Chapter 9 Air Quality, Noise, Water Quality and Groundwater

9.1 INTRODUCTION

This chapter provides additional information to address the concerns raised, and comments made, by stakeholders during the review of the international-style EIA report. More specifically, it addresses the following issues raised through the review process:

- Comparison of the Russian and UK air quality modelling methods:
  - Calculation of the Sanitary Protection Zone;
  - Relocation of dachas;
- Comparison of the Russian and "International" air emission and water discharge standards;
- Quantification of flaring during commissioning;
- Discussion of noise impacts and groundwater usage at Booster Station 2;
- Sustainability of groundwater use at the Onshore Production Facility (OPF).

For these reasons, the chapter is a series of responses to questions rather than a structured update of the situation regarding the environmental parameters in question.

9.2 COMPARISON OF THE RUSSIAN AND INTERNATIONAL MODELLING METHODS

9.2.1 Overview

Impacts upon local air quality from the LNG/OET facilities have been assessed using two distinct modelling methods:

- The Russian OND-86 model;
- The United Kingdom (Cambridge Environmental Research Consultants, UK) ADMS 3.1 model.

The OND-86 modelling method is the only approach that is prescribed in accordance with Russian Federation standards. Following publication of the international-style EIA (in 2003), the Russian Ministry of Natural Resources (MNR) has approved an air quality assessment that increases the diameter of the SPZ from one kilometre (as reported in the EIA), to 3.5km. Further progression of this issue is presented in Section 9.2.4 and Figure 9.1.

In keeping with international best practice, SEIC elected to conduct a modelling assessment using the Air Dispersion Modelling Software (ADMS) model to enable comparison with the World Health Organisation (WHO) objectives.

9.2.2 OND-86

The Russian MNR, through a series of Ministerial Decrees, requires the use of the OND-86 methodology to predict the impacts on local air quality for developments within the Russian Federation.

OND-86 is a non-Gaussian multiple-source regulatory dispersion model developed by the team of specialists of the Main Geophysical Observatory (MGO). It is based on analytical approximations of the numerical solution of the advection-diffusion equation, which were obtained initially for point sources and then integrated to provide expressions for line and area sources (ETC/ACC 2004).

Rather than actual concentrations corresponding to certain meteorological conditions, the model is intended for calculation of the worst-case concentration fields. These fields comprise the values of 98th percentiles of the probability distribution functions (PDFs) of concentrations at a given set of receptor points. The results of calculations of concentrations of noxious pollutants are to be compared with Russian short-term national ambient air quality standards called Maximum Permissible Concentrations. They correspond to the averaging time of twenty to thirty minutes. The use of OND-86 in Russia is obligatory when applying for emission permits, determining the emission standards ("maximum permissible emissions") when designing new industrial facilities. The outputs from the modelling exercise are used to define a Sanitary Protection Zone (SPZ).

The OND-86 model calculates the distance at which pollutant concentrations are predicted to be below the Russian regulatory standards and thus, the geographic limit of the SPZ is delineated. Russian law forbids sensitive land uses (*e.g.* agriculture) and people from living (*i.e.* residential land use) in the SPZ.

9.2.3 Air Dispersion Modelling Software (ADMS)

ADMS, on the other hand, is a PC-based model of dispersion in the atmospheric of passive, buoyant or slightly dense, continuous or finite duration releases from single or multiple sources, which may be point, area or line sources. The model uses an up-to-date parameterisation of the boundary layer structure and the boundary layer height.

Its applications are air quality assessments, regulatory purposes and to provide information on industrial emission sources (*i.e.* it is used to by, and on behalf, of the Environment Agency in the UK and by private industry). It is also used to support policy (*e.g.* UK National Air Quality Strategy and assessments of exceedences of EU and proposed UK and EU air quality

standards), emergency responses (*e.g.* for chemical spills) and scientific research. ADMS 3 has been submitted to the US EPA for use as a regulatory model.
It is frequently used in "international class" EIAs including those carried out for World Bank-funded developments. ADMS is primarily used to predict ground level concentrations originating from emissions from a specific facility or range of sources and compare these with World Health Organisation (WHO) air quality standards and guidelines.

9.2.4 Comparison of Models

Both models utilise input data such as stack height, emission rates etc. However, due to the difference in the way the dispersion is calculated and presented, it is not possible to directly compare the OND-86 results to those predicted by ADMS.

These models differ in a variety of ways including the treatment of pollutant dispersal within a plume and how the model approximates dispersion within the boundary layer.

The key differences in the assessments of the LNG/OET facility using the two modelling methods investigated in this section are:

- The meteorology data used;
- Development of the emission scenario.

These differences are discussed in the following sections. A comparison of the results of these two distinct methods is presented in Section 9.2.5.

9.2.5 Meteorology

The OND-86 methodology calculates the maximum predicted concentrations for both 20-minute and 24-hour averaging periods. Annual wind roses are used to create a SPZ to broadly simulate the frequency and distribution of wind directions throughout the year. Different wind speeds (*i.e.* 1.9 ms^{-1}, 3 ms^{-1}*)* are used in the model, in line with the requirements of Russian regulations; these are prescribed in the methodology and not based on observed data from the proposed location of the facility.

ADMS uses observed meteorological data with a whole range of parameters including wind direction, wind speed, ambient temperature and normally includes hourly information for an entire 12-month period. The model predicts the maximum hourly impact from the facility by simulating the effect of meteorological conditions on emissions from the facility for every hour of the year. The annual average is obtained by averaging the hourly results.

9.2.6 Emission Scenarios

In both modelling approaches, dispersion pollutants are modelled to estimate the likely impacts of the facility. The different stages in the development life-cycle (*i.e.* from commissioning to operation – and including shutdown, restart and abnormal conditions) emit different types and quantities of pollutants.

Nitrogen dioxide (NO_2) is the most significant pollutant emitted by the facility, which will affect local air quality. Other pollutants investigated in the model include sulphur dioxide (SO_2), carbon monoxide (CO) and hydrocarbons.

OND-86

The Russian methodology for calculating the size of the SPZ requires that all relevant sources in each of the project phases be considered. The OND-86 modelling of the LNG/OET facility therefore included the following phases:

- Pre-commissioning of LNG train 1, operation of LNG Plant power plant using diesel fuel and operation of the OET and TLU;
- Commencement of LNG train 1 start up; operation of OET and TLU;
- Completion of LNG train 1 start up; operation of OET and TLU;
- Operation of LNG train 1 and common facilities; operation of OET and TLU;
- Full-scale operation of LNG plant (two trains); operation of OET and TLU;
- Emergencies during the full scale operation:
  - Flaring of feed gas from tanks and equipment;
  - Venting of acid gas;
  - Release of hydrocarbons due to clogged gas turbine equipment and shutdown of process equipment.

Modelling of emissions using OND-86 was conducted by two agencies: Ecocenter and Saint Petersburg Mechnikov State Medical academy. The results of these two separate assessments differed in one area: the method of calculating emissions from vessels in Aniva Bay.

The Ecocenter assessment followed the prescribed Russian methodology as approved by the MNR, therefore sources that operate for periods in excess of 20-minutes are treated as continuous. This included tugboats, which will only be used for a few hours at a time and during this time have high emission rates of NO_2. The Ecocenter assessment therefore included a conservatively high estimate of emissions from tugboats in particular, and other vessels in general.

The assessment conducted by the Saint Petersburg Mechnikov State Medical academy estimated emissions from tugboats based on the anticipated level of operation as approved by the Ministry of Health. This approach consequently predicted a smaller SPZ than the Ecocenter assessment.

ADMS

Shell Global Solutions conducted modelling of the facility using ADMS. This assessment looked at a number of variations of the two basic scenarios:

- One LNG train and OET;
- Two LNG trains and the OET.

The ADMS modelling did not consider impacts from emergency situations either during start-up commissioning or operation of the LNG plant. Emissions from the tugboats and other vessels were estimated based upon their anticipated level of operation.

The predicted concentrations were compared to the WHO guidelines with particular reference to the concentrations predicted at the dachas, the only inhabited area within the vicinity of the plant.

9.2.7 Comparison of Modelling Results and the SPZ

An initial assessment using the OND-86 model was conducted by Ecocenter. This assessment was based on the full-scale operation of the two-train LNG plant, recommending a SPZ extending, onshore, to a maximum distance of 3.5km from the LNG plant. The offshore locations in which the tugboats will operate resulted in an extension of the SPZ to a maximum of seven-kilometres offshore from the LNG plant.

Subsequently, and as a result of a separate assessment by SEIC, the Ministry of Health approved a one-kilometre diameter SPZ (see Figure 9.1) based on the approved OND-86 methodology and their health risk assessment using modelling results.

As outlined in 9.2.4 and the following sections, the ADMS modelling predicted air emissions within World Health Organisation guidelines.

In May 2005, SEIC decided to adopt the 1km SPZ. A tract of farmland is located within the 1km SPZ and will be vacated. An agreement between all parties for appropriate compensation has been reached. The remaining land within the 1km SPZ does not include farmland.

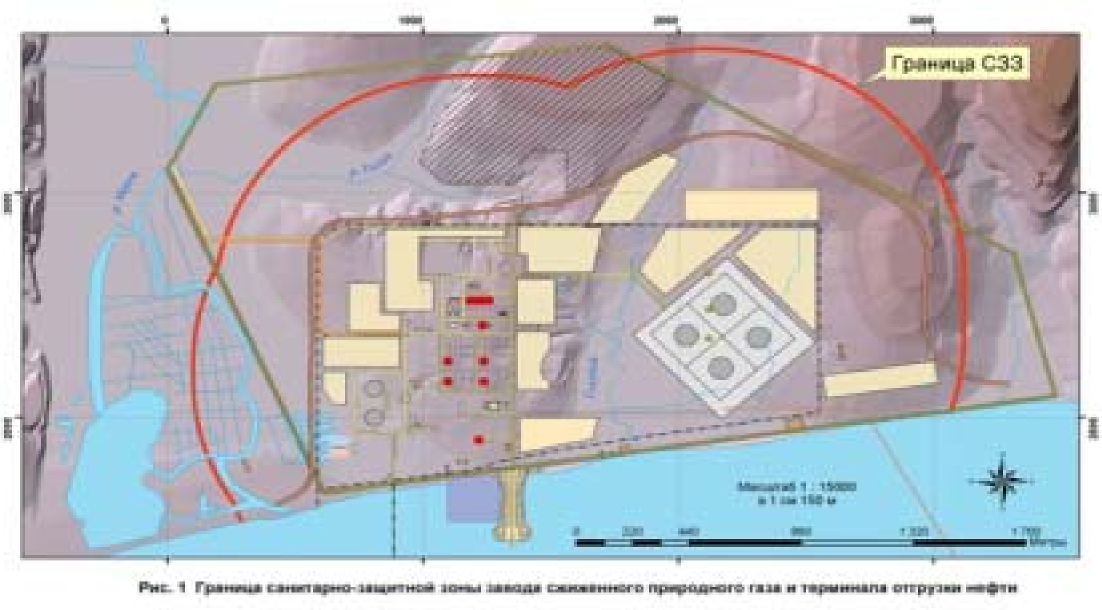

Figure 9.1. Boundary of SPZ for LNG and OET as Approved by Ministry of Health (denoted by red (arced) line)

ADMS

The predicted ground-level concentrations of pollutants using ADMS during the normal operations of 1 and 2 LNG trains are shown in *Tables 9.1* and *9.2.* These are the highest predicted concentrations from a range of variations including operation mode, seasonal changes and different vessels.

Table 9.1 Highest Predicted Ground Level Concentrations of using ADMS – One Train Operation

Pollutant	Averaging Period	Location (highest point within modelling domain or at the dachas)	Predicted Concentration ($\mu g/m^3$)	WHO Air Quality Objective ($\mu g/m^3$)
NO_2 (1)	1-hour	Highest point within domain	67 (2)	200
NO_2 (1)	1-hour	Dachas	15 (2)	200
NO_2 (1)	Annual	Highest point within domain	13	40
NO_2 (1)	Annual	Dachas	0.7	40
SO_2	Annual	Highest point within domain	13	50
SO_2	Annual	Dachas	0.3	50

(1) NO_x as 100% NO_2.
(2) Calculated as the 99.5 percentile concentration

Table 9.2 Highest Predicted Ground Level Concentrations using ADMS – Two Train Operation

Pollutant	Averaging Period	Location (highest point within modelling domain or at the dachas)	Predicted Concentration ($\mu g/m^3$)	WHO Air Quality Objective ($\mu g/m^3$)
NO_2 (1)	1-hour	Highest point within domain	101 (2)	200
NO_2 (1)	1-hour	Dachas	17 (2)	200
NO_2 (1)	Annual	Highest point within domain	16	40
NO_2 (1)	Annual	Dachas	0.7	40
SO_2	Annual	Highest point within domain	22	50
SO_2	Annual	Dachas	0.5	50

(1) NO_x as 100% NO_2.
(2) Calculated as the 99.5 percentile concentration

The ADMS model has been used to predict ground level concentrations from normal operation of the LNG / OET facility. The predicted ground level concentrations at all locations within the modelling domain, including the dachas, are less than the WHO air quality objectives and therefore no significant impact to air quality is expected during normal operation of the facility using these guidelines.

It should be noted that these predictions are for the facility impact alone and do not make any allowance for background pollutants in ambient air. There is limited relevant available data regarding background air quality concentrations at the site; an overview of the available data is provided in Section 1.3.2 "Air Quality" of the international EIA *Chapter 1, Volume 5* (SEIC 2003).

Monitoring of atmospheric pollution in towns of the Sakhalin region has been carried out for more than 20 years; some specific baseline studies of air pollutants were carried out in the period from June-September 1998 by Roshydromet and Sakhydromet for the pipeline and infrastructure construction sites including observations in Prigorodnoye.

The limited available baseline data is not considered to compromise the results of the modelling given the location of the LNG site and general compliance with international standards predicted by the modelling assessment, particularly at the dacha locations.

It is worth mentioning that impacts on air quality will be carefully monitored throughout the different phases of the Project. The Atmospheric Air Pollution Monitoring for construction phase (CTSD Document No. 7000-E-90-04-P-0006-01) describes the monitoring programme, including fixed and mobile monitoring points around the LNG Plant area and sampling frequencies. The air quality parameters included will be: NO_2, CO, SO_2, suspended solids and soot. Studies are also to be carried out by Sakhydromet.

Monitoring activities will be summarised in the HSESAP.

9.2.8 Conclusion

The approach of the OND-86 and ADMS models differ significantly and therefore the results are not directly comparable. The ADMS model is used in the assessment to predict the maximum concentration within the modelling domain. OND-86 assists to calculate a SPZ beyond which the Russian air quality objectives should not be exceeded.

The OND-86 model also uses a simplified description of pollutant dispersion and limited site-specific meteorological data. The size of the SPZ used in the model can therefore be regarded as overestimated and in this regard OND-86 is considered to be a conservative model.

Whilst different in approach, the output from the two models does show some similar trends. The stacks and exhausts, from which the pollutants will disperse, have been designed to ensure that adequate dispersion of the pollutants, particularly NO_2, will occur.

Based on the ADMS modelling carried out (normal operation) the predicted impacts from SO_2 and NO_2 emissions from the facility are within the WHO objectives.

9.3 COMPARISON OF RUSSIAN FEDERATION AND INTERNATIONAL AIR QUALITY AND WATER STANDARDS

9.3.1 General Considerations

The Sakhalin II Phase 2 Project is subject to a broad range of environmental standards and objectives. SEIC is committed to meeting, and in many cases exceeding, the requirements of the Russian Federation and ”international” standards.

The environmental monitoring plan will be further developed during the detailed design phase as well as during the construction and operation phases. Effluent and emissions will be monitored routinely to ensure that the construction and operational activities are complying with regulations, permits and industry best practice.

As part of the Russian Federation approval process, a comprehensive list of pollutants that will be emitted from the development has been compiled. The Russian Federation prescribes Maximum Permissible Concentrations (MPCs) for each of these pollutants.

As part of the EIA process, emissions from the development are compared to international standards and objectives, such as those set by the WHO and World Bank.

9.3.2 Air Quality

A comparison of the different standards for common pollutants from the development is shown in Table 9.3.

Table 9.3 Comparison of Russian and International Air Quality Standards

Pollutant	Russian Federation MPC (µg/m^3) and averaging period	WHO Objective (µg/m^3) and averaging period
Nitrogen dioxide (NO_2)	85 (20-mins) 40 (24-hours)	200 (1-hour) 40 (1-year)
Sulphur dioxide (SO_2)	500 (20-mins) 50 (24-hours)	500 (10-mins) 125 (24-hours) 50 (1 year)
Carbon monoxide (CO)	5,000 (20-mins) 3,000 (24-hours)	100,000 (15-mins) 60,000 (30-mins) 30,000 (1-hour) 10,000 (8-hours)

The WHO objectives are based on the protection of human health. The different averaging periods reflect the potential impact on health; pollutants assigned a standard with a short-term reference period have acute effects, and those with long-term (annual) reference periods are associated with more chronic effects.

For the protection of public health, no standard should be exceeded. The higher the concentration, the shorter the period of exposure is required to limit the effect on the subject. Conversely, the exposure periods can be extended with lower pollutant concentrations.

As shown in Table 9.3 above, the Russian Federation MPCs are more stringent than the WHO objectives with the exception of the SO_2 20-minute MPC for sulphur dioxide. In this instance, the WHO guideline is the same concentration but half the exposure period.

In the case of NO_2 (the principal pollutant of interest), the Russian MPCs are far more stringent than the WHO objectives with lower or equivalent averaging-times.

9.3.3 Water Quality

Introduction

A straightforward comparison between Russian and international standards for water quality is not possible. This is primarily because the most often quoted international standards*, i.e.,* those advocated by the World Bank, are for effluent quality (or “end-of-pipe”). In Russia, on the other hand, wastewater discharges are controlled through a more sophisticated process that starts with the nature and use of the receiving water for the discharge and then works back to determine an allowable effluent discharge. This procedure is broadly similar to that followed in Europe and the two approaches are compared in the following sections.

The Russian Approach to Regulating Water Quality

There are three key parameters that are involved in Water Quality Regulation:

- Maximal Permissible Concentrations (MPC) – ambient standards of water quality for certain pollutant in water body of certain type of usage;
- End of Pipe Permissible Concentrations (EPPC);
- Maximum Permissible Discharge (MPD) – limit for discharge of certain pollutant to certain water body per hour and total (per year).

In general, ambient standards are set which relate to the “quality” of surface waters, however, this is dependant upon the classification of use of surface waters. For example, waters classed as important for fisheries have more stringent standards than, say, those waters used for general industrial abstraction. Thus, this is a classification based on “use”. Each class then has Maximal Permissible Concentrations (MPC) for a wide range of substances, where the Maximum Permissible Discharges (MPDs) and End of Pipe Permissible Concentrations (EPPC) have to be developed for specific discharges into this range of surface waters. MPDs are developed for water users (not waterbodies) and their derivation depends on the factors of usage (e.g. the purpose of usage, characteristics of equipment used by water user for treatment of specific wastewaters, and the ability of water body to dissolve the specific discharges).

A simplified representation of the approach is given below – in this instance, drawing from the development of the MPDs for the PA-B platform discharges.

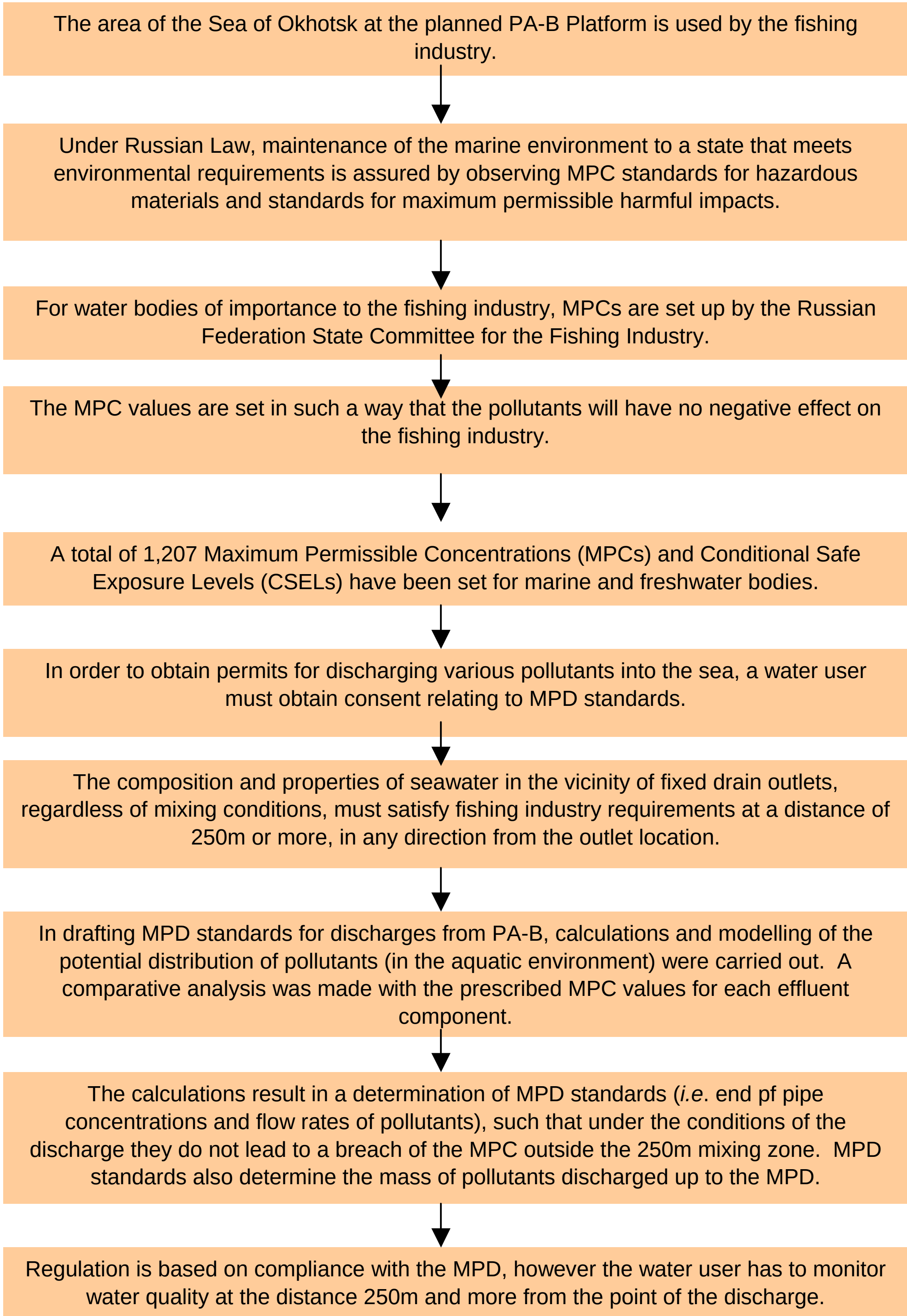

Figure 9.2 Regulation of Water Quality – MPDs for PA-B Platform Discharges

The European Union Approach to Regulating Water Quality

The EU also uses a variety of standards and targets to help protect and improve water quality. They are used to calculate the potential impacts of industry and agriculture and to work out the conditions to be imposed upon discharges in order to protect water quality. Such standards, usually referred to as Environmental Quality Standards (EQS), may have a variety of aims, including:

- Protecting wildlife and nature;
- Controlling risks to the quality of water abstracted for potable supply and agricultural use;
- Making sure that enjoyment of leisure activities such as bathing, angling and boating are as safe as possible.

Most of the standards (*e.g.* those concerning bathing waters, habitats, shellfish and freshwater fish) support the requirements of European Directives. Consequently, different EQSs are often applied to different water uses or classifications. EQSs are therefore prescribed for certain substances and are used to define the upper level of a substance's concentration in the environment that is considered tolerable.

In terms of determining discharge consents, these are made on a case-by-case basis so that in addition to the class of receiving water, an effluent quality standard is determined on the basis of factors including dilution characteristics, effluent composition and volume, concentrations of individual components and the size of the mixing zone. Finally, "Best Available Technology" (BAT) also plays a role.

Comparison of Standards

A comparison of standards between EU and Russian practices is not strictly possible. Both parties set "acceptable" concentrations for a long list of substances in the environment (more than 2,500 chemicals have MPCs in Russia and more than 1,200 chemicals have EQSs or equivalent in the UK). In both cases, these concentrations are set down by experts based on knowledge of the substances' effects in the aquatic environment; different levels are set according to the water use involved. Furthermore, in both the EU and Russia, waters that are important to fisheries tend to have the most stringent MPC or EQS values. Finally, in both Russia and the EU, discharge limits are set on a case-by-case basis, often involving extensive scientific studies and the scrutiny of experts. The resulting limits must be complied with, monitoring requirements are identified and any breaches are subject to financial penalties.

There are some key differences, however, such as:

- The drivers in the Russian system are financial penalties as a deterrent compared to the more proactive BAT approach in the EU;

- In Russia, for waters considered of highest (fishery) value, any discharge is prohibited.

As stated above, a meaningful comparison of actual numerical values would not be a valid exercise. If this was carried out, the result would be that for some substances Russia has a stricter regime compared to the EU whereas for other it is less so. For most, however, both are comparable.

An MPD is calculated based on the discharge – into a specific receiving waterbody – of a defined concentration of pollutant. This allows for a (theoretical) mixing zone to be calculated and the pollutant concentration is measured at the edge of this mixing zone. The end of pipe concentration may therefore be many times higher than the background concentration of a waterbody. EQSs, on the other hand, are standards that should be met across a waterbody and not associated with a point of discharge. In Europe, the term “environmental quality standard” includes several numerical standards that specify maximum allowable concentrations, or target levels, of named pollutants (or potentially toxic substances) for water. In addition to numerical EQSs, there are also qualitative Community EQSs that may require stricter limit values.

Interestingly, there is no UK EQS for petroleum products, however the commonly applied standard is that there should be no visible surface petroleum hydrocarbon pollution.

9.3.4 Conclusion

Air Quality

SEIC is committed to compliance with all relevant regulations, permits and industry best practice. The Phase 2 project has been assessed against both Russian Federation and international environmental guidelines. Comparing objectives is inherently difficult as averaging periods or methods of measuring compliance can be different. However, based upon the air emission guidelines provided in Table 9.3, it can be seen that the RF guidelines are often as stringent, if not more so, than comparable international standards.

It is worth noting that international standards are designed to protect human health (and flora) as well as the environment and should therefore be viewed as absolute design and operational performance targets, whereas the Russian standards represent a threshold above which further penalties are applied.

Water Quality

Overall, it is reasonable to state that the approach used in Russia is one that is in accordance with international practices. Monitoring for compliance will be based on Russian Federation legislation and, as such, is aimed at meeting these requirements.

As far as the different systems allow, SEIC will compare MPDs with World Bank end-of-pipe discharges in the Health, Safety, Environmental and Social Action Plan (HSESAP) standards comparison table.

9.4 AIR EMISSIONS AND FLARING POLICY

9.4.1 Flaring during Commissioning

Volumetric Study

During 2005, the Operations Planning team is preparing a volumetric flaring forecast, amongst the aims of which are to quantify the flaring volumes during commissioning and assess steady-state operations at SEIC facilities. The study is looking at the basis assumptions during the TEO-C and will also assess how the plant will be commissioned.

9.4.2 Flaring at the OPF

There are a number of causes of major amounts of flaring during commissioning of the OPF and the hydrocarbon systems it supports:

- Well tests on Lun-A wells;
- Commissioning of OPF facility;
- Supply of very low amounts of gas to the LNG plant for their commissioning below the turn-down rate of the OPF or the multiphase pipelines.

Of these three sources, the OPF team is directly responsible for the second; for the other two, the team responds to demands from other hardware groups. Different options to reduce the flaring during commissioning are being explored by co-ordinating between the different hardware groups. Until an option is selected, the final amount of flaring during commissioning flaring will not be known.

There will be no venting of hydrocarbons during commissioning.

9.5 NOISE AND AIR IMPACTS AND GROUNDWATER USAGE AT BOOSTER STATION 2

The international-style EIA presented information on the establishment of a Booster Station (referred to as Booster Station 2) midway between the OPF and LNG/OET. At the time of publication, the EIA stated that the final design and location of Booster Station 2 (BS2) had not been determined. The BS2 site has since been located north of the village of Gastello. The current design of the BS2 facilities includes a compressor station only, not a pump station. The BS2 facility will be commissioned in 2008.
Following more definitive design, SEIC will:

- Conduct an assessment of the noise impact. This will include the identification of appropriate mitigation techniques where required to ensure compliance with Russian Federation and international noise standards;
- Conduct air modelling required by the Russian Federation to determine the boundary of the MPC in relation to the nearest residences;
- Likewise, the possibility of water extraction at Booster Station 2 depends on the final design. Should water extraction be required, an appropriate study into the sustainability of the aquifer for the proposed water extraction rates will be conducted. This will include sampling and groundwater modelling using Russian Federation and international standards where appropriate.

9.6 SUSTAINABILITY OF GROUNDWATER USE AT THE OPF

The OPF will require a supply of water for plant maintenance, domestic and industrial uses, amongst others.

SEIC has identified an artesian water supply four kilometres to the south-west of the OPF site. Three exploration wells were drilled and three development wells have subsequently been drilled to 130m. Each well can sustain approx 700m^3/day of water depending on the pump size used. The water has a pH of approximately 6 with an iron content around 5.3 mg/l.

It will fully accommodate the project water requirements at the required sustainability for the next 30 years. Three wells were drilled and gravel packed. These will have 13 KW ESP pumps installed that will pump water to the OPF facility via two six-inch diameter plastic pipelines. Two monitoring wells have also been drilled. The production wells were required to deliver a maximum of 72m^3/hr for the worst-case scenario, this being the filling of firewater tanks. Moreover, these wells will be able to produce in excess of 90m^3/hr with the 13KW pumps being installed.

The water requirements of the OPF facility during and after construction will be well within production capacity predicted by both well test data and groundwater modelling. The wells are all artesian with a positive head of around 2m.

The effects of long-term extraction will be monitored to assess the accuracy of the developed model. A monitoring program will commence in 2005 for a minimum of three years and the results will be used to update the model and long-term production forecast.

The plan is to abandon the beach wells at the end of 2005 once the new 130m well results have proven their reliability.

SEIC intends to obtain further data over a wider area to validate, and if appropriate amend, the model calibration and give a greater confidence to the model simulations. In addition, detailed aquifer testing will be undertaken to provide more reliable information on hydraulic conductivity than that obtained to date. The effects of long-term abstraction will be monitored to assess the accuracy of the model.

The construction and assessment of the water wells was undertaken in full compliance with all RF standards.

Water Aquifer and Water Quality Monitoring Plan

A monitoring programme will be developed for the permanent groundwater intake located south-west of the OPF. The programme is to be carried out during water intake during the operational period starting from the water intake commissioning. The area to be monitored under the programme includes the area of the water intake as such and the area of the cone of depression.

The programme is being developed to determine the volumes and dynamics of groundwater production, to identify the environmental factors that affect the quality of ground and surface water, identify the mechanisms of groundwater hydrochemical regime alterations, monitor sanitary conditions in the water intake sanitary protection zones and monitor technical conditions of the water intake facilities.

The parameters to be monitored under the programme are as follows:

- Volumes of water production;
- Groundwater dynamic level;
- Groundwater table;
- Groundwater quality, analysis of microbiological, organoleptic, generalised, inorganic and organic matter, and radiological parameters.

The frequency of sampling for water quality analysis will include:

- Microbiological parameters – once a month;
- Organoleptic and generalised parameters – four times a year (by seasons of the year);
- Inorganic, organic and radiological parameters – once a year.

9.6.1 Disposal of Oily Wastewaters during Construction and Operation

Construction

Currently the OPF contractor is using an oil separator to treat oily wastewaters. They divert separated water to a sewage treatment plant (STP) and discharge treated waters to the sewerage system. Separated oil is collected and stored at the OPF waste storage facility. Eventually it will be sold or donated to the owners of local boiler(s) and used as supplemental fuel for heat recovery.

Oil volumes are low at the construction stage. Oily wastes will not be disposed of down the disposal wells.

Operation

It is the intention of the OPF team to dispose of all produced water and surface wastewater streams to the two disposal wells. The treated sewage water and laundry water will not be disposed of down these wells because of anticipated bio-fouling problems. The OPF is currently investigating opportunities to continue disposal to land in line with that permitted in the construction phase.

OPF studies show that the disposal of wastewater in what are relatively small quantities is environmentally safe in the OPF area. The well locations have specifically been chosen on the basis that the underground plume of injected wastewater will not contact any of the major faults. The OPF area is also overlain with 400m of impermeable clay and the chances of any injected wastewater reaching the surface would be extremely remote. It is anticipated that the injection interval will be deeper than 1,500m and it is known in addition to the 400m of impermeable clay at surface the reservoir is interbedded with very low permeability layers. This will reduce the chance of any vertical migration of fluid within the reservoir itself.

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TEO-C Commitment Matrix, Item 35.

APPENDIX 1

Aquifer Water Test Results
Dated 6 May 2004-06-15

1. Name and address of organisation (Client): OOO HydroGeo
2. Water origin: Water well
3. Date and time of receipt in laboratory: 28.04.04, 10.45
4. Date and time of sampling: 24.04.04, 14.00
6. Applicable Regulatory documents: SanPiN 2.1.4.1074-01 "Potable Water. Hygienic Requirements for Water Quality in Centralised Water Supply Systems. Quality Control".

Parameters	**Norms**	**Content in Tested Sample**	**Normative Documents**
Organoleptic Properties			
Odour, points	max. 2.0	0	GOST 3351-74
Taste, points	max. 2.0	Not tested	GOST 3351-74
Turbidity, EMF units	Up to 2.6	14.83*	GOST 3351-74
Coloration, degree	max. 20.0	15.2	GOST 3351-74
General Properties			
pH value	6.0 – 9.0	6.5	GOST 3351-74
Permanganate oxidability, mg 02/l	max. 5.0	0.56	Water Quality Analysis Procedure
Alkalinity, mg equ/l	max. 10.0	0.76	Water Quality Analysis Procedure
Hardness, total, mol/l	max. 7.0	0.25	GOST 4151-72
Solids, mg/l	max. 1000.0	69.56	GOST 18164-72
Benzol, mg/l	max. 0.01	<0.002	MUK 4.1.739-99
Toluol, mg/l	max. 0.5	<0.01	MUK 4.1.739-99
Ethylbenzene, mg/l	max. 0.01	<0.002	MUK 4.1.739-99
Xylol, mg/l	max. 0.05	<0.01	MUK 4.1.739-99
Chlorbenzene, mg/l	max. 0.02	<0.02	MUK 4.1.739-99
Styrene, mg/l	max. 0.1	<0.05	MUK 4.1.739-99
DDT, mg/l	max. 0.002	<0.001	MU 4120-86

Hexachlorocyclohexane, mg/l	max. 0.002	<0.001	MU 4120-86
2,4 D, mg/l	max. 0.03	<0.03	MU 3161-84
Toxicity index, %	70-120	98.2	MR TsOSPBR 005-95

Non-Organic Matters

Ammonia nitrogen, mg/l	max. 2.0	1.54	GOST 4192-82
Nitrites, mg/l	max. 3.0	<0.5	PNF F 14.1:2:4.157-99
Nitrate, mg/l	max. 45.0	<0.5	PNF F 14.1:2:4.157-99
Calcium, mg equ/l	3.5	0.15 (±0.02)	PNF F 14.1:2:4.167-00
Magnesium, mg equ/l	max. 20.0	0.10 (±0.02)	PNF F 14.1:2:4.167-00
Sodium, mg/l	max. 200.0	3.96 (±0.59)	PNF F 14.1:2:4.167-00
Potassium, mg/l	max. 20.0	0.75 (±0.13)	PNF F 14.1:2:4.167-00
Chlorides, mg/l	max. 350.0	5.28 (±0.79)	PNF F 14.1:2:4.157-99
Sulphates, mg/l	max. 500.0	12.45 (±2.49)	PNF F 14.1:2:4.157-99
Iron, mg/l	max. 0.3	5.35*	GOST 4011-72
Phenols, mg/l	max. 0.25	<0.0005	PND F 14.1:2.4.117-97
Chromium, mg/l	0.05	<0.02	Water Quality Analysis Procedure
Barium, mg/l	0.1	<0.05	PNF F 14.1:2:4.167-00
Arsenic, mg/l	max. 0.05	<0.01	GOST 4152-89
Fluoride, mg/l	max. 1.5	<0.25	PNF F 14.1:2:4.157-99
Aluminium, mg/l	max. 0.5	<0.02	GOST 18165-89
Phosphate, mg/l	3.5	<0.08	GOST 18309-72
Lead, mg/l	max. 0.03	<0.03	ISO 8288
Cadmium, mg/l	max. 0.001	<0.001	ISO 8288
Copper, mg/l	max. 1.0	<0.01	ISO 8288
Zinc, mg/l	max. 5.0	<0.05	ISO 8288

Manganese, mg/l	max. 0.1	<0.08	ISO 8288
Nickel, mg/l	max. 0.1	<0.02	ISO 8288
Mercury, mg/l	max. 0.0005	<0.00024	GOST 51212-98
Cobalt, mg/l	max. 0.1	<0.02	ISO 8288
Lithium, mg/l	0.03	<0.02	PNF F 14.1:2:4.167-00
Strontium, mg/l	max. 7.0	<0.5	PNF F 14.1:2:4.167-00
Surfactants, mg/l	max. 0.5	<0.025	GOST R 51211-98
Petroleum products, mg/l	max. 0.1	<0.020	PNF F 14.1:2:4.128-98
Boron, mg/l	0.5	<0.05	PNF F 14.1:2:4.36-95

***** These results were above SANPIN standards and therefore require treatment.