Drilling Waste Management
Opportunities for Murmansk
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About the BOGC Project

The Barents Oil and Gas Cluster Project aims to support the development of a service and supply cluster for the offshore petroleum industry in Northwest-Russia and Norway with participation from Russian, Norwegian and international companies.

The project facilitates experience exchange between regional authorities on securing regional benefits of oil and gas projects through focusing on issues such as business climate, investment facilitation, infrastructure development and education.

Project owners are the Norwegian counties of Rogaland, Troms and Finnmark and Murmansk oblast in Russia.
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Summary
This report describes prevailing technologies and regulatory requirements for drilling waste management, the purpose of which is to provide input to the discussions within the fourth working session of the BOGC project. A rough economic assessment is provided illustrating the main parameters influencing the feasibility of waste treatment in Murmansk.

Conclusions
- Drilling waste management represents both an opportunity for regional economic growth and a first step towards building a local supply industry.
- The role of regional authorities lies in insisting upon top-standard treatment solutions, as this would favor the establishing of new facilities in Murmansk contrary to exporting waste further south.
- Drilling waste management represents a clear business opportunity in Murmansk already in the early stage of offshore developments, however:
  - Gazprom and Rosneft are planning only a modest drilling campaign, which limits the potential waste volumes and challenges the commerciality of treatment in Murmansk compared to export to other locations.
  - Developing local facilities would require oil company coordination and support through long-term contracts. Regional authorities play a key role in facilitating such coordination and support.
  - Preliminary estimates show that treatment in Murmansk may be competitive to export to Hammerfest. But a shift to road transport in Murmansk has not been accounted for in the analysis and may drive down the costs of the export alternative.
  - High investment costs and proximity of Murmansk and Kirkenes create a first mover advantage when establishing local treatment capacity. Should Kirkenes establish such capacities first, treatment in Murmansk will be even harder to justify. However, timing of drilling campaigns in Norwegian and Russian waters suggests that there is a window of opportunity for Murmansk.
  - There is a potential for cooperation between Russian and Norwegian companies that may help mitigate risks by developing an export option as a first step toward full-scale local treatment when waste volumes are sufficient.
1 Waste from Offshore Operations

Offshore oil and gas exploration and production, as other industrial activities, generates a variety of waste. However, as illustrated in Figure 1, the vast majority (92 percent) are hazardous wastes, which in turn are primarily comprised by drilling wastes.

Figure 1 Waste Mix from the NCS in 2012 – Waste Brought to Shore

Source: Miljøstatus.no

Figure 1 does not however provide the complete waste picture for the NCS since it only counts waste volumes that are brought to shore. Norwegian regulations allow companies to emit drilling wastes with permissible levels of hazardous content. In practice almost all drilling wastes from drilling with water-based drill fluids is dumped at sea. Thus depending on regulations the actual waste volumes in need of onshore handling could be much higher.

Drilling Wastes

The terms cuttings, drill fluids, mud and slop are all employed in the classification of drilling wastes and discussion of drilling waste management. Drilling fluids are added to the well during drilling to cool the wellbore, carry out cuttings and maintain pressure to avoid external fluid permeating into the well. Drill fluids, which are also called mud, are either water-based or mineral oil-based. Synthetic oil-based fluids exist as well, but are less prevalent. For the purpose of this report we define two types of waste generated from drilling operations:

- Drill cuttings
- Slop / sludge

Drill cuttings are solid materials that are extracted from the borehole during drilling. Drilling fluids are separated from the cuttings and reused while the cuttings are stored in containers. Nonetheless, separation is not perfect and cuttings will retain traces of drill fluids.

Slop in this reports covers used drill fluids, oily sludge and water-oil emulsions as well as slop oil. Water-oil emulsions that do not contain drilled solids are defined as slop, otherwise cuttings. Due to limited tank capacity on drilling rigs and vessels, drill fluids that cannot be re-used are often not stored separately, but added to slop tanks. Hence slop is commonly used to cover both waste fractions.

In addition, water is produced from the reservoir as part of the three-phase well stream. After it is separated, it is discharged directly to sea. Thus, although produced water is a byproduct of the drilling operation and a potential pollutant it is not technically classified as a waste product. Produced water only reaches substantial volumes during field production and constitutes only a minor contribution to overall waste in the drilling stage.
2 Regulations and Responsibility

Norway

In Norway, the chemical components of water-based drill fluids are classified as green chemicals and direct discharge to sea of water-based drill fluids and drill cuttings that have not been contaminated by oil is permitted. The Management Plan for the Barents Sea provided an exception in its original version prohibiting any physical discharges to sea. However, in its revised version as of 2011, discharge to sea of uncontaminated cuttings and used water-based drill fluids were now permitted.

Discharge of slop to sea is permitted if oil content is lower than 30mg/l. Average oil content of discharged slop in Norway is 11mg/l.

Drilling also brings naturally occurring radioactive substances from the well to the platform. Waste with specific activity of 1 bq/g or more is considered radioactive and subject to explicit declaration. Waste with specific activity of 10 bq/g or more is subject to obligatory disposal at specifically designated sites. Cleansed cuttings may be dumped at a landfill with non-permeable bottom membrane. Liquids may not be dumped.

Russia

The pollution regulation for drilling waste emissions in Russia is not quite clear. Balaba (2004) claims that the Water Code and Laws on Territorial Waters prohibit the discharge and deposition of hazardous substances, but provide exemptions for drilling wastes. The “Rules for exploration and development of oil and gas fields on the continental shelf” are said to state that drilling wastes must be managed and treated in accordance with the approved drilling plan (proekt) and environmental requirements. Whether this means discharges of drilling wastes are allowed or not is however not clear. Finally according to Balaba, there is a complete ban on discharge of even cleansed flue water in areas of the “highest maritime (fisheries) value”. However the State Ecological Expertise, which is the body approving drilling plans is said not to view discharge of drilling waste as violating regulations.

On Sakhalin, the environmental organization ‘Sakhalin Ecology Warden’ claims that drilling wastes were discharged directly to sea without cleansing up to the late 90s. The organization claims that legislation prohibits the discharge of drilling wastes, however the State Ecological Expertise still permitted discharge to sea. The organization narrates a public relations and lobbying campaign lasting from 1997 to 2001 to implement a ban on discharge to sea in the pollution permissions issued by the State Ecological Expertise arguing that companies should reinject wastes. Apparently, Exxon was the organization’s firmest opponent in this struggle, insisting on the right to discharge wastes directly to sea.

Figure 2 Onshore Disposal Practices

Note: top left – sludge pit with no membrane, bottom left – sludge pit with membrane, right – prevailing land restoration technique ‘bury and forget’
‘Sakhalin Ecology Warden’ ends their story by noting that in 2001 both Exxon (Sakhalin 1) and Sakhalin Energy (companies) (Sakhalin 2) announced a voluntary shift to a ‘zero-discharge’ policy. Since then, supposedly no drilling operations have relied on discharge to sea.

These sources reveal two points that are worth highlighting. First, the distinction between water and oil-based drill fluids and oil contaminated cuttings, which plays an important role in Norway does not seem to be present in the Russian discussion. Second, a zero-discharge policy seemingly plays a determinant role in defining drilling waste management in Russia. But in contrast to Norway, where zero discharge came as a government ultimatum for the Barents Sea and was later countered by the oil industry, zero discharge in Russia seems to be a prevalent, but still voluntary restriction the industry has laid upon itself.

Siberia is infamous for its semi-legal sludge disposal pits (RPN, 2012). These sludge pits, which are sanctioned as temporary during drilling operations, have tended to become permanent. Sometimes they are covered with gravel and dirt, but many times not.

It is clear that best available techniques (BAT) will not be price competitive with such an approach.

Responsibility Beyond the Limits of the Law

In both Russia and Norway the strictly legal obligation of the waste producer (oil company) is to handover waste to a licensed waste management entity. Oil companies are therefore not punished if their contractors’ final treatment turns out to be substandard. But they do face reputational risk if it appears they have chosen a cheaper alternative at the expense of the environment; either knowingly or by negligence. So although they not legally accountable for subcontractors’ practice, international oil and gas companies are often concerned with the final fate of their own waste.

Such extended responsibility may also extend beyond the requirements of the law. If the legal requirements in a country are considered insufficient by international standards, the oil company may chose to comply with international standards in order to avoid criticism and support its image as a responsible player on the world arena. For example, Exxon’s switch to full reinjection on Sakhalin was facilitated by this mechanism.

Players in Murmansk who wish to provide full standard treatment solutions should therefore strive to promote transparency of actual waste management practices in order to expose oil companies to the reputational risk of choosing low-standard suppliers.

**Box 1 An Example of Oil Company Negligence in Norway**

In 2011 an explosion occurred onboard Sovcomflot’s Mar Christiania while loading slop from Oloen’s plant in Sandefjord. It was later uncovered that Oloen did not have the necessary permits for storage of such hazardous waste leading to a reprimand from Norwegian pollution authorities Klif. The director of the company owning the waste DVS Norway had to leave his post. And in the aftermath, the whole company was sold Halliburton because the clean-up job proved too large for DVS Norway.

The incident however has had larger repercussions. Environmental watchdog BELLONA traced the waste back to Statoil and threatened to file charges with the police. Claims were made to make oil companies legally responsible for their waste also downstream. The case has so far not gone that far, but the next incident may lead to greater legal responsibility for Statoil and other waste producers.
Waste Export

The Basel Convention to which both Russia and Norway are signatories regulates export of waste from one country to another and opens up for export of waste from Northwest Russia to facilities in Norway. According to the Convention, drillings wastes may be exported from Russia if complying with the following steps:

The exporter notifies the competent authority in the country of export, which subsequently requests the consent of the competent authority in the destination country. The destination country is obliged to answer in writing either consenting to import the waste in question with or without conditions, deny permission or request additional information.

Having received written consent to import, the notifying (competent) authority in the exporting country shall grant permission for the export of waste in question.

Convention text and appropriate notification forms are downloadable at www.basel.int.

Box 2 Competent Authorities

Russia
Waste Management Department
Federal Service for Supervision in the Field of Natural Resource Use
4/6, Str. Bolshaya Gruzinskay 12
3995 Moscow Russian Federation
phone: +7 499 254 54 44 / +7 499 254 28 53 fax: +7 499 254 84 77

Norway
Climate and Pollution Agency (Klif)
P.O. Box 8100 Dep
N-0032 Oslo
Norway
phone: (47) 22 57 34 00
fax: (47) 22 67 67 06
email: postmottak@klif.no
### 3 Treatment Technologies

This section gives a rudimentary introduction to treatment practices in use on the NCS that are considered to be 'best available technologies’. Reinjection and onshore treatment of wastes are the dominant disposal methods in the offshore oil and gas industry today. Offshore treatment has developed as a technically feasible alternative to transporting wastes onshore. However, limited space onboard drilling rigs has limited the application of this technology.

**Reinjection**

Field operators will generally tend to reinject both used drill fluid and cuttings into a geologic formation to cut logistics costs, which maybe done through separate wells designated for reinjection, through existing producing wells or through the well that is being drilled. However, this may not always be possible and reinjection may for various reasons break down. In Norway the share of cuttings and slop that was reinjected dropped from above 50 percent in 2006 to 40 percent in 2009. In 2010 the share dropped below 20 percent and in 2011 below 8 percent due to formation fractures causing leakages from disposal wells.

**Slop treatment**

Slop is typically treated through a two-stage processing involving first chemical, then biological cleansing.

The chemical cleansing stage first breaks the emulsion membrane using sodium hydroxide allowing particles to sediment. Particles are then added to the cuttings treatment process. Later flocculants are added to help oil float so it can be skimmed off. Oil content is reduced to about 20 ppm, but dispersed organic content is not removed. Biological agents later remove dispersed organic content bringing oil content below 10 ppm.

**Cuttings treatment**

Initial treatment takes place onboard the drilling vessel whereafter slop is transported in fixed tanks onboard supply vessels and cuttings are transported in specialized containers (skips) to shore for further processing. The offshore processing stage is generally limited to recycling drilling fluids and improving transport logistics by separating cuttings from drilling fluids, which are either reused or discarded as slop. Technology providers are working toward complete offshore processing, but technology innovation is still needed to meet space and power supply constraints offshore.

In Norway oil-contaminated cuttings may be disposed in one of three ways:

- Combustion
- Thermal condensation
- Biological decomposition
**Combustion** subjects cuttings to a pressured airflow and are burned at 800-850°C. Normally no secondary fuel is needed to keep the combustion process going. Energy efficiency will depend on the heat capture equipment installed at the site. Combusted ashes are stored at a landfill.

**Thermal condensation** subjects drill cuttings to a secondary heat source in order to separate the rock from oil and water, which are subsequently cleaned and reused. This method allows oils and water to be reused and recycled, rather than evaporated or converted into heat energy as with the combustion technology.

**Biological decomposition** relies on microorganisms and in some cases added biomass. This method may be more time consuming, as it requires cuttings to be stored as contaminated soil (safe storage) and its efficiency is vulnerable to external factors such as climate. Currently closed, tank-based systems that improve bacterial efficiency have been implemented in Norway.

**Mobile Units**

**Mobile thermal units** are emerging as an alternative for treatment offshore and in distant locations. Service suppliers such as TWMA and equipment suppliers like Termtech offer mobile treatment facilities using thermal condensation. Both the suppliers claim that their solutions are workable offshore and TWMA has several references from offshore waste processing on the UKCS. On the NCS, however, such solutions have not yet been applied offshore. But mobile facilities are being used, by among other SAR in Sandnessjøen, to expand the geographical reach of treatment capacities.
Treatment facilities in Norway

In Norway there are six companies with locations that treat oil-contaminated cuttings with facilities located around Stavanger, Bergen, Kristiansund and Sandnessjøen.

Sandnessjøen is the northernmost location so far where Veolia together with Oiltools and SAR have established thermal treatment of oil drilling wastes three-four years ago. Production at the Norne field, however, commenced in 1997, and was subsequently followed by the Urd and Marulk fields. The latest development being supplied from Sandnessjøen area, Skarv, commenced production only early 2013 after two years’ delay. Additional projects are in the pipeline such as the Aasta Hansteen field.

This development story underlines a potential challenge for Murmansk: one field development is not enough. Until three-four years ago, Sandnessjøen only exported drilling waste southbound. In Hammerfest, despite Snohvit and Goliat developments as well as substantial exploration drilling compared to the Russian sector, companies such as SAR and Perpetuum only receive wastes. Final treatment is still conducted further south although SAR is planning to install a mobile unit to provide local processing.

The same companies that provide cuttings treatment also handle and treat slop. Slop is a waste fraction that is not oil and gas specific, hence other suppliers exist as well.

<table>
<thead>
<tr>
<th>Box 4 Waste treatment companies</th>
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<tbody>
<tr>
<td>Wergeland-Halsvik</td>
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<tr>
<td>Frantzefoss Gjenvinning</td>
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<tr>
<td>SAR</td>
</tr>
<tr>
<td>Veolia / Oiltools</td>
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<tr>
<td>TMWA</td>
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<td>Halliburton</td>
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<th>Box 3 Total Waste Management</th>
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<tr>
<td>Companies in Norway are increasingly experiencing demand for management of all waste fractions. The industry’s largest companies such as SAR, Frantzefoss and Norsk Gjenvinning all offer complete waste management services.</td>
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</table>

Figure 7 Treatment Facility Components

Basins for Drill Cuttings

TCC Unit

Mixing Tanks for Slop

Rena Pure Unit

Source: Perpetuum
4 Volume Prognosis

Viable treatment alternatives in Murmansk will depend on the total amount of waste produced. This section provides a volume prognosis based on expected drilling activity.

Figure 8 displays the known drilling plans of the operators on the Russian continental shelf in coming years. Gazprom is expected to be the main contributor. One exploration well is planned at Dolginskoe already in 2013 and production drilling is expected to commence at Prirazlomnoe in 2013-2014. 40 wells are planned drilled over an eight-year period resulting in an average of 5 wells annually. Rosneft's contribution is much less and reflects foreign partners’ drilling obligations in the strategic partnership agreements with ExxonMobil, ENI and Statoil. No sources have been found indicating that Rosneft’s recent additional license acquisitions carry drilling obligations.

Figure 8  Known Drilling Plans as of February 2013 – Wells per Year

![Graph showing drilling plans](image)

In sum the contributions of Gazprom and Rosneft constitute only a modest drilling program.

For comparison, production and exploration drilling in the Norwegian Barents Sea is optimistically expected to exceed 20 wells per year in the same time horizon. See Figure 9 below.

Both Russian and Norwegian drilling activity is subject to uncertainty. In Norway, estimates beyond the next 2-3 years are based on expectations rather than firm drilling plans which means that drilling activity might be substantially reduced if oil companies’ expectations change, if geological plays do not prove themselves or in the wake of an oil price fall. Drilling on the Russian side, however, may increase as figures are based on company plans rather than expectations. That being said, it is considered unlikely that a potential increase would be substantial given Russian oil companies’ history of under-exploration of the shelf and the economic logic behind exploring onshore assets first. It is perhaps more likely that drilling activity will be lower than indicated in Figure 8. Prirazlomnoe has been repeatedly delayed and production drilling may not commence in 2013-2014 as planned.
Table 1 provides estimated drilling wastes generated by one ‘dummy’ well. The estimates are based on input variables provided by the Norwegian Petroleum Directorate in the Development Scenarios for Year-Round Petroleum Activity in Lofoten and the Barents Sea. This document prescribes that for the purpose of estimations each well shall be assumed to have a length of 3000 meter, generate 450 cubic meters of cuttings and consume 2000 cubic meters of mud.

By these assumptions total drilling waste generated from one well totals 2450 cubic meters. Assuming densities of 2.3 and 1.2 for cuttings and mud/slop respectively, total mass translates into 3435 tons drilling waste per well. The ecology department of ‘RN-Shelf-Dalny Vostok’, Rosneft’s operator company for the company’s planned well in the Kara Sea in 2014/15, estimates total wastes in the amount of 2000 cubic meters or 2500 tons. Compared to the Norwegian estimates, Rosneft’s estimates are lower both in relation to total mass 2000 versus 2450 and the implied average density amounting to 1.25 compared to 1.4 in the Norwegian estimates.

Sigra does not have a basis to judge neither the accuracy of either estimate, nor the reasons for the discrepancy. However, Rosneft’s lower estimates give reason to proceed with caution when building expectations for the future.

Multiplying the expected drilling program with waste per well estimates of the NPD and Rosneft yields high and low scenarios for drilling waste generation as depicted in Figure 10.

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1 Formation density of 2.3 has been employed by Akvaplan-Niva when assessing the capacity to manage drilling wastes in Northern Norway, see: Akvaplan-Niva Report APN-421.2631.

MUD density of 1.2 has been selected as a cautious assumption as MUD densities vary considerably based the requirements of the drilling operation from 1 toward the density of the formation itself in extreme cases.
Company plans

Gazprom Neft-Shelf boasts a complete reinjection plan for Prirazlomnoe production drilling. Should reinjection be complicated for whatever reason, the company may transport wastes to shore (as was done in Norway in 2010-2011), halt production drilling until a reinjection capacity has been restored or discharge wastes to sea. No contingency plan is provided on the company’s websites. Understanding the exact relationship between planned reinjection capacity and expected waste production as well as contingency plans will require close dialogue with the Gazprom Neft-Shelf and Gazprom Neft when responsibility for the field is transferred to them.

Rosneft is currently developing its waste management plan for the upcoming exploration wells in the Kara Sea. Considering the remote location, Rosneft and Exxon can be expected to count on reinjection to the extent possible. Drilling waste that is not reinjected will be transported to shore unless offshore processing is chosen.

Estimating onshore treatment capacity requirements is complicated and requires geological as well as reinjection knowledge in addition to close dialogue with operating companies.
5 Costs and Location Choice

This section presents costs estimates from the NCS. These take Norwegian requirements and practices as a point of departure. They illustrate the costly nature of waste processing and hence hint toward the scope for financial savings if sub-standard methods are applied.

No processing facilities for slop and/or cuttings have been identified in Murmansk oblast as of today. Waste treatment following from the promised drilling program may therefore constitute an opportunity for local value creation. This section investigates the economic rational for establishing local capacities as compared to exporting drilling wastes to existing facilities in Norway. The export option to other regions in Russia has not been explored due to lack of information and data.

Three factors influence economic rationale of establishing treatment facilities in a given location: relative distance from waste origin (drilling site) compared to alternate treatment facilities, amount of waste and oil companies’ local content policies.

The two first factors determine total costs associated with transportation to the alternative site. When sufficiently high, investments in local treatment capacity will be justified. The third factor influences the oil companies’ willingness to pay a premium in order to support local service development.

In addition the viability of offshore processing may eliminate or substantial reduce the need for onshore treatment.

Input Estimates

Economic estimates and data are scarce creating challenges for credibility and accuracy. Nonetheless, some estimates were found based on practice from the NCS, which allow a rough comparative analysis of waste management options.

According to DNV (2013) the capital cost for mobile units are in the range of 26-28 MNOK, or about 4,5 mln. USD. The offshore treatment costs are estimated to 2 000 NOK per ton.

The onshore treatment costs using the same technology are estimated to be 1 500 NOK per ton. Supply base handling is estimated to cost 1 000 NOK per ton. An older report by Akvaplan Niva (2003) estimates maritime transportation costs in the range of 13.33-16.66 NOK per ton-kilometer. Through interviews with industry players the cost of a slop treatment unit has been estimated at 12-14 MNOK.

By these estimates the unit cost of local treatment using a mobile treatment unit costs would start in the range of 18-30 thousand NOK assuming 500 tons of processed waste, which is approximately equal to 3-5 thousand USD using a 6 NOK/USD exchange rate. Unit costs would subsequently fall if annual volumes increase as illustrated in Figure 11.

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<th>MURM</th>
<th>EXP</th>
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<tr>
<td><strong>CAPEX</strong></td>
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<td>Cuttings facility m nok</td>
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<td>Slop Facility m nok</td>
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<td><strong>OPEX</strong></td>
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<td>Supply Base Handling noked/ton</td>
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<td>Facility Operation noked/ton</td>
<td>1500</td>
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</tr>
<tr>
<td>Transportation noked/km</td>
<td>0</td>
<td>13.5</td>
</tr>
</tbody>
</table>

Sources: DNV (2013), AKVPLAN-NIVA (2003), Industry interviews, Sigra Group
Figure 11 assumes that the investment decision at a distant facility is independent of volumes originating in Murmansk. Therefore, unit cost of treatment is independent of the investment cost, but a function of the treatment costs at the given location and the cost of transportation to the given destination, which is assumed to be by sea. Both Figure 11 and Figure 12 discard costs on board the drilling installation from the analysis handling as these would be applied in both cases and would not influence on the choice between the two alternatives.

Comparing Figure 11 and Figure 12 illustrates that while unit costs of local treatment drop markedly as annual volumes rise transportation costs quickly increase the cost of distant treatment. As volumes exceed 2 000 tons per year, unit costs start to compete with existing facilities located 400 kilometers away and further.

**Applying the distance estimates in**

Table 3. Figure 13 compares the cost of establishing local treatment capacity to the export option.

A positive finding for Murmansk is that even with low annual volumes local capacity may be able to compete with export to Hammerfest, which is the nearest location where treatment capacity is planned today.

However, should facilities be established in Kirkenes first, substantially higher volumes would be needed to justify investments in Murmansk. Drilling operations outside Kirkenes may be expected only in 2016-2017. Thus although capacities in Kirkenes may be a competitive threat, it may also be a commercial opportunity for Murmansk. If capacity is installed in Murmansk first, this would undermine the rationale establishing capacity in Kirkenes.
It needs to be highlighted that the Murmansk investment case presupposes a long-term contract with an oil company and sufficient volumes. Should contract lengths fall short of 3 years, implied unit costs would rise substantially undermining the commerciality of the investments. Volumes are equally important.

The oil companies therefore have an important role to play through their contracting strategy in order to support local service providers. These elements should be a central part of regional authorities dialogue with the companies.

A word of caution

The analysis above is not rigorous and not intended to be accurate. The analysis shows that local waste treatment may be economically justifiable, but not more. Better and more detailed information will need to be obtained through dialogue with the oil companies, technology suppliers as well as potential service providers.

The total waste amount has been estimated to average approximately 12 000 tons per year under the conservative assumptions. However, oil companies are planning to rely on reinjection. Should reinjection succeed in handling about 1/2 of the total waste as was the case on the NCS in 2006-2009, then onshore processing of cuttings might reach only 2 000 tons per year. Taking into consideration the substantial risk of drilling fewer wells than planned, the commercial decision might not be clear-cut for investors unless oil companies’ provide corresponding guarantees.

Maritime transport to a treatment facility in Hammerfest has been assumed resulting in substantial transportation costs. However, a shift to road transport might bring down costs considerably.

The analysis also assumes simple payback meaning that capital costs have not been accounted for, which would lead the real unit cost to be higher.

Role of the Supply Base

Despite its deficiencies, the analysis above leads to one certain and very important conclusion for Murmansk. Substantial maritime transportation costs imply field logistics will be concentrated around a limited number of onshore supply-bases. In other words, winning the competition for the supply-base will seal the inter-regional competition to provide waste management services as well as other business opportunities.

Equally important however is that the region that can offer the most of the required services will also be the best placed in the completion for the supply base. Hence, efforts need to be made in order to put both a supply base and waste management services in place.
6 Options for Murmansk

Murmansk should work hard to get supply base functions. Provided the supply base function is located in Murmansk it is recommended that waste management services should be organized according to international best practice.

Substandard solutions, even if they are legal, will create environmental costs to that are not compensated, but credited to the oil company in terms of lower prices and to the waste management company’s owners in terms of profits leading to less net economic benefit for the region.

As a strategy for maximizing local economic benefits while mitigating risk, local companies may establish cooperation with Norwegian partners that includes the following arrangements:

- Waste reception in Murmansk and transport to treatment facility in Norway up the annual threshold volume, upon which treatment in Murmansk is economically feasible.
- Establishment of a treatment facility in Murmansk given economic volumes of waste.

Such cooperation would build upon:

- Joint bidding through consortium agreement or mutually owned company
- Predefined conditions for investment in local treatment facility

Alternatively:

- Local companies may organize waste reception and export to Norway without planning a jointly-owned treatment facility in Murmansk.
- Norwegian companies may establish operations in Murmansk independently, at first-based on export and later on local treatment

However there are several arguments in favor of a cooperative approach, some of which include:

- Establishing a treatment facility may be part of a long-term contract with an oil company focused on building local content (export today, but treat tomorrow). In this case cooperation with a Norwegian partner might bring reassurance for the oil company that the consortium has the competence needed to build a satisfactory final treatment facility.
- Cooperation may warrant lower pricing of reception and transport on the Russian side as well as treatment and technology export from the Norwegian side, which could bring costs down and make the offer more cost-competitive compared to other alternatives.

Nonetheless, some Norwegian investors in Northwest-Russia who have taken early risk are remembered in Norway for either having been cheated by their Russian partner, having miscalculated future demand or met troubles with the authorities.

Successful cooperation would require mutual understanding and well-founded trust between the Russian and Norwegian companies. An independent approach is perhaps more likely, but would be less likely to ensure the highest environmental standards.

In any case local authorities should insist upon full standard treatment, as this will bring the largest positive regional ripple effects through less ecologic damage to the region and larger local investments in modern facilities.
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