared with six months to a year via Tyumen'.

Figure 4
Roads in West Siberian Oil and Gas Region



[a] Includes all roads in the region.

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development has recently begun. During 1986-90, the Soviets plan to construct 5,000 km of hard-surfaced roads, including beginning work on a 300-km hard-surfaced highway from Urengoy to Yamburg. A major part of a Sverdlovsk-to-Tyumen' hard-surfaced road is also planned. The road will be the first all-weather road link from the region to the western USSR.

Servicing Individual Projects

The handful of giant fields that produce the bulk of the region's oil and gas are linked to supply centers by railroad and a few by all-weather roads. Their early development, however, was supported almost entirely by the water and winter road transport systems:[5]

- The Samotlor, Mamontovo, and Federovo oilfields were developed in the mid-1960s, about the time a

[5] The water and winter road transport system has continued to support the development of these fields. Large gas-processing plant sections, for example, are assembled in Tyumen' and delivered on pontoons to the Taz Peninsula via the river system, a distance of 2,600 km. These pontoons are then dragged by vehicles to the Yamburg field over snow and ice.

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rail line to Tobol'sk was completed. Freight delivered to Tobol'sk was transshipped several hundred kilometers on the river system to ports near the fields and then by trucks over winter roads. Rail service to these fields was not established until two to seven years after development began, when they were in their prime production stage.

- The buildup of production from the major gasfields was supported mainly by freight transshipped from the rail system to rivers and winter roads and to a lesser extent by freighters via the northern sea route. Direct rail service was established five to 10 years after development began, when the fields were already producing large volumes of gas.

Transport Performance: Barely Adequate

Soviet leaders chose to develop West Siberian energy before the supporting transportation infrastructure was fully in place. Inadequate capacity and poor scheduling have led to chronic transportation bottlenecks, and shortfalls in meeting delivery commitments have frequently been cited in the Soviet press (see inset). The Soviet approach contrasts sharply with the integrated approach to field development followed by US firms at Prudhoe Bay (see inset).

Although transport shortfalls have disrupted and delayed energy development, they have not generally undermined the region's ability to meet energy production plans. Natural gas output has met or exceeded annual targets. The region's oil production has fallen slightly short of targets in recent years, partly because of inadequate transport to support exploration and field development and the expansion of electric power facilities. Nevertheless, plans to commission new oilfields generally were met through 1987.

Under the circumstances, skimping on West Siberian transportation development may have been a rational decision:

- Oil and natural gas production in established fields in the western USSR was declining in the 1970s, largely because of poor field management. The Soviets needed immediate gains from West Siberia to satisfy their voracious appetite for energy.

- The Soviets faced a chronic shortage of investment and transport construction resources. Development of West Siberian transport was already expensive, constituting at least 25 percent of the region's spiraling energy costs, according to the Soviet press. In the early 1980s other transport projects—especially the Baikal-Amur Mainline Railroad—were accorded higher priority and drew resources away from West Siberia.[6] And the need to reverse a national decline in rail performance in the early 1980s was probably too great for Soviet planners to divert resources from other parts of the country.

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Although perhaps rational in the short run, lagging transport development imposes potentially severe long-run costs. Poorly managed, accelerated development and production of established energy fields can substantially reduce lifetime fuel production (see inset). For example, peak production at the largest Soviet oilfield, Samotlor, was sustained for only one year, after which output fell by roughly 30 percent within five years. In contrast, the maximum level of output from the Prudhoe Bay field in Alaska was sustained for about 10 years.

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Moreover, West Siberian transport, already strained, is likely to have considerably greater difficulties meeting the larger challenges of the 1990s. As indicated earlier, the construction of transport facilities—and especially railroads—slowed in the early and mid-1980s. As a consequence, key transport projects are considerably behind schedule and are unlikely to be in

[6] Nearly one-third of national primary railroad construction took place in West Siberia during 1976-80; only about one-tenth was completed during 1981-86.

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Transport Bottlenecks: Cases and Causes

The Soviet press is rife with examples of transport bottlenecks that have prevented timely delivery of equipment and supplies to support West Siberian oil and gas development. All modes of transport are responsible for the delays.

On the rail system:

- *Because of insufficient unloading sidings, thousands of railcars waiting to be unloaded reportedly often block traffic on the single main track from Tyumen' to Urengoy.*
- *Widespread shortages of cranes and storage facilities turn whole trains into "warehouses on wheels." The failure to efficiently schedule freight deliveries adds to the problem, because several loaded trains often arrive at one location within a short timespan.*
- *Because there are not enough specialized freight cars to transport bulk materials, several thousand cars must regularly be pulled off the railroad for up to several weeks in the winter when coal, crushed stone, and other cargo freeze into a solid mass.*
- *Commuting oil and gas field workers frequently have to wait at stations for up to several days for space on a train.*

On the region's rivers:

- *The Ob'-Irtysh Steamship Company was unable to ship 2- to -3 million tons of freight each year during the early 1980s, roughly one-tenth of the total shipments to support energy development in the region.*
- *Ports serving as major transshipment points reportedly lack sufficient freight-handling equipment to transfer freight onto river craft.* 25X1
- *Shortages of ships, boats, and barges are compounded by scheduling problems. In 1986 over 1,300 loaded railcars accumulated at several locations because of insufficient river craft; yet in 1985 the river fleet was reportedly idle for 8 million ton-days more than planned because of delayed rail deliveries.* 25X1

Inadequate roads have also created problems:

- *Chronic shortages of road construction equipment and materials reportedly force builders to take shortcuts to meet unrealistically high road construction plans. Failure to build adequate roadbeds in permafrost areas means that roads frequently sink into the ground during the spring thaw and are more susceptible to flooding. Workers reportedly find themselves in an endless cycle of rebuilding the same shoddy roads each year.* 25X1
- *Delays in building and using winter roads are frequently cited as the cause of delays of up to six months in the delivery of crucial equipment to individual oil and gas fields.* 25X1

a position to adequately support development of the new oil and gas fields essential to sustaining West Siberian production.

Maintaining Energy Production in the 1990s: A Growing Transport Challenge

West Siberian energy development and production are moving into areas that promise to substantially increase demand for transport services. The Soviets plan to offset declines from established fields by developing a larger number of smaller fields and by moving into areas even more remote and inhospitable than the areas of current production. Each thrust promises to accelerate demand for transport services. But transport appears to be less well equipped to meet the surge now than it was in the 1970s and early 1980s. 25X1 25X1

Oil Development Strategy on Alaska's North Slope

US oil companies developing the Prudhoe Bay field on Alaska's northern coast faced problems similar to those confronted by Moscow in developing West Siberia. The Alaskan deposit is located well above the Arctic Circle (at about the same latitude as the Bovanenko gas deposit on the Yamal Peninsula) in a region of severe winter weather and continuous permafrost, far from equipment suppliers and a labor pool. US oil company officials estimate that transport costs at Prudhoe Bay constitute about 20 percent of the total delivered cost of equipment and materials.

US firms adopted an efficient strategy of building a supporting infrastructure before beginning oil development in earnest. Transport construction proceeded in three stages:

- *During exploration and very early development, transport was provided by helicopters, all-terrain vehicles, and trucks traveling over winter roads.*
- *A port that can accommodate four large barges was built, but the six- to eight-week shipping window limits the amount of freight that can be delivered. Moreover, even if enough supplies could have been brought in, reliance on sea transport would have been uneconomical because of the high cost of storing one year's supply of equipment.*
- *Trucks transported most of the equipment and supplies on a 650-km all-weather road constructed to the site from Fairbanks. To insulate the road from the permafrost, several million tons of locally available gravel was used to build a bed 5 feet high and 30 feet wide. According to US officials, without a nearby gravel supply, the road's construction would have been prohibitively expensive. And, without the road, the oil project would not have been economically feasible.*

To maintain stable production, US oil companies built a housing complex, including a gymnasium, movie theater, and television system to attract and retain a labor force. Workers commute by jet aircraft from Anchorage, alternating two-week tours of duty.

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Oil: Developing Smaller Fields

By 1990, oil production from West Siberia is scheduled to provide nearly 70 percent of national output, offsetting production declines in other regions. Once West Siberian oil production ceases to grow, national output will almost certainly fall. The extent of this decline, however, will depend on how rapidly the Soviets can bring new production from the Pre-Caspian Basin on line.

Soviet ability to keep West Siberian oil output growing depends critically on bringing new fields into production rapidly enough to offset declining output from 46 fields that were developed in the 1960s and 1970s and 20 to 22 fields developed in 1981-85. On the basis of average field size and likely production potential, we estimate that the 94 small fields scheduled for development during 1986-90 could account for about 20 to 25 percent of total West Siberian production by 1990. In the 1990s the Soviets will need to develop an even larger number of smaller and more remote oilfields.

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These plans create escalating challenges for transport services:

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- The 94 oilfields apparently are scheduled to be developed at least as fast as fields have been developed in the past, and similar momentum will have to be maintained for even smaller fields in the 1990s.

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Transport: A Vital Link in Oil Development

Maximizing a field's ultimate oil recovery and ensuring a high and stable level of output over a field's life require balanced and timely development. This means that drilling and production proceed according to a preestablished plan that is strictly adhered to: water treatment plants are built before water injection begins; water-injection programs are uniform and carefully monitored over the field's producing strata; and the field's producing infrastructure is properly maintained. In short, this requires the timely delivery of equipment and supplies in the right volume.

In West Siberia, however, transportation bottlenecks often prevent or delay the arrival of needed equipment. The following typical Soviet oilfield development practices are exacerbated by such bottlenecks:

- *Delays in the delivery of drilling equipment and drilling supplies lead to uneven field development.*
- *Wells idled because of pump shortages cause oilfield managers to step up production from other wells with little regard to how this may eventually damage the overworked equipment.*
- *Water injection begins before water treatment plants are completed. The use of untreated water eventually leads to major corrosion and well-plugging problems.*
- *Water injection begins in one area at a larger rate than planned because the construction of other water-injection facilities is behind schedule. Excessive water injection leads to rapidly rising water production and frequently to pump failures.*

This approach has a domino effect. The decline in a field's production is faster than anticipated, forcing accelerated development of other new fields. Inadequate transport infrastructure often leads to repetition of the same inefficient development practices.

- New fields are located farther from established supply bases than were fields developed before 1986. In the 1960s there was already some river shipping near the large oil deposits on the Ob' and Irtysh Rivers, but, as of 1985, the Soviets had virtually no transport infrastructure established within 100 km of many of the fields.
- Development of the requisite transport infrastructure will be expensive and time consuming. The Soviets want to develop the region's vast network of small rivers, but in 1985 most of the rivers reportedly needed to be surveyed and the Soviets needed considerably more shallow-draft boats and barges. The planned construction of a 2,500-km skeletal all-weather road system to serve all 94 fields would cost roughly 2 billion rubles—one-half of the entire region's road construction budget for the 1986-90 period. 25X1
- Transport services concurrently must support maintenance of an ever-growing number of established fields and wells. 25X1

Gas: Moving North

By 1990, gas production from West Siberia is scheduled to provide about 75 percent of national output. The giant Yamburg field is to provide nearly all of the increment in national production during 1986-90. During the 1990s, Moscow plans to continue to boost national output mainly by developing the Bovanenko and Kharasavey deposits on the Yamal Peninsula. 25X1

Development of these gas deposits increases transport challenges because of their distance from established services and because of more inhospitable development conditions. When the Urengoy field was developed in the late 1970s, the Soviets could rely on river transport and some preexisting infrastructure. The Soviets also confronted more manageable problems with permafrost. In contrast: 25X1

- The Yamburg field is located above the Arctic Circle, much farther away from supply bases and a labor pool than any other producing field. The 25X1

several thousand people who work at the site commute more than 200 km from Novyy Urengoy and Nadym for short tours of duty; many have to be transported by helicopter. Although its requirements are not as great as those for completely developing Urengoy, Yamburg still requires a huge volume of freight, a large share of which is the ballast needed for facility construction (see inset). Shipments to the project via the river system are planned to rise to 4.8 million tons annually by 1990—more than triple the 1-1.5 million tons that we estimate were delivered in 1985—and the Soviets also plan to boost shipments via the northern sea route.

- Bovanenko and Kharasavey, about 80 km apart, are located in an area with virtually no existing transport infrastructure. The Soviets plan to develop the fields by rotating thousands of workers for short tours of duty from Labytnangi; they apparently consider the cost of building the infrastructure necessary to maintain a permanent on-site work force too high. Timely development depends on the completion of the rail line from Labytnangi, according to a Soviet deputy minister of the gas industry. To provide a supporting roadbed, the Soviets plan construction of an enormous embankment that reportedly will require 50 million cubic meters of ballast—some 90 million tons—and will cost several billion rubles. A total of 101 bridges and hundreds of water-drainage conduits to handle melted snow and ice during the summer are also planned.[8]

Transport: Falling Further Behind

The apparent decision taken in the early 1980s not to fully develop transport services in step with accelerated energy development has led to a growth of transport shortfalls since 1985. Moreover, work on several major transport construction projects needed to meet energy development demands in the 1990s either has not been started or has been severely delayed

[8] In late 1986 the Soviet press stated that sand and gravel were being excavated from an Ob' River tributary near Labytnangi for use in West Siberian energy-industry construction. Some of these materials are reportedly earmarked for use in construction at the Yamburg field, but some are probably being used to build the Yamal Peninsula rail line.

Major Components of Freight Requirements To Support Yamburg Gasfield Development in 1986-90

Gasfield Equipment
Ten gas-treatment plants [a]
Five ethane-extraction plants
Tank farms
About 2,300 kilometers of intrafield gas pipelines
Equipment to drill and outfit 780 wells

Supporting Infrastructure
Airport with hard-surfaced runway
Trucks and other vehicles
Construction equipment
At least 8,500 square feet of housing
Fuel, food, and other provisions for about 10,000 people

Other Construction Materials
40 million cubic meters (about 64 million tons) of gravel or other ballast materials to build insulating beds over the permafrost [b]
Concrete slabs and mix for building foundations and roads

[a] *The 10 plants require the delivery of about 250 preassembled sections, weighing a total of 600,000 to 750,000 tons. The first three plants were successfully delivered at the end of 1987.*
[b] *This figure is an estimate by a Soviet engineer working on the project. He also estimated that more than 2.5 million cubic meters (about 4 million tons) of ballast material was needed for construction of the first gas-treatment plant that was completed in 1986.*

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Railroads appear to be in the worst shape. The inadequacies of existing railroads, which are operating at capacity and straining to meet obligations, reportedly are disrupting energy development, mainly at new oilfields and at Yamburg. In June 1986 officials complained that only about 30 freight cars per day were arriving at Yamburg. In 1987 the director of the Yamburg gasfield complained that the 235-km rail line from Novyy Urengoy to Yamburg

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was virtually unusable. An inadequate roadbed over the permafrost limits the amount of freight that each railcar can carry, and extreme temperature changes often cause rails to come loose from the ties. Poor track conditions force trains to travel very slowly, and spring flooding over the rail lines frequently delays shipments. Insufficient rail capacity may have been the reason that helicopter crews were working overtime in 1987 to transport urgently needed workers from Urengoy to Yamburg.

Plans for new railroads are reportedly inadequate to meet requirements, and even these plans are not being implemented. A railroad official complained in a press article in December 1985 that, during 1986-90, projected rail freight shipment increases for the region were much greater than planned capacity increases. The official flatly stated that a second track on the Tyumen'-to-Urengoy rail line would have to "be built immediately." Because that track would take several years to complete, he insisted that additional sidings "must be started literally today." Double-tracking the rail line from Tyumen' to Urengoy would cost more than 2 billion rubles. The line has not been double tracked, and in 1986 nearly all requests to build rail sidings in the region were turned down because of insufficient resources.

The volume of unfinished construction reportedly is enormous and growing. In 1986 a regional railroad official complained that nearly every rail construction project in the region was incomplete. Soviet press reports support his complaint:

- In mid-1988, track construction at the Nizhnevartovsk railway station that was started in 1981 and scheduled for completion in 1985 was not yet finished.
- By 1987 the Surgut railway station and the Tobol'sk railcar maintenance facility had yet to be completed after 10 years of work.
- Most sidings and railheads have not yet been built on the Novyy Urengoy-to-Yamburg rail line.
- In 1986 the backlog of unfinished construction along a total of 100 kilometers of rail line from Surgut to Nizhnevartovsk and from Tobol'sk to Noyabr'sk amounted to 165 million rubles.

According to the same official, as soon as a rail line is formally accepted by the Ministry of Railways (after traffic starts up), the Ministry of Transport Construction sharply reduces the funds available to finish work (such as sidings) and quickly transfers construction workers to other projects in the region. 25X1

Most serious, construction of the Labytnangi-to-Bovanenko rail line appears to be well behind schedule. In late 1985 the Minister of Transport Construction complained that plans to complete the rail line by the end of the decade were unrealistic considering available resources, adverse weather conditions, and construction difficulties. He stated that researchers had not completely figured out how to adequately build a rail line over the sand and loam permafrost. Work began in 1986, and by October 1988 the Soviet press reported that less than 100 km had been completed. 25X1

In mid-1987, only 1,500 workers were working on the project, but the Soviets projected that a labor force of 15,000 would be needed by mid-1988. The 1990 planned startup date for the rail line to Bovanenko implies a construction rate higher than that for any of the region's other rail construction projects to date. Failure to meet the deadline would undermine development plans for the entire Yamal Peninsula. Freight is currently being delivered to a makeshift ice port and trucked over winter roads to the deposits (see figure 6). 25X1 25X1 25X1

River transport appears increasingly strapped. The Ministry of the River Fleet was harshly criticized in the press in 1986 by the first secretary of the Tyumen' Oblast party committee for not planning an adequate transport capability to support development of the small oil deposits using the river system. He projected that the planned 25-percent increase during 1986-90 in freight deliveries by the Ob'-Irtysh Steamship Company via small rivers would not meet projected requirements. An enormous amount of preliminary work is still needed to meet future requirements, including surveying and dredging the rivers to navigable

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depth. The party leader also implied that a severe shortage of shallow-draft vessels would develop, complaining about an existing shortage of at least 65 to 70 boats and 100 to 120 barges, which could only be overcome by diverting vessels from other river shipping organizations outside the region.[9]

Road construction is falling further behind. In mid-1987 the director of the Yamburg gas project complained that so far there "is no sign" of the vital Urengoy-to-Yamburg highway.[10] The Soviet press has reported that failure to complete planned road construction on time delayed drilling in the Yamburg gasfield and the scheduled startup in 1985 of the Yershovoye oilfield. The Soviets planned to link this small oilfield to the Vakh River and also to the Surgut-to-Nizhnevartovsk highway, but, by the end of 1985, only about 20 km of the roughly 60-km route was complete. New road construction is probably being hampered because road repair and reconstruction may require the diversion of increasing amounts of construction resources as the overall length of roads increases. This could become an increasingly large burden because most of the roads built during the late 1970s and early 1980s may soon need reconstruction.

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Outlook and Implications

West Siberia's transport system will be inadequate to fully support energy development through the early 1990s. We project that overall freight transport requirements to support West Siberian oil and gas development—including necessary infrastructure—will rise at least 50 percent during 1988-93. This projection is based mainly on Soviet projections of rising demand for transport services.

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The pace of ongoing construction, however, along with chronic shortages of investment resources, indicates that far less capacity will be added. Moreover, the capacity increasingly will be strained as the

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[9] In mid-1988, not enough ships able to navigate the rivers and the turbulent Ob' Gulf waters to Yamburg were available, according to a Soviet transport journal. In late 1987, officials of the region's river fleet complained that they needed 40 to 50 more such vessels but that they were only getting four or five each year.

[10] The director also stated that the planned Yamburg airport is not yet ready for use. In early 1988 a press report complained that only one-fifth of the 95-million-ruble budget for the airport's construction had been spent. Cargo aircraft began delivering freight to the airport in 1986, using a temporary runway. Even when the airport is finally completed, air transport will be able to deliver only a small share of the freight that will be needed.

Figure 6. Yamal Peninsula ice port. 25X1

number of customers and volume of long-distance shipping continue to rise. In the coming years the growing competition for investment and other resources—from agriculture, machine building, and consumer goods producers—will almost certainly guarantee that Moscow will continue a policy of developing the transport system in West Siberia "on the cheap." Indeed, the cost of building an adequate rail and all-weather road system in the near term that would fully meet energy development needs would add billions of rubles to existing expenses, even if enough labor and equipment resources could be made available.

Bottlenecks on the railroad system probably will become worse, because the system's capacity will become increasingly inadequate as the demand for shipments rises. The outlook for the development of long-distance trucking as a viable alternative is dim because of a continuing shortage of roads. These factors will combine to place an increasing burden on the region's river system and the northern sea route, and we believe they will not be able to measure up fully to the challenge. Most of the region's key ports will continue to have inadequate capacity, and shortages of boats and labor will probably continue.

the port capacity in the northern part of the region would have to more than double during 1987-90 and more than double again by the year 2000 to fully satisfy demand. 25X1

We cannot accurately project how much the planned development of individual projects will be delayed by these transport constraints because we are uncertain about the size, composition, and location of potential delivery shortfalls. Moreover, continuing labor and equipment shortages would probably delay some projects even if adequate transport capacity were in place. Also, Moscow could choose to adjust development schedules and subsequently alter priority for shipments. Nevertheless, given current development priorities and transport programs, we believe the following energy projects are candidates for delay, in *increasing* order of likelihood: 25X1

- Transportation problems could cause a limited delay in bringing the giant Yamburg gasfield up to full capacity. Even if freight earmarked for Yamburg is given priority on the Tyumen'-to-Urengoy rail line, the Soviets would still have problems increasing traffic on the Urengoy-to-Yamburg rail line because of its low weight-bearing capacity. Moreover, likely

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delays in completing the Urengoy-to-Yamburg highway will prevent long-distance trucking from becoming an alternative. Moscow will probably offset delays in developing Yamburg with continued overproduction from the Urengoy gasfield. Although Urengoy is a huge field, sustained overproduction could affect ultimate gas recovery and cause a faster-than-expected output decline in the future, a concern expressed by Gorbachev in his September 1985 speech in Tyumen' Oblast.

- Chances are better than even that the transport infrastructure will not be able to fully meet the demands to exploit a growing number of smaller and more remote oilfields and also meet the increasing requirements for maintenance of existing oil wells and associated equipment. Dredging the small rivers to a navigable depth to support development of these fields will not be complete, and truck transport cannot be developed substantially because of the high costs and long leadtimes necessary to build an integrated road system. This increases the likelihood that oil production in West Siberia, and hence national output, will fall in the 1990s.

- Transportation problems probably will set back development of the Bovanenko and Kharasavey gas deposits in the early 1990s. Even if the Labytnangi-to-Bovanenko rail line were completed on time, operating problems probably would restrict traffic flow. Likely delays in building intrafield roads will also prevent much development during the approximately four-month period when the top layer of permafrost melts. To meet plans to expand gas production in the 1990s, the Soviets must first make substantial improvements in transport infrastructure on Yamal. If they do not, growth in the region's gas output probably will slow. [redacted] 25X1

If growing transport bottlenecks should threaten to substantially delay energy development, the Soviet leadership would have several options available. Moscow could, for example, divert even more rail or road construction capacity from other parts of the USSR, step up the use of helicopters, or import more transport equipment, such as all-terrain vehicles and boats. East European countries could be called upon to supply equipment and labor. Any new, major rail or road construction, however, would probably take several years to complete, and the risk of diverting more domestic railroad construction and rolling stock might be too great for the Soviet leadership. In 1987 the laggard performance of the railroads was a primary cause of the poor performance of the economy and provided a warning sign that the national railroad system has little capacity to spare. [redacted] 25X1

On balance, although the Soviets may be able to moderate the severity of transport bottlenecks, the cumulative shortfalls, especially when contrasted with their ambitious development plans, are so great that some disruptions are likely. As a result, Moscow will need to closely monitor progress in providing transport support to West Siberian energy development in order to prevent a serious setback to its energy production in the mid-to-late 1990s. In view of potential setbacks to West Siberian energy development, Moscow may also need to accelerate development of oil and gas deposits in other parts of the USSR such as the Pre-Caspian Basin and step up conservation efforts to moderate growth in energy demand. [redacted] 25X1

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