SAKHALIN ENERGY INVESTMENT COMPANY LTD

PHASE 2 PROJECT

ONSHORE PIPELINES

RIVER CROSSING STRATEGY

EXECUTIVE SUMMARY

This document summarises Sakhalin Energy Investment Company's[1] strategy for the construction of all river crossings associated with the Sakhalin II Phase 2 Project.

The strategy document is the parent of a series of documents relating specifically to river crossings. The two other supporting documents are the Monitoring Plan and Execution Plan. In combination, the three documents describe the approaches and techniques planned, predict environmental impacts, outline what monitoring will be undertaken and specify how SEIC and their Contractors will implement mitigation measures.

This strategy report firstly describes the fluvial and ecological characteristics of the island environment before documenting the philosophy and approach adopted for the crossing of watercourses along the length of the pipeline from the north of Sakhalin Island to the south. It also presents the potential effects of the installation of pipelines and fibre optic cable crossings together with the associated potential environmental impacts and, where appropriate, selected mitigation measures.

Many of the watercourses traversed by the pipelines and fibre optic cable are important for commercial salmon fisheries or contain Red Book protected species and it is therefore Sakhalin Energy's (SEIC) duty and objective to minimise the potentially adverse environmental impact on these natural resources. Together with the relevant Russian authorities, SEIC has assessed and categorised the environmental and commercial importance of each watercourse and has adapted the proposed crossing methods to correlate with the respective importance of each of the rivers. These methods, which are described in this strategy, include the construction of the majority of crossings for rivers of sensitivity for commercial fisheries and ecological interests during the winter months, when most watercourses are frozen or have very low flow rates. These rivers will be crossed using wet-cut trenching methods and executed in line with international best practice. A range of mitigation measures will be utilised to ensure that sediment inputs into a river during and after construction are minimised. These mitigation measures are assigned to specific river groupings on the basis of assessments of both river ecological sensitivity and susceptibility of hydrogeomorphological change, taking into account the potential influence of crossings undertaken through tributaries into these sensitive rivers. Implementation of the proposed mitigation measures will not eliminate the input of sediment into the watercourses and it is recognised that aquatic life within the vicinity of crossings may be impacted adversely due to a rise in suspended sediment concentration levels and modification of in-river habitat. Based on research and monitoring from other similar pipeline construction projects, it is anticipated that such impacts will be localised and affected aquatic communities will fully recover within two years following construction.

Six of the largest rivers to be crossed – the most important in terms of commercial fisheries potential – will be crossed using Horizontal Directional Drilling (HDD). HDD involves drilling through the bedrock underlying the watercourse in order that contact with the water itself is avoided completely. It is only technically feasible under certain geological conditions. Whilst HDD

[1] Hereafter referred to as "Sakhalin Energy", "SEIC" or "the Company".

minimises impacts on the aquatic environment, it may cause indirect terrestrial impacts that may need mitigating measures to be implemented.

In order to place the specific river assessment work in context and the crossings strategy as a whole, analysis has been undertaken to indicate the potential influence of the pipeline construction works on salmon spawning habitat at a system level.

Data from Sakhrybvod indicates that approximately 77% of all potential spawning habitat in rivers of importance for commercial importance occurs upstream of the river crossing construction sites. Using this data a sensitivity analysis has been undertaken to determine the potential extent of spawning habitat that could be affected by the downstream transport of sediment during pipeline installation. Using generalised figures for sediment transport distances and a simple indicative proportional model for spawning habitat distribution, the area of spawning habitat within the zone likely to be affected by the works ranges from 0.38 -1.34% of the total available spawning habitat within the sensitive rivers. It is considered highly likely that the total area affected would fall within the lower part of this range.

It should also be considered that the calculated figures only represent the potential loss of habitat for a subset of the total spawning habitat available on Sakhalin Island. Numerous smaller river networks in the south, west and north of the island would remain unaffected by the works and as these systems also support salmon spawning habitat, the likely loss in relation to the entire resource would be lower than that calculated.

From both ecological and commercial perspectives, any influence of the construction works on salmon populations would be temporary. The effects of wet cuts on riverine ecology and fish fauna (including salmonids) is limited with recovery of food resources and habitat occurring typically within a 1-2 year period. Recovery of the overall habitat would also be assisted, and potentially enhanced in the longer term, through the placement of approximately 26,000 m^2 of gravel substrate at crossing points, which would compensate for the 15,300 m^2 directly disturbed within the pipeline Right of Way (ROW) during the works.

The mortality of eggs and young salmon within spawning gravels and the temporary loss of between 0.38-1.34% of potential spawning habitat for a period of 1-2 years would also be highly unlikely to relate directly to commercial productivity and catch. In some rivers, particularly those of the north and east, larger areas of spawning habitat are likely to be available in comparison to stock levels (i.e. in these rivers the population levels are unlikely to be habitat limited). Much of the commercial catch is also focused on the use of hatcheries, where potential habitat loss in the rivers associated with the construction work is not an issue. Available data indicates that approximately 70% of the pink salmon catch (pink salmon constitutes approximately 90% of the total commercial salmon catch) is taken from the rivers and hatcheries in the southeast of the Island. Approximately 30% of all of the crossings over medium-high sensitivity rivers would occur in this area and the percentage of spawning habitat that could be influenced is also lower in these rivers than those further to the north. This suggests that with respect to commercial interests that the influence of the construction works is likely to be proportionally much less in the area of greatest production than in areas of lesser commercial production.

This strategy forms the basis for the ongoing development of a River Crossings' Execution Plan and Monitoring Plan that will specify, for each river crossing and based on site-specific data, the details of construction techniques together with the planned mitigation and the supervisory and monitoring approaches to be used. Sensitive river crossings will only proceed once detailed Execution and Monitoring Plans for a specific river are in place, in the right seasonal and freezing/low flow conditions and thus in compliance with the intent of this River Crossing Strategy and also best practice. If conditions are not in accordance with those set out in this strategy then the work will not proceed or will be suspended.

Supervision and monitoring will be key mechanisms through which the Company will ensure that its Contractors follow the required mitigation measures and also to assure SEIC that these measures are effective. These measures are described further in the Monitoring Plan. Supervision and monitoring will take place at five levels for those crossings where there is potential for significant adverse environmental impact:

- On-site Contractor supervision at each of the five construction sections (sections 1A,B and C, 2, 3 and 4 – see Figure 2-1). The Contractors will ensure that these supervisors have the appropriate level of experience and effectiveness;
- On-site SEIC supervision at each of the five construction sections. The Company will ensure that these supervisors have the appropriate level of experience, empowerment and effectiveness. They will provide continual training and capacity-building where required;
- Regular environmental monitoring by a subcontracted Russian environmental consultant to ensure continuity in monitoring that has already taken place (since 2003) in order to build up a long-term baseline. For the sensitive river crossings, this environmental monitoring applies to pre-installation, actual installation and post-installation phases of the crossings;
- Compliance observations during the winter river crossings installation period by a team of external observers. Throughout the period December 2005 to April 2006, these observers (comprising appropriate technical specialists) will be on site to observe and confirm compliance against the detailed river crossing Execution Plans, to highlight any areas of non-compliance or where actions could be strengthened. The observers will be stationed at each of the five construction sections and will report to the Company's Corporate Health, Safety and Environment (HSE) Department. To take advantage of the efforts invested in this monitoring strategy, SEIC also intends to publish the independent observer reports on its website in order to demonstrate transparency and accountability; and
- SEIC will make provisions and commitments to enable interested stakeholders to monitor the Company's river crossing sites and activities. Subject to prior discussion and agreement, stakeholder representatives will be able to visit and inspect river-crossing sites during the construction phase.

It is SEIC's firm belief that the proposed strategy, mitigation measures and associated monitoring and supervision will be sufficient to minimise the potential adverse impacts of construction to a level that is environmentally acceptable. Notwithstanding this belief, SEIC will launch two independent initiatives aimed at promoting additional salmon spawning areas on the island and in improving general knowledge about the ecology of the Sakhalin taimen:

Firstly, SEIC will develop and initiate a river restoration project, in association with relevant authorities and other stakeholders. It is proposed that this project will aim to restore degraded habitat within selected river catchments on the island to achieve no net loss of this habitat overall as a result of pipeline construction activities. The focus will be on the restoration of salmon spawning habitat through the use of appropriate management measures, such as limiting fine sediment inputs from sources adjacent to watercourses and/or the creation of new in-channel habitat. Such measures will be viewed within the overall concept of restoring ecological function to the selected systems so as to benefit a wide range of species and not just spawning salmonids. Additionally, the possibility of making links with socio-economic issues (e.g. sustainable fisheries) will also be considered and adopted where appropriate.

Secondly, in recognition of the lack of information on the ecology of the Sakhalin taimen, SEIC will develop and instigate a taimen research project. It is envisaged that this will be a research-based project, that will involve Russian, Japanese and other international specialists and which will aim to further describe the ecological requirements, distribution and biology of this enigmatic and important species.

GLOSSARY

BNNB	Big northern Nysh bypass
BS	Booster station
BSNB	Big southern Nysh bypass
EPB	Environmental Protection Book
FERC	(United States) Federal Energy Regulatory Commission
FOC	Fibre optic cable
GIS	Geographic information system
HDD	Horizontal directional drilling
HDPE	High density polyethylene
IUCN	International Union for the Conservation of Nature and Natural Resources
LNG/OET	Liquefied natural gas plant and Oil export terminal
MAC	Maximum allowable concentrations
MEG	Mono-ethylene glycol
MNR	Ministry of Natural Resources
NFI	Not fish industry
NTU	Nephlometric turbidity units
OPF	Onshore processing facility
ORV	Off-road vehicle
ROW	Right of Way
SEIC	Sakhalin Energy Investment Company
SSC	Suspended sediment concentrations
SSNB	Small southern Nysh bypass
TEO-C	Technical and economic substantiation for construction

1 INTRODUCTION

1.1 BACKGROUND

This document sets out SEIC's strategy for the construction of river crossings during the execution of the Sakhalin II Phase 2 Project. The onshore pipelines and telecommunications facilities component of the Phase 2 Project comprise the installation of oil and gas pipelines and a fibre optic cable that all cross some 1,084 watercourses of different sizes, characteristics and importance along the length of the pipeline route. Some of these rivers are important for the presence of commercial salmon or contain Red Book protected species. It is therefore SEIC's duty and objective to minimise the potentially adverse environmental impacts on these natural resources.

The main effect associated with the construction of a crossing will be an increase in suspended sediment concentration in the watercourse to be traversed and its transport (often referred to as a sediment plume) and downstream deposition of sediment from the plume. High suspended sediment concentrations in the water column may have a potentially adverse impact on fish communities, for instance, by clogging gills or reducing the ability to undertake upstream migration. Changes in riverbed and channel morphology may also occur as a result of the downstream transport of sediment and/or excavation works at the crossing point itself.

To avoid, reduce and minimise construction impacts, particularly with respect to the generation of in-channel sediment, SEIC will carry out construction activities in line with international best practice (e.g. guidelines and advice published by the United States Federal Energy Regulatory Commission). Furthermore, in order to ensure Contractor compliance, SEIC supervisors, environmental monitors and a team of third-party (i.e. external) observers will be present at all sensitive river crossings prior to commencement of, and throughout all, pipeline crossings.

1.2 OBJECTIVES AND CONTENT OF THE DOCUMENT

This strategy document for river crossings is intended to:

- Provide a brief overview of the river crossing techniques and their specification (see Section 2);
- Identify the key environmental and ecological receptors affected by river crossings (Section 3);
- Analyse the potential impact on these key receptors (see Section 4);
- Describe the proposed mitigation measures to ameliorate these impacts (see Section 5).

It is SEIC's firm belief that the proposed mitigation measures are sufficient to minimise the potential impact of construction to an acceptable level. To record and measure the actual impact, a monitoring programme has been developed (refer to Section 6).

This document sets out the updated strategy for the actual construction of the river crossings. At the time of writing (December 2005), approximately 50% of the oil pipeline and 15% of the gas pipeline crossings had been constructed across rivers of various sensitivities in line with the strategy as previously documented. This updated strategy presented here has been developed using the experience gained during construction of these river crossings, but clearly focuses on the rivers that still need to be crossed.

Defining the River Crossings' Strategy is the first step in a three-step approach. It is followed by a second step defining the way in which all the different rivers and streams will be crossed, including mitigation measures (specified in the River Crossings' Execution Plan). The third step is the definition of monitoring requirements (specified in the River Crossings' Monitoring Plan).

The River Crossings' Execution Plan will specify, for each river crossing, and based on site-specific data, the details of construction techniques together with the planned mitigation measures and the supervisory and monitoring approaches to be used. An outline of the Execution Plan is attached to this Strategy (Annex D). The backbone of the Execution Plan is formed by a portfolio of separate River Crossing Assessment Sheets for all the rivers that are high or medium sensitive from a hydrogeomorphological and/or fish value/ecological point of view (see Section 5.1 for more details). The Assessment Sheets provide, for each river crossing, an overview of the relevant baseline information, a characterisation of the likely impacts as well as defining the mitigation measures and monitoring requirements. An example is shown in Annex E.

The Monitoring Plan details the monitoring organisation, the roles and responsibilities and the reporting requirements. An outline of the Monitoring Plan can be found in Annex F.

It is important to note that the crossing of a sensitive river will only be progressed once a detailed execution and monitoring plan for a specific river is in place, is in compliance with the intent of this River Crossing Strategy and aligns with good industry practice. If such measures are not in place, the work will not progress or will be suspended.

1.3 OTHER DOCUMENTS RELATING TO RIVER CROSSINGS

This River Crossing Strategy should not be regarded in isolation or seen as a "stand alone" document. Over recent years, more than one hundred surveys, studies and documents have been undertaken and drafted on the watercourses (likely to be affected) on Sakhalin Island, providing information on their hydrological conditions, importance for commercial fisheries and ecological conditions and the potential environmental effects of the works (e.g. Environmental Impact Assessment, SEIC 2003). In addition, a large number of technical studies and designs on the construction of the pipelines and the fibre optic cable have been issued. Together with international standards and best practise guidelines and experience gained in other major river crossing projects around the world, this information provides the basis on which the River Crossing Strategy has been developed.

Where appropriate, cross-references to these documents are given in this Strategy. For an overview of the most relevant documents see Annex B.

Many stakeholders have been consulted during the course of developing this project including, for example, discussions with international academic specialists, a recent meeting on the Strategy with the State Hydrological Institute, the Environmental Monitor Contractor Averina and the pipeline construction Contractor and their subcontractors in Moscow and Yuzhno.

This River Crossing Strategy Report is the "parent document" from which the series of follow-up initiatives have been developed, the Monitoring and Execution Plans being the most important ones. The link between the three main reports that comprise the overall approach to river crossings is shown graphically in the Document Map (see Figure 1-1). The Document Map shows, graphically, all the documents related to river crossings.

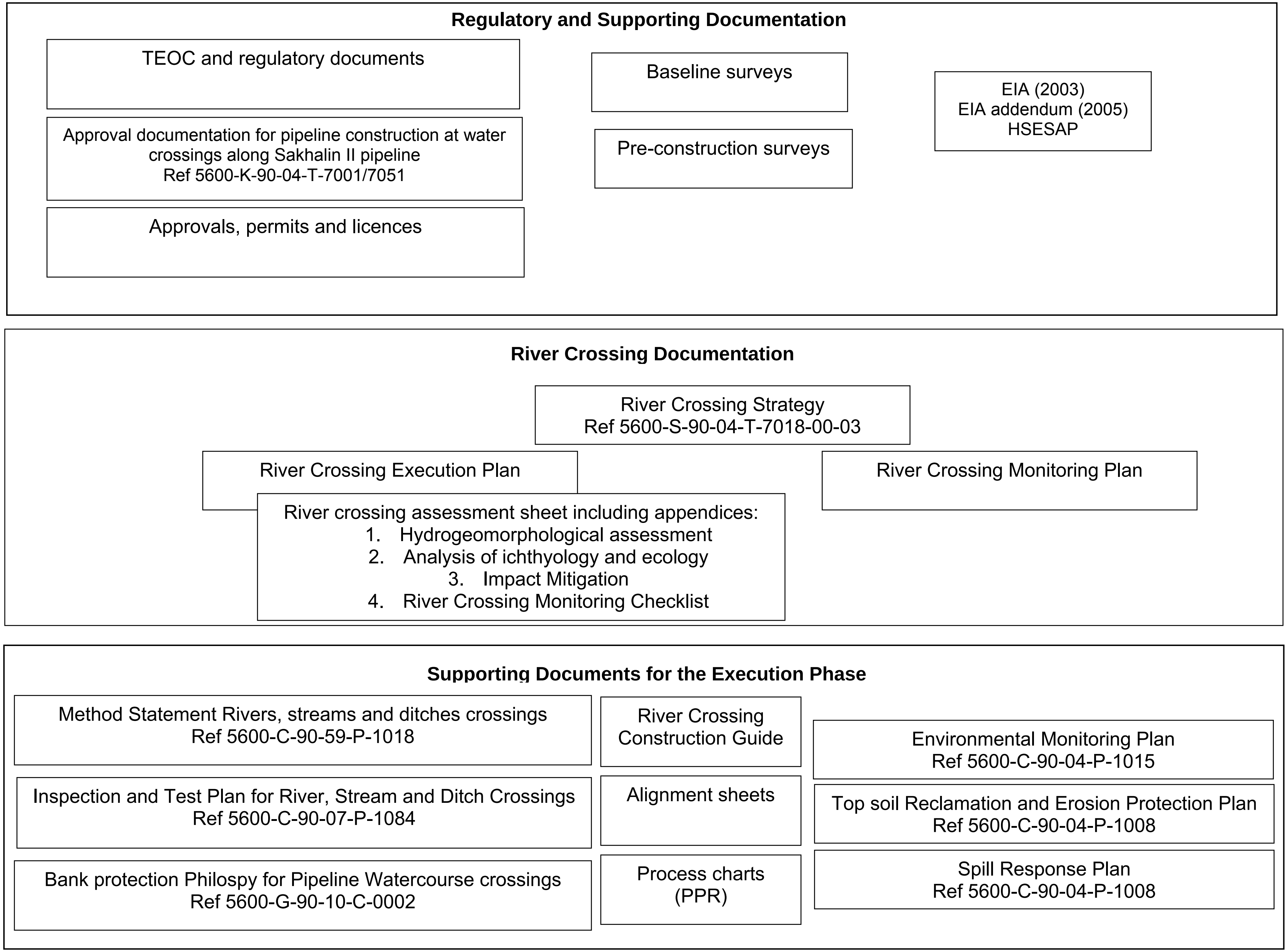

Figure 1-1: Document Map Showing Relationships of River Crossings Documents

2 RIVER CROSSING TECHNIQUES AND SPECIFICATIONS

2.1 TECHNICAL OBJECTIVES

The Sakhalin II Phase 2 Project involves the installation of oil and gas pipelines and a fibre optic cable that cross more than 1,000 watercourses of different sizes (i.e. from small ditches through to rivers), characteristics and importance. It is SEIC's objective to minimise the impact on the environment whilst crossing these rivers, through:

- Minimising sediment generation during construction and potential sediment input into watercourses (i.e. taking measures to reduce suspended sediment concentrations in the sediment plume and therefore reducing its potential for downstream effects);
- Minimising changes to river bed morphology, river banks and river channels;
- Minimising disruption of known areas of salmon spawning habitat.

Steps taken during the design phase have minimised the potential for adverse impacts by studying alternatives in route selection and a thorough evaluation of crossing methods, while at the same time focussing on constructability, integrity and safety distances from existing man-made and natural obstacles.

The following sections describe the technical characteristics of the pipeline system, route selection and the crossing techniques considered in the development of this strategy. Section 2 concludes with a description of the Russian legal context within which the work will be executed.

2.2 TECHNICAL CHARACTERISTICS

2.2.1 Oil and Gas Pipelines

The pipeline system is required to transport oil and gas from the production fields in the northeast of the island to Aniva Bay in the south. Aniva Bay is almost always ice-free and so will allow year round export of oil and gas. The main gas pipeline has the capacity to transport 50.1 x 10^6 Sm^3d^{-1} (1768 x 10^6 scf d^{-1}) in winter and 40.8 x 10^6 Sm^3d^{-1} (1440 x 10^6 scf d^{-1}) during summer. The main oil pipeline has a capacity of transporting 31,003 m^3 d^{-1} (195,000 b d^{-1}).

The onshore pipeline transportation system consists of the following key components:

- One 20-inch diameter oil pipeline and one 20-inch gas pipeline from the Piltun landfall to the OPF. The lateral distance between these pipelines will be 13 metres (m);
- Two 30-inch diameter multiphase pipelines transporting product from the Lunskoye landfall to the OPF and one 4.5-inch pipeline transporting monoethylene glycol (MEG) from the Onshore Processing Facility (OPF) to the Lunskoye landfall. The lateral distance between the two multiphase pipelines will be 13 m; the lateral distance between the MEG pipeline and the multiphase pipeline will be 10 m;
- One 24-inch main oil pipeline and one 48-inch main gas pipeline from the OPF to the Oil Export Terminal (OET) and Liquified Natural Gas (LNG)

Plant via a Booster Station (BS) located approximately halfway between the OPF and the OET/LNG. The lateral distance between the pipelines is 18 m.

2.2.2 Fibre Optic Cable

A fibre optic cable (FOC) will be installed next to the oil and gas pipelines. The purpose of the FOC is to provide a data transport system for the pipeline telemetry systems and to interconnect the main operational facilities including the offshore platforms, OPF, and the LNG Plant/OET. The FOC will be laid and buried 9 m east of the oil pipeline (within the right of way [ROW] but near to its eastern edge). The external diameter of the cable ranges from 15.1 mm to 20.3 mm depending upon cable type. The width required for the laying of this cable is 6 m. It is planned to install the FOC separately from the pipeline as the FOC is installed in a separate trench and installation rates are typically two to five times faster than conventional pipeline construction.

2.2.3 Pipelines' Corridor

The total length of the onshore pipelines network is approximately 1,600 km with 800 km of fibre optic control cable. As the pipeline ROW is in close proximity to the existing transport network much of the land to be used is within the existing range of human influence.

The oil and gas pipelines share the same ROW, which varies in width from 36 to 66 m. This width is determined by Russian Federation pipeline safety and design regulations. The ROW needs to be sufficiently wide to allow construction of the oil and gas pipelines as well as the FOC and in some parts electrical cables (all of which will be in separate trenches). The distances between pipelines and/or the FOC can be decreased in short sections where certain obstacles exist.

For the pipelines, a "Protection Zone" is required and specified by Russian regulations and is typically 25 m either side of the pipeline plus the distance between the pipelines. However, at watercourses this widens to 100 m, extending over the watercourse itself, either side of the pipeline and the distance between the pipelines. Third parties operating within the pipeline Protection Zone may not perform any work without prior approval from the pipeline operator.

Figure 2-1 provides an overview of the pipeline project, the onshore pipeline specifications and section numbers.

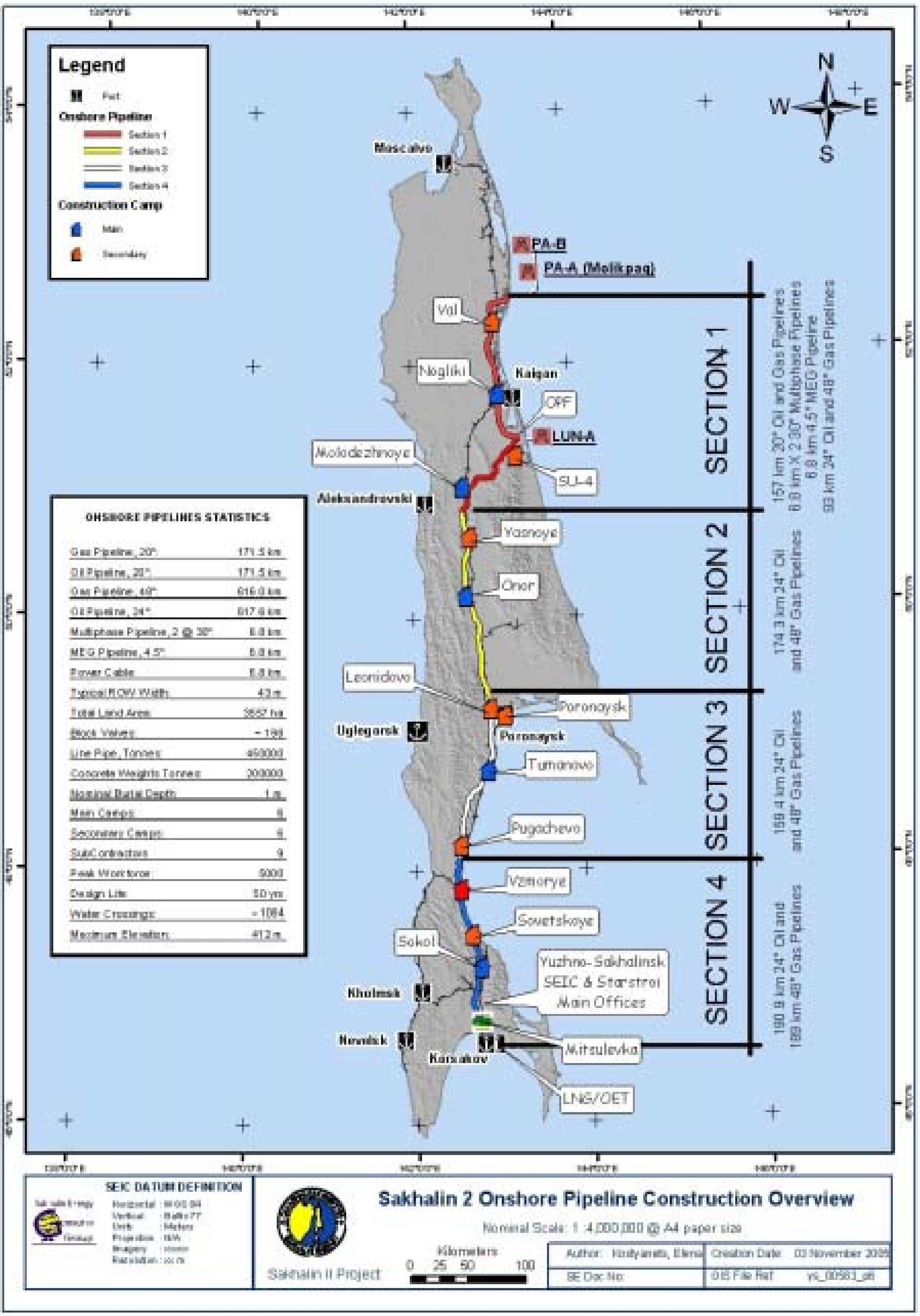

Figure 2-1: Overview of the SEIC Phase 2 Pipelines Project

2.3 SELECTION OF THE PIPELINE ROUTE

2.3.1 Major Routing of the Pipelines' Corridor

Screening studies carried out by SEIC concluded that the two main feasible alternatives were either a predominantly onshore pipeline system or a predominantly offshore one. Based on a careful evaluation, a wholly offshore route was discounted due to economic, environmental and socio-political considerations. Onshore pipeline routes traversing the spine of the island offer the best opportunity to provide development opportunities on the island whilst maximising the use of existing infrastructure and minimising impacts from construction. More information on the routing is provided in the Environmental Impact Assessment (SEIC 2003).

The route of the onshore pipelines was originally selected to follow the existing communications route that traverses the island (from north to south) as closely as possible. The route runs adjacent to the existing highway, railroad, power lines and telephone Rights-of-Way for a significant portion of its length. The utilisation of this route keeps the pipeline in, or near, existing developed areas, minimises the need to develop additional infrastructure (e.g. access to the pipeline ROW), and minimises the environmental footprint of the project.

2.3.2 Alternative Routes

Following completion of the major routing of the onshore pipeline, several sections of alternative routing were also considered:

- **The Big Northern Nysh Bypass** (BNNB): This re-route reduced the overall pipeline length by approximately 27 km from the Piltun landfall to the OPF. The route deviated from the original line immediately south of the Tym River crossing, approximately 32 km north of Nysh, to approach the OPF in a south-easterly direction. The new route length of approximately 33 km runs through relatively flat and dry country and is easily accessible by an existing forest road;
- **The Small Southern Nysh Bypass** (SSNB): This re-route reduced the pipeline length by just over 3 km from the OPF to the LNG Plant/OET near Prigorodnoye. The new route deviated from the original one just east of the Vazi river crossing, approximately 12 km west of the OPF, to rejoin the original route at a location approximately 5 km south of Nysh. The new route length of approximately 20 km runs through relatively flat and dry country, and will be accessible by extending existing forest roads;
- **The Big Southern Nysh Bypass** (BSNB): This re-route reduced the pipeline length by approximately 22 km, including the SSNB. The BSNB itself is approximately 95 km long. It runs through relatively dry land parallel to the Nabil river floodplain but crosses a mountain range at an elevation of approximately 400 m. No access roads exist to provide access to the first 35 km of the route from the OPF.

In late 2001, SEIC took the decision to construct a Southern Access Road to the OPF. As a result of this, access to the northern 35 km of the BSNB would become possible. A more detailed evaluation of the BSNB highlighted the substantial economical and environmental advantages of the bypass and hence the BSNB re-routing was considered to be the optimal choice, superseding the SSNB.

The original pipeline route crossed 1,103 watercourses. With the implementation of the BNNB and the BSNB and additional minor re-routings, 19 watercourse crossings were avoided, reducing the total number of watercourse crossings to 1,084. These crossings are shown on the map in Annex A.

Although the pipeline route is largely fixed, there remain a number of minor re-routing decisions that could affect the total number of watercourse crossings. These include the final location of the offshore pipeline landfall; detailed design of fault crossings; slope stability design (where civil works are optimised against reroutes); and obstacles found during the course of detailed design or construction (e.g. archaeology finds, protection zones around water intake wells, proximity to built-up areas).

2.4 CROSSING TECHNIQUES

The following river crossing techniques have been considered by SEIC as part of the pipeline construction planning process:

- Above ground (pipeline bridges);
- Horizontal directional drilling (HDD);
- Wet cut crossing; and
- Dry cut crossing.

These crossing methods are described in more detailed below.

2.4.1 Above Ground (i.e. pipeline bridges)

An above ground (or aerial) crossing has a number of advantages over other methods including minimum streambed and bank disturbance and that the fact that during construction passage for fish can be maintained. An indirect but nonetheless welcome benefit is that any accidental oil leaks can be identified at a much earlier time compared to an underground pipeline.

From an international best practice standpoint, aerial crossings are rarely applied and only in specific circumstances when burial is impractical. An example would be the crossing of a very narrow and deeply incised channel (e.g. greater than 30 m depth and less than 30 m width) with high potential for very deep scouring (e.g. flood drainage features that occasionally handle torrential rains in a desert). In Sakhalin, however, the presence of large floodplains and meandering characteristics would require bridges of several kilometres in length and the use of supporting structures that would need to be constructed in the watercourse. The complexity of construction would lead to potentially longer periods of impact and the placement of structures in river channels would increase the risk of scour compared to a buried pipeline crossing.

Additionally, consideration of the factors listed below determined that aerial routing would not constitute an appropriate and safe technique for the crossings:

- Ambient and dramatic temperature changes (e.g. between day and night; summer and winter; and freezing and thawing) can affect the long-term integrity of an exposed pipeline (see examples below);
- Adverse effects on the coating of the exposed pipeline leading to increased external corrosion;

- Lowering of the effectiveness of the cathodic protection system leading to increased external corrosion, higher maintenance costs and an increased potential for leaks;
- More regular expansion and contraction of the pipeline (i.e. changing the length of the pipe span on an hourly basis, which in-turn, increases the cost and complexity in design of supporting structures;
- Potential plugging of the pipeline system due to increased viscosity of the oil in the pipeline;
- The abutments and supports holding the pipeline may be subject to movement, particularly during seismic events;
- Scouring and non-uniform settlement of abutments and supports due to changes in-river morphology or flooding when the river overflows, particularly in floodplains;
- Natural physical impacts (e.g. falling trees; trees floating upstream) that may hit the pipeline;
- Mechanical impact caused by third parties (pipelines used by hunters and poachers for target practice, pipeline used to cross watercourses with heavy loads, watercraft impact etc);
- Exposure to vandalism, terrorism and/or sabotage.

2.4.2 Horizontal Directional Drilling (HDD)

With HDD, a well bore, similar to that for constructing oil and gas wells, is drilled beneath the bed of the watercourse. The process involves the use of drilling mud (e.g. bentonite) under pressure to facilitate the removal of cuttings from the borehole and to maintain hole integrity (i.e. preventing wall collapse). Once the hole is complete, a pre-welded and hydrotested section of pipe is then pulled through the mud-filled well bore for tie-in.

Like small aerial crossings, HDDs have the advantage that there is potentially no streambed and bank disturbance, thus significantly reducing the creation of in-stream suspended sediment concentration increases during construction. This technique also ensures that fish passage during construction is maintained. However, HDD is only viable as a crossing option within a range of specific circumstances where factors such as width, depth and substrate type make it technically feasible. It is also applicable in the following applications:

- Presence of ship traffic and where navigational and anchorage issues must be mitigated;
- Where excessively high levels of pollutants are entrained in bottom sediments and there is a desire to not re-introduce or re-suspend them into the water column during construction;
- Wide and/or deep river channels;
- Sensitive fish species or habitats in areas that are a poor candidate for the open cut methodology because of flow volumes or river geometry.

The use of HDD is not always possible due to topographical or geological characteristics and features. The use of HDD must be carefully balanced against the risk of fracturing into the bottom of a stream and causing more extensive environmental damage than would have been the case using a wet cut. This is especially true of high-energy streams with gravel substrate – a common occurrence in Sakhalin.

2.4.3 *Wet Cut Crossing*

The wet cut technique is used around the world in the majority of watercourse crossings. In the wet crossing method, a trench is dug and a pre-welded and hydrotested (for widths greater than 10m) pipe section is lowered into the trench. The trench is backfilled while the stream continues flowing in the stream/river channel (through the work site). In most cases, pipeline trenches are cut with an excavator or, because of the excavator's limited reach, a dragline. Sediment is typically placed into decanting structures or a trench on the pipeline ROW and trenches are subsequently refilled with clean spoil from the ROW or a borrow pit.

Without appropriate use of water management measures, sediment disturbance and transport can be severe, depending upon the water velocity and the nature of the substrate that is being excavated. This could have implications in terms of direct and indirect impacts on fish, invertebrate, and aquatic plant communities. However, the crossing can be undertaken relatively quickly and is normally used to cross smaller and/or less sensitive (from an ecological perspective) rivers.

2.4.4 *Dry Cut Crossing*

Dry cut techniques involve water containment, such as the use of dam and pump or diversion of the watercourse by damming or other means, to allow work in "dry" stream/river beds.

The dry cut technique minimises the degree of sediment mobilisation and, subject to certain considerations, is the most appropriate methodology for crossing watercourses with high biological or fisheries' sensitivities. In Russia, however, the use of the dry cut method is less common and there has been objection to its use by the local fishing authority (Sakhrybvod[2]). SEIC has engaged in consultation with Sakhrybvod to explain the benefits of the different types of dry cut crossings on several occasions, however, Sakhrybvod has maintained the position that the wet cut method is more favourable and that they will not permit the use of dry cut crossings. Their main arguments are that a wet cut can be executed faster than a dry cut and that a dry cut requires more equipment, enlarging the potential construction footprint of the crossing.

These arguments do not apply in situations where crossings are naturally dry i.e., when a stream is completely frozen (in winter) or dried up (in summer).

2.4.5 *Fibre Optic Cable*

The methods of installation detailed below will be employed for crossing water bodies with the fibre optic cable. Most crossings will be made using the first two methods.

Cable installation with cable layer
The cable layer is pulled from one bank of the river to the other by means of a rope, fixed on a tractor or winch. The trench is not excavated by a mechanical excavator, but the soil is forced apart and compacted with a special blade on

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[2] Sakhrybvod has recently restructured and now comprises two organisations: Sakhrybvod and Rosselkhoznador. To avoid any confusion, both organisations will be referred to under their old name – Sakhrybvod – in this document.

the cable layer before laying the cable into the trench. This method is quick and requires just one crossing of the watercourse by installation equipment.

Open trench method
The excavator will be placed on the riverbanks and excavate a trench in the river. After trenching an open ditch, the cable will be laid in the trench. This method can either be carried out whilst water is flowing (known as the wet method) or during the winter when flow is reduced. Although the latter method is preferred, as the turbidity caused by excavated material will be minimised, winter installation is unlikely due to the minimum allowable installation temperature of the cable being significantly higher than ambient temperatures in winter.

HDD
Firstly, a pilot hole is drilled using a drill head and drill bit suited to the ground conditions. The location of the drill head is monitored at all times to ensure integrity of the pilot bore. Upon completion of the pilot hole, the drill head is removed and a back cutter that suits the diameter of the pipe is fitted. The drill rig is then used to back cut the hole and pull the pipeline into the bore. A kapron halyard is laid into the pipes. After pulling the underwater pipe from one bank to the other, the FOC is pulled into the pipe with the help of the kapron halyard. As the FOC could be pulled through at a later stage, this method can be used all year round.

Where the pipeline Contractor will use HDD, a conduit pipe for the fibre optic cable will also be installed. Afterwards, the FOC will later be pulled through the conduit.

Conduit pipe installed prior to cable laying
When a river is dry or frozen, a conduit pipe (either steel or high density polyethylene – HDPE) is installed in a trench along the riverbed for the required length. With the help of a rope or kapron halyard, the FOC will be pulled through the installed HDPE pipeline. This method can be used all year round.

HDPE conduit pipe installed in same trench as oil pipeline
With this method, a HDPE conduit is strapped to the oil pipeline during installation and lowered into a pre-excavated trench. The FOC is later pulled through the conduit as described above (allowing installation at any time of the year).

2.5 DECOMMISSIONING

At the conclusion of the design life, the pipelines will be decommissioned. In specific cases, the Russian Party or a local governmental organisation may wish to use a facility. The Company will endeavour to fully address the social impacts associated with decommissioning and or of any facility in so far as it is allowed to by the Russian Authorities. Actual abandonment procedures will address industry best practices and Russian regulations in place at the time of decommissioning. The following steps will need to be taken in decommissioning the onshore pipelines:

- Depressurise the pipelines;
- Purge the pipelines;
- Clean the pipelines;
- Leave in place;
- Conduct environmental survey to determine if any reclamation is needed;

- At shore crossings, determine if pipelines need to be removed (i.e. after environmental survey is conducted).

Whilst actual abandonment procedures will reflect industry best practices and Russian regulations in place at the time of abandonment, it is recognised that in decommissioning the pipeline large amounts of solid and liquids waste, as well as air emissions, will result. A workforce to carry out the decommissioning activities will also need to be mobilised.

Mitigating the impacts associated with the generation of wastes will depend upon the effectiveness of reusing or recycling the materials that comprise the assets. Prior to decommissioning, an activity and logistics plan will be developed to identify the wastes likely to be generated as well as to determine the most appropriate reuse or disposal method. Mitigating the impacts associated with air emissions will include minimising the amount of venting and flaring as much as possible.

The environmental significance of the impacts associated with abandonment cannot be determined at this stage of the project. Nevertheless, the impact will be minimal as the overall aim of decommissioning is to reduce the operational footprint of the project and wherever possible, restore the environmental integrity of the land impacted by the project during its operation.

The Company and the Russian Party have agreed to maintain discussions on the issue of decommissioning strategy and the allocation and funding of associated costs.

2.6 RUSSIAN CONTEXT

As part of the Russian approval process, SEIC prepared detailed, project facility specific Environmental Protection Books (EPBs), which formed part of the report on Technical and Economic Substantiation for Construction (TEO-C). The EPB for the Pipeline facility includes an assessment of the impact of river crossings. As part of the preparation of this document, the crossing methods were discussed with relevant Russian authorities, including the Sakhalin Region Natural Resources Committee and the local fisheries authority, Sakhrybvod. Following the recommendations contained in the TEO-C, detailed drawings for the construction of river crossings and relevant method statements have been agreed with Sakhalin Region Environmental Protection Authorities.

Prior to the start of construction, the necessary Water Use Licences were obtained. These licenses permit all types of work related to waterbody usage, such as construction of the pipeline and equipment water crossings, construction and operation of permanent and temporary bridges and water intake and disposal during hydrotesting. The Ministry of Natural Resources (MNR) issues the licences but Sakhrybvod can issue conditions to the licence. For example, for crossings through salmon spawning grounds during construction, specific mitigation measures need to be taken. These measures include avoiding construction during spawning periods and minimising the duration of such works. In addition, potential damage to spawning grounds was estimated and compensation was provided. SEIC has agreed with the State Fisheries Agency, Oblast Administration and Sakhrybvod to fund $US11 million for the development of three hatcheries, as compensation for potential damage to salmon fisheries that may result from the works.

Russian legislation furthermore prescribes that activities that cause death, reduction or disturbance of natural habitats of rare or endangered species listed in the Red Book, such as Sakhalin taimen, are prohibited (Article 24 of the Wildlife Law [Federal Law of the RF No. 52-FZ]). This is discussed further in Section 5.6.

3 FLUVIAL AND ECOLOGICAL CHARACTERISTICS OF SAKHALIN ISLAND

3.1 OVERVIEW OF PHYSICAL NATURE OF SAKHALIN ISLAND

3.1.1 Topography

Sakhalin Island is mountainous with its large-scale structure resulting from its location along the junction of the Eurasian and North American tectonic plates. It is characterised by a series of north-south trending, relatively low (1,000-1,600m) mountain ranges, hills and intervening, generally waterlogged, lowlands. The Tym-Poronaiskaya Valley separates the Western-Sakhalin Mountains from the Eastern-Sakhalin Mountains. The West Sakhalin Mountains comprise a group of parallel mountain chains and ridges extending along the western coast. The main one is the Kamyshovy ridge with heights of 1,000 to 1,300m. The East Sakhalin Mountains comprise the Lopatinsky mountain juncture with its radially extending ridges that reach heights of 1,000 to 1,600m. The Susanaisky and Tonino-Anivsky Ranges are situated in the south of the island, forming peninsulas on either side of Aniva Bay.

Plains and lowlands occupy approximately 25% of the island, the largest being the Northern Sakhalin Plain, which is characterised by a rolling terrain with hills from 200 to 400 m high. Coastal areas of the northern and north-eastern parts of the island are swampy lowlands with typical residual marine terraces and offshore bars. The Tym-Poronay lowland, between the Eastern and Western Sakhalin mountains, is essentially a flat waterlogged plain with a width of 10 to 15 km in the middle reach of the river Tym. The plain is about 5 km wide at its narrowest in the area of the Tymovskoye settlement. The surface of the Tym-Poronay lowland has a height of 60 to 70 m above sea level, increasing to about 160m at the divide between the rivers Tym and Poronay. The Susunaiskaya and Muravyevskaya lowlands are situated in the south. The Susunaiskaya lowland extends from Aniva bay in the south to the estuary of the river Naiba in the north. Its width in the middle reaches is 20 km, increasing to 40 km at the coast (Aniva Bay).

3.1.2 Climate

Generally speaking, Sakhalin is influenced by a moderate monsoonal climate, characterised by damp winters and cool, rainy summers. The cooling effect of the Siberian continental monsoon system during the winter and of the cold waters of the Okhotsk Sea in the summer make the local climate cooler and harsher than other locations at the same latitude. Summer monsoons bring wet ocean air with considerable precipitation in the summer and autumn. Parts of the eastern coast of Sakhalin are colder than other areas as cold-water currents influence them, while the southwest is subject to the warmer Tsusima Current.

The average air temperature in January in the north of the island varies between –17.7 to –24.5°C, while in the south of the island it ranges from –6.2 to -12°C. Winter generally lasts 5-7 months and summer 2-3 months. The average air temperature in August in the north of the island ranges from + 10.9 to +15.6°C, while in the south it ranges from +16 to +19.6°C. Fog frequently occurs in the coastal zone in the summer season. Autumn may be characterised by frequent typhoons and storms.

Annually, average precipitation in the central part of the island is 500-750 mm, in the north it is over 400 mm (rising to 1,000-1,200 mm in mountainous areas) and in the south 1,000 mm. The majority (65 to 78%) of precipitation falls between April and October, with September generally being the wettest month, as this is normally the period of most intensive cyclone activity.

3.1.3 Soils

Sakhalin Island is located within the Far Eastern Taiga-Forest Bioclimatic Region. In general, soils tend to be boggy, fragile and podzolised, although soil type varies across the Island in line with aspects such as vegetation, relief and climate. Generally, peaty, podzolic, loamy and clayey soils dominate in lowland areas with alluvial and gley-type soils occurring in river valleys. Mountainous areas are characterised by podzolised and nonpodzolised forest, brown soils. Despite the diversity, it is possible to define areas that are characterised by similar chemical and hydrologic soil composition:

- In the North-Sakhalin Lowland, free-draining sands predominate in coastal areas and on former marine terraces, while poorly-draining loams and clay-rich soils occur in river valleys;
- In the West-Sakhalin, East-Sakhalin Mountains, the Susunai and Tonino-Aniva Ridges, friable soils occur, largely derived from eroded sediment deposited as alluvial fans and other depositional landforms. These soils are generally permeable and free-draining;
- Depressions/lowland areas between mountain/hill ranges are characterised by loamy and clayey alluvium. These types of soil are relatively impermeable and retain a lot of moisture; and
- Low coastal zones are characterised by loamy and clayey soils. These types of soil are found adjacent to lagoons, river mouths and enclosed depressions and are poorly-draining. Permeable, marine sands are present along the low-lying coastal zone.

3.2 FLUVIAL BASELINE CONDITIONS

This section describes physical baseline conditions relating to the fluvial system of Sakhalin Island, focussing on rivers along the route of the pipeline. Rivers are broadly characterised in terms of their physical character, hydrology and fluvial morphology, using baseline information reported in a number of studies undertaken prior to construction of the pipeline (See Table 3-1).

Table 3-1: Overview of baseline surveys

Survey/Reference	Description
Sakhhydromet, 1998. Gathering, processing and analysis of hydrometeorological data for environmental engineering surveys along the Sakhalin – 2 project pipeline.	Collation processing and analysis of published and archived hydro-meteorological data for Sakhalin Island. The description of climatic conditions is based on data, gathered at 14 weather stations of Sakhalin Hydromet. Average long-term climatic conditions have been determined on the basis of 1966-1995 observational data. Extreme conditions derived from the entire period of weather observations (1892-1995). Hydrological information on the river systems is based on data obtained from multi-year hydrometeorological observations from a system of 60 stations spread north-south on Sakhalin (department for hydrometeorology and environmental monitoring).

Survey/Reference	Description
Sakhhydromet, 1999. Study of hydrochemical, hydrologic and radiation-ecological characteristics of watercourses along the pipeline route, the Sakhalin II Project.	Surveys on hydrochemical, hydrological and sanitary characteristics of watercourses crossed by the pipeline route. A total of 50 new and 10 previously surveyed watercourses were surveyed during the summer and autumn. Data collected for each watercourse included: water depth, flow velocity, channel width and water level. From this data, attributes such as average and maximum depth, water area cross-section (profile) and average and maximum flow velocity were calculated. Hydrochemical analysis was undertaken at a total of 61 stations, including 10 reference rivers for which data had been obtained in 1998. At each station the following parameters were measured: dissolved oxygen, temperature, pH, concentration of dissolved metals and substances (Mg, Ca, Si, Fe, Cu, Zn,), phosphates, nitrates, nitrites, phenols, concentration of suspended solids, COD, BOD, pesticides, surfactants and oil derivatives (total hydrocarbons, tar and asphaltenes).
Sakhhydromet, 1999a. Engineering And Ecological Surveys Along The Pipeline And The Infrastructure Constructions Sites Within The Framework Of Sakhalin-II.	Survey of 50 watercourses that were not included in the 1998 and 1999 survey and 11 previously surveyed watercourses. Report includes data on atmospheric conditions during 1998, data from air monitoring stations and radiation (alpha and beta activity) for the surveyed watercourses. The landscape characteristics of the watercourse catchments in relation to the general river types found on the Island is also described.
Sakhhydromet, 2000. Investigation of the hydrochemical, hydrologic and radiation-ecological characteristics of the rivers at the pipeline in frames of the project Sakhalin 2 in the year 2000.	Literature review to obtain 10 years of archived data on the watercourses that were included in the 1998 and 1999 surveys. Hydrochemical and hydrological survey for 50 additional watercourses that were not included in the 1998 and 1999 survey and 11 previously surveyed watercourses is included.
Sakhhydromet, 2002. Assessment of the background hydrochemical and public-health state of the rivers of Sakhalin in Regions where infrastructure for the Sakhalin project is located in 2001.	Hydrochemical observation studies in Sakhalin rivers where these flow near the project facilities to assess their baseline condition. A total of 32 rivers were surveyed. Hydrochemical analysis included the following parameters: dissolved oxygen, temperature, pH, concentration of dissolved metals and substances (Mg, Ca, Si, Fe, Cu, Zn,), phosphates, nitrates, nitrites, phenols, concentration of suspended solids, COD, BOD, pesticides, surfactants and oil derivatives (total hydrocarbons, tar and

Survey/Reference	Description
	asphaltenes). Radioactivity and bacterial content were also recorded. The work concentrated on rivers in the vicinity of the OPF, LNG/OET and pipeline re-route section in the Makarov area.
Sakhhydromet, 2002. Supplemental assessment of the background hydrochemical and public health state of the rivers of Sakhalin that will be crossed by the trunk pipeline route in the Sakhalin 2 project in 2001.	Assessment of the baseline hydrochemical status (background metal contamination) of 15 major Sakhalin rivers crossed by the pipelines of the project. Data collection as for the rivers above.
Sakhhydromet, 2002. Investigation report hydrochemical and hydrological investigation in the river stations along the re-routed pipeline sections and in the vicinity of BS2 for the purpose of evaluation of their background condition in 2002.	Conducting hydrochemical observation studies in rivers where these flow along the pipeline re-route sections and near Booster Station 2 in order to assess their baseline condition. A total of 15 rivers were sampled. Report details hydrochemical data (parameters as detailed for previous studies), hydrological data (flow velocity, suspended sediment concentrations, water depth, channel width) and landscape characterisation.

The relatively high levels of precipitation, limited moisture loss as a result of evaporation processes and the general topography of Sakhalin Island has resulted in the development of an extensive and dense river/stream network. One of the peculiarities of the river systems on Sakhalin is the significant dissociation of the catchments. The absence of one or several major common catchments is explained by the fact that most of the rivers and lakes are divided by mountain chains and intervening ridges. At a high level, the watercourses can be divided into two groups: northern Sakhalin rivers and southern Sakhalin rivers. The northern grouping includes the two major rivers of Sakhalin, the Tym River (359 km long) and the Poronai River (350 km long), both with relatively large catchment areas (7,850 and 7,990 km^2 respectively). In contrast, the rivers of southern Sakhalin are relatively short and small. The large majority of rivers originate in mountainous areas and therefore upper reaches and tributaries tend to be of the higher gradient, faster flowing upland type while lower reaches are more lowland in character (meandering, lower flow velocities). Many rivers are therefore of mixed type, apart from the smaller, mountain rivers that issue from the eastern slopes of the Eastern Sakhalin Mountains and which fall rapidly to the coast (e.g. in the Makarov area).

The river network is generally distributed unevenly along the length of the Island. The highest density of watercourses occurs in the south-eastern coastal area, the basins of the Poronai River right tributaries, in the upper reaches of the Pilenga River, Vladimirovka River and some other rivers along the eastern coast, where the density varies between 1.5 - 2.3 km/km^2. In the central part of the island, river density is in the region of 1.2 to 1.5 km/km^2 and it only increases in the basins of some of the rivers (Naiba, Orlovka, Makarova) to 1.7 - 2.0 $km/\ km^2$. The lowest river network density occurs on the North-Sakhalin Lowland and in the southern part of the Poronai River basin, where in most cases it does not exceed 1.0 km/km^2 and only increases in some of the river basins to 1.4 km/km^2.

3.2.1 Overview of hydrological conditions

Four phases of hydrological condition are typical for Sakhalin rivers. These conditions are largely influenced by the variable nature of precipitation received within the catchments (Sakhhydromet 1998, 1999). Water supply sources change over the year. In spring most of the water comes from melting snow; in summer and autumn it comes mostly from precipitation, while in winter the only source of water is groundwater. Water levels in the rivers generally vary according to the following cycle: spring flood (April - June), summer low water (July - August), autumn flood (September – November) and winter low water (December - April). All Sakhalin rivers receive their water resources mainly from melting snow. The exception is the rivers of the North-eastern Lowland, which receive most of their water from groundwater aquifers (over 50% of the annual water resource). Because of the nature of inputs, the river systems of Sakhalin are characterised by a very variable distribution in annual catchment flow. The difference between the maximum and the minimum water flow rate varies from several dozen times (rivers of the North-Sakhalin Lowland and boggy and wooded rivers of southern Sakhalin) to several thousands times (rivers of the Terpeniya Bay southern coast and left tributaries of the Poronai river). The maximum flow rate in most rivers occurs in the warm seasons of the year (April-November) and represents 90-96% of the annual flow rate. The flow rate in the winter season (December-April) decreases to 4-10%. Exceptions are the rivers flowing on the North-Sakhalin Plain, which have a significantly greater percentage of flow during the winter (15-25%).

Spring floods are generated mostly by melting snow, which contributes the greatest volume of water to the rivers on an annual basis. The start of high flow volumes associated with the spring snowmelt varies from south to north, as shown in Figure 3-1and Table 3-2. The duration of spring floods is from 40 to 75 days. Floods associated with high rainfall occur mostly in the autumn, and often, maximum flow rates during this period exceed spring flood rates. Smaller rivers, with catchment basins less than 50 km^2 often dry up in periods of low rainfall or freeze up to the riverbed in very cold winters.

3.2.2 Overview of sediment budget

The processes that affect soil and rock weathering and sediment loadings in Sakhalin rivers are diverse. The most frequent ones are: rain wash, river wash (reworking of fluvially deposited sediment) and landslides. These processes frequently occur in the river basins in the southern and central part of the island. River wash and rain-wash are not very intensive in the river basins of the North-Sakhalin Lowland. The differing occurrence and intensity of these processes, along with soil, bedrock and vegetation cover conditions across the island, leads to considerable spatial variation in average suspended sediment concentrations and river water turbidity. Low suspended sediment concentrations (SSC) values are recorded for the rivers of the North-Sakhalin Lowland (up to 50 mg/l), while further to the south levels are several times higher (see

Table 3-3). Maximum values occur in rivers in those area characterised by large amounts of precipitation which activates rain-wash and river wash processes.

Suspended sediment load and turbidity varies significantly over the year. Generally, it is the lowest in winter, from December to April, when there is no rain-wash from the river basin surface. Maximum SSC levels are observed, as a rule, during the spring snowmelt periods and in the southern rivers can rise up to 5,700 mg/l or sometimes higher. High rainfall also leads to significantly increased SSC (up to 5,100 mg/l) during the summer and autumn.

Sakhalin regulatory agencies are aware of natural variation in SSC and the conditions causing wide-scale variability in this parameter and have made allowances in the legal framework to allow for topography and soil type between districts when setting Maximum Allowable Concentrations (MAC) of suspended solids for activities likely to introduce sediment into watercourses (see Table 3.3).

The main hydrological characteristics of spring flood for many years

No	River - point	Observation period, years	Flood beginning				Flood end			
			1998	norm	early	late	1998	norm	early	late
			Area 1							
1	r. Val - stl. Val	33	20.04	24.04	15.04	10.05	12.06	27.06	25.05	05.07
2	r. Dagi - stl. Dagi	10		28.04	12.04	06.05		19.06	02.06	07.07
3	r. Tym - stl. Nysh	45	24.04	22.04	06.04	03.05	30.06	09.07	18.06	30.07
			Area 2							
1	r. Tym - stl. Krasnaya Tym	49	24.04	25.04	09.04	05.05	28.06	07.07	10.06	30.07
2	r. Tym - stl. Ado-Tymovo	62	22.04	23.04	02.04	03.05	28.06	08.07	10.06	31.07
3	r. Krasnaya - stl. Yasnoye	35	28.04	21.04	31.03	02.05	22.05	15.06	30.05	04.07
4	r. Malaya Tym - stl. Belaya	45	25.04	23.04	14.04	05.05	29.05	25.06	27.05	16.07
5	r. Slavka - stl. Slavy	23	29.04	21.04	09.04	30.04	28.05	25.06	07.06	09.07
6	r. Pilenga - stl. Ado-Tymovo	38		25.04	12.04	09.05		01.07	08.06	16.07
7	r. Argi - r. Argi-Pagi	19		25.04	16.04	04.05		26.06	10.06	14.07
			Area 3							
1	r. Onorka - stl. Onor	49		20.04	08.04	07.05		28.04	02.06	20.07
2	r. Pobedinka - stn. Pobedino	24	30.04	17.04	06.04	30.04	12.06	19.06	09.06	04.07
3	r. Orlovka - stl. Smirnykh	21		18.04	09.04	06.05		24.06	01.06	17.07
4	r. Buyuklinka - stl. Buyukly	5		25.04				30.06		
5	r. Kamenka - stl. Matrosovo	12		28.04	13.04	11.05		28.06	10.06	26.07
6	r. Leonidovka - stl. Leonidovo	41		18.04	06.04	01.05		28.06	29.05	18.07
7	r. Tikhmenevka - stl. Tikhmenevo	11		17.04	10.04	01.06		09.06	19.05	02.07
8	r. Gastellovka - stl. Gastello	35		14.04	05.04	27.04		15.06	06.05	12.07
9	r. Goryanka - stl. Vakhrushev	5		13.04				10.06		
			Area 4							
1	r.Makarova - t. Makarov	46	17.04	14.04	03.04	27.04	20.06	23.06	28.05	18.07
2	r. Nitui - stl. Novoye	45	12.04	14.04	04.04	27.04	17.06	21.06	29.05	18.07
3	r. Gornaya - stl. Gornoye	14	17.04	08.04	26.03	25.04	08.06	22.06	16.05	01.07
4	r. Pugachevka - stl. Pugachevo	23	05.04	11.04	29.03	22.04	19.06	18.06	25.05	10.07
5	r. Tikhaya - stn. Tikhaya	25	06.04	09.04	21.03	25.04	11.06	08.06	25.05	29.06
			Area 5							
1	r. Phirsovka - stl. Phirsovo	15		11.04	29.03	24.04		14.04	21.05	28.06
2	r. Nayba - stl. Bykov	50	06.04	09.04	27.03	20.04	12.06	16.06	21.05	09.07
3	r. Komissarovka - stl. Tchapaevo	35	05.04	08.04	28.03	17.04	05.06	11.06	03.05	01.07
4	r. Susuya - stl. Sanatorniy	25	07.04	05.04	29.03	18.04	09.06	03.06	31.05	01.07
5	r. Susuya - t. Yuzhno-Sakhalinsk	52	04.04	06.04	25.03	21.04	20.06	15.06	12.05	29.06

Figure 3-1: The main hydrological characteristics of spring flood for many years (Sakhhydromet, 1999)

Table 3-2: Data on timing of river freezing and thawing and ice thickness for monitoring stations on selected Sakhalin Island rivers. Data from Sakhhydromet (1998). Average long-term climatic conditions have been determined on the basis of 1966-1995 observational data. Extreme conditions derived from the entire period of weather observations (1892-1995)

Area & river name	Beginning of freezing date (early)	Beginning of freezing date (late)	Beginning of ice clearing (early)	Beginning of ice clearing (late)	Max ice thickness (most) (cm)	Max ice thickness (least) (cm)
Area 1						
Piltun -Piltun village	30-Oct	30-Nov	23-Apr	25-May	136	60
Val -Val village	16-Oct	10-Nov	22-Apr	15-May	120	62
Daghi -Daghi village	28-Oct	22-Nov	23-Apr	19-May	116	63
Tym -Nysh farm	26-Oct	23-Nov	24-Apr	17-May	94	70
Area 2						
Tym - Krasnaya Tym Farm	13-Jan	09-Feb	25-Jan	01-Apr	-	-
Tym - Ado - Tymovo village	05-Nov	20-Dec	16-Apr	06-May	120	73
Krasnaya -Yasnoye village	22-Oct	21-Nov	22-Apr	10-May	135	72
Malaya - Belaya village	01-Nov	26-Nov	10-Apr	11-May	110	57
Pilenga - Ado- Tymovo village	13-Nov	25-Dec	26-Mar	09-May	71	41
Uskovo - Uskovo village	02-Nov	19-Dec	02-Apr	05-May	88	44
Slavka - Slavy village	10-Nov	21-Dec	12-Mar	20-Apr	-	-
Area 3						
Poronai - V.Abramovka	08-Nov	21-Dec	21-Apr	08-May	119	52
Poronai - st.Pobedino	07-Nov	19-Dec	19-Apr	05-May	133	60
Poronai - v.Red October	02-Nov	12-Dec	17-Apr	08-May	119	48
Онорка - v.Onor	12-Nov	11-Dec	15-Apr	25-May	191	67
Pobedino - st.Pobedino	11-Nov	29-Nov	12-Apr	10-May	217	55
Orlovka - v.Smirnykh	08-Nov	18-Dec	16-Apr	10-May	249	108
Area 4						
Leonidovka - Leonidovo village	09-Nov	12-Dec	15-Apr	13-May	185	96
Gastellovka - Gastello village	15-Nov	08-Dec	06-Apr	24-May	153	20
Nitui - Novoye village	09-Nov	20-Dec	08-Apr	05-May	126	59
Gornaya - Gornoye village	11-Nov	14-Dec	08-Apr	10-May	164	63
Makarova - Makarov city	01-Nov	05-Dec	13-Apr	07-May	155	66
Pugachevka - Pugachevo village	11-Nov	03-Dec	03-Apr	26-Apr	120	88
Area 5						
Firsovka - Firsovo village	06-Nov	29-Dec	29-Mar	26-Apr	No data	No data
Naiba - Bykov village	16-Nov	20-Dec	06-Apr	30-Apr	118	58
Komissarovka - Chapayevo village	13-Nov	20-Dec	29-Mar	28-Apr	83	35
Susuya - Sanatorny village	16-Nov	17-Dec	03-Apr	23-Apr	75	22
Susuya - Yuzhno-Sakhalinsk	24-Nov	15-Jan	11-Jan	26-Apr	No data	No data

Table 3-3: Suspended sediment concentrations in selected Sakhalin Island rivers. Data from Sakhhydromet (1998)

	Oha and Nogliki districts	Tym districts	Smirnykh districts	Poronay and Makarov districts	Dolinsk, Aniva and Korsakov districts
Average	4.0-7.3 mg/l	10.6-45.9 mg/l	26.1 mg/l	61.4-70.5 mg/l (Pugachevka 27.4 mg/l)	88.0-175 mg/l
Minimum	0.2-1.0 mg/l	0.0-0.4 mg/l	2.6 mg/l	0.0-3.6 mg/l	0.0-0.8 mg/l
Maximum	9.8-56.0 mg/l	74.6-199 mg/l (Argi 753 mg/l)	127 mg/l	64-1,160 mg/l	692-1,250 mg/l
MAC	10.75 mg/l	200.75 mg/l	200.75 mg/l	200.75 mg/l (Pugachevka 100.75 mg/l)	100.75 mg/l

Available data indicates that some or all of the rivers from time to time exceed MACs during spring floods (Sakhhydromet 1998). During naturally occurring yearly floods, values of 1040 and 714 mg/l have been recorded for rivers in the Tymoyskiy and Anivskiy areas. Specific rivers periodically in excess of their MACs include the Yuzhnaya Khandasa River (1,080 mg/l), River Onorka (810 mg/l), River Pobedinka (254 mg/l), River Lesnaya (283 mg/l), River Borisovka (377 mg/l) and River Pilenga (559 mg/l).

Available data provides insight into the frequency of how often MACs has been exceeded:

- In the Okha and Nogliki district, the maximums rarely exceed the MAC considerably, however in certain years the MAC has been recorded to be exceeded by 5-7 times;
- In the Tym district, it has been recorded that MAC exceeded once in the Arga river (3.7 times in 1994) and twice in the Tym river (20%);
- For the Smirnykh district, the maximums have exceeded MAC twice in the Leonidovka River (1.5 times).
- In the Poronay and Makarov district, MAC has been recorded as being exceeded in 22 cases (1.1-6.6 times);
- The most frequent MAC excess is registered in the Dolinsk, Aniva and Korsakov district (247 cases exceeding 1.1-15.6 times MAC). Here values exceeding MAC were registered at all hydrological regime stages and peak values were registered during the autumn rain floods.

3.3 REGIONAL VARIABILITY IN FLUVIAL SYSTEMS

In order to examine regional differences in the character of the fluvial system, the island network is generally described in terms of 5 areas, defined by the following administrative districts:

- Area 1: Okha and Nogliki districts;
- Area 2: Tymovsky district;
- Area 3: Smirnykhovsky district;
- Area 4: Poronaisky and Makarovsky districts; and
- Area 5: Dolinsky, Anivsky, Korsakovsky and Yuzhno-Sakhalinsk districts.

Figure 3-2 shows the location of these areas on Sakhalin Island, together with some of the main watercourses. The decision to base the physical characterisation on these areas, rather than on river basin areas as would ideally be the case, is driven by the fact that much of the baseline data gathered has been gathered according to these areas (Sakhhydromet, 1998 – 2002b). The districts also reflect broad physical characteristics of the river system and are not dissimilar to the river basin-based division of the island presented in the report of Sakhalin State University (2000).

For each of the areas the following parameters are used to describe the fluvial system:

• Physical Character	Topography Landscape Character Geology and Soils Climate
• Hydrology	Precipitation Discharge and Flow Regime Freezing regime
• Fluvial geomorphology	Channel Form and Adjustment Hydraulics Sediment Regime

Figure 3-2: Location of regional areas used to describe hydrological characteristics

3.3.1 Area 1: Okha and Nogliki districts

The river system of the Okha and Nogliki administrative districts comprises more than 5,500 rivers (Sakhhydromet, 1998). The area broadly corresponds with the North Sakhalin group of watercourses identified by Sakhalin State University (2000) with the addition of rivers draining the East Sakhalin Mountains (these rivers are not described as part of the regional assessment as they are not crossed by the SEIC pipeline). The rivers can be divided into two subgroups: typical lowland rivers (e.g. Rivers Ossoy, Nutovo, Tapauna, Val with tributaries) and mountain/mixed type rivers (e.g. Rivers Askasay, Dagi, Evay, Imchin and Vazi) (Sakhalin State University, 2000). The majority of watercourses flow eastwards into the Sea of Okhotsk. However, the area also includes the lower reaches of the River Tym, which flows northwards from the centre of the island, and the River Nysh, which flows southwards before joining the River Tym. The River Tym is one of two largest rivers on the island with a catchment area of 7,850 km^2.

Topography and Landscape Character

The North Sakhalin plain is characterised by rolling terrain with hills from 200 to 400 m high. The plain features isolated low mountains (Mount Daakhuria is the highest at 601 m). The coastal area has pronounced marine terraces with heights ranging from 10 to 80 m, while the central area is characterised by weakly pronounced and ridged hill terrain. Small lacustrine-alluvial plains and lacustrine-marshy flats are widespread (Sakhhydromet, 1998). The Nabilskaya lowland, around the mouth of the River Nabil, is essentially an open waterlogged depression (mari) with a height of 40 - 60 m lowering to 20 – 30 m towards the mouth of the river. The width of this lowland varies from 5 km in the south to 10 km along the coast. The rivers flowing across it are characterised by extensive floodplains (200 to 700 m wide) with considerably waterlogged surfaces (Sakhhydromet, 1998). The area crossed by the pipeline route is a hilly plain of low gradient, heavily waterlogged in places and incised by a network of ravines, gullies and rivers (Averina, 2004).

Geology and Soils

The area is underlain by rocks from the Nutov and Okobykai stratigraphic suites formed of interbedded clays, sands, sandstones and siltstones (Averina, 2004). Superficial geology consists of unconsolidated Quaternary eluvial and alluvial deposits (clays sands and pebbles) over 3-5 m thick. Soils are mainly sandy and podzolic, exhibiting leaching and are typical of those formed in cool, humid climates (Averina, 2004). Free-draining sands predominate in coastal areas and on former marine terraces, while poorly draining loams and clay-rich soils occur in the river valleys (Sakhalin State University, 2000).

Climate

The north-eastern coast of the North-Sakhalin lowland climatic zone is characterised by cold, windy winters with little snow and cool, foggy summers. Evaporation is very limited due to the relatively low temperature and high humidity and even light precipitation can result in waterlogged ground conditions. The soil freezes to a great depth due to the long period of cold weather and thin, uneven snow cover. The coldest month is January when average air temperatures fall to between -16 and -19°C. Air temperatures rise above 0°C at the end of April or the beginning of May but, due to the influence of the cold sea, currents rise very slowly. The maximum air temperatures are registered in August, and are between 11 and 14°C (Sakhhydromet, 1998).

Precipitation

Precipitation in the north is generally lower than in the south (see Section 3.1.2). Snow predominates from November to March and rain from April to

October. In the Okha and Nogliki districts, strong winds reduce the chance of precipitation. During the summer season humid air from the sea brings twice as much precipitation as during the winter – the average monthly precipitation level in August is 98-104mm. (Sakhhydromet, 1998).

Discharge and Flow Regime

The flow regime of Sakhalin rivers typically consists of four stages: spring melt water (April – June), summer low water (July – August), autumn floods (September – November) and winter low water (December – April) (see Figure 3-3). This pattern, however, is subject to variation regionally and between years (Sakhhydromet, 1998). In comparison with other Sakhalin rivers, the rivers in Area 1 have a smaller annual average runoff, the longest freezing period, an early freezing date and a late open water date.

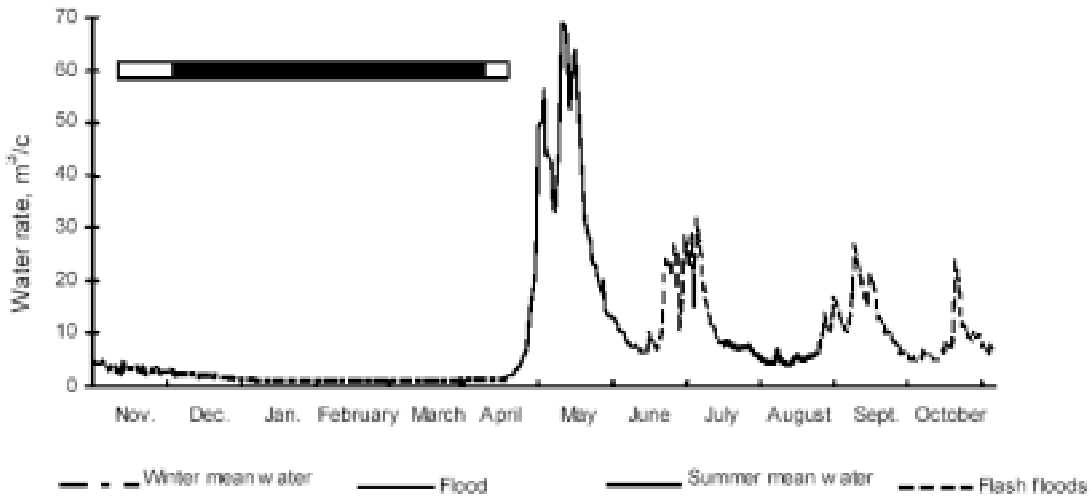

Figure 3-3: Drainage Hydrograph for a Hydrologic Year Identifying the Water Regime Stages (River Piltun - Piltun settlement, 1971 - 1972) (Source: Sakhhydromet, 1998)

The rivers in the Okha and Nogliki districts are lowland watercourses that are predominantly fed by groundwater, accounting for 60% of the annual drainage volume; melt water accounts for about 30%; and rainfall water for about 10% (Sakhhydromet, 1998). Annual fluctuations in water level due to spring melt water and rainfall floods are relatively small in comparison with other areas of the island. This is due to the groundwater dominated flow regime and interaction with aquifers. During the melt water period the rivers in the north pass from 35 to 47% of the annual drainage volume, the level of small rivers may rise by 0.5 to 1 m and that of medium sized rivers by 2 – 5 m (Sakhhydromet, 1998).

Freezing regime

Ice-cover on the rivers occurs from late October – early November for a period of approximately 155-185 days (max. 185-200 days) (Averina, 2004), see Table 3-2. Ice is typically between 60-90 cm thick and reaches its maximum in March. Rivers usually clear from ice as a result of the inflow of melt water in early May. Jamming and subsequent highly destructive ice movement often accompanies this inflow of water on the floodplain of larger rivers such as the Tym. On small watercourses, ice typically thaws in situ (Averina, 2004). Thawing starts to begin as soon as the air temperature rises above 0°C (see Figure 3-4) and ice starts to break up during late April-early May (sometimes as late as 15th-25th May) and in the case of the rivers Tym and Nysh, towards the middle of May. Rivers are generally clear of ice during by the third week of May. Flooding during the melt water period is generally a rare occurrence, except on the River Tym where discharges can be of a high magnitude (Figure 3-5).

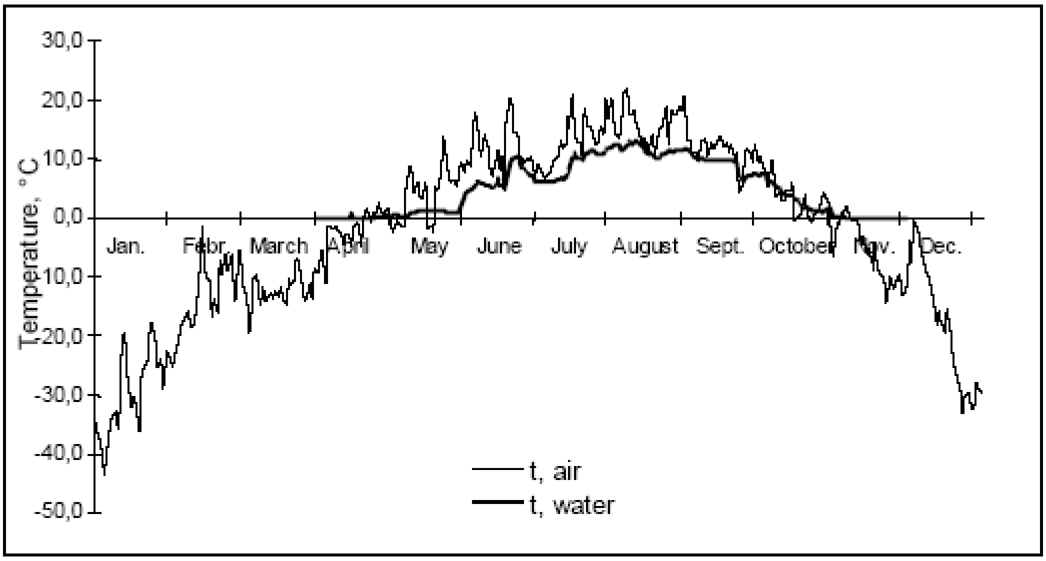

Figure 3-4: **Average Diurnal Temperature of Air and Water - River Piltun, Piltun settlement (1994)**

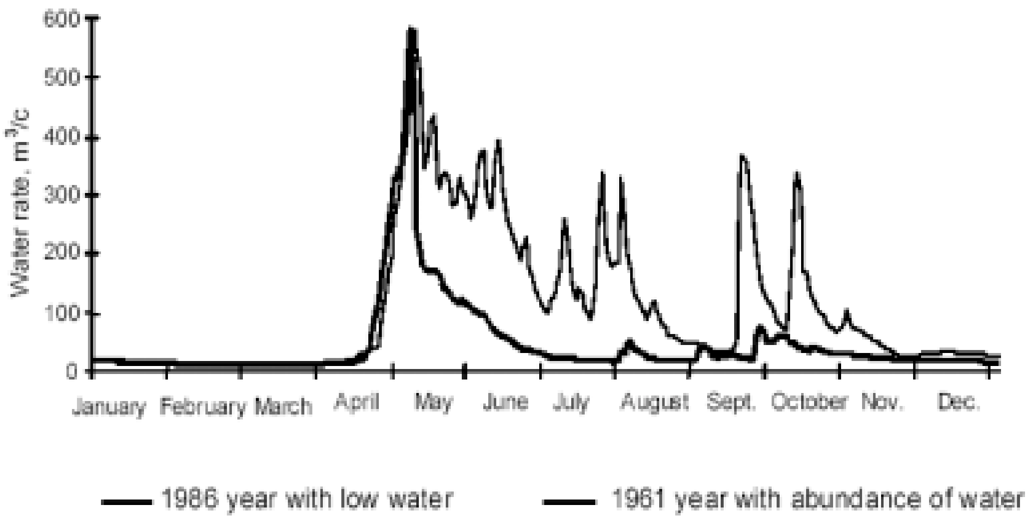

Figure 3-5: **Drainage Hydrograph for High-Water and Low-Water Years, River Tym - Nysh Farm (Source: Sakhhydromet, 1998).**

Channel Form and Adjustment

The river system of Area 1 consists largely of small rivers less than 10 km long. Significant large rivers are the River Tym (330 km long), Evay (117 km) and Val (112 km). The width of the large rivers in the lower reaches is between 60 – 100 m. During the spring melt water period and rainfall floods the maximum depth of these rivers is between 4.0-8.5 m. The width of other channels does not exceed 40 m and their maximum depth is from 2.0 to 4.5 m (Sakhhydromet, 1998).

Rivers generally meander freely across extensive, swamped floodplains and are highly sinuous in planform (Sakhhydromet, 1998; Sakhalin State University, 2000). Dynamic lateral adjustment occurs through bank erosion, meander development and cut-off, and formation of ox-bow lakes. This adjustment is further exacerbated by blockages caused by ice and large woody debris.

Hydraulics

Rivers within Area 1 are generally of low gradient (0.001-0.004) (Averina, 2004). However, velocities vary within a wide range reflecting the seasonal cycles shown in Figure 3-3. During spring meltwater and floods the stream velocity in the rivers Tym, Val, Dagi that flow across the plain can reach 2.0 to 2.5 m/s (Sakhhydromet, 1998). In winter, flow velocities are typical low and the depth reaches its minimum. Data for rivers that can be found in this area is shown in Table 3.4.

Table 3-4: Water depth and flow velocity in winter for selected rivers in Area 1

Watercourse	Average depth at low-water, $h_{l.w.}$ m	Average current velocity at low-water, $V_{l.w.}$ m/sec.
River Khanduza	0.3	0.34
Brook Koisikil-Urun	0.5	0.33
River Tomi	1.1	0.23
River Bauri	1.0	0.19
Brook Sopochniy	0.6	0.14
River Chernaya	0.3	0.1
Brook Spokoiny	0.4	0.1

Sediment Regime

The average content of suspended matter reported in Area 1 watercourses is between 4.0 – 7.3 mg/l, which is below the Maximum Allowable Concentration (MAC) level of 10.75 mg/l. This range is the lowest of all of the Areas considered due to both the low gradient and velocity of the rivers and the small amount of precipitation in the area. There is variation both between rivers and with time throughout the year (Sakhhydromet, 1998). The main sediment movement period is the springtime meltwater flood, which carries 90% of the annual volume of suspended sediment discharge.

3.3.2 Area 2: Tymovsky District

The Tymovsky district comprises the middle and upper reaches of the River Tym and its tributaries, together with the upper tributaries of the Poronai catchment that drains southwards to Terpeniya Bay. The River Poronai is the second major river on Sakhalin Island with a catchment area of 7,990k m^2. The area broadly corresponds to the Tymovskaya river group identified by Sakhalin State University (2000).

Topography and Landscape Character

The area comprises the West Sakhalin and East Sakhalin Mountains with the Tym-Poronay lowland lying in between. The West Sakhalin Mountains include the main Kamyshovy ridge with heights of 1,000 to 1,300m while the East Sakhalin Mountains comprise the Lopatinsky mountain juncture with ridges of 1000 to 1,600m in height (Sakhhydromet, 1998). The Tym-Poronay lowland is a flat waterlogged plain with a width of 5 to 15 km. The elevation of this lowland increases to the watershed between the Tym and Poronai catchments, and is characterised by hilly relief and elevations of 80-105 m (Averina, 2004). Rivers in the area are mixed mountain–lowland rivers. Land use in the area is around 80% woodland and 4-5% marshland. Vegetation in the mountains is dominated by spruce and fir forests with areas of birch woodland (Sakhhydromet, 1998). Poplar trees and grassland areas predominate on the floodplain of the River Tym.

Geology and Soils

The rivers within Area 2 have their headwaters in mountains composed of metamorphic rocks that are generally resistant to erosion. Soils in the mountainous areas are predominantly brown mountainous-taiga, unpodsolised soils. (Sakhhydromet 1998). In contrast, the Tym-Poronai lowland is composed of alluvial and marine deposits with swampy-peaty and peaty-gleyey soils (Sakhhydromet, 1998).

Climate

Tymovsky district is situated in the north of the Tym-Poronai valley and has a continental climate with large variations in temperature. The annual variation of air temperature can be up to 40°C, while daily variation can be approximately up to 30°C. The coldest month is January when the average air temperature is -23.6°C. July is the warmest month with temperatures of 15.7 to 16.0°C (Sakhhydromet, 1998).

Precipitation

Annual precipitation within the Tymovsky district is distributed relatively evenly across the area, ranging from 710 to 760 mm. The minimum monthly precipitation is reported to be in March (30 mm), while the greatest monthly precipitation is registered between August and October (101 mm), as is typical of a monsoon climate (Sakhhydromet, 1998).

Discharge and Flow regime

The rivers in the Tymovsky districts are mixed mountain / lowland rivers predominantly fed by melt water, which accounts for 60 % of the annual drainage volume; groundwater accounts for 25%; and rain water for 15% (Sakhhydromet, 1998). The flow regime is therefore characterised by spring high water and summer–autumn high water periods (see Figure 3-6). The spring melt water period in late-April to June is the main stage and accounts for 50 to 70% of the annual drainage volume. The melt water period features two to three flood waves from snowmelt and abrupt fluctuation between warm and cold periods. Flooding during the melt water period on the rivers of the Tym-Poronai valley is an almost annual occurrence, caused by the coincidence of high melt water levels, rainfall and clogging of the river channel during the period of ice break-up (Sakhhydromet, 1998). 20-25% of annual runoff occurs during the summer and autumn floods and only 5-7% of the annual runoff during the winter months (Sakhalin State University, 2000).

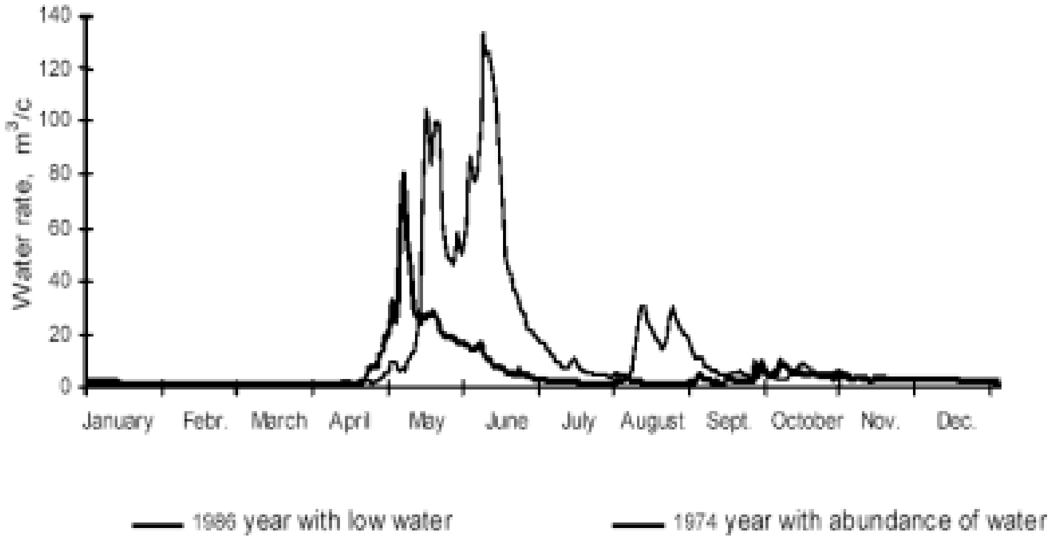

Figure 3-6: River Pilenga - Ado-Tymovo settlement. Drainage Hydrograph comparing periods of high and low precipitation (Source: Sakhhydromet, 1998).

Freezing regime

The ice regime of the rivers in this area is formed under a severe and relative snowy winter. The first river ice formations normally appear in early November, but can start in mid-October or as late as mid-December. The freezing of the rivers takes 6 to 30 days. In some warm years, freezing-of the upper reach of the River Tym in the area of the Krasnaya Tym farm may occur as late as February. By late November-early December the rivers are fully frozen, this period normally lasting on average for 150-180 days. Maximum ice thickness on the rivers varies from 40 to 72 cm during warm winters and from 90 to 135 cm during harsh winters. Thawing starts to begin as soon as the air temperature rises above 0°C and ice starts to break up during mid-late April and rivers are generally clear of ice towards late April-early May.

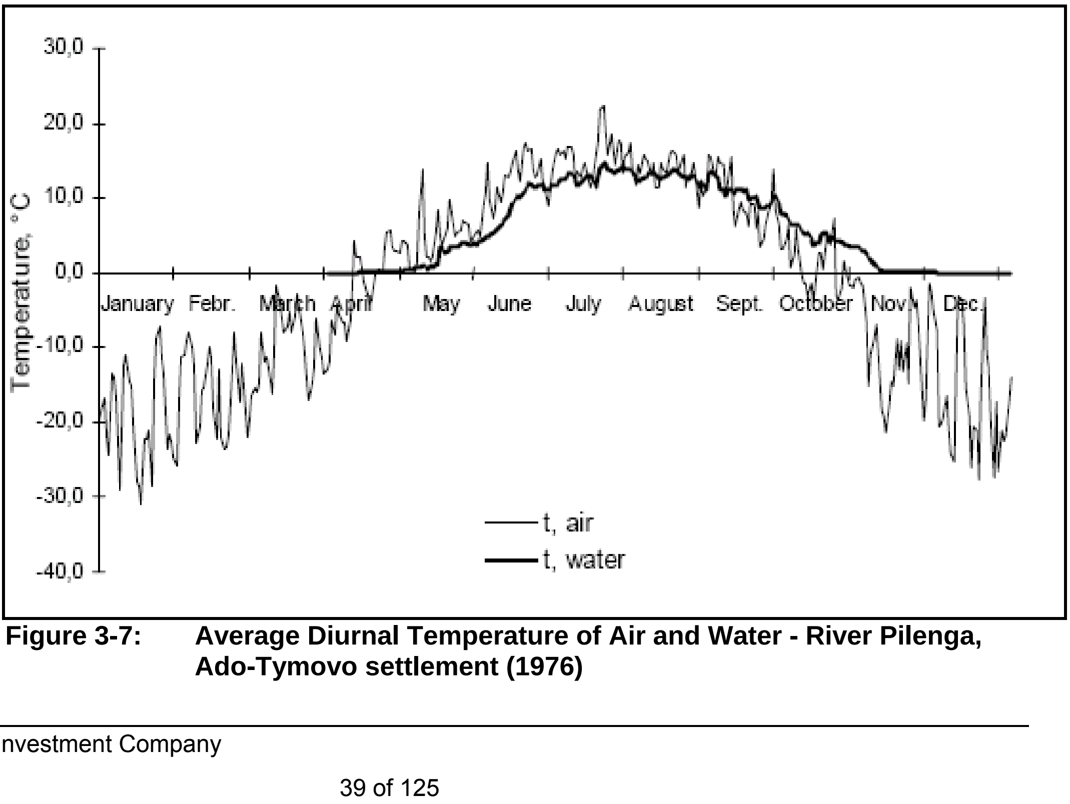

Figure 3-7: Average Diurnal Temperature of Air and Water - River Pilenga, Ado-Tymovo settlement (1976)

Channel Form and Adjustment

The river system of the Tymovsky area comprises more than 15,000 watercourses, the bulk of which consists of small rivers (99%) less than 10 km long. The River Tym itself is between 60 and 100 m wide and maximum depth during spring snowmelt and rainfall floods can be from 4 to 7 m. The channel width of medium-size rivers does not exceed 40m and the maximum depth is from 2 to 4 m (Sakhhydromet, 1998). In the upper mountainous reaches (e.g. tributaries of Rivers Vosi and Pilenga) watercourses are incised within narrow V-shaped valleys and are of high velocity. Further downstream the rivers are of a more lowland character and meander over their floodplains (Averina, 2004). Channel adjustment of large and medium lowland river reaches is characterised by branching and free meandering of the river channel, together with bank erosion and meander development. Relict channels and ox-bow lakes are common and often overgrown. Floodplains are frequently swamped. Large woody debris in the form of fallen trees influences bank erosion and planform change. Smaller rivers and brooks are characterised by sinuous channels and more gradual meander development (Averina, 2004).

Hydraulics

The velocity of rivers varies within a wide range, reflecting the different gradients of mountainous and lowland sections of watercourses in this area. In mountainous reaches, high velocities of up to 1.5–3 m/s occur, particularly during the spring snowmelt period (Averina, 2004). During this period the stream velocity of the River Tym flowing across the associated floodplain can also reach 1.5 to 2.5 m/s (Sakhhydromet, 1998). In winter, flow velocities are typical low and the depth reaches its minimum. Data for rivers that can be found in this area is shown in Table 3.5.

Table 3-5: Water depth and flow velocity in winter for selected rivers in Area 2

Watercourse	Average depth at low-water, $h_{l.w.}$ m	Average current velocity at low-water, $V_{l.w.}$ m/sec.
Vtoraya Rechka	0.5	0.08
Berezovka	0.2	0.12
Voskresenoka	0.85	0.5
Brook Kirpichny	0.8	0.3
Brook Izvestkovy	0.5	0.4
Sergeevka	0.32	0.3
Brook Tikhiy	0.2	0.5
Glubokaya	0.2	0.1
Zaprudnaya	0.41	0.4
Golubichnaya	0.2	0.2
Daldaganka	0.9	0.4

Sediment Regime

Fine sediment delivery from hill slopes is augmented by disturbance of the vegetation cover due to tree felling, forest fires and road development (Averina, 2004). The Maximum Allowable Concentration (MAC) for this particular area is 200.75 mg/l. This concentration may be exceeded during high flow events as a result of meltwater or rainfall events. For example, the average suspended solid concentration in the River Argi is 41.3 mg/l, the minimum level is 0.4 mg/l, while the maximum level recorded is 753 mg/l (Sakhhydromet, 1998).

3.3.3 Area 3: Smirnykhovsky District

The Smirnykhovsky district is located in the centre of Sakhalin Island and is dominated by the River Poronai and its tributaries, draining mainly from the West Sakhalin Mountains. Major watercourses are the rivers Poronai, Orlovka (83 km) and Onorka (77 km). This area forms part of the Poronasiskaya group identified by Sakhalin State University (2000).

Topography and Landscape Character
The topography of the area is diverse with the spurs of the West Sakhalin Mountains to the west and the Abramovsky and Tsentralny ridges of the East Sakhalin Mountains to the east. The Poronay lowland lies in between the mountains. Rivers within the area are primarily mountain-streams becoming more lowland in character downstream. Woodland accounts for around 50% of land use. A major part of the area is covered with spruce and fir forests with occasional stone birch forest and Kuril bamboo underbrush (Sakhhydromet, 1998).

Geology and Soils
The Poronay lowland is waterlogged and composed of Quaternary deposits. The upper surface sediments comprise pebble with loam and clay interlayers and is saturated with groundwater (Sakhhydromet, 1998). Along the pipeline route, deposits are very thick and unconsolidated, composed mainly of alluvial sands, loamy sands, clay loams, clays, pebbles and weathered rock (Averina, 2004). Soils are predominantly swampy-peaty and peaty-gleyey. Soils in the mountainous areas are predominantly of the brown mountainous-taiga unpodsolised and weakly podsolised type.

Climate
The coldest month in the Smirnykhovsky district is January, when the average monthly air temperature is -17.2 – -19.4°C. However, during long periods of very cold weather spells of warmer weather occur, when air temperature rises even in January during the day to 1-2°C. The average daily temperature rises over the freezing point at the end of April. However, cold spells often reoccur due to the influence of the cold sea current. The maximum air temperature occurs during August. The average monthly temperature in August is 12 to 15°C.

Precipitation
There is 2-3 times more precipitation during the summer in the Smirnykhovsk district than during the winter. The greatest monthly precipitation (96-104 mm) is registered in August/September while the smallest amount (18-33 mm) occurs during January (Sakhhydromet, 1998).

Discharge and Flow regime
The rivers in the Smirnykhovsky districts are of mixed mountain-lowland type. Meltwater accounts for 35 to 45%, ground water for 25 to 30% and rainwater, for 30 to 35% of the annual drainage volume. (Sakhhydromet 1998). Annual variations in water level due to spring melt water and rainfall floods are abrupt as a result of the mountainous nature of the headwaters. Snowmelt typically starts in late-April/early-May and often coincides with rainfall floods (see Figure 3-8). Rainfall events often affect the rivers in August through to October and are normally short in duration, characterised by brief peaks in flow. Flooding during snowmelt in the area occurs but is rare, while high rainfall floods occur once approximately every 5 to 7 years.

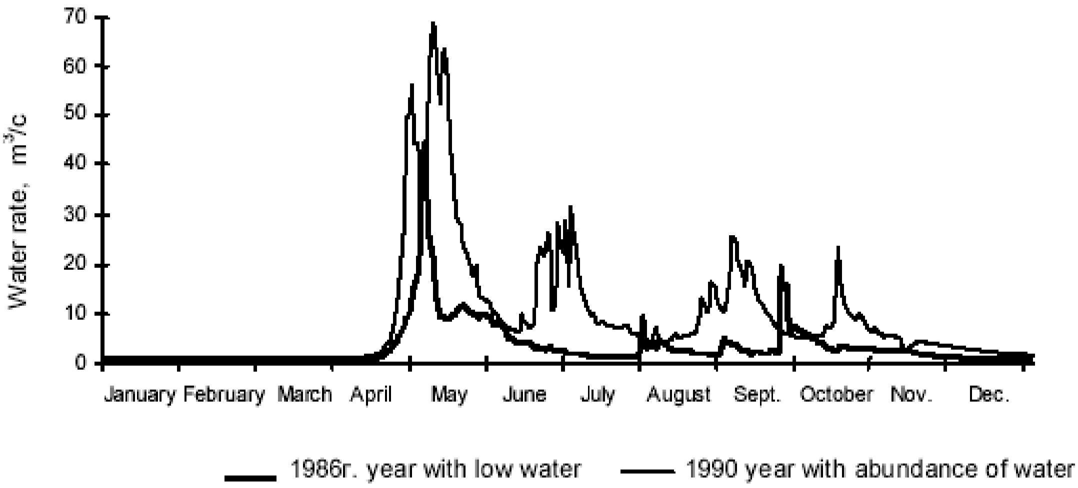

Figure 3-8: Drainage Hydrograph for High-Water and Low-Water Years, River Onorka - Onor settlement (Source: Sakhhydromet, 1998).

Freezing regime

The ice regime of the rivers in this area is formed under a severe winter, but generally with lower falls of snow compared with districts further to the north. First ice formation normally appears in early November, but may be as late as mid-December. Typically, freezing of the rivers takes place by mid-late November. The freezing of the river (from the appearance of first ice formations until freeze-up) takes 6 to 30 days. The duration of the river freezing period is from 150 to 165 days, with 170 to 185 days as a maximum. Maximum ice thickness can be very variable and is typically from 48 to 108 cm in warm winters and up to 119 to 249 cm in cold winters. River thaw and break-up normally occurs as early as April 12 - 21 (Figure 3-9) and as late as May 5 - 25 when the water level rises as a result of the influx of melt water.

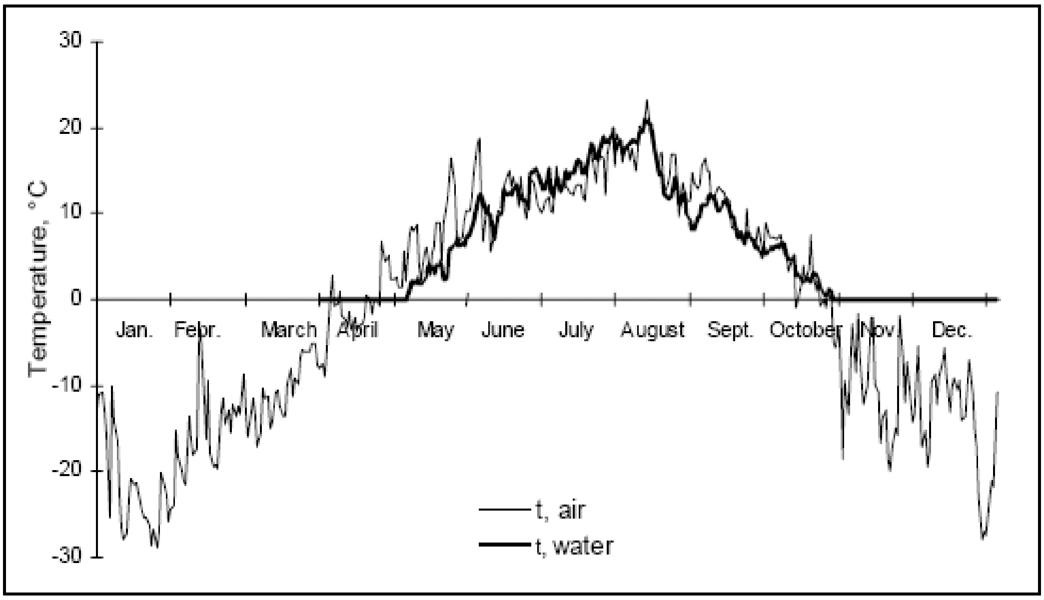

Figure 3-9: Average Diurnal Temperature of Air and Water - River Onorka, Onor settlement (1979)

Channel Form and Adjustment
Watercourses are primarily contained within the Poronay catchment and comprise more than 6,000 rivers. Typical river width is between 10 - 40 m. Maximum depth during snowmelt and rainfall floods can be from 2.0 to 3.5 m. The channel width of small rivers does not exceed 10 m and the maximum depth ranges from 0.5 to 1.5 m (Sakhhydromet, 1998). Adjustment through erosion is of greater intensity than in other areas, especially where there is local neotectonic uplift (e.g. the River Onorka), and slopes are poorly vegetated and composed of easily eroded soils. The majority of watercourses are characterised by numerous ravines or small gorges. Some degree of lateral adjustment through meandering is exhibited by the larger watercourses, which increases in areas of floodplain development in the lower lying reaches of the rivers (Averina, 2004).

Hydraulics
The stream velocity in the rivers varies within a wide range. During spring snowmelt and floods, velocities in the rivers flowing across the lowland do not exceed 1.0 to 1.5 m/s. In the mountains, stream velocity can reach 2.0 to 2.5 m/s. (Sakhhydromet, 1998). In winter, flow velocities are typical low and the depth reaches its minimum. Data for rivers that can be found in this area is shown in Table 3.6.

Table 3-6: Water depth and flow velocity in winter for selected rivers in Area 3

Watercourse	Average depth at low-water, $h_{l.w.}$ m	Average current velocity at low-water, $V_{l.w.}$ m/sec.
Alla River	0.5	0.3
Povorotnaya River	0.3	0.2
Pobedinka River	0.4	0.4
Shumny Brook	0.35	0.3
Barachny Brook	0.24	0.3
Porok Brook	0.25	0.1
Usanovka River	0.2	0.2
Bolotnaya River	0.2	0.2
Porochnaya River	0.2	0.35

Sediment Regime
The average suspended solids concentration level is 26.1 mg/l, the minimum level is 2.6 mg/l, and the maximum is 127 mg/l. The Maximum Allowable Concentration (MAC) for suspended solids in this area is 200.75 mg/l (Sakhhydromet, 1998).

3.3.4 Area 4: Poronaisky and Makarovsky Districts

Rivers within the Poronaisky and Makarovsky districts also form part of the Poronaiskaya group identified by Sakhalin State University (2000). The area includes the lower reaches of the River Poronai and its tributaries, which drain the Poronay plain. The area also includes several smaller rivers south of the district boundary, which flow eastwards from the mountains to the sea.

Topography and Landscape Character
The topography of the area is diverse, and includes the East Lisyansky, West Lisyansky and Makarovsky ridges that run in a latitudinal direction with heights ranging from 476 to 953 m. The Kamyshovy ridge runs along the coast within the Makarov district, reaching a height of between 700 to 900 m. The pipeline route runs along the foothills of the ridge. Coastal lowlands are present in

between the ridges and are associated with low marine terraces. River valleys normally have well-defined first and second above-floodplain terraces; overlying terraces are less clearly defined. Woodland accounts for around 60% of land use in the area. A major part of the area is covered with spruce and fir forests with occasional stone birch forests, Kuril bamboo and other shrubs.

Geology and Soils
The Marakov district in particular contains a variety of geological, geomorphological and geotectonic conditions, including high seismic activity, intense erosion, landslides and other processes, which influence the river network. Loose quaternary deposits from 0.5 – 5 m thick are present on hill slopes along the pipeline route. Soils in the mountainous areas are predominantly of the brown mountainous-taiga unpodsolised type and weakly podsolized type. Turfy-meadow and meadow-gleyey waterlogged soils are widespread in the floodplain.

Climate
Air temperature in the Poronaisk and Makarov districts largely depends on the monsoon atmospheric circulation and on the cold temperatures of the Sea of Okhotsk. In winter the sea is almost completely covered with ice and the climate is consequently cold with average monthly temperatures of -10 to -17°C. Summers are also cold, overcast and short, with frequent rains and fogs, due to the transport of cold air from the Sea of Okhotsk. The mean maximum temperature of the warmest month August is 19 to 20°C. (Sakhhydromet, 1998).

Precipitation
The total annual precipitation in Area 4 increases from Poronaisk in the north (757 mm) to Makarov in the south (938 mm). Approximately 75% of the precipitation falls in the warm season, peaking in September, while the lowest precipitation is registered from December – March (Sakhhydromet, 1998).

Discharge and Flow regime
The rivers in the area are of the mountain-lowland nature. Melt water accounts for 35 to 45%, groundwater for 25 to 30% and rainwater for 30 to 35% of the annual drainage volume. The main stage of the water regime is the spring snowmelt and accounts for 46-53% of the annual drainage volume. Snowmelt typically occurs in mid to late-April. However, rainfall events also form a significant part of the flow regime, contributing 28 to 39% of the annual drainage volume mainly from the summer and autumn flooding period (see Figure 3-10). During the summer-autumn, up to five pulses of peak flow may occur and high rainfall events are usually observed once every 5-7 years.

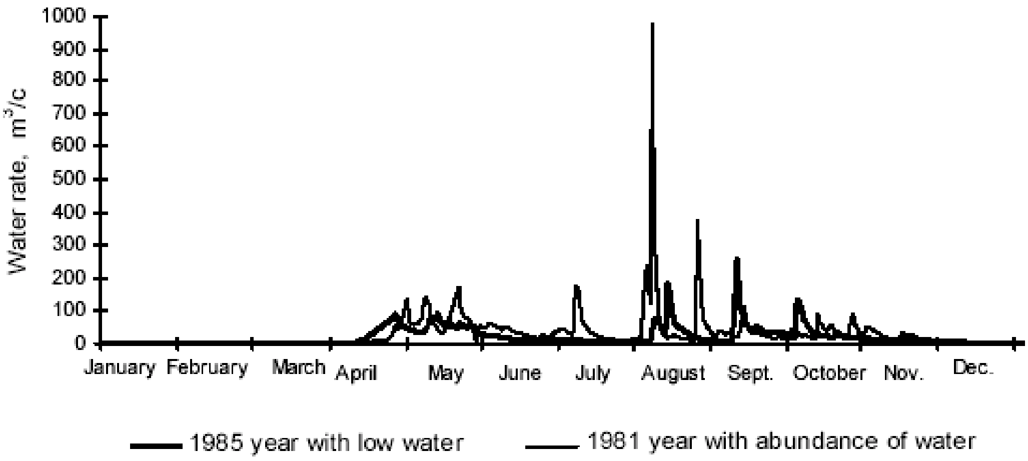

Figure 3-10: Drainage Hydrograph for High-Water and Low-Water Years, River Makarova - town of Makarov (Source: Sakhhydromet, 1998).

Freezing regime

The ice regime of the rivers in this area reflects the harsh winter, which is typified by lower snowfall than areas to the north. First ice formation normally occurs in early November, sometimes as early as late October. River freezing normally takes place during mid-late November and lasts for approximately 140-160 days, up to 185 days in harsh winters. Maximum ice thickness normally occurs during March and varies from 60 to 100 cm, reaching 120 to 185 cm in some years. Ice thickness of the rivers of the Makarovsky district does not normally exceed 0.2 to 0.5 m and in the case of Poronaisk district, 0.6 to 1.2 m. Ice starts disintegrating towards late March - early April (see Figure 3-11) and full break up by mid April, although in cold springs this can occur as late as early May.

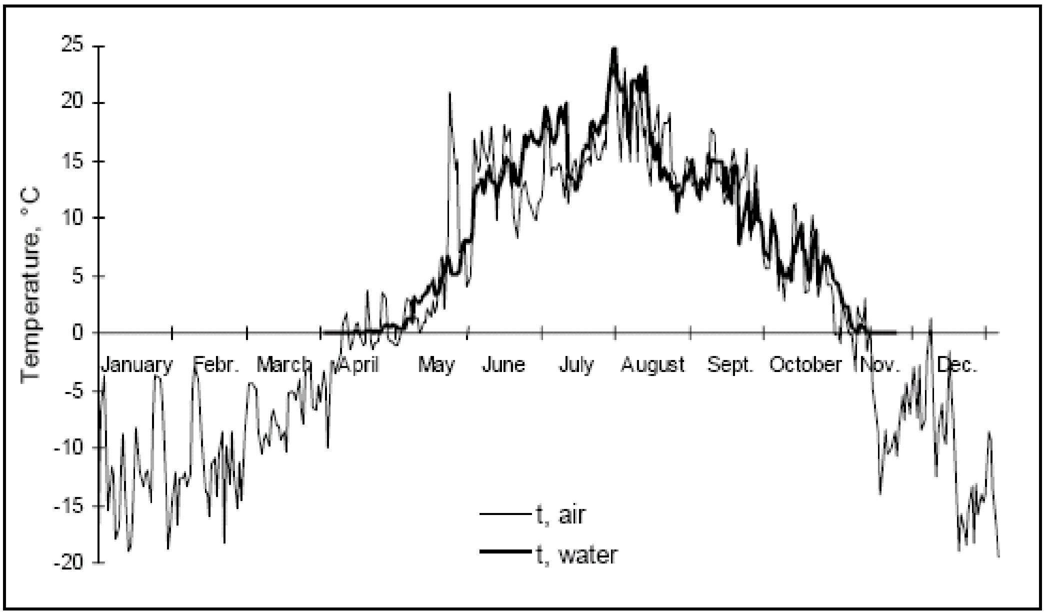

Figure 3-11: Average Diurnal Temperature of Air and Water - River Makarovka, Makarov town (1984)

Channel Form and Adjustment

The rivers in the area are predominantly mountain-streams with a few lowland rivers occurring in the north of the area. Maximum water depth during spring snowmelt and rainfall flood events can be from 2.0 to 6.5 m on the larger rivers and from 0.5 to 2.0 m on smaller rivers (Sakhhydromet, 1998). Channel processes within this area are diverse, and relate to topographical differences and the variety of geological-geomorphological processes present in the area. On the Poronay floodplain channels adjust laterally though meander development. In contrast, channel adjustment in mountain areas is through deep incision. Within the Makarov district, numerous small watercourses drain eastwards off the Kamyshovy ridge to the sea and are characterised by deep V-shaped valleys, high gradient, and the intensive development of rockslide/screes landslide processes on steep valley slopes (e.g. Rivers Kormovaya, Vidnaya and Krinka). Medium-size rivers are characterised by U-shaped valleys with a series of river terraces. Alluvial sediments in these valleys are typically 2-5 m thick. Outcrops of bedrock (alluvial sandstones) are frequently observed in channel beds and terraces (e.g. Rivers Makarova, Makarovka and Turovka) (Averina, 2004).

Hydraulics

Flow velocity in the rivers varies according to season and river type (e.g. gradient). During spring snowmelt and flows associated with periods of intense rainfall, flow velocity in the rivers flowing across lowland areas does not generally exceed 1.0 to 1.5 m/s. In mountainous areas flow velocities may reach 2.0 to 2.5 m/s. (Sakhhydromet, 1998). In winter, flow velocities are typical low and the depth reaches its minimum. Data for rivers that can be found in this area is shown in Table 3.7.

Table 3-7: Water depth and flow velocity in winter for selected rivers in Area 4

Watercourse	Average depth at low-water, $h_{l.w.}$ m	Average current velocity at low-water, $V_{l.w.}$ m/sec.
River Morskaya	0.5	0.3
River Lazovaya	0.3	0.56
River Biya	0.3	0.15
River Vostochnaya	0.2	0.2
River Uspenka	0.3	0.15
River Garta	0.2	0.2
River Travyanaya	1	0.15
River Tikhaya	0.4	0.24
River Duet	0.7	0.4
Dneprovskaya River	0.1	0.4
Kazarovka River	0.35	0.2
Zamyslovataya River	0.45	0.2
Kissa River	0.4	0.4
Khvoynaya River	0.7	0.3
Zubatka River	0.4	0.3
Mana River	0.5	0.3
Klinovka River	0.41	0.2

Sediment Regime

The Maximum Allowable Concentration for suspended solids concentration in this particular area is 200.75 mg/l, and for the River Pugachevka – 100.75 mg/l. (Sakhhydromet, 1998). Average content of suspended solids was 61.4-70.5 mg/l, in the river Pugachevka –27.4 mg/l. Maximum recoded values were: in the river Leonidovka and Pugachevka 164 mg/l and 168 mg/l (1.7 MAC), and in the rivers Nituy and Makarova – 1,160 mg/l (5.8 MAC) and 833 mg/l

(4.2 MAC) respectively. The minimum values of suspended solids concentrations ranged from 0.0 to 3.6 mg/l.

3.3.5 Area 5: Dolinsky, Anivsky, Korsakovsky and Yuzhno-Sakhalinsk districts

Area 5 covers the southern end of Sakhalin Island and corresponds to the South-Sakhalin group of rivers identified by Sakhalin State University (2000). Main watercourses include the Rivers Nayba and Takoy, which drain into Terpeniya Bay, and the River Susuya, which flows into Aniva Bay.

Topography and Landscape Character

The topography of the area is complex and comprises a series of ridges and associated spurs (e.g. the Susunaisky ridge in the east and the South Kamyshovy ridge in the west). In the south, the Susunaisky ridge adjoins the Korsakovsky plateau that undulates in height between 60 m to 80 m above sea level. The plateau slopes southwards and is broken-up by ravines and river valleys. The Susunaisky lowland lies between the Mitsulsky and Susunaisky ridges and extends from Aniva bay in the south to the estuary of the River Naiba in the north. Its width is 20 km to 40 km at the coast of the Aniva bay. Woodland covers from 15 to 100% of river catchments. The western part of the area features predominantly stone birch forests mixed broad-leaved and spruce-fir woodland and an under-storey of Kuril bamboo. The rest of the area is covered by typical mixed boreal forest in which spruce predominates (Sakhhydromet, 1998).

Geology and Soils

The South Kamyshovy ridge is composed of sediments of Tertiary age. The Susunaisky ridge is composed of Paleozoic metamorphosed rocks. The Korsakovsky plateau is formed of sandstones and conglomerates. The Susunaisky lowland is a tectonic depression covered with very thick marine alluvial deposits of quaternary age, compromising layered sands with interlayers of gravel-pebble soils, clay loams, clays and silts. Soils in the mountainous areas are of the brown mountainous-taiga unpodsolised type and weakly podsolised, primarily turfy soils. Meadow-turfy and meadow-gleyey waterlogged soils, as well as marshy-peaty and peaty-gleyey soils are widespread in the Susunaisky lowland (Sakhhydromet, 1998).

Climate

The southern climatic zone is the most favourable in comparison with the rest of the island. Winters are milder and summers are warmer than in other zones. The mildness of climate is the result of several factors: the latitudinal position of this part of the island, and the influence of the comparatively warm Sea of Japan and the warm Tsusima sea current (Sakhhydromet 1998). The average annual air temperature here is above zero. The coldest month is January with temperatures from -13.2 to -14.9°C. The warmest month is August when the average monthly air temperature is 17°C. (Sakhhydromet, 1998).

Precipitation

Average annual precipitation ranges from 861 mm in Yuzhno-Sakhalinsk to 1100 mm in Ogonki. Distribution throughout the year is more even than in other areas, although September/October remain the peak months, while the lowest level of precipitation generally occurs during March and April (Sakhhydromet, 1998).

Discharge and Flow regime

The rivers in the area are of the mountain and lowland mixed type and are predominantly supplied by snow melt water, which accounts for 50 to 60% of the annual drainage volume - groundwater accounts for 20 to 30% and rainwater, for 20 to 25%. The main stage of the water regime is the spring snowmelt that accounts for 47 to 63%of the annual drainage volume (see Figure 3-12). Snowmelt typically occurs in late-April/early April and can continue until as late as late-June. Flooding during the snowmelt period is rare, although flooding can occur as a result of intense run-off associated with high rainfall during the autumn.

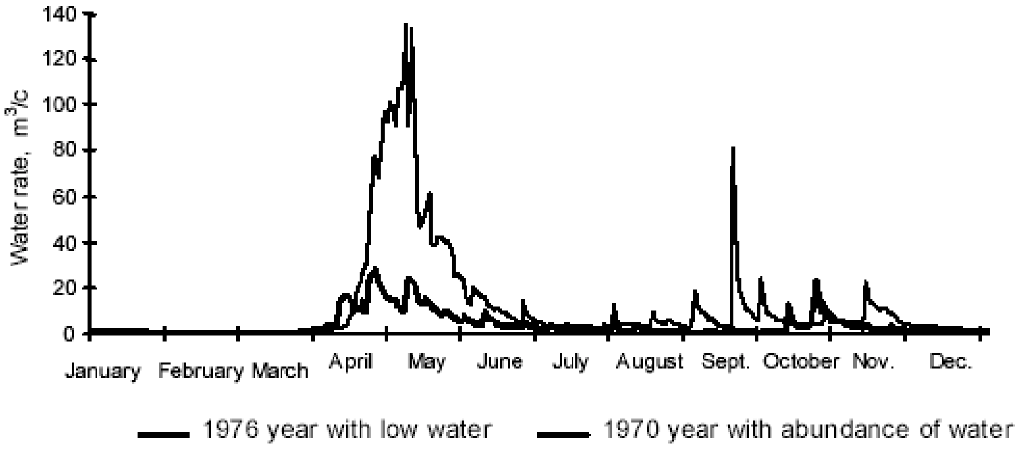

Figure 3-12: Drainage Hydrograph for High-Water and Low-Water Years, River Susuya - Yuzhno-Sakhalinsk (Source: Sakhhydromet, 1998)

Freezing regime

First ice formation normally appears during mid-November, with freezing up of the rivers normally occurring by early December, sometimes as late as the end of December. The average duration of the freezing period is from 105 to 150 days (145 to 163 days as a maximum). In warm years, the maximum ice thickness is from 19 to 58 cm, reaching 118 cm in some years during harsh winters as normally observed in March. Break-up of the rivers in this area occurs from early-late April and rivers are cleared of ice towards late April.

Channel Form and Adjustment

The rivers in the area are mountain-streams combined with lowland channels and reaches. The width of medium-size rivers is within 20 - 60 m and their maximum depth during snowmelt and rainfall floods can reach 2.0 to 5.5 m. The channel width of small rivers does not exceed 20 m and maximum depth is within 0.5 - 2.0 (Sakhhydromet, 1998). Most river valleys are narrow, incised and rivers exhibit limited meandering. The River Susuya, however, is freely meandering. The river system is less dense within this catchment, although the waterlogged lowland area is crossed by a dense network of soil-reclamation canals (Averina, 2004). Similar meandering processes, as observed on the Susuya River, are noted on the lower reaches of the Mereya River, the estuary of which is noticeably influenced by tidal processes (Averina, 2004).

Hydraulics

During snowmelt and floods, flow velocity in the rivers flowing across the lowland does not exceed 1.0 to 1.5 m/s. In mountainous areas the same rivers may exhibit flow velocities of 2.0 to 3.0 m/s (Sakhhydromet, 1998). In winter, flow velocities are typical low and the depth reaches its minimum. Data for rivers that can be found in this area is shown in Table 3.8.

Table 3-8: Water depth and flow velocity in winter for selected rivers in Area 5

Watercourse	Average depth at low-water, $h_{l.w.}$ m	Average current velocity at low-water, $V_{l.w.}$ m/sec.
Large Takoy	0.4	0.2
River Bereznjaki	0.2	0.2
River Susuya	1.1	0.19
River Magometka	0.14	0.25
River Vladimirovka	0.1	0.28
River Slavuta	0.1	0.25
River Mayakovskogo	0.1	0.27

Sediment Regime

The average concentration of suspended solids within Area 5 is 88.0-175 mg/l. This can be compared with a MAC of 100.75 mg/l (Sakhhydromet, 1998). The MAC is frequently exceeded in this area with peak values occurring during autumn rainfall floods.

3.4 TIDAL INTERACTION

Average tidal ranges on the east coast of Sakhalin Island are relatively small (less than one metre maximum tidal range). This small movement in tidal waters will affect the degree of tidal exchange and hence limit the forces available to mobilise and transport sediments (tidally). There is likely to be a degree of set-up of the tide within estuaries and tidal lagoons that will tend to increase the range but this will be relatively small where lagoonal basins are relatively wide and the tidal extent within river systems relatively short. Table 3-9 provides an indication of average tidal conditions. This average is based on data over a nineteen year period, based on standard measured ports, and will therefore allow for any changes in lunar cycle effects over time.

Table 3-9: Predicted mean tidal ranges for selected Sakhalin East Coast Locations (Source: Admiralty Tide Tables)

Standard Port Location	Latitude (N)	Longitude (E)	Max Mean Tidal Range ('Spring tide')	Min Mean Tidal Range ('Neap tide')	Mean Sea Level (compare to Std Port)
Hong Kong, 1979-97 (19 years data)			*Semi-diurnal Ranges*		*1.4*
Port Korsakov (Otamari Ko)	46 39	142 45	0.90	0.10	0.73
Starobdubakoye	47 25	142 49	0.70	0.20	0.65
Makarova	48 38	142 48	0.70	0.30	0.7
Poronaisk	49 14	143 08	0.80	0.30	0.71
Qinhuangdao1978-96 (19 years data)			*Diurnal Range*		*0.9*
Zaliv Nyyskiy	51 58	143 11	1.00		1
Zaliv Chayvo	52 23	143 12	0.90		0.85

One of the important aspects of these tidal ranges is their semi-diurnal/diurnal nature. This means that the predicted tides to the north display (on average) only one tide per day whereas those to the south (on average) two tides per day; with one larger tidal rise and fall (between 0.7 m and 0.9 m) and a small secondary rise and fall (between 0.1 m and 0.3 m) to the south. The lack of uniformity in the tidal waveforms means that associated sedimentary processes are also likely to be non-uniform over time and space. This means that whatever movement there is of sediment (erosion/entrainment, transportation, deposition/accretion) will also be variable.

The small tidal range means that sediment arriving within lagoonal systems (e.g. such as those of the north-east of the island) is likely to remain resident and may not be re-entrained from any deltaic deposits at the mouths of river systems (i.e. where they meet the tidal lagoons) or where coarse sediments are deposited at the tip of any saline wedges.

Coarser sediments will be available for re-working (under wave action) into the barrier beaches that front lagoons, this material probably being both fluvial and glacial in origin and delivered through melt water and rainfall events to the coast. Any sediment held in suspension within the near shore zone may provide a sediment pool at a background level that can contribute to fine sediment (cohesive) processes within lagoons and estuaries. It is likely that there will be longer incursions of fine sediment plumes into the sea where less dense freshwater jets above denser saline water. This will tend to form well-developed saline wedges as the tidal range is low and, with melt water, the fluvial discharge is potentially high. This process is, again, seasonal in nature and largely governed by the freshwater discharge from rivers.

Clearly within the estuarine and tidal lagoon systems there is potential for the movements of sediment relating to the freshwater/saltwater mixing processes, largely related to the location of the saline wedge within estuarine-freshwater transitions, although given the variability of the location of the wedge it is unlikely that any prolonged morphological bed changes will be apparent.

3.5 ECOLOGICAL CHARACTERISTICS OF WATERCOURSES

During baseline surveys, 221 watercourses have been surveyed. In the pre-construction phase an additional 239 rivers were surveyed. These surveys provide an insight in the ecological characteristics of the river systems of the island. This number includes all large rivers and a selection of medium and small rivers, ensuring a representative cross-section of river types and equitable distribution of sampled rivers along the pipeline route. Appropriate Russian authorities have approved the selection of rivers for survey, with most having been surveyed at the crossing location. The surveys are listed in Table 3.10.

Table 3-10: Overview of ecological baseline surveys

Survey/Reference	Description
SakhNIRO, 1998. Fisheries Characteristics of Sakhalin Surface Water Courses Along the Pipeline Route and Construction Sites	Collation of existing information on fish fauna and invertebrates found within the surface watercourses of Sakhalin. Report includes information on general hydrological characteristics of Sakhalin rivers. Data on flora, benthic fauna and fish fauna (including protected species) is provided on the basis of literature review and data collected by SakhNIRO and other agencies prior to 1998. Discussion of the aquatic ecology of the different river types is provided in the context of zonal schemes developed for the Russian Far East. Ecology and biology of commercial fish species is described on the basis of data from the relevant fisheries agencies.
SakhNIRO, 1998. Report about the results of field works on studying the background characteristics of water courses, crossed by the pipeline route	Execution of field surveys on fish fauna and invertebrates found within the surface watercourses of Sakhalin. A total of 56 rivers were surveyed. Data is presented on the composition of the benthic invertebrate communities and distribution of these communities along the Island. Similar information is presented on the fish fauna sampled during the survey work. Particular emphasis was given to the presence and distribution of fish (juveniles) of commercially important species and data presented on the quality of spawning grounds (also incorporating historical data) for selected rivers. .
Sakhalin State University, 2000. Report about hydrological, hydrobiological and Ichthyofauna surveys studies of Sakhalin surface watercourses of Sakhalin Island along the trunk pipeline route and construction sites	Collection and analysis of ecological field survey information on watercourses crossed by the pipeline route and description of species composition and biological characteristics of fish and invertebrates found within the surface watercourses of Sakhalin. A total of 50 new and 10 previously surveyed watercourses were surveyed. The survey work provides additional data on aquatic flora, including microalgae, of the watercourses.
SakhNIRO, 2000. Ichthyofauna Studies in Surface Watercourses of Sakhalin Island Along Pipeline Route Including Appendices	Fish fauna survey for 50 additional watercourses that were not included in the 1998 and 1999 survey and 11 previously surveyed watercourses. This work concentrated on obtaining data on the fish fauna, with particular reference to commercially important species, during the salmon spawning season and at the end of the spawning season. Survey work was undertaken at the proposed crossing points for the pipeline and data was collected on benthos, periphyton, zooplankton and phytoplankton in addition to the fish fauna.
SakhNIRO, 2002. Investigation Of Ichthyofauna And Benthos In Surface Watercourses Of Eastern Sakhalin On The Route Of Mainland Pipeline And The Booster Station Construction Site	Collecting and analysing field survey information on the commercial and non-commercial fish in watercourses on Sakhalin island, along the proposed pipeline route beginning at the OPF site going south to Tymovskoe (Big South Nysh Bypass; BSNB) and at the Booster Station #2 site near Gastello (approximately halfway between the OPF and the LNG/OET). Data on aquatic invertebrates was obtained and physical description of the watercourses provided. In total 11 rivers along BSNB and 2 rivers near BS2 were sampled.

Averina, 2003, River Crossing Field Survey Report	Survey to determine the presence or absence of spawning areas within the crossing area and at a distance 50 m upstream and 100 m downstream of the ROW at 179 water crossings by the pipeline routes and in the vicinity of locations of 6 temporary construction camps. A total of 185 watercourses were surveyed. In addition, Averina added information about the presence of other fish species, based on information available from the Sakhrybvod database and previous surveys.
Averina, 2004, Combined report on the results of fishery survey in reference watercourses. Pre-construction monitoring of watercourse crossings by Sakhalin II project Phase II Pipeline Routes.	Survey of 92 reference watercourses, studying composition and abundance of macrozoobenthos and seasonal dynamics of benthos population, assessment of spawning grounds and sites potentially suitable for spawning of anadromous Pacific salmons, and studying composition and major biological characteristics of fish populations, including distribution specifics within the survey strip.
Averina, 2004, Survey and development of fishery characteristics for watercourses crossed by Sakhalin II project pipeline.	Surveys of 239 rivers of the first and highest fish category that were not surveyed before, to assess if spawning areas were present at the pipeline crossing location.

3.5.1 Flora

The available limited information suggests that the aquatic flora of Sakhalin is relatively impoverished compared with mainland Russia and comprises approximately 50 species, comprising pondweeds (20 species), duckweeds (3 species), frogbits (wild celery), species belong to the families Callitrichaceae, Nymphaeaceae and water milfoils as well as a few species of other families (e.g. water smartweed (*Poligonum amphibium*), watercress and water buttercups).

Many normally common aquatic plants, for example several species and genera of water lilies, water chestnut etc. are absent and others are rare such as water buttercups (*Ranunculus* spp.) and water smartweed. White water lilies are presented only by two species, *Nymphaea tetragona* and *Nuphar pumilum*. Pondweeds are relatively diverse, but are seldom common in comparison with continental water basins. Vascular water plants are generally absent in most of the mountain and foothill rivers and aquatic plant assemblages of any note only tend to occur in the lowland sections of the larger rivers (e.g. the Tym and Poronai) and ponds formed from cut-off meander loops and abandoned channels. The generally low diversity of the aquatic flora of Sakhalin watercourses probably results from a number of factors, but notably high water acidity and the lack of dissolved ions of potassium and especially calcium.

3.5.2 Invertebrate fauna

As with the flora, the fauna of Sakhalin's watercourses is generally poorly studied, although the basic characteristics of the fauna are known, as are the assemblages typical of the main hydrological conditions.

Small woodland brooks and springs, with variable bottom substrates (rocks: pebbles, gravel, sand and detritus and silt in low flow areas) generally support a mixed assemblage of crustaceans (amphipods such as *Gammarus lacustris* and isopods such as *Asellus hilgendorfi*), small bivalves of the genus *Euglesa*, oligochaete worms and some species of stoneflies, caddisflies and mayflies Biomass is usually low and is on average 3-4g/m^2; and only in-stream sections occupied by the Gammarus-Euglesa community does biomass sharply increase (e.g. *Gammarus* sp. - to 9,000 ind./m^2; 190 g/m^2; Euglesa sp. - to 3,000-4,000 ind./m^2; 37-45 g/m^2).

The majority of small-medium sized rivers on Sakhalin, typical of those crossed by the pipeline route, are characterised by relatively high flow rates and well-oxygenated waters with rocky, pebbly and/or sandy substrates. Only in areas of slack current does detritus and silt form the channel substrate. In-channel vegetation is generally uncommon apart from various species of unicellular and filamentous encrusting algae (e.g. diatoms). The macroinvertebrate assemblage of these rivers is relatively diverse and comprises various species of crustaceans (amphipods and isopods), small bivalves, oligochaetes and fly (diptera) larvae. The Sakhalin freshwater pearl clam *Dahurinaia laevis* is a quite specific representative of rivers on the lower hill slopes, the Tym-Poronai basin forming its main area of distribution. The biomass of these invertebrate communities is not very large and usually varies from 1 to 10 g/m^2. However, in areas where the Sakhalin pearl clam occurs, the biomass may rise considerably and reach levels of 15 - 20 kg/m^2 (SakhNIRO 2000) In cut-off channels where standing water is present, aquatic vegetation is more plentiful and the invertebrate fauna is correspondingly diverse and more abundant. Snails (gastropods), chironomid midge larvae and bivalves (e.g. *Euglesa*) often form the basis of the assemblage in these areas, but water mites, isopods, mayflies and the larvae of dragonflies and water beetles are often common in small numbers.

In addition to the general characteristics of the invertebrate fauna described above, the species assemblages can be grouped into several zoogeographic provinces and within these broader groupings by specific hydrological and physio-chemical parameters (SakhNIRO 2000). From an aquatic ecological perspective the island can be split into two provinces: the Orelian (the Amurian subregion of the Sino-Indian region) and Aniwan (the Japanese subregion of the Sino-Indian region). The boundary between these provinces on the island is located approximately along the watershed of Tykhmenovka River (Poronai River Basin) – Gastellovka River (Terpeniya Gulf Basin).

Orelian (Palaeamurian) province embraces the northern part of Sakhalin, which formed part of the Amur River Basin during the early Holocene (6,000-10,000 years ago). The species found here are boreal/Palaearctic species associated with the Amur River and generally cooler/colder climatic conditions. In mountain and foothill streams, these species typically include the pearl clam *Dahurinaia laevis*, the crustacean (gammarid), *Gammarus lacustris*, mayflies of the genus *Ephemerella* (*E. kozhovi*, *E. mucronata*), *Baetis* (*Baetis vernus*, *Baetis acinaciger*) and *Heptagenia* (*Heptagenia flava*, *Heptagenia fuscogrisea*), stoneflies (*Pictetiella asiatica*, *Pictetiella zwicki*) and the chironomids *Cricotopus trifasciata* and *Smittia sedula*.

Aniwan Province covers the southern part of Sakhalin, which had connections with northern Japan in the past and the assemblage includes more heat-loving southern boreal species. In the mountain and foothill watercourses in this area, the main indicators of this species complex are: the bivalve *Dahurinaia kurilensis*, the amphipods *Gammarus koreanus* and *Sternomoera* sp, mayflies (*Baetis fenesratus* and *Baetis gnom*, *Cloeon bifidum* and *Epeorus pellucidus*) the chironomid midge *Cardiocladius capucinus* and the stonefly *Paraleuctra cercia*, among others.

3.5.3 Ichthyofauna

The freshwater fish fauna of Sakhalin is generally less well studied than that of mainland Russia. Recent survey work and analysis of available literature suggests that the fauna of fresh and brackish waters comprises 79 species, belonging to 12 classes, 28 families and 50 genera. The most numerous representatives belong to the families Cyprinidae (20 species and forms - 23.0%), Salmonidae – (11 species - 12.6%), Gobiidae – (9 species,10.3%), Osmeridae – (7 species, 8.0%), Gasterosteidae, Cottidae, Pleuronectidae – (4 species each, 4.6%). The rest of the families are represented by 1-3 species each (1.2 - 3.5%).

Survey data indicates that for almost all districts of the Island the following genera of anadromous species are present and spawn in suitable habitats: *Lethenteron*, *Oncorhynchus*, *Parahucho*, *Salvelinus*, *Osmerus* and *Tribolodon*, while other semi-anadromous species inhabit but do not spawn in the river systems - *Lethenteron japonica*, *Oncorhynchus masu* and *Salvelinus malma* (SakhNIRO 1998, 2000).

The ichthyofauna has been split into six faunal complexes, which reflect habitat types, hydrologic conditions and biogeographic influences (SakhNIRO 1998):

- Arctic freshwater - malma, Sakhalin char, Ussuri whitefish, arctic smelt, hake;
- Ancient upper Tertiary – Asiatic brook and arctic lampreys, kaluga sturgeon, Soldatov's toothed gudgeon, Amur bitterling, carp, asp, loach, Amur catfish;
- Boreal foothill - lenok, grayling, Sakhalin taimen, common minnow, Lagovsky's minnow, Siberian stone loach and others;
- Boreal plain – Amur sturgeon, Amur ide, goldfish, lake minnow, Amur pike, spiny loach;
- Chinese plain – spotted barbel, skygazer, white amur, silver carp, zheltoshek, Chinese perch; and
- Indian plain – banded catfish, sleeper-rotan.

The freshwater ichthyofauna of Sakhalin can also be divided into six zoogeographical regions: northwest, extreme north, east, Tym and Poronai Rivers Basin, west and south and southeast of the Island. Species diversity is generally poor with 1-3 freshwater species being typical for the greater part of the Island, particularly in western, southern and eastern areas with the exception of the basin of the biggest rivers - Tym and Poronai. Generally it can also be stated that the shorter the river the less diverse the species assemblage. The pipeline route does not impinge upon the northwest or western regions and therefore description of these assemblages is excluded from the summaries of these areas provided below.

Freshwaters of northern extremity of the Island (from the coastal line delimited by the Val River to Baikal Bay, embracing the whole of the Schmidt Peninsula). Anadromous species are: pink salmon, southern malma, Sakhalin char, rainbow smelt, and three-spine stickleback as well as the semi-anadromous brook malma (or dolly varden). These species belong to the arctic freshwater complex (southern malma, rainbow smelt and others) and the boreal foothill complex (salmon of the genus *Oncorhynchus*).

Freshwaters of eastern Sakhalin (including water bodies from Terpeniya Cape to Nabil Bay). Typical anadromous species include: arctic lamprey, salmon (pink, chum, masu, sockeye and coho), southern malma, Sakhalin char, Sakhalin taimen, arctic smelt, redfins (T. brandti, T. hakonensis) and three spine stickleback. Semi-anadromous species include brook malma and arctic brook lamprey. Survey work indicates that species such as the brook malma are ubiquitous in mountain-streams, often occurring in relatively small watercourses (SakhGu 2000). Typical freshwater species are Siberian stone loach and sculpin (*Cottus* sp.). This fish assemblage forms part of the arctic freshwater complex (southern malma, rainbow smelt and others) and the boreal foothill complex (salmon of the genus *Oncorchynchus*, Siberian stone loach and others).

The basins of rivers Poronai and Tym (including the coastal area northwards to the Val River). Anadromous species include: arctic lamprey, salmon (pink, chum, masu and coho), southern malma, Sakhalin char, Sakhalin taimen, Ussuri whitefish, rainbow smelt, redfins (3 species) and three-spine stickleback. Semi-anadromous species include brook malma and arctic brook lamprey. Typical freshwater species include: Amur pike, golden carp, Amur ide, Lagovsky's minnow, Amur bitterling, spiny loach, Amur loach, Siberian stone loach, burbot. Sculpins, and Sakhalin stickleback. The ichthyofauna of these rivers is representative of the arctic freshwater complex (southern malma, arctic smelt, burbot and others), the boreal foothill complex (representatives of genus *Oncorchynchus*, Siberian stone loach and others), the boreal plain complex (Amur pike and ide, Sakhalin lake minnow and others) and the ancient upper tertiary complex (Amur loach and bitterling). In contrast to the fresh waters of the south-east and south, east and west of the Island, burbot is a typical component of the arctic freshwater complex.

Freshwaters of south-eastern and southern Sakhalin (from Cape Krilyon, including the coast of Aniva Bay, to Gastellovka River (Terpeniya Gulf) - Typically anadromous species include: lamprey, salmon (pink, chum, masu, coho), southern malma, Sakhalin char, Sakhalin taimen, arctic smelt, redfins (3 species), three-spine stickleback. The Sakhalin sturgeon has been observed in coastal waters. Semi-anadromous species include brook malma, arctic brook lamprey and Asiatic brook lamprey. Species, inhabiting exclusively fresh waters include: Siberian stone loach, Sakhalin stickleback (endemic of fresh waters of the majority Sakhalin regions), and several species of gobies (*Chaenogobius urotaenia, C. castaneus, Rhodonuchthyslaevis, Rhinogobius brumleus* and *Tridentiger brevispinis*). The ichthyofauna is mainly representative of the arctic freshwater and boreal foothill complexes, which are typical of flowing waters.

3.6 RED DATA BOOK SPECIES

The majority of organisms inhabiting watercourses that will be crossed by the pipeline route are widespread within the Russian Far East and often common where they occur. However, there a number of freshwater species that are notable for their rarity or limited distribution (e.g. species or subspecies endemic to Sakhalin Island). The majority of these species are listed and described in the Russian Red Book. The Red Book is a Russian Federation document that contains details of all species of conservation importance and protected status within the region. A separate Red Book has also been developed for Sakhalin and contains all of those species listed in the Russian Red Book and which occur or may occur on Sakhalin.

Two fish species listed in the Red Book may either potentially be present in watercourses along the pipeline route or, on the basis of available data, are known to occur in some watercourses. These are Lagowsky's Manchurian minnow (*Phoxinus lagowskii oxycephalus*) and the Sakhalin taimen (*Parahucho perryi*).

3.6.1 Lagowsky's Manchurian minnow

The ecology of the *oxycephalus* subspecies of the Manchurian minnow has not been well studied. On Sakhalin, it inhabits the headwaters of streams and rivers in the central part of the Island (e.g. rivers found in the Palevsky Hills, headstreams of the Tym and the Poronai rivers) in cut-off channels with low current velocities. This species was recorded from a small tributary of the Berezovaya River (3 individuals) and from an oxbow lake on the Pilenga River (1 individual) during survey work by SakhNIRO (SakhNIRO 2000). It appears that where it occurs it forms small shoals, which remain close to the channel bottom amongst any vegetation or debris. Spawning apparently occurs in June when eggs are laid on vegetation or small pebbles. All known locations for this species and its main habitat are located upstream of the pipeline corridor.

3.6.2 Sakhalin Taimen

The Sakhalin taimen is a widespread migratory species of salmon that occurs in Sakhalin, the Amur Basin and northern Hokkaido. On Sakhalin it appears to be generally distributed in rivers of the central and northern part of the island and occurs rarely in the smaller-medium rivers of the south (SakhNIRO 2000).

Its main habitat is the lower and estuarial areas of large rivers, brackish-water lagoons, estuarial cut-offs, and bays, although spawning takes place in upstream sections of rivers. Taimen spend winter in the estuarial sections of rivers and normally begin to winter in mid-October through to November depending upon the weather. After wintering, mature individuals spend a short time offshore before they begin moving up-river. Spawning coincides with spring floods, at the end of April or beginning of May. Spawning areas are located in areas of cobble-large gravel substrate in the well-defined channel sections of rivers (in middle and lower courses of small rivers, and in upper courses of large rivers, typically 3-4 m wide) in water depths greater than 1m and with current velocities of 0.3-0.5 m/s (SakhNIRO 1998, 2000). After spawning (May-June), individuals migrate back to estuaries and coastal areas.

Eggs hatch during early summer and young fish normally stay in the river systems for 2-5 years. The characteristics of wintering habitat in river systems for juveniles are poorly known, but it is likely that similar conditions to those sought out by silver salmon (i.e. areas of cover in slower moving water, such as cut-off channels) are utilised. Young fish mainly feed on benthic invertebrates and insect larvae until body length reaches approximately 20 cm, when they then begin to prey on other fish. Maturation takes 8-10 years and a fully mature fish can measure up to 2m in length. The annual spawning life cycle of this species is shown in **Figure 3-13**.

At several locations on Sakhalin, Sakhalin taimen are being artificially reared, although on a limited basis. Because of their protected status, fishing for Sakhalin taimen is not permitted.

The presence of Sakhalin taimen in the watercourses to be crossed by the pipeline has been determined from a number of sources, notably available data from previous fish surveys undertaken by fisheries agencies and records obtained during specific ecological surveys for the Sakhalin II Project (see Table 3-11). This data backs up the general information on the distribution of this species on Sakhalin. Of those rivers the pipeline crosses and in which taimen is known to be present, 51% occur in Section 1 of the pipeline route (most northerly, see Fig 2-1), 25% in Section 2, 13% in Section 3 and 11% in

Section 4. Additionally, given the protected status of this species, analysis has been undertaken to determine the potential for watercourses either to support taimen or provide spawning habitat for this species. This work has been reviewed and examined by an independent fish ecologist (Dr. Skopet, formerly with the Wild Salmon Centre) in order to verify both the approach taken and the criteria used in determining the potential presence of suitable habitat for taimen. This data will be used in determining the level of ecological sensitivity of a river crossed by the pipeline route and the appropriate mitigation measures required to ameliorate potential impact to fisheries interests, including the potential presence of Sakhalin taimen (see Section 5.1 for further detail).

Table 3-11: Watercourses crossed by the pipeline route that are known to or may potentially support Sakhalin taimen. Rivers that may support this species are shown in italics.

River	KM ROW	Width (m)	Depth (m)	River	KM ROW	Width (m)	Depth (m)
Nutovo River	20.702	6	1.1	*Voskresenka River*	84.241	8	1.0
Handuza River	38.238	0.7	0.3	Tym River	91.637	52	1.5
Askasai River	54.009	13	1.5	Malaya Tym River	95.066	14.5	1.0
Koisikil Urun	54.205	2.0	0.5	Taulanka River	143.348	12.5	0.3
Tapauna River	72.648	10	1.2	Daldaganka River	147.853	4.5	0.9
Dagi River	77.579	24	1.2	Yuzhnaya Khandasa	189.845	9	0.8
Tomy River	82.715	8.0	1.1	*Pobedinka River*	211.994	8	0.3
Bauri River	92.657	4.0	1.0	Shumni Stream	215.997	3	0.3
Mali Veni River	98.788	14	1.4	Orlovka River	221.361	18	0.9
Djimdan River	110.751	40	1.4	Buyuklinka	246,467	12	0.3
Chachma River	119.854	22	3.3	Leonidovka River	274.88	17	0.4
Tym River	123.001	175	3.3	*Gastellovka River*	297.236	18	0.5
Nabil River	163.832	37	1.5	Nitui River	324.02	15	0.1
Orkun'i River	166.832	12	0.4	*Gornaya River*	341.202	5.5	0.5
Spokoini Stream	167.964	10	0.9	Lazovaya River	380.5	0.9	0.3
Spokoini Stream	3.169	1.4	0.6	Lazovaya River	387.817	4.0	0.5
Orkun'i River	7.229	10	2.0	Travyanaya River	419.199	4.0	0.5
Palanga River	13.648	20	0.5	Travyanaya River	429.627	0.6	0.1

River	KM ROW	Width (m)	Depth (m)	River	KM ROW	Width (m)	Depth (m)
Plelyarna	14.846	31	0.5	Manui River	453.91	24.5	3.3
Tikhi Stream	31.535	10	0.8	Firsovka River	486.074	24.2	0.5
Nabil' River	41.905	23	1.5	Ai River	505.525	14.8	0.9
Vos'i River	53.661	10	0.7	Naiba River	523.649	53.5	2.3
Pilenga River	65.121	17	1.5	*Maly Takoi River*	536.279	10.0	1.1
Uskovo River	78.739	12	0.5	Bolshoi Takoi River	548.501	9.0	0.2

3.6.3 Other protected species

Fish

Two further protected fish species have been recorded from Sakhalin and, potentially, may still be present in suitable habitat on the island. These are described below.

Acipenser medirostris (green or Sakhalin sturgeon)
This species of sturgeon is very rare and is listed in the Red Book of the Russian Federation and Sakhalin. It is distributed in the northern part of the Pacific Ocean, from the western seaboard of North America (San Francisco to Columbia River), where it is known as the green sturgeon, to the Asian seaboard (Bering Sea to Korea (Vonsan) and Hokkaido) coasts. There is recent genetic work to suggest that the Asian form of the green sturgeon (i.e. the Sakhalin sturgeon) is a separate species to the American form. In Russia it is known to occur from the border with Korea to the Amur estuary and in some rivers of Primorye, notably the Datta (Tumnin) River and the Amur River. On Sakhalin, this species was known from the lower reaches of the Tym River, although there is no recent evidence to suggest that it is a breeding species (SakhNIRO 1999, Lindberg and Legeza 1965).

A. medirostris has a life cycle typical of anadromous fish. Juveniles inhabit the brackish waters of estuaries and coastal areas, while adults inhabit the sea and enter rivers for spawning. The ecology and biology of the Sakhalin sturgeon is relatively poorly studied, but is known that it reaches a length of approximately 2 m and more than 60 kg in weight. Fish generally reach sexual maturity at 10-12 years, when they enter rivers for spawning. Once in the rivers, fish migrate upstream in stages, following ice-breakup and then again in late autumn, and then overwinter in order to spawn the next year in June-July. After spawning fish return to coastal and estuarine waters to continue feeding. Young fish (up to five years old) tend to feed in the lower reaches of rivers where they feed on benthic invertebrates.

Stock levels are known to be extremely low and probably decreasing. Fishing for this species has been banned since 1958. On Sakhalin an artificial breeding programme for this species was initiated at the Okhotsk hatchery (Tunaytsha Lake basin). Although the present status of this species on Sakhalin is unknown, it is considered that the river crossing construction works would not pose a threat to this species. The Tym will be crossed in its lowermost reach using HDD and therefore potential disturbance to wintering habitat that could be used by this species would be highly unlikely to occur. The crossing area is located downstream of likely potential spawning areas.

Husco dauricus (Kaluga sturgeon)
This species of sturgeon is included in the Red Book of the Russian Federation and is included in the Red Book of Sakhalin. *Husco dauricus* is one of the largest freshwater fish species reaching a length of 5 m and a mass of 1000 kg. It is known to inhabit the Amur River Basin from the mouth of the estuary up into the rivers Shilka, Argun and Onon. Young fish have been caught from the northwestern part of the Okhotsk Sea, not far from the mouths of Tauy, Okhota, Inya and other rivers along the coast of northern and northeastern Sakhalin and in the Tatar Strait. Occasional specimens have also been recorded from the mouth of the Tym River and at Niysky Bay. Reproductively mature fish spawn during May-July in the upper tributaries of the Amur River in areas of pebbly and sandy riverbed substrate and then return to estuarine and coastal waters for feeding. There is no evidence to suggest that this species is spawning in any of the rivers of northern or eastern Sakhalin. *H.dauricus* is a fast growing species and mainly feeds on pink salmon, herring, saffron cod and other fish species. Due to overfishing, stocks reached very low levels at the beginning of the 20th century, but since a ban on sturgeon fishing in the Amur River in 1958, stocks have gradually recovered and a small, regulated fishery is now in operation. Given the apparent absence of kaluga in Sakhalin rivers it is considered that the river crossing works would not have an impact upon this species.

Otter – Lutra lutra
The common otter is listed in the IUCN red list, but is not contained in the Sakhalin Red Book as, in comparison to the mainland, Sakhalin Island supports a good population of this species. Otters occur in riverine habitat along the whole pipeline length, but the extent to which certain river areas are suitable for this species may change from season to season. Survey work undertaken along the pipeline route identified three optimal areas of permanent habitat: from the Severnay Khandasa river to Taulan river, from Vazi river to Nabil river, and the rivers located to the north of the Evai river. Under favourable conditions, it is estimated that an individual will hold territory along 1-3 km of a river. The total number of individuals present along the pipeline corridor has been estimated at 31 to 38. The main threat to otters is induced access into areas and the potential for increased hunting pressure and disturbance.

Invertebrate species

Freshwater mussels

Two species of the genus Dahurinaia, belonging to the Margaritiferidae, a small family of freshwater mussels that has a nearly worldwide but discontinuous distribution, are listed in the Sakhalin Red Data Book. These mussels, commonly known as freshwater pearl mussels, are typically oval in shape with moderate to poorly developed hinge teeth. *D. laevis*, has a distribution covering the central and northern part of the Island and is known from the headwaters of the rivers Tym and Langri and was recorded during specific survey work from the Nysh area of the Tym River. *Dahurinaia kurilensis*, has more of a southern distribution and is known to occur in the Naiba River and was recorded during survey work from the crossing point over the Churochka River.

Two other Red Data Book freshwater mussels, *Beringiana taranetzi* and *Anemina (Buldowskia) adotymensis*, are associated with floodplain cut-off channels and lakes of the Tym River. Neither species has been recorded during survey work undertaken for the project.

Pteronarcys sachalina

This stonefly is endemic to the south of the Russian Far East. The aquatic nymphs inhabit mountain and foothill streams in well-oxygenated flowing water and typically occur in areas of vegetation accumulation. The nymphs spend 2-4 years in the stream/river, while the adult stage is relatively short-lived at a few weeks.

SakhNIRO (1999) recorded this species from a diverse benthic community dominated by the caddis fly *Stenopsyche marmorata* from the Tym River near the settlement of Zonalnoye and the rivers Pilenga, Nabil and Krasnoselskaya. At the sampling sites all of these rivers were characterised by relatively strong flows and a rocky-pebbly substrate with very limited or no vegetation. *P.sachalina* was frequently encountered and contributed an average of 27.7% of the biomass in the community, although this high figure probably reflects the large size of the nymphs rather than its overall abundance (3 /m^2). On the basis of survey data SakhNIRO consider *P.sachalina* to be a representative species of this community, which is typical of fast flowing mountain and mountain-slope rivers. Given the location of the majority of the pipeline river crossings downstream of such habitat and the apparent relative abundance of this species it is considered that the construction works would not pose a threat to the continued existence of this species in the watercourses crossed by the pipeline.

3.7 ECOLOGY AND LIFE CYCLES OF SALMONID FISH

The salmon fishery on Sakhalin is of great importance to the local economy and for the livelihoods of many people, including indigenous people in the north of the island. The two most common species involved in the commercial fishery are:

- Chum salmon or dog salmon, (*Oncorhynchus keta*); and
- Pink or humpback salmon, (*O. gorbusha*).

Together these two species constitute approximately 95% of the total commercial catch on Sakhalin Island, with cherry salmon (*Oncorhynchus masou*) and silver (coho) salmon (*Oncorhynchus kisutch*) making up the rest. Given the commercial importance of salmonids, significant research, surveying and monitoring has been undertaken over the last 50+ years by Soviet and Russian fisheries agencies and research institutions in order to assess the status of stocks, the distribution and quality of spawning areas and the general biology of these species. On Sakhalin, this effort has focused on pink and chum salmon because of their overwhelming importance as a natural resource to the economy.

As part of the development of baseline data for the Sakhalin II Project, much of the available literature from these studies was compiled (e.g. SakhNIRO 1998, 2000), along with river specific surveys undertaken by SEIC, to inform the river classification process and the development of the crossing strategy. The following sections provide a brief synopsis of the life cycles of the main salmon species, as derived from the available data, and information on variations in phases of the cycles where these occur on the island.

3.7.1 Pink Salmon

This is a typical anadromous fish (those that spend most of their lives in the ocean but migrate to fresh water to spawn) with a two-year life cycle, shorter than other salmon species. As a result pink salmon is the smallest of the Pacific salmon, averaging 1.3-1.4 kg at maturity and seldom growing larger than 3-4kg.

Adult pink salmon leave marine waters in the late summer and early autumn (see **Figure 3-13**), their migration normally coinciding with the summer mean water flow period and ending near the autumn flow increase (see Section 3.2 for details of river hydrology). The timing of the spawning migration varies slightly across the island, with the run starting earlier in the east and south and lasting longer in the south (see Table 3-12).

Table 3-12: Timing of spawning migration of pink salmon *(from SakhNIRO 1998)*

Area	Beginning of run	Main run	End of run
North-east	25.06-5.07	30.07-10.08	5.09-10.09
East	7.06-26.06	25.07-15.08	1-10.09
South-east	20.06-30.06	25.08-31.08	5.09-15.09

Once they begin to spawn, male pink salmon develop a prominent hump in front of the dorsal fin. For this reason, pink salmon are commonly called humpback salmon. Males also develop a characteristic elongated snout and large teeth. They usually spawn in-streams that are not fed by lakes and typically their spawning grounds are only a short distance from the ocean. Spawning sites are characterised by clear water with gravel/pebble substrate and minimal sand content. Water depth at pink salmon spawning grounds varies from 0.2 to 1.6 m and current velocity 0.2-1.1 m/s (SakhNIRO 1999). Pink salmon redds (depressions in the gravel where eggs are laid) require a continuous water flow (up-welling or hyporheic flow) through the gravels for successful hatching to occur. Approximately 45 to 90 days after spawning, the eggs hatch and the young fish (alevins) remain buried in the substrate, surviving on their yolk sac. From early-mid April young fish (fry) start to leave the gravel bed and move into the water column and begin migration to the sea. The migration of pink salmon fry varies across the island with migration occurring earlier in the south (late April to mid-June) than in the north (mid-May to the end of June). Seaward migrating pink salmon fry have an average weight of 230-250 mg and length of 30-35 mm and feed in the ocean for over a year before returning to their natal streams.

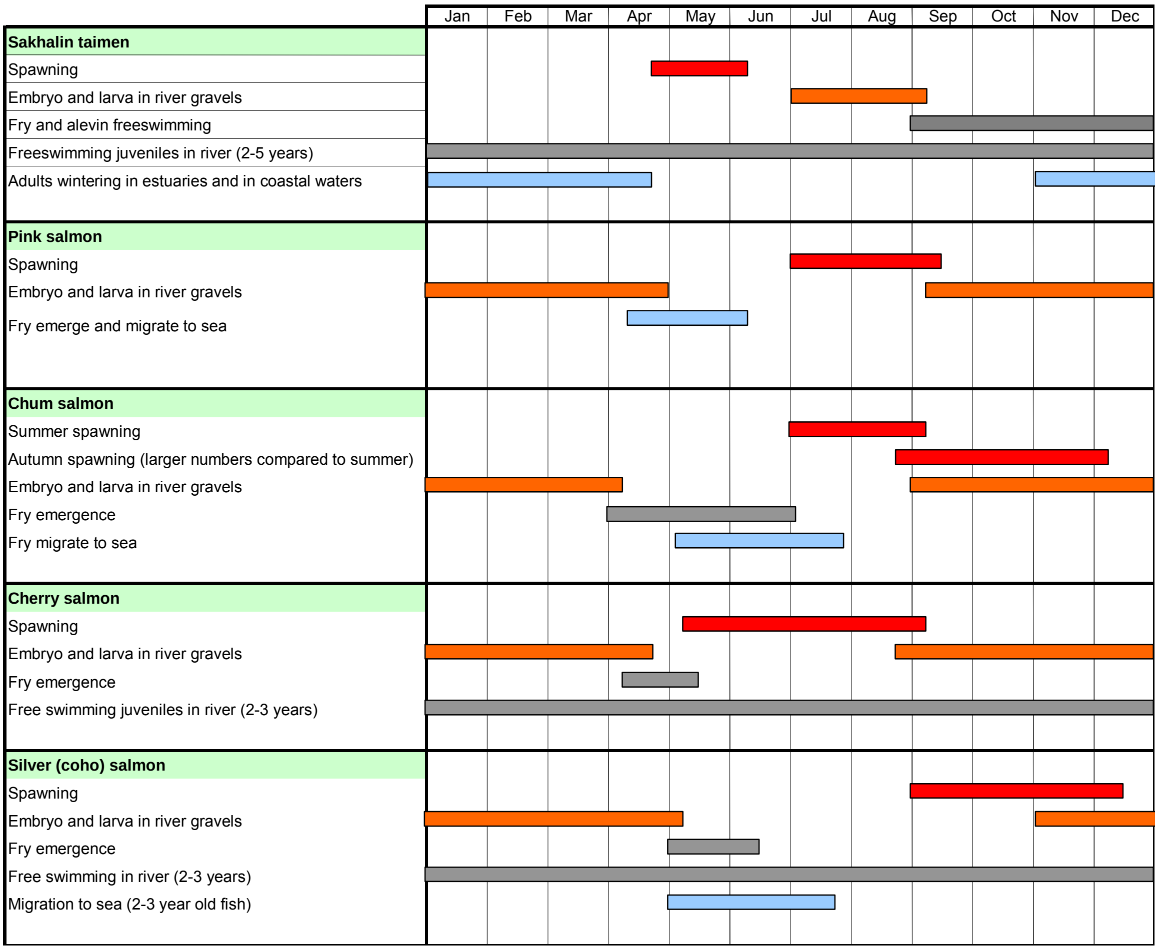

Figure 3-13 Salmonid fish spawning periods

The pink salmon stock in the Sakhalin-Kuril Islands region is relatively high in comparison with many other areas in the north Pacific. In the 1990s the average annual catch of pink salmon was 72,500 tonnes, up from 13,000 tonnes in the 1950's when intensive drift fishing at sea led to large declines in Pacific salmon populations. The current high stock levels are largely due to the intensive cultivation of fish in hatcheries, which has occurred since the 1970s, the natural recovery of stocks and potentially the influence of climate change. On Sakhalin, the 1980s saw considerable changes in the artificial cultivation of pink salmon with the optimisation of the growing and timing of release of fry. The renovation of hatcheries has also helped to ensure that stocks and catches of pink salmon have been at very high levels during the 1990s (see Table 3-13).

Table 3-13: Catch of pink salmon in Sakhalin 1989-1999. From SakhNIRO (2000)

Year	South-west	Aniva Bay	South-east	Terpeniya Bay	North-east
1980	2.44	2.64	18.34	10.36	1.43
1981	1.05	2.30	4.56	1.54	1.18
1982	2.59	0.51	1.18	0.32	0.19
1983	1.41	3.19	10.60	3.59	1.18
1984	0.82	0.18	0.38	0.05	0
1985	1.52	5.93	13.29	6.51	4.30
1986	0.11	0.02	0.24	0	0
1987	4.18	6.91	15.52	0.59	1.31
1988	0.38	0.02	1.1	0	0

1989	7.39	8.5	43.84	7.63	0.43
1990	2.12	0.64	7.62	0.25	0.25
1991	6.21	29.72	42.96	8.6	4.35
1992	3.32	4.8	13.72	1.21	0.04
1993	3.10	3.17	11.34	11.60	1.57
1994	1.63	10.46	28.80	0.67	0.12
1995	2.93	23.10	20.85	12.09	1.43
1996	1.61	3.85	6.22	4.14	0.12
1997	1.57	15.73	27.98	20.18	2.87
1998	2.00	4.76	16.19	5.64	0.06
1999	0.11	15.53	42.66	19.46	2.49

3.7.2 Chum Salmon

The chum salmon is the most widely distributed of the Pacific salmon species, breeding on both sides of the Pacific from San Francisco to Bering strait, and from Providenia Bay to Peter the Great Bay and Tumen-Ula River on the Asian coast. On Sakhalin Island the chum salmon ranks second, in terms of abundance and commercial importance, to the pink salmon.

Although it occurs throughout the rivers of Sakhalin, this species only attains relatively high abundance in the river systems of the northeast, particularly the Tym, and some rivers in the southwest of the island.

Chum salmon spawning runs occur twice a year, in the summer and autumn, with the number and location of migrating fish varying according to the season.

The summer chum salmon spawning run begins during the first half of July, simultaneously with the pink salmon spawning run. The main spawning grounds of summer chum are located in the Longari River, where it dominates above other salmon species, and also in the upper reaches of the Poronai River – from the mouth of the Valza River to its source. The run peaks at the end of July – to the beginning of August (see

Table 3-14). The average length of a spawning chum salmon is 62 cm, weight, 3.3 kg, and gravid females carry approximately 2400 eggs. Summer chum salmon spawn in similar in stream habitats to pink salmon; i.e. clean gravels with hyporheic flow. The downwelling of oxygenated stream water through redds, mixing with the colder temperatures of groundwater, creates an environment ideal for egg development. Leman (1993) reported that 30-40% of Kamchatka River summer chum salmon spawned at sites influenced by hyporheic flow.

The autumn chum salmon spawning run is larger and more economically important than the summer run and takes place in river basins from the end of August till November (see Table 3-14).

Table 3-14: Timing of spawning migration for chum salmon

Area	Chum salmon form	Beginning of run	Main run	End of run
North-east (Tym River)	Autumn	11.08	12.09-10.10	23.11
East (Poronai River)	Summer	24.06	17.07-31.07	26.08
	Autumn	28.08	16.09-4.10	12.10
South-east (Nayba River)	Autumn	25.08	20.09-250	10.11

The largest autumn runs occur in the Tym River and in the rivers of southwest Sakhalin; however individuals can be found in almost all Sakhalin rivers (SakhNIRO 1999). In the Tym the average size of autumn chum salmon ranges from 67 to 74 cm, weight ranges from 3.3kg to 4.6kg, and gravid females will carry from 2,900 to 3,100 eggs. In smaller rivers the length and weight of fish averages 52-66 cm and 2.2-4.2 kg respectively. Smaller females can carry 2,600-2,800 eggs.

Autumn spawning chum salmon prefer to spawn in sheltered places in small rivers where the bottom is covered with fine pebbles and gravel. Current velocity at these spawning grounds varies from 0.1 to 0.9 m/s, with fish laying fewer eggs at sites where flow rates are higher (Rukhlov 1982). Water temperature is also an important factor in spawning site suitability and, while river water temperature during the spawning period usually falls from 8 to 1°C, spawning sites are selected where upwelling waters wash the redds with water at a constant temperature of 3-4°C for the entire winter period (SakhNIRO 2000). In situations where small rivers completely freeze to their base mass mortality of eggs and alevins may occur.

Chum Salmon incubation lasts 120-150 days. Alevins lie motionless in river gravels and absorb their egg yolk. Juveniles (fry) come out of the gravel substrate at the beginning of April and then feed in the area of their spawning grounds for one to two months eating microscopic or near microscopic plankton, as they grow they start to eat small insects and insect larvae that fall into the water. In May, when they reach 38-40 mm in length they begin migrating to the sea, where they typically spend a couple of months in estuarine, tidal and nearshore waters prior to moving out into the open ocean. Fish will spend 3-4 years feeding in oceanic waters before migrating back to their natal rivers.

As noted above, the commercial importance of this species centres on the autumn migration, when the bulk of fish are caught in coastal waters. The chum salmon stock in the Sakhalin-Kurils region has been low in recent years (1989-2000, see Table 3-15) and the catch of this species over the period has been in the range of 2.2 – 5.8 thousand tonnes. Traps and coastal fishing gear are normally used but at sites where artificial cultivation (hatcheries) takes place, they are caught next to fish screens.

Table 3-15: Catch (tonnes) of chum salmon in Sakhalin 1989-2000 (SakhNIRO, 2000)

Year	South-west	Aniva Bay	South-east	Terpeniya Bay	North-east	Rybnovsk (North-west)
1989	1273	28	0	0	686	1220
1990	1688	0	11	1	955	1149
1991	1777	0	150	30	875	1747
1992	901	0	0	0	664	1344
1993	253	0	0	0	229	1304
1994	200	0	0	46	239	1518
1995	388	0	200	155	573	880
1996	534	0	196	358	417	590
1997	630	0	1309	70	211	687
1998	593	1	686	173	169	553
1999	1944	0	25	43	60	616
2000	936	12	1404	399	238	346

3.7.3 Silver (coho) salmon

This species has a distribution throughout the North Pacific Ocean from central California, Alaska, through the Aleutian Islands, Kamchatka, to Hokkaido, Japan. In Sakhalin, the silver salmon is not numerous and mainly occurs in the rivers of the northeast of the island and those flowing into Terpeniya Bay. The ecology of the coho salmon and cherry salmon is similar and it is thought that the latter species replaces the coho in the warmer, southern regions.

The silver salmon undertakes it spawning migration later than all of the other Pacific salmon species. The spawning migration can be highly protracted and continue from early September through to mid-December in some seasons. In the in Tym river, the dates of coho spawning migration vary from year to year, but migration typically occurs during the first half of September through to December (Gritsenko 1973).

Spawning sites comprises sections of main river channel and tributaries with upwelling groundwater and with current velocities ranging from 0.08 to 0.7 m/s (SakhNIRO 2000). Females dig out redds up to 70 cm deep with a mean size of 1.8 m x 1.2 m and typically lay about 800-1,100 eggs. After 50-150 days, depending on the water temperature, the alevins hatch from the eggs and remain largely motionless within the gravel bed. The alevins start leaving river gravels and enter the water column at night in late May-mid-June.

During their first year, silver salmon fingerlings normally inhabit cut-off channels and tributaries of the main channel of the spawning river where deeper pools, log jams and banks with overhanging tree roots and debris occur (Tschaplinski and Hartman 1983). These sites are often characterised by low current velocities and fine sediment deposition and in the spring/summer support the larvae of chironomid midges, which form the main prey items for the young fish. These channels and ponds can often harbour large numbers of fish and are thought to provide refuge during the winter months, as total freezing of the river is less likely and therefore mortality rates may be much lower than in mainstream channels. Over time the fingerlings establish small home ranges, which they aggressively maintain, and also move to deeper waters. The fish actively hunt mayflies, flies, and mosquitoes and during the spawning season of pink and chum salmon they also feed on the eggs released from spawning sites.

The typical silver colouration of the migratory phase of this species develops in fish aged 2-3 years old. In the Tym River, this silver form normally appears in the upper reaches of the river in late May and in the middle reaches by early/mid-July with the majority migrating to the open sea by August. SakhNIRO (2000) report, using collated survey data, that the bulk (90%) of initial migrants from the river systems of northeast Sakhalin are three-year-old fish. Once at sea, sliver salmon spend a year feeding prior to returning to their natal rivers for spawning.

Silver salmon is not considered to be a main commercial species and is normally taken during fishing for the autumn chum salmon run. However, SakhNIRO (2000) report that in some years significant migrations of this species (e.g. up to 40,000 fish in 1961) on the Tym River, make it of occasional commercial value. Subsequent to 1961, silver salmon numbers fluctuated in the range of 6,000 – 15,000 individuals. No sample taking or monitoring of the migration of this species up the main rivers is currently conducted (SakhNIRO 2000).

3.7.4 Cherry or masou salmon

The cherry salmon occurs in small numbers in Sakhalin rivers and is the first migratory Pacific salmon to appear in coastal waters, normally in mid- to late May in southern Sakhalin. Mass migration upstream occurs during the second half of June – mid-July with spawning occurring in late July – early August, although this timing varies across the island (SakhNIRO 2000). Before spawning, the cherry salmon spends about two-eight weeks in the river, lingering in holes in the main channel and enters tributaries directly before spawning. An important factor in stimulating the spawning migration is a rise in water level and increase in river current velocity (e.g. as associated with spring-early summer floods), which permits fish to reach their spawning grounds, which are situated largely in the upper reaches of rivers. On the southwestern coast and in Aniva Bay, migration generally occurs mid-May to mid-June, while in northern Sakhalin (middle reaches of Tym river) mass migration occurs from the second half of July into the first half of August and spawning from late July to early September. In the rivers feeding into Terpeniya Bay (e.g. Poronai River), the migration starts approximately a month earlier than in the Tym and spawning occurs early July to mid-August (Gritsenko 1973).

Normally, cherry salmon spawning areas are isolated from the spawning grounds of other salmon species. In southeastern Sakhalin (in the tributaries of Belaya river - the Naiba river basin) it spawns in areas of pebbles, with rocks and some sand and relatively high current velocities. In northern Sakhalin, spawning grounds are situated in the upper reaches of the main rivers and its tributaries. These sites tend to be small watercourses with an alternation of pools and riffles. Spawning redds are situated in areas where water depth is 10-25 cm, current velocity 0.2 to 0.8 m/s.

Alevin hatching occurs after 35–50 days and by about day 80-85, juveniles start moving into the water column where they begin actively feeding. They leave the redds by the second half of April (later in northern Sakhalin). Shoals of juveniles then disperse into the upper and middle reaches of the rivers where prefer sections of watercourses with a rapid, turbulent current and cover provided by bushes and log jams (SakhGu 2000). During the summer, young fish feed on a varied diet of airborne and aquatic insects as well as the eggs of pink and chum salmon. The duration of the river-dwelling stage of this species appears to be dependent on diet and generally during the second year in freshwater the juvenile population divides into smolts, which undertake migration to the open sea, and parrs that remain in the river for another year. Some individuals achieve sexual maturity without leaving the rivers. These are dwarf males, which sometimes occur in large numbers in the upper tributaries and which actively take taking part in reproduction. The cherry salmon migration in northern Sakhalin occurs at an older age (three years) compared with that in many other regions of the range, where the bulk of juveniles leave the rivers during the second year of life (SakhNIRO 2002). Cherry salmon smolts, among which females prevail, spend a large amount of time in the near shore zone where they feed on crustaceans and small fish, before moving offshore into open waters.

From a commercial perspective cherry salmon is of minor importance and is only caught in relatively large amounts in south-western Sakhalin during May-June, in the course of the pink salmon migration. Between the late 1950s and the late 1980, its catch normally did not exceed 5-10 % of the totals caught during the pink salmon migration, although in some years, it constituted up to 40 % in an area from Slepkovsky Cape to the Lopatin Cape (SakhNIRO 2000). In the course of the pink salmon fishery in other parts of the Island, cherry salmon may be present as a bonus catch in small amounts, which is explained by its lower numbers and the fact that the bulk of fish have already entered the rivers for spawning.

4 POTENTIAL EFFECTS AND IMPACTS

This section describes the potential effects of the river crossing works and the impact they may have on the environmental receptors that are identified in Section 3. An effect is defined as a change in conditions that results from the river crossing works, and may be direct or indirect. An impact is the response exhibited by key environmental receptors to this effect (positive or negative).

Effects and impacts upon ecology are considered below for each of the crossing methods carried forward for further consideration in the strategy, namely the wet cut crossing method (Section 4.1) and Horizontal Directional Drilling (HDD) (Section 4.2). Aerial crossing and dry cut methods have been discounted based on the arguments presented in Section 2.4.1 and 2.4.4. The effects and impacts of other activities, water intake and use of chemicals are discussed in Section 4.3.

The following sections discuss the main physical changes related to in-channel construction works and go on to describe the ecological effects associated with these potential changes. Given the importance of the watercourses that are to be crossed by the pipeline to salmonid fish, particular emphasis is given to the potential effects of suspended sediment concentration increase and substrate change on salmon spawning behaviour and habitat.

4.1 WET CUT CROSSINGS

Wet cut river crossings are undertaken without diversion of river flow away from the work area. The main construction processes associated with the works are:

- Trench excavation;
- Sediment storage on the ROW;
- Insertion of pipe section; and
- Backfilling of the trench.

Site preparation will include stripping of topsoil from the worksite, which will be temporarily stored on the pipeline ROW for later replacement following the works. The main work involves excavating an open trench, while the water continues flowing through the work site (unless the river is dry or fully frozen and there is no flow). In most cases, pipeline trenches will be cut with an excavator working from the riverbank or from a temporary bridge depending on the length of the river crossing. A dragline, which has a longer reach than an excavator is needed to cut trenches through larger rivers. The spoil from the trench is typically placed into decanting structures or a trench within the pipeline ROW located at a suitable distance from the river bank to prevent the flow of spoil or silt-laden water into the river. A pre-welded and hydrotested (for widths greater than 10 metres) pipe section is then lowered into the trench, and the trench is backfilled using the excavated spoil. If the excavated spoil is considered unsuitable, material from the ROW or a borrow pit will need to be used instead.

The area of the footprint required to undertake the works will depend on site-specific variables and is therefore difficult to generalise at this stage. All work will be confined to the pipeline ROW and no additional footprint is planned to be taken at river crossings. The construction time varies between several hours for small streams and a few days for large rivers (see Section 5.3.1 for more information).

4.1.1 Morphological effects

Reid and Anderson (1998) identify that the introduction of sediment into watercourses during in-stream construction can occur through:

- Trench excavation, scour and backfilling;
- The storage and disposal of dredged or fill material directly into watercourses;
- Erosion and run-off from adjacent upland worksites; and
- The discharge of water from hydrostatic pipe testing, or trench dewatering.

The morphological effects of such changes can be described as follows:

- Release and entrainment of sediments during construction;
- Sedimentation;
- Direct modification of channel bed and banks; and
- Cumulative effects.

Release and entrainment of sediments during construction

Both coarse and fine sediments can be released during the process of trench excavation, dewatering and backfilling with direct and indirect effects. The volume of sediment entering the watercourse, and hence the potential magnitude of any effect, can however be managed to a certain extent using appropriate sediment and water control measures. Fine sediments will be entrained at lower flow velocities but it is likely that some coarse sediment will be moved during higher flow events (in addition to mechanical action, which is covered below in the section on direct modification of channel bed and banks).

Levels of sediment released increase rapidly at the onset of in-stream activity and discrete peaks of high-suspended sediment concentrations occur in association with activities such as trench excavation, trench dewatering and backfilling. According to a review of wet-cut crossings by Reid and Anderson (1999), suspended sediment concentrations can exceed 2,500 mg/l or the equivalent in nephlometric turbidity units (NTU) during pipeline trench excavation and backfilling. Their review findings are summarised in Table 4-1. The duration and magnitude of suspended sediment concentration reflects watercourse size, volume of flow, construction activity, management practices and sediment particle size. Typically, the highest peaks in suspended sediment concentrations are associated with trench excavation.

Table 4-1: Turbidity and suspended sediment levels measured downstream of open-cut water crossings in the U.S. and Canada. From Reid and Anderson (1999).

Watercourse	Distance downstream (m)	Trenching	Backfilling
Moyie River	180	214-2,652 [1]	155-1,783 [1]
Ten Mile River	55	1,150 [2]	112 [2]
Bouquet River	22	503 [2]	

Watercourse	Distance downstream (m)	Trenching	Backfilling
Brazeau River	290	555 [2]	40-83 [2]
Findlay Creek		2,960 [2]	2,880 [2]
Humber River	At trench	700-2100 [1]	920-4,700 [1]
Little Miami River	16	1,461 [2]	

1 – measured in NTU; 2 – measured in mg/l

The magnitude and duration of sediment entrainment and transport downstream of sediment as a result of in-stream construction work depends on a number of variables.

1) The type of disturbance (press or pulsed)
A press disturbance is of no defined duration and may continue for a long time, whereas a pulse disturbance is of a relatively short and defined duration. If disturbance to riverbed and banks can be restricted in scale, and limited to a short-term pulse, then the release of total sediment may be minimised.

Generally any increase in suspended load (potentially sediment concentration) can be assumed to be restricted to the duration of in-stream construction activity, and therefore, depending on the size of the watercourse crossing, any direct effects are likely to be short term as they will be related to the construction time (see Section 5.3.1). The length of the period for which the channel may be potentially disturbed through construction activity, and therefore the need for potential measures to reduce sediment input, will be considered during the development of the River Crossing Execution Plan (see Section 5.1)

2) Flow conditions
Under low flow conditions (e.g. as typical during winter and summer conditions in Sakhalin watercourses), there will be minimal dilution and as a result high suspended sediment concentrations are likely to occur and residence time be prolonged within the watercourse. However, under low flow conditions the transport of sediment downstream can be greatly reduced in comparison to conditions when high water velocities predominate, limiting the potential length of downstream riverbed that may be affected during the construction period. However, this material is likely to become entrained when flows do increase (e.g. during snowmelt or flooding events), thus extending the potential downstream zone of influence of the sediment released during construction.

It is therefore important to consider the effect of sediment being retained within the system until flows increase, as the delayed entrainment of sediment will change the characteristics of the disturbance. The nature of the typical flow regime varies from region to region and will be considered when assessing the inherent morphological capacity of the system to absorb the disturbance (discussed in Section 5.1). It is important to recognise that high velocity flows and discharges associated with significant flow events (e.g. snowmelt) can lead to large increases in background sediment loads which may mean that the entrainment and erosion of fine sediments as a result of the crossing will not significantly increase the suspended load or concentration.

3) Nature of boundary conditions
The propagation of the sediment plume downstream and associated suspended sediment load and concentration will also be controlled by the

grain size of the excavated sediment used in backfilling operations (material will be derived from the excavated trench and returned to the channel). The smaller fraction (fine sediments) is likely to be transported as suspended bedload or in suspension for longer distances downstream than coarse sands and gravels. More persistent plumes of high suspended sediment concentration and/or higher turbidity levels will therefore be generated in areas where the streambed and banks are composed of fine-grained sediment (clay, silt) as it can take significant amounts of time for particles of this size to settle out of suspension (i.e. into areas where current velocities are low enough to promote settlement). Under the right flow regime, silt particles (diameters smaller than 0.01 mm) can travel as far as 500 times the river depth and fine clay can travel even farther. Analysis of experimental and field data in calculating transport and settling dynamics of sediment show a rapidly decreasing transfer range for larger particles. For example, for medium silty and fine sand (diameter between 0.2 and 0.1 mm) the transport distance is around 100 times the riverbed depth. Typically, using these data, the indicative distances for downstream transport of sediment for the majority of the Sakhalin rivers during low flow winter conditions is therefore in the order of 10-100 m for medium silt-fine sand and up to 50-500 m or greater for silt (see Section 3.3 for typical water depth data for rivers during periods of low flow).

With the cessation of construction activity, suspended sediment levels reduce rapidly with only occasional residual increases due to scour of the trench, erosion of exposed surfaces at the crossing site, and the re-suspension of deposited material (Reid and Anderson 1999). Although sediment produced during construction may only be transported relatively short distances, further transport downstream is likely to occur when flows are competent (a competent flow is described as one that exceeds the entrainment values for that size of sediment). On the basis of the flow regimes of Sakhalin rivers, such competent flows are likely to occur during the spring snowmelt and periods of intense rainfall (e.g. associated with autumn typhoons) and it is expected that much of the sediment generated during the construction work would be re-suspended and entrained during these events, particularly spring snowmelt. As meltwater flow during the spring is typified by relatively high suspended sediment loads and undoubtedly represents the main phase of sediment (by volume) transport and distribution during the annual cycle, it is expected that material produced during construction would form a relatively small component of the substantially greater sediment volume being transported downstream.

Basic analysis of available data on sediment loads (suspended sediment) and average annual flow and melt water flow rates for Sakhalin rivers indicates that this is likely to be the case. Typically the volume of material lost during the construction phase (i.e. pipeline installation) is predicted to be in the range of 5-30m^3 (ECMOS reports for indivdiual rivers and river groups), depending on the size of the river crossing section, with fine sediment loss generally constituting between 0-60 % of this amount. While the localised presence of this volume of material released into the rivers would lead to high suspended sediment concentrations at a time when the life stages of some aquatic organisms may be more sensitive to such effects (see Section 4.1.3), its subsequent transport and contribution to the overall sediment load of these rivers is considered negligible. **Table 4-2**provides an indication of the scale of the sediment loads transported by some of the Sakhalin rivers. The analysis that has been undertaken is very broad brush and, given data availability (e.g. lack of bedload data) and variability in results that may be obtained using different analytical approaches, the results can only provide an indication of the magnitude of potential sediment transport. For this work, sediment load has been simply calculated as the product of average annual flow rates (as reported in Sakhhydromet 1998) and averaged data for suspended sediment loads. The results of this simple analysis, as shown in column 5 in Table 4-2, demonstrate that, on an annual basis, the amount of sediment transported by these rivers far outweighs the amount of sediment likely to be released during pipeline construction work.

As stated, peak flows during the spring snowmelt probably account for a large proportion of the annual volume of sediment transport and it is also useful to compare the potential rate of transport of sediment during this period with the volume of sediment generated during construction, as this event would occur soon after completion of the winter period river crossings. **Table 4-2** provides an estimate of suspended sediment transport in tonnes/day for a range of rivers during the spring mean peak flow. The suspended sediment data used in this calculation is based on the annual average (using higher mean values, where provided, see Section 3.3) and therefore is likely to significantly underestimate the actual transport rate, as suspended sediment concentrations would be much higher than the annual average. However, this crude analysis clearly demonstrates that during snowmelt large volumes of sediment are likely to be transported downstream by the rivers. Specific data on suspended sediment loads during snowmelt for the Makarova (833 mg/l) and Nitui (1,160 mg/l) indicate that the volumes (9,860 and 11,825 tonnes in one day respectively) that could be transported may be considerable in relation to the volumes likely to be released during pipeline construction.

Table 4-2 Flow rates and estimated suspended sediment loads for a range of rivers. Data on flow rates and average suspended sediment concentrations derived from Sakhhydromet 1998.

River and location	Mean annual flow rate (m3/s)	Mean spring flow rate (m3/s)	Mean suspended sediment concentration (mg/l)	Annual suspended sediment load tonnes	Sediment load tonnes/day during spring flood
Area 1					
Piltun	7.68	42.8	4.0 - 7.3	969 – 1768	27.1
Val	21.9	102	4.0 - 7.3	2763 – 5042	64.3
Dagi	10.8	77.2	4.0 - 7.3	1362 – 2486	48.7
Tym	80.7	593	4.0 - 7.3	10180 – 18580	374.0
Area 2					
Krasnaya	1.59	18.2	No mean data for suspended sediment concentrations available for these rivers	Not calculated	
Pilenga	9.07	92.2			
Uskovo	2.41	25.8			
Slavka	1.98	28.1			
Area 3					
Poronai	78.9	426	26.1	64942	960.6
Onorka	7.2	76	26.1	5926	171.4
Pobedino	2.66	24.8	26.1	2190	55.9
Orlovka	8.95	75.7	26.1	7367	170.7
Area 4					
Gastellovka	3.5	30.3	61.4 – 70.5	6777 – 7782	184.6
Gornaya	2.12	17.7	61.4 – 70.5	4105 – 4713	107.8
Makarova	17.4	137	61.4 – 70.5	33692 – 38685	834.5
Nitui	13.2	118	61.4 – 70.5	25559 – 29347	718.8

Pugachevka	5.17	49	27.4	4467	298.5
Area 5					
Firsovka	7.52	71.7	88.0 – 175.0	20869 – 41501	1084.1
Naiba	20.7	282	88.0 – 175.0	57446 – 114239	4263.8
Susuya	7.58	81.7	88.0 – 175.0	21036 - 41832	1235.3

Given the energetics of flows during spring snowmelt, it is considered likely that much of the sediment generated during construction and available to be entrained would either be re-deposited within areas of similar sediment size (i.e. fine-grained material would be likely to be removed from areas of coarser sediment and re-deposited in areas of similar sediment type) or flushed out of the river systems, where the crossing areas are sufficiently close to the coast. The significance of such flows in both locally altering and maintaining salmon and other fish habitat in coarse substrate bedded rivers has been demonstrated through a number of studies (e.g. Lisle 1989 and Pitlick & Van Steeter 1998) and similar processes are also likely to operate in Sakhalin rivers and will play an important role in sustaining spawning habitat in Sakhalin rivers.

Additionally, given the relatively small volumes of sediment likely to be generated during construction, in comparison to annual transport volumes or daily transport volumes during periods of spring melt water, the subsequent potential effects of the pulsed downstream transport of sediment are likely to be negligible in the majority of rivers (see further comments below). This potential for loss of sediment from river systems will be further explored on an individual river basis as part of the assessment process described in Section 5.1.

<u>4) The location of the crossing within the drainage basin</u>
In channel suspended sediment concentration may be affected by the position of the river crossing in relation to the rest of the drainage network. For example, if the river crossing is located upstream of unaffected tributaries, discharge from these tributaries will act to dilute suspended sediment concentrations downstream of the crossing point (see Figure 4-1).

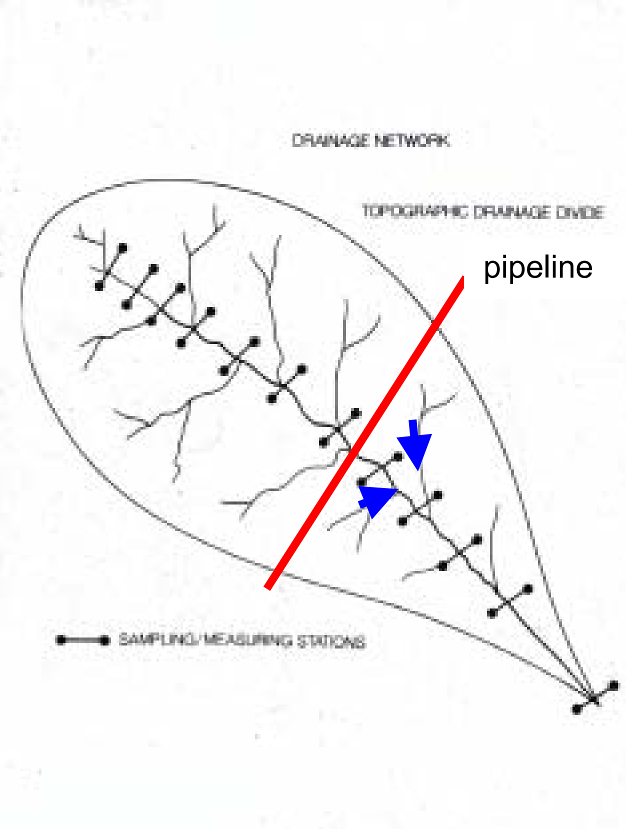

Figure 4-1: Schematic pipeline route across a drainage basin. Note the two unaffected tributaries immediately downstream from the crossing point that may dilute sediment inputs from construction activity (Lawler, 2005)

Sedimentation

During construction, as the sediment excavated from trenching and replaced during backfilling is generally greater in volume and of a larger grain size than that transported under normal flow conditions, significant deposition of released sediment can occur within a relatively short distance downstream (Anderson et. al. 1998). This rapid pulse of sedimentation largely consists of the coarser grained material (sand and gravel) contained within the excavated material and can lead to changes in-streambed sediment composition and channel morphology, particularly as it is subsequently transported downstream. Anderson et al. (1998), observed deposited sand 30 cm thick within 100 m of a pipeline crossing to alter downstream stream channel morphology and associated habitats as it slowly moved downstream as bed load.

Where sediment loading is already high due to the flow regime or as a result of the cumulative impacts of a number of river crossings in the same watercourse or river catchment (discussed below) the competence of the system to entrain sediment may be reduced causing sediment to be shifted downstream. The sediment transport in rivers has been likened to a jerky conveyor belt, in that, having entered the fluvial system sediment may be moved downstream every time a competent flow occurs in the river.

Sedimentation is therefore dependent upon particle size, competence of the flow and existing geomorphological characteristics of the channel. The deposition of finer sediment (clay and silt) from the sediment plume generated during construction will occur further downstream, either as a veneer on streambed sediments (e.g. trapped on organic films coating pebbles) or in areas where current velocity falls to speeds in which settlement can occur (e.g. deeper pools in river beds or temporary channels). This latter process is of particular relevance to streambed ecology as fine sediment can infiltrate pore space between larger sediment particles and alter its porosity and composition, a process known as embedding. Embeddedness is a measure of how much finer sediment surrounds or covers larger sediment particles and higher values are generally associated with lower spawning habitat viability for salmonid fish. Research work on the survival rates of salmon eggs in gravels demonstrates that it is sediment in the range of 0.1-1 mm, critically about 0.8 mm, which has the greatest influence (see Section 4.1.3 for further discussion). Monitoring data from eight open-cut pipeline crossings of the Moyie River showed that the embeddedness of riverbed material rose from 0-18% to 9-61% as a result of increased sediment deposition (quoted in Reid and Anderson 1999).

Post-construction monitoring of downstream streambed conditions indicates that changes to streambed conditions are generally short-term (Crabtree et al., 1978; Anderson et al., 1998). Fine sediment deposited downstream of a pipeline crossing is typically transported shortly after construction. However, larger deposits in areas of slow current velocity, such as shallow side pools and behind boulders and in stream debris may require longer periods or higher flows for complete removal (Anderson et al., 1998). In-stream sediment derived during construction work is generally transported away from a crossing site within 6 weeks to 2 years after construction.

Although most studies report that streambed alterations are short-term (less than 1-2 years and of the pulse type of disturbance), Crabtree et al. (1978), as quoted in Anderson and Reid (1999), from an examination of 56 pipeline water crossings in Michigan (31 open-cut; 13 plough-method; and, 12 flumed) identified longer term alterations to channel morphology at the crossing location. Increases in channel width, reduced water depth and meanders were observed 2-4 years after the construction of water crossings in areas with open forest canopies, in comparison to undisturbed upstream reaches. However, observed effects were probably linked to non-pipeline construction activities or poor management practice during construction, which led to the generation of press type disturbances. Increased off-road vehicle (ORV) traffic limited the recovery of riparian vegetation and reduced bank stability; while improper re-contouring of the stream channel and the placement of uncovered sand and sackrete bags influenced channel morphology and sediment deposition. Little change to the channel morphology was evident at older crossings (5-7 and >10 years old). The full recovery of riverine habitats influenced by increased sediment deposition has been suggested to be dependent on high flow conditions associated with storm events, or spring melt water conditions flushing deposited sediments downstream.

Direct modification of bed and banks

Bed and bank structure are important in terms of both geomorphological processes and physical habitat conditions. In-channel works associated with the open wet cut method of river crossing will result in direct modification of the channel profile at the crossing point. Excavation of a trench through the watercourse will disrupt the existing bed and bank material together with in-channel and riparian vegetation. Following backfill of the excavated trench the channel cross-section may be different to the original profile.

Impacts of modification of the channel profile may occur at the site, as well as further upstream and downstream. The new channel profile is likely to readjust in response to high flow events associated with snowmelt or rainfall floods following completion of the in-channel works, but the release of sediment may continue during this readjustment phase. Excavated material is likely to be less compact and settled than the original bed and banks and may be more vulnerable to erosion during subsequent high flows as a result of snowmelt or high rainfall events. The integral structure of the channel bed and banks (e.g. bed armouring) will also be disturbed during the works, although it may be possible to minimise this during river crossing works undertaken in the winter due to the frozen conditions. The rate of recovery of riparian vegetation where the bank is used for support structures or access points may also be limited during periods of low temperatures. This lack of vegetation cover may lead to an increase in sediment yield and mitigation to reduce this may be necessary at highly sensitive sites.

More widespread impacts of change in channel profile may occur if the profile is not reinstated with regard to the continuity of natural processes and appreciation of the potential for subsequent adjustment. For example, if the bed is reinstated at a lower or higher elevation than original, knock-on impacts, e.g. knick-point migration upstream may occur as a result of the discontinuity that is created.

Changes in channel morphology should be set within the existing natural variability associated with the dynamic fluvial systems found on Sakhalin. Where river crossings cause change sufficient to result in accelerated erosion or bed/bank stability, which could continue into the future, suitable mitigation measures (e.g. bank stabilisation) should be considered. The hydrogeomorphological assessment (Section 5.1) will identify inherent morphological conditions, type of disturbance and as a result likely short-term and long-term effects that may require management to limit potential environmental impact.

Cumulative effects

In addition to effects resulting from specific crossing activities, the cumulative impact of a number of crossings on a single watercourse or within a catchment may increase the magnitude and/or duration of an effect. The cumulative increase of sediment load within the system may limit the competence of the river to entrain and transport sediment downstream resulting in deposition of material and pulsed effect where 'slugs' of sediment move down the system. This could change the type of disturbance from a pulsed impact to a longer-term press impact. This is particularly the case on lower order rivers within the system where sediment may arrive in the system at the same time as a result of sediment being transported during snowmelt. Where a possible cumulative effect is identified, this will be considered in relation to potential mitigation measures that could be applied to limit sediment inputs at the wider catchment level (see Section 5.1).

The estimation of cumulative impacts will also be part of the hydrogeomorphological assessment and will be addressed in the Execution Plan. The hydrogeomorphological assessment considers the impact on a catchment scale. Besides this, a qualitative cumulative impact assessment, on a river system/drainage basin basis, will be prepared once these individual plans have been prepared.

4.1.2 Effects of increased sediment supply on the coastal zone

It is possible that fine sediment released during and after construction of crossings on watercourses that drain to the coast may enter a tidal river reach. This is only likely to be the case for those rivers where the crossings are situated relatively close to the coast or for catchments where a large number of crossings may occur (i.e. cumulative effect). Once in a tidal reach, sediment may have a long residence time as it may be mobilised, deposited, accreted, entrained, eroded and mobilised again. The flux of sediment linked to the tidal exchange will be affected by the temporal variability in tidal conditions, which vary from north to south of the island (see Section 3.2). The extent to which additional fine sediment sourcing to the tidal system will have an impact is dependent upon a number of factors:

<u>1) The existing dynamics of the system</u>
It is possible, given the nature of the environments and volumes of material entering from construction that the sediment released will contribute to the formation of deltaic deposits at river mouths and lagoon in-fill. However, the total magnitude of sediment released during construction needs to be considered in the context of natural background events. On the open coast it is unlikely that such sediment release will be of any consequence as there is a fall-off into a deep basin and this is, again, an already naturally occurring set of circumstances.

<u>2) The nature of the sediment supply (whether pulsed or pressed)</u>
For a single sediment supply of known duration the impact will be different than if the effect is lagged and pressed (of no known duration). This will depend upon the location, number, timing and size of river crossings upstream of the tidal section and will be considered as part of the river classification process. The total volume of sediment will also be of consequence. Large volumes of sediment import will tend to accumulate rapidly where conditions allow, this may be clear in generating more linear drainage that will re-adjust over time. More gradual supply can allow morphological development during the depositional process, although again the potential volume of material available for transport will determine the scale of this change.

<u>3) The extent to which the system is open or closed</u>
In partially or (potentially) totally closed systems, such as coastal lagoons or lakes the pool of sediment is maintained through re-working but added to through fresh sediment supply by river systems and on the tide, in the case of saline lagoons. Where the coast is open (to the sea) then the ‘pool of sediment’ will link to the marine sediment system.

Adding additional material to this sedimentary system it is unlikely to have any long-term effect as the degree of diffusion and dispersion offshore is likely to outweigh any sediment contribution apart from in the short term. Thus it is the timing of any sediment release that is probably of significance in relation to the impacts on coastal, estuarine and lagoonal morphology and associated habitats. It is thus also likely that in the long-term natural processes will even out such consequences. Thus the significance of these events from construction (if any) should be ascertained through the characterisation of the combination of the fluvial system contributing sediment to the estuarine/coastal environment and the features of the coast.

The delivery of sediments downstream will be considered as part of the hydrogeomorphological assessment. The effect will be considered in terms of the contemporary sediment regime.

<u>4) The degree of mixing within the tidal reach related to the development of the saline wedge</u>
The degree of turbulence or exchange between fresh and saline water within an estuary will affect the degree of mixing of fine sediments in the water column and thus will influence the nature and extent of the impact of any increase in fine sediment load.

Lawler et. al. (2006) and Old et. al. (2005) quote examples of sediment plume migration distances for rivers of similar size and gradient to those in Sakhalin, including Spain (storm runoff event affecting road-cutting: 500 m), Iceland (meltwater river; sediment from glacier; 8 km), UK (urban-impacted headwater river: 28 km), and Western Australia (storm in large basin: 125 km). These transport distances suggest that under certain conditions it is possible that for some rivers very fine sediment derived from pipeline construction may be transported significant distances and reach the coast particularly in areas without lagoons. However, it is more likely that this situation is typical of spring snowmelt conditions rather than the low flow conditions typical of the winter when flow velocities and river depths are, in comparison, much reduced (see Section 3.3). Given this, it is therefore more likely that localised sediment generation and increase in suspended sediment concentration may be of greater relevance in determining the level of impact if sediment is allowed to enter the system unmanaged.

4.1.3 Ecological effects of increased stream borne sediment

Sediment load or suspended sediment concentration increases can directly and/or indirectly affect aquatic invertebrates and fish through direct exposure or modification of their habitats (Anderson et al. 1996). In addition to increasing sediment related effects, modification of the physical habitat at the crossing site can be altered directly through the excavation and backfilling of the pipeline trench and associated changes to bank conditions and riparian vegetation.

The ecological responses to pulse and press disturbances in riverine environments differ, largely with respect to the duration of potential recovery as discussed below.

Associated direct effects on aquatic biota will generally be limited to the duration of the in-stream construction time frame. However, excavated sediment deposited downstream can cause more protracted effects on aquatic habitat. As the effect on, and subsequent recovery of, benthic invertebrate and fish communities are highly reflective of this habitat alteration and recovery, it is important to identify physical changes to habitat and the likely timeframe for recovery. The timeframe for recovery to pre-disturbance conditions is especially relevant to construction timing related concerns associated with life-history requirements of resident species (e.g. spawning).

The increase in-stream borne sediment generated during and potentially after in-stream construction work can have a number of direct and indirect effects on freshwater organisms through increases in suspended sediment concentration, increase in and transport of bedload and changes in channel morphology. Some of the key effects are listed below:

- An increase in suspended sediment concentration and associated turbidity can reduce photosynthetic efficiency in aquatic plants leading to a reduction in growth and increased susceptibility to disease;
- High concentrations of in-stream sediment can dislodge plants, invertebrates, and insects in the stream bed, which in turn reduces prey and food availability for fish;
- Entrained bedload sediment can alter existing in-stream habitats;
- Fish migration and spawning behaviour may be impaired by elevated concentrations of suspended sediment;

- Suspended sediment in high concentrations irritates the gills of fish, potentially causing death, and can destroy the protective mucous covering the eyes and scales of fish, making them more susceptible to infection and disease. This may be of greater significance for overwintering fish when energy levels need to be conserved;
- Fine sediment settling out of suspension can bury and suffocate fish eggs/embryos;
- Released sediment particles can carry toxic compounds derived from agricultural and industrial products which may bio-accumulate; and
- Change to river ecosystems can occur in situations where increased sediment input as a result of works persists in the longer term.

Impacts of increased suspended sediment concentrations
The increase in suspended sediment concentration in the water column during construction can have a direct physical impact on organisms present in the stream at the time of the works. Studies on stream benthic invertebrate communities have observed immediate increases in drift rates (downstream movement of animals) at the onset of in-stream activities. For example, shortly after the installation of a gas pipeline across a small creek in British Columbia where suspended sediment concentrations reached 11,600 mg/l, Tsui and McCart (1981) reported a 74% reduction in the benthic invertebrate abundance (quoted in Reid and Anderson 1999).

It is generally accepted that the magnitude of the impact of suspended sediments on fish is a function of sediment concentration and the duration of exposure (Newcombe and MacDonald 1991; Newcombe and Jensen 1996; Wilber and Clarke 2001). During in-stream construction, fish may be exposed to a sediment plume if the activity starts in, or moves into, the area in which they live, or the fish move into the plume area. For adult and larger juvenile fish, exposure to high suspended sediment concentration is likely to be of short duration. Most adults are mobile enough to move out of an affected area if they find conditions hostile. Avoidance of areas of high concentrations of suspended sediment by adult fish may limit physiological effects resulting from prolonged exposure. Kraft (1981), reported that tagged fish were observed moving past a crossing site on the Bow River during in-stream construction activities for the Alaska Highway gas pipeline. During an open-cut crossing of the Elk River in British Columbia, fish were visually observed to locate areas of lower suspended sediment concentration thereby avoiding prolonged exposure to higher concentrations (TERA, 1996). However, some benthic adult fish (e.g. loaches), most larvae and all eggs of fish have little or no ability to avoid the sediment plume created during construction and may be exposed to high suspended sediment concentration for the total duration of the plume in the water body or area of residence.

Increasing the turbidity (which is often closely correlated with an increase in suspended sediment concentration) will also reduce visibility in a water body. Since many open water fish are visual feeders a reduction in visibility could reduce their hunting success. For instance, in the case of silverside (Atherina breviceps) even quite small increases in turbidity have been shown to reduce their ability to feed.

An increase in suspended sediment can also cause respiratory problems in fish due to their gills becoming clogged by sediment particles. In extreme cases this can lead to suffocation. Raised levels of sediment in the water lead to higher mucus production in the gills and subsequently, increased gill clearing. Both of these have a metabolic cost associated with them and, if high suspended sediment concentration long enough, it may affect energy budgets. This factor is probably of more significance for those fish species that are not adapted to natural high-suspended sediment concentration levels.

There has been significant study of the effects of turbidity and suspended sediment concentration on the physiology and behaviour of salmon. These studies generally indicate that salmon are well adapted to fluctuations in suspended sediment concentration and can tolerate short-term (a few days) pulses of high-suspended sediment concentration without detrimental impact to either their health or ability to migrate. Such adaptation would be expected in species that inhabit watercourses subject to rapid changes in sediment loadings as a result of snowmelt or increased run-off. Studies in which salmon were exposed to longer-term, high-suspended sediment concentration show that detrimental physiological effects and mortality can occur (see Table 4-3). However, the levels of suspended sediment concentration used in these laboratory studies generally far exceed those to which fish would normally be subject, both in respect of duration and concentration (Newcombe and McDonald 1991). In comparison with the suspended sediment concentration levels which salmon can tolerate, and that occur naturally (e.g. during snowmelt or runoff from flood events), the suspended sediment concentration likely to be generated during in-stream construction is of the same magnitude or less and would be of lesser duration.

Table 4-3: Summary of suspended sediment effects on salmonids in the Yakima River Basin. From Newcombe and McDonald (1991

Species	Concentration (mg/l)	Duration (hours)	Effect
Chinook Salmon	1400	36	10% mortality of juveniles
	488	96	50% mortality of smolts
	82,000	6	60% mortality of juveniles
	19,364	96	50% mortality of smolts
	1,547	96	Histological damage to gills
Rainbow trout	90	456	5% mortality in sub-adults
	19,364	96	50% mortality of smolts
	100	1	Avoidance response

Impacts of sediment deposition and transport on fish

The deposition of sediment from the water column directly following construction and the subsequent transport of sediment as bedload downstream from the crossing point may have a number of relatively immediate (e.g. increased mortality of fish eggs and larvae) and longer-term effects (e.g. habitat alteration). One of the most potentially ecologically damaging and significant aspects of fine sediment deposition, particularly in coarse substrate rivers, is the direct effect that this may have on fish egg and larval mortality within salmon redds and stream gravels. Excess sediment can profoundly affect the productivity of a salmon or trout stream. In a healthy stream, young salmon and trout hide in the interstitial spaces between cobbles and boulders to avoid predation. The area of the stream where flowing water extends down into the gravel is also extremely important for aquatic invertebrates, which supply most of the food for young salmon.

Salmon eggs, buried in the gravel redd, rely on a steady flow of clean, cold water to deliver oxygen and remove waste products. Once alevin hatch from the eggs they remain in the gravels where they live off the nutrients contained in their yolk sacs. During the 30-60 day period when salmon eggs and alevin are in the gravel, major shifts of the stream bottom or changes in sediment type can kill them (Nawa and Frissell, 1993). Research has shown that increased fine sediment in spawning gravels leads to decreased survival and emergence of salmonid eggs and alevin, largely as a result of reducing oxygen availability. Experimental work indicates that particles less than 1mm have the highest impact on salmonid spawning success. Particles of less than 6.4 mm are recognised as having the potential to infiltrate redds forming a layer in the stream gravels that sometimes prevents emergence of fry (Lisle, 1989) and salmonid emergence and survival may be reduced by up to 50% in situations when fines (<0.064 mm, i.e. silt and clay particles) exceed 30% of total sediment. Studies conducted in actual redds in Olympic Peninsula streams in Washington found that if more than 13% fine sediment (<0.85 mm) intruded into the redd, almost no steelhead or coho salmon eggs survived (McHenry et al., 1994).

Significant reductions in the diversity and abundance of stream invertebrate communities have been recorded at some sites immediately following pipeline construction work. These reductions in abundance are attributed to high downstream drift rates during instream construction and changes to the suitability of downstream habitat due to sediment deposition (e.g., the infilling of interstitial voids between gravels and cobbles). Anderson et. al. (1998) report that one week after construction, the downstream benthic invertebrate community in Findlay Creek, Ontario was generally limited to only sediment tolerant species of oligochaetes. At upstream control sites, the benthic invertebrate fauna was far more diverse with over 26 species of chironomid midges, caddis flies, stone flies, may flies, and dragon flies. The observed changes were postulated to result from a reduction in habitat availability for species dependent on interstitial spaces between coarse substrates.

Data from other monitoring and research studies suggests that changes in downstream community structure as a result of pipeline construction using wet cut techniques may be very limited, although the results could be attributed to sampling variability, natural variation in-stream habitat characteristics and benthic invertebrate communities, and the assessment approach applied (Reid and Anderson 1999). However, all of the studies undertaken indicate that changes in observed benthic invertebrate communities tend not to be long-term and the full recovery of benthic invertebrate communities has been identified within six months to a year after construction. The rapid recovery of these invertebrate communities has been attributed to the flushing and downstream transport of deposited sediment during both normal and high flow conditions and invertebrate recolonisation from upstream sites. This type of response is typical of that associated with pulse disturbances, where an ecosystem is able to remain within its normal domain and recover to conditions prior to the disturbance. In effect, the species and processes contributing to overall ecological function and integrity are adapted to the effects associated with a disturbance such as that generated by short term in-stream construction work as such as disturbance generally mimics natural processes and events (Yount and Niemi, 1990).

With respect to fish populations, immediate post-construction decreases in downstream fish density have been observed. Anderson *et al*. (1998) report that one week after the installation of a 1067 mm diameter (NPS 42) gas pipeline across Findlay Creek, Ontario, brook trout (*Salvelinus fontinalis*) abundance over a 500 m reach downstream had decreased from twenty to six trout. However, within a year, full recovery of the brook trout population had occurred, in line with recovery of benthic communities and streambed conditions. Other studies have been unable to detect any direct effects on fish communities. It is apparent that the early life stages of several salmonid species and adult and young of many other resident fish species are dependent on the existence of suitable wintering habitat. Disturbance to habitat during this critical period may have adverse effects on the fish fauna, particularly juveniles. For salmon, as discussed, spawning areas are characterised by gravel with significant interflow for egg incubation. Groundwater or hyporheic upwelling areas and winter ice cover affect flow, temperature, and ice pattern. Small species and life stages have the advantage of burrowing in the substrate or using large woody debris for protection during winter, but larger individuals must move to deeper areas that have adequate flowing water during severe freezing periods (Cunjak 1996).

Generally, during winter, riverine fishes select habitats with relatively high temperatures and low flows. Riverine fishes spend the winter in velocity shelters and areas with warmer temperatures and lower flows than mainstream river sections, such as off-channel backwaters, under overhanging banks and in areas of in-stream snags and obstructions (e.g. fallen trees). By occupying favorable habitats during winter, fishes avoid the stresses of variable flow velocity in the main channel portion of rivers and are more able to maintain energy levels.

Survival probability of fishes during winter often increases with body size and individuals suffer increased mortality during winter compared to larger fish. Due to the higher loss of young individuals, winter is a critical period for recruitment into a population. Limiting exposure to severe winter conditions allows fishes to persist through winter and with the onset of winter conditions, juvenile fish seek out and occupy habitats that are favorable for increasing the probability of survival during winter.

With respect to river pipeline construction during the winter, no increases in downstream emigration, or mortality of overwintering fish, were noted during the winter construction of a pipeline crossing in the Northwest Territories (McKinnon and Hnytka (1988), quoted in Reid and Anderson 1999). However, overall, the data on the potential effects, in freezing or frozen rivers, of an increase in suspended sediment concentration associated with construction on wintering fish is very limited. Potentially if sediment were released or transported into areas where fish were not able to actively egress then chronic effects and potential mortality (under high concentrations) could result. Suitable areas for many of the fish species present in the watercourses including juvenile silver salmon and possibly juvenile taimen will be characterised by low flow rates and the presence of shelter. Such sites are likely to be off the main channel or in areas out of the main channel flow and potentially, therefore, in areas that are less susceptible to sediment-laden flows immediately downstream of crossing sections. In areas where egress of fish is possible then it is likely that an increase in suspended sediment concentration would induce an avoidance reaction and more favourable habitat would be sought by fish.

Longer term impacts associated with press disturbances

Following pipeline installation, the exposure of soil and sediment at the crossing point and its subsequent erosion during periods of higher water flow/levels may continue to provide increased sediment input into the river. While the area of disturbance may be limited in size (i.e. to the width of the Right of Way) the effects can extend downstream leading to longer-term, but localised ecological change.

In general, natural ecosystems have a large capacity to absorb change without being dramatically altered. However, if disturbance, such as that created during a pipeline river crossing, exceeds the resilience of the ecosystem then a shift in the system may occur and new conditions or states may develop that had not previously been exhibited (Reeves *et. al*. 1995). In this instance, it is considered highly unlikely that a pipeline crossing of a watercourse would constitute a disturbance of a magnitude that could cause an ecosystem shift. However, on a smaller scale the longer-term introduction of sediment, particularly if fine-grained, from exposed banks at crossing points, could locally shift habitat conditions in a direction that displaces species adapted to coarser grained substrates. This is of particular relevance to the maintenance of salmonid spawning habitat within rivers, given both the influence upon egg and larval mortality and longer-term habitat suitability that fine sediment infiltration into gravel beds may have.

With respect to the latter effect it should be noted that the suitability of spawning habitat within a river and within catchments may vary naturally from year to year, depending on factors such as hydrological events (e.g. floods) and changes in channel form, and location and variation in sediment erosion and transport processes associated with these factors. Anadromous salmonid populations are well adapted to these dynamic changes as adults often stray, are highly fecund and juveniles are mobile. Straying by adults aids in the reestablishment of populations in disturbed areas on large and local scales provided there are suitable spawning and rearing conditions available. Pacific salmon are relatively fecund for benthic-spawning fishes with large eggs, which contributes to the establishment and growth of a local population if conditions are favourable.

4.1.4 Summary of effects associated with wet-cut watercourse crossings

Sediment disturbed and released during in-stream construction (i.e. wet cut construction) has the potential to affect downstream aquatic life through the suspension and subsequent deposition of sediment. The effects of this disturbance will depend on the nature of the construction activity itself (e.g. duration, timing, management measures) and the attributes of the receiving waters (e.g. existing suspended sediment concentration levels, riverbed substrate conditions). The following effects are highlighted:

- The removal of deposited sediment from affected habitats is dependent on subsequent flow conditions, physical attributes of the watercourse such as gradient and streambed composition, and the characteristics of the deposited sediment. Full recovery of streambed conditions has been reported to occur between six weeks and two years after construction;
- Short-term reductions in the abundance and diversity of benthic invertebrate and fish communities have been observed downstream of pipeline water crossings. These effects probably result from emigration by invertebrates and fish out of affected downstream areas and post-construction reductions in habitat suitability due to sediment deposition; and

- Observed changes to aquatic communities are typically non-residual and recovery to post-construction conditions is usually reported within a year. Recovery of benthic invertebrate and fish communities coincides with that of affected downstream habitats.

Additionally, in situations where the long-term exposure of sediment liable to erosion at the crossing point occurs, the continued introduction of sediment into a watercourse may lead to localised and longer-term impacts on aquatic flora and fauna.

Minimising the short and long-term ecological effects of wet-cut pipeline construction across rivers is, therefore, strongly linked to ensuring that sediment release during and post construction is minimised. This can be achieved through a number of mechanisms, primarily linked to in-river construction techniques and suitable restoration measures (see Section 5.3). Besides actually limiting the direct and indirect effects of the works during construction, the appropriate timing of works should also be an integral component in developing an overall crossing strategy, particularly with respect to minimising potential impact on ecologically sensitive interests (e.g. rivers with significant areas of salmon spawning habitat). Chapter 5 highlights and provides further detail on the process of strategy development and demonstrates how ecological factors have been considered in the process, so as to minimise potential impacts during and post construction.

4.2 ENVIRONMENTAL IMPACTS ASSOCIATED WITH HORIZONTAL DIRECTIONAL DRILLING (HDD)

HDD crossings are often undertaken to minimize the potentially adverse environmental effects associated with trenched pipeline construction techniques for larger watercourse crossings. Nevertheless, HDD as a technique does not guarantee that all adverse environmental effects will be prevented. Potentially adverse effects can occur and include:

- Introduction of drilling cuttings and mud into a watercourse and any subsequent clean-up operations;
- Disruption of aquifers that feed in-stream up-welling;
- Improper water withdrawal;
- Larger footprint (for equipment, bridge construction, mud pits and spool fabrication site) invariably involving cutting down of trees.

Bentonite drilling muds are often utilized in HDD applications to keep cutting tools cool, as a lubricant, to remove cuttings, and to confine liquids by creating an impervious coating on the inside wall of a drill hole. However, drill muds can seep up through fractures in the upper soil profile (inadvertent returns), and, in the case of watercourses, potentially seep into or be released into the water column. With respect to aquatic ecology and fish populations in particular, the release of very fine-grained sediment during HDD operations may result in:

- Elevated turbidity and increased deposition of sediment downstream;
- Interruption of fish movements up or downstream; and
- Increased stress to individuals;

In addition, injury to or mortality of fish may occur due to improper operation and screening of water pump intakes and the accidental release of toxic substances into a watercourse through spills.

4.3 OTHER POTENTIAL SOURCES OF IMPACT ASSOCIATED WITH PIPELINE RIVER CROSSINGS

4.3.1 Hydrotesting

Hydrotesting will be undertaken to detect pipeline leaks and weaknesses. Prior to hydrotesting, the pipeline is pre-cleaned and gauged. The hydrotesting will be done in short pipeline sections; the lengths of these sections will depend on the safety class of the pipeline and terrain profile. Water for the testing will be drawn from watercourses along the pipeline route. Where practical, the discharge of hydrotest water will be undertaken in the same watershed in order to avoid mixing of waters with varying biotas. If this is not possible, discharge in the open field shall be considered.

Though in general hydro-testing will be undertaken during the summer months, there may be a need to do some hydro-testing during the winter months for the short pipe sections that will be installed at the winter river crossing sites. The pre-hydrotesting for these river crossings will be undertaken above ground. Because the testing will take place in subzero temperatures, it may be necessary to selectively employ an antifreeze (mono ethylene glycol or MEG).

Ethylene glycol is readily biodegradable and generally of low toxicity to aquatic organisms. Toxic thresholds for microorganisms are above 1000 mg/litre. EC_{50}s for growth in microalgae are 6500 mg/litre or higher. Acute toxicity tests with aquatic invertebrates where a value could be determined show LC_{50}s above 20,000 mg/litre, and those with fish show LC_{50}s above 17,800 mg/litre (World Health Organisation, 2000). However, Laboratory tests exposing aquatic organisms to stream water receiving runoff from airports (where large amounts of antifreeze (de-icer) are used) have demonstrated toxic effects and death.

Given the potential toxic effects of antifreeze, its use and disposal should be carefully controlled and managed in order to ensure that it does not enter watercourses. Potential measures are discussed in Section 5.5.1.

4.3.2 Oil spills

Oil spills into watercourses during construction may result from leakages or the handling of fuels, and generally, if they occur, will be small. The potential impacts of oil spills in the aquatic environment are generally well studied and understood. The introduction of oil, or petroleum products, into a watercourse can have direct acute effects on aquatic organisms (e.g. death due asphyxiation or ingestion of significant amounts of oil) or chronic effects due to the longer-term residence of potentially toxic products in sediments or the water column. The effects of oil spills in rivers will vary depending on a wide variety of factors including the physical characteristics of the receiving watercourse (e.g. flow velocity, sediment type etc.), climate, ecological sensitivity etc. However, the key point is that although spills in rivers may have less of an impact that in standing waters, the potential for detrimental impacts may be high, even from small spills, and therefore stringent measures should be adopted during construction to avoid spills in the first place (see Section 5.5.2).

4.3.3 *Induced access*

Besides the direct ecological impact of vegetation clearance from the pipeline ROW, the ROW itself may increase accessibility and habitat/ecological disturbance in previously inaccessible areas. Of particular concern is the potential for increased access to river sections that the ROW may provide and the potential for increased poaching of salmon stocks in some rivers. Specific mitigation measures will be taken to minimise this potential impact (see Section 5.5.3).

5 STRATEGY DEVELOPMENT AND IMPLEMENTATION

This section presents the River Crossing Strategy that has been developed for river crossing works for the Phase 2 Project pipelines and fibre optic cable. Implementation of the strategy is intended to minimise impact on key ecological receptors (Section 3) and the potential effects and impacts of the methods to be used (Section 4).

Section 5.1 describes the classification of watercourses to be crossed according their ecological and hydrogeomorphological sensitivity. This classification is used to undertake a final evaluation of which of the river crossing methods (the wet cut method or HDD) will be implemented (Section 5.2). Having selected the river crossing method, mitigation actions based on the sensitivity of the river system using hydrogeomorphological and ecological criteria are devised in Section 5.3-5.5. While mitigation actions will aim to minimise the effects and impacts of the works, residual effects and impacts may still occur. These are summarised in Section 5.6.

In addition to the classification system described below and its linked mitigation measures, the overall strategy also includes consideration of the timing of the construction works, with particular emphasis given to the phasing of works on sensitive rivers, as identified through the classification process. This timing component of the strategy is effectively a mitigation measure aimed at ensuring that the construction works will be undertaken at a time when the potential for environmental impact is minimised. Consideration of the most appropriate crossing period has been based on hydrological and ecological data (as detailed in Sections 3 and 4) and specific data will be used in refining the phasing within the defined crossing period for some river groups (see Section 5.3).

5.1 SENSITIVITY CLASSIFICATION AND IMPACT RATING

The pipelines and fibre optic cable will cross a total of 1,084 watercourses. However, on the basis of available data, it is apparent that some rivers are ecologically more sensitive and/or of value for commercial fisheries interests and/or the risk of disturbance to fluvial and ecological processes as a result of the works is greater for some rivers than others. In order to determine mitigation measures appropriate to the level of sensitivity and/or potential risk, an impact rating has been developed that takes into account the ecological sensitivity/fish value and the potential susceptibility to disturbance. This rating is elaborated below and summarised in Figure 5-1. The outcome of this analysis will be utilised in assigning appropriate mitigation measures to individual rivers in order to meet the objectives outlined in Section 1 and will be detailed in the execution plan for individual rivers where appropriate.

The basis for the categorisation shown in Figure 5-1 is the three-tier system used by Sakhrybvod to evaluate the value of individual rivers with respect to commercial fish interests (i.e. salmonids). The Sakhrybvod classification distinguishes the following categories and has been applied to the rivers that the pipeline crosses to determine the number of rivers falling into each category, as listed below:

- Highest fish category (482 rivers);
- 1st class (235 rivers);
- Not Fish Industry (NFI), including water channels of reclamation systems (367 rivers).

The latter two categories mainly include small channels and streams in which any works undertaken in-river would be highly unlikely to have an adverse impact on salmon populations or protected fish species, if present in the watercourses. These rivers are therefore excluded from further analysis of potential ecological sensitivity, although their contribution to cumulative effect at the catchment level will be considered through the hydrogeomorphological impact analysis process described below.

Rivers included in the highest fish category may support significant areas of spawning habitat or are tributaries of rivers that may be of importance for salmon. Thus, the potential exists for works within these highest fish category rivers, even if not important for fisheries in their own right, to have an impact on downstream spawning areas as a result of the transport of suspended or bedload sediment from upstream. Because of this potential for impact, Sakhrybvod has determined that these rivers can only be crossed outside of the spawning season of commercially important salmon species.

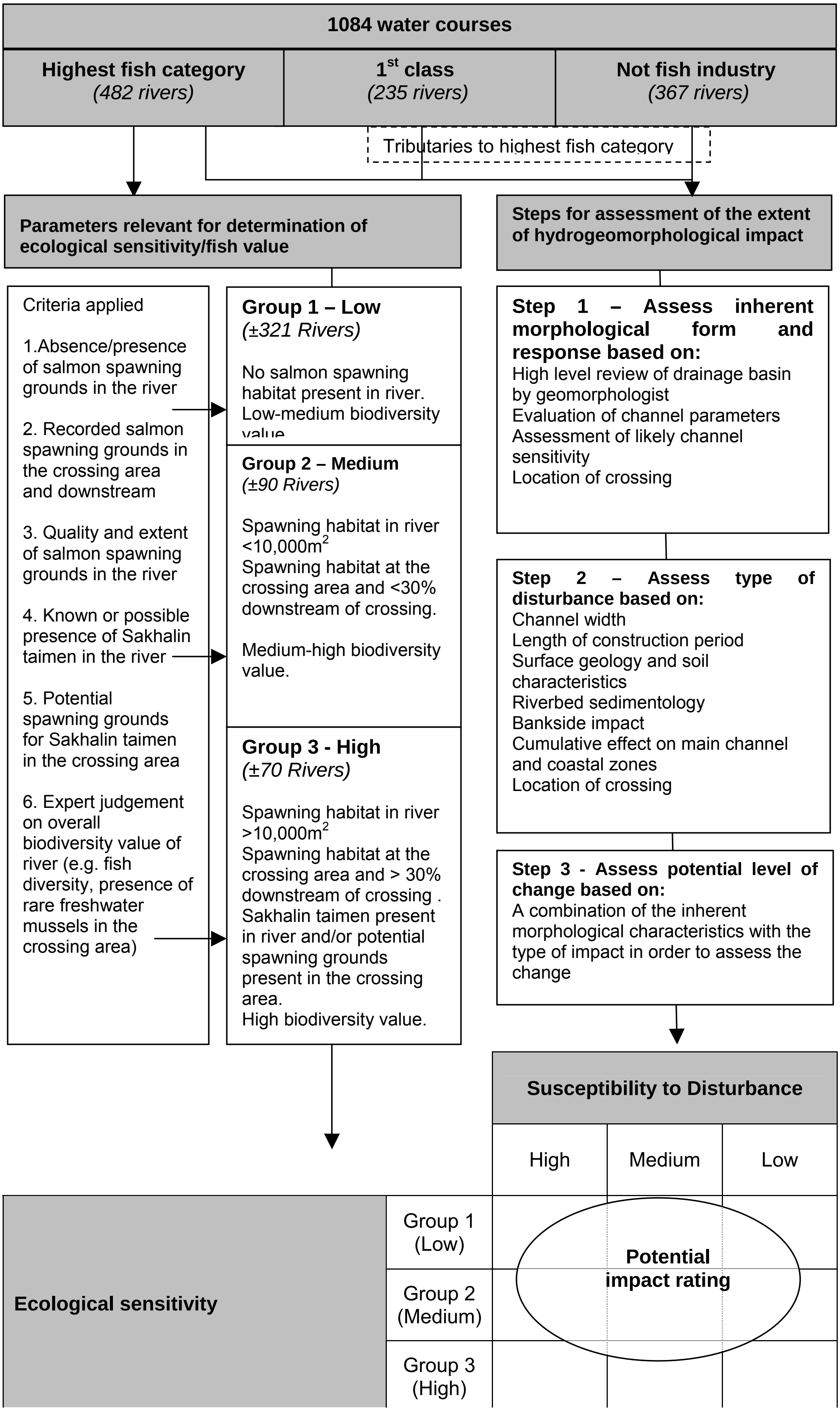

Figure 5-1: Assessment technique for potential impact rating

5.1.1 Ecological sensitivity and commercial fisheries value

Of the 482 rivers classified as highest fish category by Sakhrybvod, it is apparent (as shown in Figure 5-1) that on the basis of survey work, almost 70% do not possess salmon spawning habitats at, or downstream of, the crossing point. These Group 1 rivers are therefore, with respect to direct impacts on salmonid populations during and post-pipeline crossing, considered to be of low sensitivity. However, the crossing of some of these rivers may generate sediment that could impact on downstream spawning habitat in rivers of known value for salmon. This potential for impact (i.e. cumulative impact) at a wider catchment level is considered through the hydrological assessment component of the sensitivity analysis as described below.

On the basis of data gained through survey work and review of historical data held by Sakhrybvod, Sakhalin Energy has identified 160 rivers (of the highest fish category) that have recorded salmon spawning areas, of varying extent and quality, and which may also be of importance for a wide range of other fish species and aquatic ecology. In determining the sensitivity of a river, the quality and extent of spawning ground for salmon species, notably pink salmon and chum salmon at the crossing point and downstream will be taken into consideration, as this aspect may have a bearing on potential impact and the application of specific mitigation measures. For instance, although a river may contain significant areas of salmon spawning habitat, this may occur upstream of the crossing point and therefore the effects of the construction work on spawning habitat could be negligible. For the purposes of the classification, a figure of 30% of available spawning habitat occurring downstream of the crossing point has been used as a threshold.

The assessment and extent of spawning ground quality will be based on historical data and data from survey work (e.g. SakhNIRO 1998, 1999, Averina 2003, 2004). During survey work, the determination of spawning ground quality and quantity by Averina and salmon abundance was based on the approach contained in Sakhalinrybvod (1987) “Brief manual on determination of spawning grounds and salmons number in Sakhalin spawning rivers”. This approach bases quality on the degree of fine sediment present within the spawning gravels, as this provides an indication of the likely survival rate of salmon eggs and embryos. The following thresholds were used in assessing quality (Averina 2004):

- Approximately 1-10% fine sediment present (survival rate > 80%): good quality spawning grounds;
- Approximately 10-20% fine sediment present (survival rate 40-80%): medium quality spawning grounds;
- Greater than 20% fine sediment present (survival rate < 40%): poor quality spawning grounds.

These criteria for determination of spawning habitat quality are based on specific data collected during survey and research work in Sakhalin rivers and are comparable with the data obtained from studies into sediment infiltration and salmon egg/fry survival from other parts of the World (see Section 4.1.3).

Some of these rivers are also known to support Sakhalin taimen or they possess physical characteristics in the crossing area, which make them suitable as spawning sites for this species.

Initial high-level review using existing survey and historical data and application of the criteria listed in Table 5-1 indicates that approximately 70 of the 160 rivers support significant areas of salmon spawning habitat that could be impacted and/or are known to support taimen or, taimen spawning grounds may be present in the crossing area. These 70 or so rivers have been placed in a high sensitivity category (Group 3) and the remainder (90) in a medium sensitivity (Group 2) category. It is likely that there will be some refining of numbers and interchange of rivers between these groupings during the detailed assessment process described in this section, but that overall the numbers mentioned above are unlikely to be altered to any great extent. It should also be noted that Group 1 tributaries that flow into Group 2 or 3 rivers, and which have an assessed high-medium susceptibility for disturbance with respect to the receiving rivers (see section 5.1.2) will be treated for the purposes of construction as Group 2 or 3 rivers themselves.

Further review of the available data will be undertaken by an ichthyologist/ecologist and, where appropriate, additional consultation with local representatives of Sakhrybvod to finalise this categorisation process.

With respect to the potential presence of Sakhalin taimen the following precautionary approach will be adopted. Where specific data are available which clearly demonstrates that this species is present in the river to be crossed, and the ecological characteristics of the crossing area are such that a potential impact could occur to this species or its habitat, then the river will be classified as being of high sensitivity. In the situation where the presence of Sakhalin taimen is not confirmed, but potential spawning habitat for this species may be present in the crossing area then the river will also be included in the highest category.

5.1.2 Assessment of hydrogeomorphology

The direct impact of the pipeline river crossings on the morphology of the river will be considered through an assessment of the river's susceptibility to disturbance. The assessment will take account of the hydrological and geomorphological conditions in the river both at the site of the crossing and at the wider river network or catchment scale. It is important to consider the response of the river to direct impact through trenching, backfilling and reinstatement as this will impact upon local and potentially further downstream as sediment is released and transported.

The assessment of hydrogeomorphology has two purposes; first to classify the river in terms of high, medium and low susceptibility to disturbance to inform the execution planning stage and second to feed into the development of mitigation measures during and post construction.

The assessment process falls into three steps as shown in Figure 5-2.

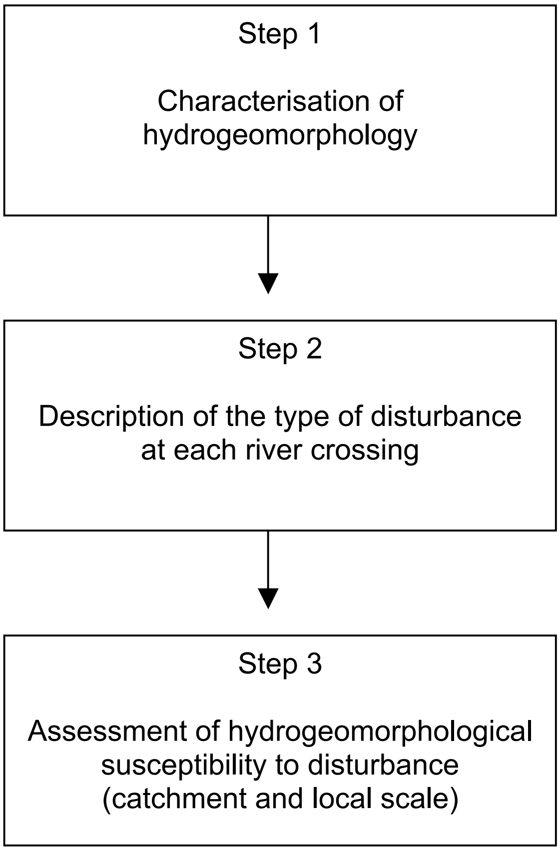

Figure 5-2: Hydrogeomorphological assessment process

Step 1 Characterisation of hydrogeomorphology

Hydrogeomorphological data from a wide range of sources including reports, survey data, technical drawings (alignment sheets) and map based data are collated in an assessment form (see the example in Annex E). The specific data are grouped under the following key areas

Heading	Description
Climate and rainfall	Typical climatic regime for the river and associated rainfall characteristics.
Drainage Basin Character	Drainage network data locating the river crossing in the context of the river network, proximity to the coast, and characteristics of floodplain and topography more local to the river crossing site. All these parameters influence the basic hydrogeomorphological character and functioning.
Channel characteristics	The form of the river channel at the site (channel geometry and bed and the processes relating to changing river form (flow regime and morphological activity) are documented in this section. Washout zones predicted using numerical modelling by State Hydrological Institute have been included to indicate potential for geomorphological change in width and depth over the next 30 years.

Step 2 Type of disturbance

This section considers the nature of the disturbance that will vary at each river crossing. The number of crossings at each site depends on whether the oil, gas and Fibre Optic Cable pipelines will cross the channel and how many times at a site. The magnitude of the impact is taken into consideration by assessing the pipeline length for each type and the total length related to the channel width. This ratio gives in indication of the relative magnitude of the disturbance at the site. The duration of the crossing is also recorded.

Step 3 Assessment of susceptibility to disturbance

This step combines the information on the characteristic hydrogeomorphology with the type of disturbance to assess the potential extent of disturbance. It is important to consider both together as it is possible that the type of disturbance may be similar at two river crossings yet the susceptibility to disturbance very different as a result of differing hydrogeomorphological conditions. For example, one river may be an active meandering floodplain river with sand, gravel alluvial bed and banks that may respond very different from a deeply incised river with predominantly clay bed and banks. It is also important to consider the influence of the drainage basin network on river channel response and the assessment of susceptibility to disturbance has therefore been split into two parts: local and catchment.

High-level indicators of susceptibility to disturbance have been used for both the local and catchment scale assessment.

- Potential for a cumulative impact in the same river
- Potential to add to cumulative impact on downstream tributary
- Unaffected tributaries downstream of crossing
- Location in catchment to confluence with main rivers/sea
- Contributing directly to closed coastal system
- Direct sediment supply from hillslope
- Potential for morphological change
- Potential for recovery
- Extent of disturbance
- Boundary sediment type
- Located on straight section
- Number of crossings

Each high level indicator will be assigned a high or low value and the results used to define a high, medium and low hydrogeomorphological condition for each river. The use of these indicators will ensure consistency in approach for each assessment. They will also be combined with an expert assessment of any particular issues or characteristics relevant to the site that may potentially have a significant influence on the overall classification. Data from all three steps will be used to help define the specific mitigation measures required at each site in discussion with site engineers and scientists.

5.1.3 Overview of impact of the crossing approach on sensitive salmon spawning rivers

As discussed above, a sensitivity analysis and impact rating for each individual river will be undertaken and from this, specific mitigation measures to limit potential impact at an individual river-scale developed and implemented. While this process will provide an assessment of the potential impact of the works at the river specific level, it is also useful to gauge the overall potential influence of the pipeline construction works on salmon spawning habitat at a system level.

Using data provided by Sakhrybvod (2002) from river passports (as reported in specific reports for river crossings by ECMOS, listed in Annex B), for all of the highest fish category rivers with spawning habitat (i.e. corresponding largely to Groups 2 and 3, see Fig 5-1) to be crossed the total area of available salmon spawning habitat (pink and chum salmon) is approximately 10,500,000 m^2, with 2,400,000 m^2 of this occurring downstream of the crossing sites (i.e. an approximate 77/23% split between upstream and downstream habitat for all of the rivers in these groups combined). Specific data on the extent of spawning habitat for silver and cherry salmon is not available. However, on the basis of the ecology of these species it is likely that silver salmon utilise spawning habitat that is also used by pink/chum salmon, while cherry salmon make use of habitat located in river headwaters (i.e. largely above the majority of the river crossing sites).

At the crossing sites, a 200 m strip of river (50 m upstream and 100 m downstream of the Right Of Way (50m width)) has been surveyed to determine the extent of spawning habitat present and which could potentially be impacted by the construction works (Averina 2003, 2004). Within this 200m zone, a total of 53,000 m^2 of potential habitat (0.51% of total available habitat) occurs across all of the medium-high sensitivity rivers. It should be noted that this figure does not represent the total area of spawning habitat that could be impacted by the construction works as a significant proportion may occur in the section upstream of the crossing and which would therefore be outside of any influence from the works. However, it does provide a basic estimate of the scale of area that could be subject to the effects of the crossing works. Specific calculations of the area of potentially impacted spawning habitat at each of the medium-high sensitivity river crossings have been provided for the purposes of gaining approvals from the relevant authorities (see ECMOS reports). However, the methodology used is based on the consideration of a single sediment grain size and does not take account of potential variability in fluvial conditions during the winter period. For these reasons, the ECMOS calculations have not been used in assessing potential impact, although the use of these data in facilitating the approval process is recognised

Using the Averina (2003 and 2004) data, and as reported by ECMOS, approximately 15,300m^2, or about 0.15% of the total potential spawning habitat, is present within the width of the ROW at the crossing points. This figure represents the total area occupied by the pipeline trenches (oil and gas) at each of the river crossings (i.e. width of the trenches multiplied by the width of the river channel). Due to the construction works this 15,300 m^2 would effectively be lost to spawning salmon returning to the rivers immediately following construction and any eggs and young fish present in spawning beds would be destroyed. Additionally, the works would disturb sediment during trenching and backfilling operations and a component of this sediment could be entrained through fluvial process and transported downstream. Although the overall objective of this strategy is to minimise the potential for the introduction of sediment into rivers during construction, it is recognised that due to sediment entrainment and transport potential spawning habitat downstream of the RoW could be adversely impacted.

The transport distance of sediment suspended in the water column varies according to a number of parameters but is largely controlled by sediment grain size, water depth and current velocity. As stated in Section 4.1.1, fine sediment may be transported significant distances downstream, suspended in the water flow (the sediment plume), while coarser material may deposit out of the flow close to the site of disturbance. Determining the extent of sediment transport can provide an indication of the likely zone of effect within a river. As reported in Section 4.1.3, it is sediment in the grain size range of 0.05-1 mm (silt – coarse sand) that is of critical importance with respect to potential impact on salmon spawning habitat.

With respect to the above, the worst case-scenario would be that all potential spawning habitat downstream of the crossings was subject to deposition of material of critical grain size from the sediment plume generated during the construction works. This would equate to the temporary loss of approximately 23% of all available spawning habitat in the Group 2 and 3 rivers. Such an occurrence is considered extremely improbable and a more realistic estimation of potential impact area can be determined, as discussed below.

As previously stated, works on the medium-high sensitivity (Groups 2 and 3) rivers would be undertaken during periods of low flow. Under these conditions, which are typical of Sakhalin winters, river water depths are low (in the region of 0.1-1m, see Section 3.3) and flow velocities are also low. Expected transport distance of all but the finest sediment (i.e. silt grade <0.06 mm) would therefore be relatively short as sediment would settle out of the shallow and relatively slow moving water within a short period of time. Evidence presented from other wet pipeline crossings indicate that while extensive sediment plumes within rivers can be created, sediment in the fine-coarse sand grade is generally deposited out of the plume within a few hundred metres of the crossing site (see Reid and Anderson 1999 and information presented in Section 4.1.1).

Using the information and generalised figures presented in Section 4.1.1, for medium silty and fine sand (diameter between 0.2 and 0.1 mm) transport distance is around 100 times the riverbed depth. For silt particles (diameters smaller than 0.01 mm) transport can be as far as 500 times the river depth and fine clay can travel even farther. Typically, using these data, the indicative distances for downstream transport of sediment for the majority of the Sakhalin rivers during low flow winter conditions (i.e. 0.1-1m water depth) could therefore be in the order of 10-100 m for medium silt-fine sand and up to 50-500 m or greater for silt. Clearly, for rivers where water depths are greater than 1 m then the transport distances will be correspondingly longer. What this estimation indicates is that for sediment particles in the critical range (i.e. 0.05-1 mm) the likely depositional zone, and therefore potential zone of effect, would be largely confined to an area of 100-500 m downstream of the river crossing points. For many of the smaller watercourses and those where coarser substrates predominate, the potential zone of effect could be less than 100 m while conversely in deeper rivers or those where fine sediments in the critical range predominate the zone of effect could extend beyond 500 m. Taking the above into account an estimate can be made of the likely disturbance to salmon spawning habitat within the Group 2/3 rivers.

Assuming that the potential loss of spawning habitat within the RoW section remains the same regardless of conditions (i.e. 15,300 m^2 would be temporarily lost due to trenching) and, using the Averina (2003, 2004) data, the remainder of the spawning habitat can be split between upstream (50 m) and downstream (100 m) sections. Thus, the extent of spawning habitat in the downstream survey section for all rivers equates to 25,130m^2 (53,000 – 15,300) / (150/100)) of spawning habitat. Extrapolating this figure downstream (making the assumption that spawning habitat occurs uniformly downstream at the same extent as it occurs in the crossing range) provides the following figures: 50,260 m^2 of spawning habitat within 200 m of the RoW, 75,390 m^2

within 300m, 100,520 m^2 within 400 m and 125,650 m^2 within 500 m. These figures are presented in Table 5-1 in the context of the overall potential spawning habitat available within the rivers under consideration.

These results cannot be directly translated into potential level of impact. However, what these results do suggest is that the overall area of salmon spawning habitat that could be affected, is still relatively small in comparison to the total available area in the Group 2 and 3 rivers (see Table 5-1) and ranges from 0.38% to 1.34%.

Table 5-1: Calculated area of salmon spawning habitat potentially affected by the river crossing works for a range of zones of effect

)istance ownstream f crossing ection	ɩrea of spawning habitat ffected by works in RoW ɱ^2)	ɓ of total available pawning habitat potentially ffected by sediment ɾansport downstream of rossing (m^2)	'otential total area of pawning habitat affected by ɿe works (m^2)	'otential total area of pawning habitat affected as ercentage of total area of vailable spawning habitat in ll medium-high sensitivity vers
100m downstream of RoW	15,300	25,130	40,430	0.38
200m downstream, of RoW	15,300	50,260	65, 560	0.62
300m downstream of RoW	15,300	75,390	90,690	0.86
400m downstream of RoW	15,300	100,520	115,820	1.1
500m downstream of RoW	15,300	125,650	140,950	1.34

It should be noted that the area of effect calculated above relates to potential impact on spawning habitat through sediment infiltration (i.e. the area of sediment in which increased embeddedness could occur) and does not relate to the length/area of river that would be affected by the sediment plume created during the pipeline installation works. The transport distance of fine sediment could be significant, but its transport and subsequent deposition in areas of low energy within the river systems, or potentially at the coast, would be unlikely to have a significant affect on salmon populations. Adult spawning fish would not be present within the rivers at the time that the construction works are being undertaken (apart from silver salmon, which could potentially still be spawning at the beginning of December) although the juveniles of some species (silver, cherry and taimen) may be present within the rivers and could potentially be adversely affected (see Section 4.1.3 and Table 4-3).

In the light of the uncertainties in predicting potential zones of effect, the river crossing strategy places an important emphasis on monitoring in assessing the actual extent of impact. In particular, monitoring undertaken during the construction of the earlier river crossing this winter will be used to verify the initial impact assessments/classifications (e.g. susceptibility to disturbance classification) of later (and more sensitive) rivers in an adaptive mitigation management process. This is explained in greater detail in Section 6.

As referred to throughout this overview, the percentages calculated above represent potential habitat, and it should also be noted, of variable quality that will support varying densities of eggs and young salmon. It is highly unlikely that in any one spawning season that all of this habitat would be utilised by fish and therefore, in relation to potential effects at the resource/stock level, the loss of this area cannot be directly translated as loss of spawning productivity (i.e. eggs and young salmon present within the affected substrates would not constitute the % habitat loss of the total stock of the year in which construction occurs). The calculated figures also only represent the potential loss of habitat for a subset of the total spawning habitat available on Sakhalin Island. The pipeline crosses the major river systems of the Island and therefore much of the available habitat of these systems is included in the above calculations. However, given the presence of numerous smaller river networks in the south, west and north of the island that would remain unaffected by the works and which are highly likely to support spawning habitat, the likely loss in relation to the entire resource would be lower.

From both ecological and commercial perspectives, any influence of the construction works on salmon populations would be temporary. Evidence presented in Section 4.1 demonstrates that the effects of wet cuts on riverine ecology and fish fauna (including salmonids) is limited with recovery of food resources and habitat occurring typically within a 1-2 year period. Recovery of the overall habitat would also be assisted, and enhanced in the longer term, through two mechanisms:

The placement of approximately 26,000 m^2 of gravel substrate at crossing points following installation of the pipelines, which would compensate for the 15,300m^2 directly disturbed within the RoW during the works; and

The development of a SEIC initiated river restoration project, in association with relevant authorities and other stakeholders. It is proposed that this project will aim to restore degraded habitat within selected river catchments on the island to achieve no net loss of this habitat overall as a result of pipeline construction activities. Potentially, the restoration of salmon spawning habitat initiative could focus on locations where human activity has led to the degradation of in-stream habitat, such as through the input of excess fine sediment, for instance, as observed on the River Travyanaya, that lies within sections 3 and 4 of the pipeline. Appropriate management measures will be viewed within the overall concept of restoring ecological function to the selected systems so as to benefit a wide range of species and not just spawning salmonids. Additionally, the possibility of making links with socio-economic issues (e.g. sustainable fisheries) will also be considered and adopted where appropriate.

The potential mortality of eggs and young salmon within spawning gravels and the temporary loss of between 0.38-1.3% of potential spawning habitat for a period of 1-2 years would also be highly unlikely to relate directly to commercial productivity and catch. In many rivers, particularly those of the north and east, significantly larger areas of spawning habitat are likely to be available in comparison to stock levels (i.e. in these rivers the population levels are unlikely to be habitat limited at the present time). Much of the commercial catch is also focused on the use of hatcheries, where potential habitat loss in the rivers is not an issue. Additionally, available data indicates that approximately 70% of the pink salmon catch occurs from the rivers and hatcheries of the southeast of the Island (from Aniva Bay to Pugachevo on the east coast). Of all of the crossings over medium-high sensitivity rivers, approximately 30% occur in this area. This suggests that with respect to commercial interests that the influence of the construction works is likely to be proportionally much less in the area of greatest production than in areas of lesser commercial production.

In summary, this brief overview assessment indicates the following:

- The overall direct disturbance to spawning habitat as a result of the river crossing construction works is considered to be limited and has been calculated as approximately 15,300 m^2 of total spawning habitat present in medium-high sensitivity rivers that will be crossed by the pipeline;

- Using an indicative proportional model, the total area of available spawning habitat within the potential area of impact of the construction works is 0.38-1.34% of total available spawning habitat in the medium-high sensitivity rivers that will be crossed by the pipeline;

- The impact on spawning habitat will be temporary and, typically on the basis of available research and monitoring data, recovery is likely within 1-2 years;

- While mortality to salmon eggs and young present in the river gravels will occur, and spawning habitat suitability may be compromised for at least a year following the works, the impact on commercial productivity is likely to be negligible; and

- In-river restoration works will be undertaken to ensure that the total spawning habitat resource is maintained and enhanced following the cessation of the construction works.

Further consideration of the potential impact of the works will be undertaken during assessment of the individual river crossing prior to the works being undertaken, as detailed in the process in Section 5.1 and a cumulative assessment undertaken once rivers within a complete catchment basin have been assessed. The results from this process, along with any relevant data derived from monitoring, will be evaluated through an ongoing process. Comparison with the conclusions reached above will be undertaken and, if required, further refining of the overall assessment undertaken to ensure that mitigation measures at both the individual river and system level are appropriate to the level of potential impact.

5.1.4 Execution and Monitoring Plans

The result of the sensitivity analysis (Section 5.1.1 and 5.1.2) will be incorporated in the River Crossing Execution Plan and Monitoring Plan. The Execution Plan and Monitoring Plan will be developed with input from internationally experienced specialists in river hydrology, river ecology and erosion control. The execution plan and monitoring will be finalised prior to construction. The Execution Plan will include River Crossing Assessment Sheets that specify for each river crossing:

- The classification category based on ecological sensitivity and the potential extent of hydrogeomorphological impact;
- Selected crossing technique;
- Equipment and resources required;
- Mitigation measures based on impact analysis and which will be applied including construction time, construction period and erosion control measures;
- Method of installation of the FOC;

- How riverbed and river bank will be reinstated; and
- Parameters on which the crossing will be monitored.

An outline of the Execution Plan is provided in Annex D. The specific mitigation measures for each river will be summarised in River Crossing Assessment Sheets for each river. An example is shown in Annex E. An outline of the Monitoring Plan is provided in Annex F.

5.2 EVALUATION OF CROSSING TECHNIQUE

As stated previously, the objectives of the overall strategy are to minimise the potential effects of the river crossing works on riverine ecology. To achieve this, certain techniques and measures need to be adopted and implemented during construction, particularly with respect to those rivers that have been identified as of high ecological sensitivity and/or have a high potential extent of hydrogeomorphological impact. There are a certain number of conditions that effectively set limiting boundaries within which the strategy has to be developed, including conditions and restrictions of Russian Law and approving agencies, climatic and physical conditions and logistics associated with the scale of the project.

The approving agencies have refused the use of dry-cut crossings (see Section 2.4.4) and therefore the strategy has been developed on the basis that the vast majority of the river crossings will be constructed using the wet cut method complemented with appropriate water management and control measures (see Section 2.4.3).

For eight (8) rivers it was decided, in consultation with the relevant Russian authorities, to construct the crossing by HDD. These rivers are:

- Val;
- Tym (first and second crossing);
- Naiba;
- Nabil;
- Vazi;
- Buyuklinka; and
- Firsovka.

Subsequent to this decision, technical surveys have indicated that HDD for the Buyuklinka river is technically unlikely to succeed due to the unsuitable nature of the subsurface geology through which drilling would have to take place. The crossing of the Buyuklinka will therefore be constructed using a wet cut technique in winter after securing the necessary approvals (including appropriate fish damage compensation) from the relevant Russian Federation agencies. It has also been determined that the execution of HDD for the Naiba River and the second Tym crossing in its original location are not technically feasible and studies are being undertaken to determine a potential re-route which would permit HDD to be used.

It is unlikely that further HDD crossings will be used. However,SEIC will evaluate if any additional HDDs would be useful and practical for the small subset of rivers that are assessed to be of both high ecological sensitivity and high potential extent of hydrogeomorphological impact and where the particular selected mitigation measures might be difficult to implement. Although, it is possible that HDD would be beneficial for this subset, it should be recognised that the HDD technique might not be feasible due to topographical or geological factors at the crossing location (as was the case with the Buyuklinka).

5.3 MINIMISING IMPACT FOR WET CUT CROSSINGS

The wet cut method is used worldwide in the majority of watercourse crossings. With a wet cut, sediment disturbance and transport can in cases be high, depending upon factors such as water velocity/volume and the nature of the substrate that is being excavated. As a consequence, environmental impacts (e.g. alteration of in-stream habitat) could also be significant, although as discussed in Section 4.1, these effects are normally of a short-term nature. The key to minimising these impacts and promoting ecological recovery within an optimal period is to both reduce the potential for sediment to enter the watercourse during construction by using effective water management and control techniques and to undertake the works at an appropriate time when environmental sensitivities are reduced. SEIC has therefore adopted the following approach:

- In the planning phase, the timing of the construction and the possibility of consecutive crossings will be considered (Section 5.3.1);
- During the execution phase, the focus will be on reducing the potential for sediment release by applying standard industry practice, minimising in-stream construction time and proper erosion control (Section 5.3.2);
- After construction, the reinstatement will ensure proper restoration of both river bed and river bank (Section 5.3.3);
- In the Water Protection Zone, erosion control measures will be utilised to reduce the potential for sediment run-off into the watercourse (Section 5.3.4).

SEIC believes that with these measures in place, the residual impact is minimal. The monitoring programme will determine the actual impact.

5.3.1 Planning

Timing

Determination of the most suitable timing for the construction works has been evaluated by analysing available data on ecological sensitivities, hydrological conditions and logistical aspects.

From an ecological perspective (e.g. the effect of increased suspended solids' concentrations on migrating salmonids), impacts can be avoided by timing in-stream construction activity to coincide with periods of reduced sensitivity. This is of particular importance with respect to the ecological requirements of commercially valuable salmonid fish, rare and protected species and the ichthyofauna as a whole.

As discussed earlier, the life cycle of the various salmon species present in the rivers varies across the year with migration, spawning and hatching taking place at differing times for the different species. Susceptibility to the effects of in-stream construction also varies with respect to the stage of the breeding cycle. Thus, given the presence of salmonid fish at all stages of their life cycle in the watercourses, the potential for impacts on fish (adults, young or eggs) could occur regardless of when construction activity takes place. Determining what is the most appropriate part of the year to undertake crossing is therefore very reliant on identifying time windows when the effects of raised suspended sediment concentration and in-stream sediment deposition would be minimised (with respect to the life-cycle stages for all of the important salmon species present).

It is apparent that with respect to "susceptibility" there are two critical periods in the salmon reproductive cycle: the spawning period; and the period when eggs/embryos are present in-stream gravels. The spawning season varies per species and starts as early as May for Sakhalin taimen and can last until mid-December for silver salmon. For the key commercial species (pink and chum salmon) the spawning season is July-September. Eggs and embryos for all species, except Sakhalin taimen, are present in river gravels mainly during the autumn-winter period (October-April).

Selecting the most appropriate period for construction therefore represents achieving a balance between potential impacts to adult fish populations and spawning activity/behaviour and egg hatching and embryo survival success. In relation to this, the following potential impacts linked to the release of sediment and increased in-stream suspended sediment concentrations during construction are relevant:

- **Direct disturbance to spawning grounds**. At some crossing sites, construction work would lead to the direct disturbance of spawning habitat, approximately 15,300 m^2 according to available data (Averina 2003, 2004). If works were therefore undertaken during or immediately prior to the spawning season, the availability of suitable habitat could be compromised.
- **Disruption to migratory behaviour of adult fish**. According to research, pink salmon spawning behaviour may be influenced by water turbidity. Suspended sediment loads as high as 900 mg/l do not impede migration, but spawning occurs only if suspended sediment concentrations (SSC) remain below 20 mg/l (SakhNIRO, 2000). SSC monitoring data for wet-cut crossings therefore indicate that SSC could be raised to levels that could prevent fish reaching their spawning sites or delay spawning activity once at the site.
- **Mortality of eggs and alevins**. Construction work during October-April could lead to excess deposition of fine sediment within gravel substrates supporting salmonid eggs and alevins, leading to mortality. However, the magnitude of this potential impact is difficult to determine with any certainty, although it can be stated that additional mortality, over and above that due to natural fluctuations in sediment deposition and transport, would be likely to occur as a result of instream construction activity during this period (see Section 5.1.3). Undertaking works later in the October-April period may provide a longer post-spawning period for both egg hatching and alevin development to take place, thus, reducing the potential level of mortality in comparison to the situation where works were undertaken earlier in this period.

In conjunction with the above factors, in-stream sediment transport distances (and therefore potential downstream impact on aspects such as salmon spawning habitat) can be minimised if wet-cut crossings are constructed during periods of low flow (Reid and Anderson, 1999, Averina 2003). As discussed earlier, Sakhalin rivers are characterised by low flows during both the summer and winter months.

Logistical and technical limitations also play a significant role in defining the most appropriate window for undertaking the river crossing construction work on sensitive rivers. Access for heavy equipment may be difficult or impossible and construction can be hazardous during flood events, in particular during the high river flow volumes of spring snowmelt). In summer and autumn, access is normally not an issue, though in wetland areas, especially after periods of high rainfall, special construction measures may be necessary. The freezing ground and water conditions typical of Sakhalin winters and which normally prevail from early December through to April, are generally more conducive to construction work as river banks may be more stable and flow velocities/volumes are very low or even non-existent.

Watercourses that are considered to have limited sensitivity and that will not cause any cumulative impact downstream, either ecologically or geomorphologically, can be crossed all year round. These are the rivers that do not belong to the highest fish category of Sakhrybvod.

Watercourses that belong to the highest fish category of Sakhrybvod need to be crossed outside the spawning period. In general, this is the period from October until April but, depending on the type of salmon, varies from river to river. Construction during this period will avoid impact on the migratory behaviour of adult fish, though it might lead to mortality of eggs and alevins. The potential for mortality of eggs and alevins and damage to spawning habitat can be greatly reduced by construction during periods of low flow, as this will decrease the downstream sediment transport distance.

Analysis of these various factors indicates that construction outside the salmon spawning season and during periods of low flow would minimise potential impact on fisheries interests and aquatic ecology. SEIC is therefore committed to crossing Group 2 and 3 rivers and those watercourses with the potential to cause adverse downstream impact on Group 2 and 3 rivers, during the winter, which is broadly defined as the period between December and April, when low flow rates predominate. However, it is apparent from the available hydrometerological data (see Section 3 and Table 3.3) that because of the variability in climatic and hydrological conditions on the Island, flow rates during this period vary according to location and in line with annual climatic conditions. Selecting an optimal time during this winter period in which to undertake individual crossings therefore needs to take into account the following factors:

- Overall pattern of freeze-thaw and snowmelt timing for typical river types and areas, based on long-term data series (Sakhhydromet 1998, 1999. See Section 3 and Table 3.3); and
- Specific long-term freeze-thaw and snowmelt data for individual rivers, where this is available (Sakhhydromet 1998, 1999).

Consideration of the above, together with the outputs from the hydrogeomorphological impact assessment process, provides the following broad timing framework for the winter river crossings:

- Group 3 rivers of high and medium susceptibility to disturbance, or where water management control is not possible, will be constructed in mid-winter (nominally, January-February).
- All other Group 2 and 3 rivers will be constructed during the December-April period or possibly during periods of low flow in October-November where it can be demonstrated for each river concerned that this is outside of the salmon spawning season (for species relevant to the river); and
- Group 1 watercourses will be constructed in accordance with Russian regulations and the criteria set out in Table 5-2, whereby those watercourses feeding into Group 2 or 3 rivers that have the potential to cause downstream impact (i.e. through sediment transport) will be treated during construction as Group 2 or 3 rivers respectively.

With respect to potential works during the October-November period, construction would only be considered if the following criteria could be met:

- Low flow rates similar to those that would be likely to occur during winter months;
- No observed salmon spawning activity within and downstream of the crossing area. This would be agreed with the local Sakhrybvod officer;
- Water management control measures could be effectively implemented and used during construction.

For those Group 2 and 3 rivers where there is no recorded salmon spawning habitat downstream of the crossing area then the second of the above points would not apply, although consultation with the local Sakhrybvod officer would still be undertaken to ensure that the data held by SEIC was correct and the decision justified.

This timing framework will be built into the Execution Plan. However, further refining of this phasing will need to be undertaken during the winter as a result of the apparent inter-annual variability in climatic and hydrologic conditions. The hydrograph and freeze-thaw data provided in Section 3 clearly demonstrates that river flow rates/volumes may increase in some areas during April due to snowmelt associated with temperature increases. These fluctuations may be difficult to determine with any certainty and therefore it is proposed that crossings of individual rivers will only be undertaken when it is apparent that low flow conditions are prevalent and, additionally, freezing conditions promote riverbank substrate stability.

The crossing of sensitive rivers will only proceed once the necessary mitigation and supervisory measures are in place and in the right seasonal and freezing/low flow conditions; otherwise the work will not proceed or will be suspended. Construction of crossings for the fibre optic cable will, in general, generate significantly less sediment than with trenching for the pipeline, as the cable is much smaller in diameter. For rivers that are of high or medium sensitivity, however, trenching of the cable will be avoided by using an HDPE conduit. This conduit will generally be strapped to the oil pipeline and the fibre optic cable will later be pulled through the conduit.

For those crossings where trenching will be involved, the construction period for the FOC will be in accordance with the construction period of the oil and gas pipelines (e.g. outside spawning season).

Disturbance reduction

The intent is to construct most oil and gas pipeline crossings consecutively and priority will be given to ensuring that this occurs for rivers of high ecological sensitivity and/or which have a high potential for hydrogeomorphologcal impact. On the occasions where two different subcontractors will undertake construction of the two pipelines, consecutive crossings may, for logistical reasons, not be possible. Efforts will be made to plan the activities such that the period between the construction of each pipeline crossing is minimised. In some cases this could be months but in any event, construction will occur in the same season (i.e. the winter months; see below).

5.3.2 Execution

Technique

For all rivers that are of medium or high ecological sensitivity i.e. Group 2 and Group 3, dedicated crossing teams under direct management of the

Contractor will construct the crossings. Prior to the construction of each crossing, a kick-off meeting will be held in the presence of the relevant SEIC and Contractor construction and HSE staff.

A SEIC representative who is aware of both construction and environmental issues will attend all Group 2 and 3 crossings. Before the construction of the crossing can start, this representative will ensure that:

- Proper erosion control materials are available on site prior to the start of construction;
- Appropriate spill response equipment, including containment and recovery equipment, are available on site and that, if necessary, spill response measures are appropriately implemented;
- The local monitoring Contractor notified in adequate time, present and adequately equipped to undertake all necessary measurements during construction of the crossing; and
- All personnel (including external observers) needed for the crossing are present and properly instructed and all necessary equipment is present and in good working order.

The trench through the crossing area will be filled with sediment-containing water and in order to minimise sediment release, the trench will be as short as possible (i.e. the length of the pipe section to be installed at the river crossing will be minimised). Furthermore, the section at the river will be removed as late in the construction period as possible and, where appropriate, effective water control measures will be utilised, thus minimising the duration and amount of sediment that could flow into the river. Pumps may be used to control water ingress or egress into the trench in a way that precludes sediment release into a watercourse during construction or in periods of inactivity between installation of the two pipelines. In such cases water would be discharged to surface, or otherwise filtered before discharge to a watercourse. This activity would be controlled and the hose so placed that it does not suck up sediment from the base of the trench.

Erosion control

Internationally recognised ‘Best Practice’ erosion control measures will be employed at all watercourse crossings, irrespective of their classification in order to protect surface and ground waters.

Measures to control sediment release into the water column include:

- Postpone the removal of bank vegetation for as long as possible;
- Avoid grubbing bank shrubs except on the trench line;
- Minimise area of bank disturbance as far as possible;
- Install silt fence and/or snow bank;
- Store bank and bed material separately for reinstatement;
- When backfilling, lower bucket into water before releasing fill;
- Avoid disturbance of bank section between pipe trenches.

In rivers known to be of importance for their fish fauna and for which the potential for the generation of fine sediment during construction is assessed as high, temporary protection of the bank and bed during in-stream activity will be recommended.

In-stream construction time

SEIC is committed to be aligned with the intent of the "Wetland and Water Body Construction and Mitigation Guidelines" from the United States Federal Energy Regulatory Commission (FERC – see Annex C). In line with these procedures, SEIC endeavours to execute wet-cut crossings of minor water bodies (less than 3 m wide) within a period of 24-hours and wet cut crossing of intermediate water bodies (between 3 and 30 m wide) within 48 hours. This applies to each individual crossing (i.e. for oil, gas and FOC) and not all crossings in aggregate. In reality, for many small watercourses, the actual period of in-stream construction is likely to be significantly less than these periods with a target of one working shift. However, for the intermediate water bodies, especially those wider than 10 m, the 48-hour period might not be sufficient. Also, site-specific conditions might complicate the crossing and could result in an increase of construction time. To allow in-stream work to be undertaken within a minimal period, controlled night working might be considered. However, this will only occur if the necessary safety measures can be implemented practically. This will be detailed in the Execution Plan.

An environmental monitoring Contractor will be used to prepare a data package for the monitored river crossing that contains photographs (at the pre-construction, construction and post-construction stages), the work-log and the monitoring results. Furthermore, observations of any non-conformances made will be filed with the package. The data package will be used throughout the winter crossing construction period to communicate any lessons learned and feedback into the construction process relevant information for subsequent crossings.

5.3.3 Reinstatement

Reno-mattresses/gabion, riprap and other erosion control measures will be implemented to stabilise the riverbanks. Reno-mattresses and gabions consist of a galvanized steel wire mesh compartmented basket with a rectangular mattress shape. The compartment or cells of the reno-mattress are of equal size and dimension and are evenly filled with stone. The structure provides a flexible and durable structure that will provide scour protection/bank stabilisation. Riprap relates to loose stone laid as protection and is one of the most versatile, flexible and commonly used types of revetment. Suitably sized riprap is appropriate as protection for high velocities and turbulent reaches and also offers flexibility in terms of protecting small awkwardly shaped areas and transitions between structures and natural channels. Other, 'soft' reinstatement techniques (such as salix wattling and brush layering) will be applied where possible and/or considered appropriate. The use of all mitigation measures will be subject to approval by Russian authorities.

Depending on the ground, soil and weather conditions, these erosion control measures will be installed directly after construction. It is likely that additional repair work will be necessary; this will be executed during the summer months (outside the fish restriction period).

Backfilling of the trench in the watercourse will be carried out with soil directly taken from the watercourse at the crossing point. Obstacles (e.g. sediment traps) that may impede salmon migration will be removed from the river channel and the river bedform within the construction zone restored as far as practical to its original form to minimise changes in the channel and hydraulic behaviour of the river. Particular attention will be paid to ensuring that the integrity of river features are restored at the crossing points so that habitat function and use, (e.g. off-channel wetland habitat that may be used by wintering fish) is maintained by reinstating any fluvial or potential fluvial connections that may have been affected by the works.

For rivers of high and medium ecological sensitivity, clean gravel or preferably native cobbles, will be used for the upper layer of the backfill, in line with the requirements of Sakhrybvod and FERC guidelines. In total it is estimated that 26,000 m^2 of potential salmon spawning habitat would be created through this technique in order to replace the 15,300 m^2 disturbed at the river crossings during construction work (ECMOS river crossing reports 2004).

One of the most important factors for successful reinstatement is the restoration of riparian vegetation. Full reinstatement of vegetation is, however, not likely to be possible before the summer months. Prior to full reinstatement, run-off will be minimised by proper erosion control, as described above. For the final reinstatement, a site-specific seed mixture that is adapted to the altered site conditions and top soils will be applied. The mixture will generally contain at least one legume, one fast-growing annual or sterile hybrid, and be comprised predominately of native seeds where they are commercially available. The local Agricultural Institute has been consulted for advice on the composition of the mixture. Hydroseeders will be used to support the reinstatement.

5.3.4 Water Protection Zone

A variety of practical techniques can be applied during pipeline construction through watercourses in order to either prevent or reduce potential sediment transport from the working area into the watercourse. Such measures include the use of slope breakers, bunds, silt fences/screens and maintaining areas of existing riparian vegetation where practical.

With respect to the use and implementation of such measures, SEIC has undertaken to apply appropriate techniques to limit sediment erosion in line with Russian legislative and permitting requirements and also in line with the intent of the guidance set out by FERC, Wetland and Water Body Construction and Mitigation Guidelines. The FERC Guidelines are provided in Annex C, along with a brief statement regarding SEIC's application of the measures, as set out in the Guidelines, in relation to existing Russian regulations.

In addition, SEIC is committed to implement the following sediment source control measures:

- Minimise the width of the ROW where practicable and only use its middle section for construction traffic;
- Possible utilisation of on-site resources such as willow (Salix sp.) branches for riverbank stabilisation, pending approval from the Forestry Department;
- Ensure that the correct equipment and sufficient erosion control materials are available on-site in preparation for the river crossing. In certain locations/situations, the possibility of leasing suitable equipment from local farmers will be pursued;
- "Track-walk" slopes where feasible;
- Construct slope breakers at intervals, with the gradient of the slope breaker no greater than 1:100. Outlets for slope breakers should be provided with suitable energy dissipation material (e.g. riprap) and directed towards vegetated areas to the side of the ROW. Silt fences will not be used in place of slope breakers;

- Regularly inspect silt fences (and other sediment controls), particularly after rainstorms and clean them out when they are one-third full, repaired or replaced. Sandbag materials will also be inspected regularly and replaced prior to any degradation;
- Implement a topsoil preservation policy for areas that have not been cleared yet, but with recognition that there are practical limits to what can be segregated with available equipment;
- Protect existing stockpiles of soil to prevent erosion and subsequent suspended sediment loads to streams. Stockpiles will be protected by grass and where necessary silt fencing will be used to prevent sediment-laden runoff.
- Mulch will be sourced and applied where feasible. SEIC will investigate the possibility of purchasing a wood-chipper and utilise the material to augment both temporary and permanent (re-instatement) re-vegetation and erosion control practices.

Contractors undertaking the works at individual crossing sites will be instructed in the proper installation, application and maintenance of erosion control and re-vegetation practices. Additional field training will be given to dedicated crews on each spread in the use of best management practices.

5.3.5 Summary

The following Table (Table 5-4) provides an overview of the selected mitigation measures for wet cuts, taken into account the susceptibility of change and the fish/ecological value of the river.

ECOLOGICAL SENSITIVITY AND COMMERCIAL FISHERIES VALUE		SUSCEPTIBILITY TO DISTURBANCE – High	SUSCEPTIBILITY TO DISTURBANCE – Medium	SUSCEPTIBILITY TO DISTURBANCE – Low
	Group 3 **Incl. Group 1 tributaries of high or medium susceptibility to disturbance that have the potential to affect Group 3 rivers**	Optimal timing Consecutive crossings critical	Optimal timing Consecutive crossings critical	Low flow, outside spawning Consecutive crossings critical
		Wet cut with water management control Best practice by dedicated crossing teams Minimise in-stream construction time Expert assessment on erosion control	Wet cut with water management control Best practice by dedicated crossing teams Minimise in-stream construction time Expert assessment on erosion control	Wet cut with water management control Best practice by dedicated crossing teams Minimise in-stream construction time Expert assessment on erosion control
		Clean gravel on river bed Priority Permanent Reinstatement Expert assessment on reinstatement	Clean gravel on river bed Priority Permanent Reinstatement Expert assessment on reinstatement	Clean gravel on river bed Expert assessment on reinstatement
		WPZ – site specific expert assessment	WPZ – site specific expert assessment	WPZ – site specific expert assessment
	Group 2 **Incl. Group 1 tributaries of high or medium susceptibility to disturbance that have the potential to affect Group 2 rivers**	Optimal timing/Low flow, outside spawning Consecutive crossings critical	Low flow, outside spawning Consecutive crossings where practical	Low flow, outside spawning Consecutive crossings where practical
		Wet cut with water management control Best practice by dedicated crossing teams Minimise in-stream construction time Expert assessment on erosion control	Wet cut with water management control Best practice by dedicated crossing teams Minimise in-stream construction time Expert assessment on erosion control	Wet cut with water management control Best practice by dedicated crossing teams Minimise in-stream construction time Expert assessment on erosion control
		Clean gravel on river bed Priority Permanent Reinstatement Expert assessment on reinstatement	Clean gravel on river bed Expert assessment on reinstatement	Clean gravel on river bed Expert assessment on reinstatement
		WPZ – site specific expert assessment	WPZ – site specific expert assessment	WPZ – standard Best Practice
	Group 1 **Incl. non-rated**	All year (in accordance with RF regulations) Consecutive crossings where practical	All year (in accordance with RF regulations) Consecutive crossings where practical	All year (in accordance with RF regulations) Consecutive crossings where practical
		Wet cut Standard Best Practice Minimise in-stream construction time Basic erosion controls	Wet cut Standard Best Practice Minimise in-stream construction time Basic erosion controls	Wet cut Standard Best Practice Minimise in-stream construction time Basic erosion controls
		Basic bed reinstatement Expert assessment on bank reinstatement	Basic bed reinstatement Basic bank reinstatement	Basic bed reinstatement Basic bank reinstatement
		WPZ – site specific expert assessment	WPZ – standard Best Practice	WPZ – standard Best Practice

Notes on the above Table:

1. The four subdivisions in each of the blocks refer to aspects related to planning, execution, reinstatement and the water protection zone, respectively.

2. Definition of terms used in the Table are provided below

Planning (section 5.3.1)
Timing: Optimal timing (mid winter, nominally January, February); Low flow, outside spawning season: construction from October – April, where it can be demonstrated for each river concerned that construction would occur outside of the spawning season for species occurring in the river; All year (construction all year round, in accordance with Russian regulation (i.e. outside spawning period where stated in the license))
Consecutive crossings critical: applied to rivers where minimising the period over which in-channel construction occurs is important in reducing the potential effects of sediment input. Planning for consecutive crossings will be prioritised over non-critical crossings
Consecutive crossings where practical: construction of consecutive crossings if no logistical problems arise

Execution (section 5.3.2)
Construction technique: wet cut with water management control to minimise sediment transport or standard wet cut
Technique: Best practice by dedicated construction teams, including short lay length; standard best practice
In-stream construction time: minimise in-stream construction time in line with FERC guidelines
Erosion control: expert assessment or basic erosion controls

Reinstatement (section 5.3.3)
Priority permanent reinstatement (also includes basic measures): in situations when permanent reinstatement is not possible in the winter then temporary measures will be used and the river prioritised to ensure that permanent reinstatement takes place as soon as practically possible prior to the onset of higher flows
Expert assessment (also includes basic measures): expert selection of reinstatement techniques, including regular bank inspection monitoring
Basic reinstatement: standard package of reinstatement techniques, including replacement of excavated material from the trench and capping with gravel

Water Protection Zone (section 5.3.4)
Site specific expert assessment: tailored assessment of erosion control measures
Standard Best Practice: standard package of erosion control measures, including slope breakers, silt fences and delineation of WPZ

Table 5-2: Application of Selected Mitigation Measures for Wet Cut Crossings

5.4 MINIMISING IMPACTS OF HORIZONTAL DIRECTIONAL DRILLING

As set out in Section 4.2, the main environmental risk associated with HDD is the release of drilling fluids. To minimise this risk, a specialist contractor will perform the construction of HDD. For each HDD, a crossing plan will be developed that includes:

- Site-specific construction diagrams that show the location of mud pits, pipe assembly areas, and all areas to be disturbed or cleared for construction;
- A description of how an inadvertent release of drilling mud would be contained and cleaned up;
- A contingency plan in the event the directional drill is unsuccessful and how the abandoned drill hole would be sealed, if necessary.

5.5 MINIMISING OTHER IMPACTS

5.5.1 Hydrotesting

Hydrotest discharges will contain non-toxic waste only, as no corrosion inhibitors or oxygen scavengers will be used. The water will be discharged in sediment pits or surface filter/dissipaters. When the sediment has settled, the water will drain away on the ROW. To minimise run-off, the water will be discharged on vegetative areas. The sediment will be cleaned up and transported from site.

For the short pipe sections that will be hydrotested in the winter, specific Work Procedures have been developed for hydrotesting in low ambient temperatures. Mono-Ethylene Glycol will be used as an antifreeze and was selected based on toxicity, product stability, and disposability. Antifreeze will be applied only after the necessary permits have been secured. As this hydro-test water will contain antifreeze, it will not be discharged on the ROW. Instead, the water will be discharged into dedicated tanks, and will be sent back to the manufacturer.

In the unlikely event there is a hydrotest incident, fish resource damage will be calculated based on actual data in conjunction with the appropriate regulatory agencies.

5.5.2 Oil spills

In order to minimise the possibility of spills, the construction and material handling guidelines (as shown in Table 5.3) will be incorporated in the work instructions. All personnel will be properly trained to effect spill prevention. Appropriate spill response equipment, including containment and recovery equipment, will be available on site.

To ensure that the response given to possible spill events that may occur during the construction is consistent, efficient and in conformance with the laws, regulations and decrees of the Russian Federation, the relevant provisions of the contract and SEIC's Corporate Oil Spill Response Plan, the EPC Contractor has prepared an Construction Oil Spill Response Plan. The broad coverage of these plans is set out in HSESAP Part 2, Table 2.1 Hydrocarbons. This plan describes the response organisation, the response operation and spill prevention (including training).

Table 5-3: Spill Response Measures [Taken from HSESAP Part 2 on Hydrocarbon prevention and response]

The storage and handling of fuels and chemicals will comply with all relevant legislation and standards.
Fuel, lube oil, hydraulic fluids, and chemicals will be handled and stored in a responsible manner, minimizing potential for spills and surface contamination.
If hydrostatic testing pump equipment is placed near a watercourse (including irrigation canals or livestock ponds), pumps will be placed within a lined bermed area capable of containing any fluid leaks.
To minimise the risk of fuel spills, the following measures will be employed: • all containers, hoses, and nozzles will be free of leaks; • operators will be trained and stationed at both ends of the hose during fuelling unless the ends are visible and are readily accessible by one operator; • fuel and service vehicles will carry a minimum of 25 kg of suitable commercial adsorbent material, 30 m^2 of 6 mil polyethylene, a shovel and one empty fuel barrel (lid removed); • Refuelling, equipment maintenance activities involving hydrocarbons, and concrete-coating activities (excluding field joints) shall not be carried out within 30m of a watercourse. • Fuel trucks transporting fuel to on-site equipment shall only travel on approved access roads.
A spill control plan will be prepared for all major operators and facilities that at a minimum: Describes the preventive and mitigating measures to avoid or minimize impacts of spills of fuel, lubricants, or hazardous materials, especially within any municipal watershed area or within the water protection zone of any water body or wetlands; Requires fuelling and lubricating to be done in areas designated for such purposes and specifies measures to avoid or minimize spills when construction equipment (such as pontoon-mounted backhoes and pumps) will be refuelled in or within the water protection zone of any water body or wetlands; Identifies emergency notification procedures in the event of a spill; Requires each construction crew to have sufficient supplies of absorbent and barrier materials on-hand to allow the rapid containment and recovery of any spills; Includes procedures regarding excavation and disposal of any soil or materials contaminated by a spill; and Identifies names and telephone numbers of all governmental agencies and individuals that will be contacted in the event of a spill.
Equipment maintenance (oil change, refuelling, etc) will be performed outside the water protection zone boundaries or bodies of water to minimize the potential for water pollution.
Spent oils, lubricants and filters, etc., shall be collected and transported to an approved location and in an appropriate manner.
Hazardous chemicals, fuels or lubricating oils shall not be stored within 30m of a watercourse. .

All such storage areas and activities must be suitably bermed.
Equipment activity will be minimised within the wetted perimeter of any stream.
Hydraulic, fuel and lubrication systems will be maintained in good repair to avoid leakage.
Wherever possible, all equipment shall be parked overnight at least 30 m from a water body or in an upland area at least 30 m from a wetland boundary. These activities can occur closer only if the spread Environmental Monitor finds, in advance, no reasonable alternative and the contractor has taken appropriate steps (including secondary containment structures) to prevent spills and provide for prompt cleanup in the event of a spill.

5.5.3 *Induced access*

The creation of the ROW and associated roads for the construction of the onshore pipeline has the potential to provide increased access to previously undisturbed or relatively intact areas of habitat. To a certain extent the potential for this has been reduced as a consequence of the pipeline being routed close to existing access networks and infrastructure (e.g. roads, railway and transmission lines), from which access to rivers is already possible. However, it is appreciated that the RoW and the access roads required for construction of the pipeline may provide an increased opportunity for access to rivers that support salmon stocks and as a result increase potential poaching pressure on these stocks. Management of access in relation to habitat disturbance and resource use is a complex issue, particularly in this situation given the extensive nature of the construction works, existing level of access to many areas and the already widespread occurrence of poaching. However, SEIC is committed to ensuring that the potential for poaching increasing as a result of its activities is minimised and managed through the application of suitable measures.

Although the effects of induced access, particularly on fisheries, will not be significant during the construction phase, as works will be undertaken outside of the salmon spawning season, consideration and planning is still required to ensure that appropriate measure are in place following the completion of the works. At a practical level, access to previously inaccessible areas will be discouraged through the appropriate use of fencing and measures such as barriers across roads. Constructed temporary access roads or new extensions to pre-existing roads or tracks constructed during the pipeline laying operations will be removed and access to the ROW blocked when construction activities have been completed, unless the road is designated as a permanent access road.

The number of permanent access roads left in place following construction will be carefully determined and minimised as far as practically possible. For the operations phase, in order to optimise the approach taken in dealing with this issue, SEIC will continue its engagement with the Wild Salmon Centre and Sakhrybvod to determine the most appropriate measures to combat potential access-induced issues and incorporate agreed recommendations into the access planning process. It is likely that this process will involve the identification of ‘core areas’ of high fishery value where the ROW and access for construction may result in the opening up of areas in which vehicular access was previously not possible or minimal. In such areas, mechanisms to avoid the development of permanent access would be fully considered and all practical measures (as mentioned above) taken to remove or eliminate access routes associated with the works would be implemented.

It should also be noted that SEIC has a “No Fishing, Gathering and Hunting Policy”. This policy requires that during the construction period, in northern and central Sakhalin (north of Dolinsk and Tomari districts), project workers shall not be permitted to fish, gather or hunt. In southern Sakhalin (Dolinsk and Tomari districts and to the south), project workers may fish with a licence, but not gather or hunt. Hunting, fishing and gathering will be allowed for the Sakhalin local construction workforce if it is outside working time, not wearing work clothes, and with a valid permit.

5.6 RESIDUAL IMPACT

The mitigation measures discussed above, combined with the approach and commitment to good construction technique, monitoring and feedback have been developed in order to minimise the potential impact of the river crossings construction work on environmental interests. Particular focus has been given to minimising the potential input of sediment into the watercourses during construction in recognition of the adverse effects that high loadings of sediment in the water column may have on aquatic life and habitats. This approach to the control and management of potential sediment inputs is viewed as the most appropriate mechanism for ensuring that ecological recovery following construction is optimised and that the rivers are returned to a state that enables them to maintain the same function as they did prior to the works. Table 5-4 summaries the proposed mitigation measures discussed in the previous sections.

Table 5-4: Overview of potential impact, mitigation and residual impact

Potential Impact	Mitigation	Residual impact
Wet cut		
Increased suspended sediment concentrations and turbidity may reduce the survival of aquatic plants by reducing photosynthesis.	Group 2 and 3 rivers (i.e. of high and medium ecological sensitivity) will be crossed during periods when plant abundance is low and photosynthetic activity is minimal.	Minor. Plants occurring in the watercourses are adapted to the high suspended sediment loads associated with snowmelt and other peak flow events as well as extended periods of river ice cover.
Sediment transport during and immediately post-construction may cause aquatic invertebrates to migrate from an affected area and mortality may also occur. The abundance and diversity of benthic invertebrate communities may therefore be reduced.	Rivers of high and medium ecological sensitivity will be crossed in winter when aquatic life is largely dormant, although it is recognised that life cycle stages at this time may still be sensitive to the effects of high suspended sediment loads and sediment transport.	Minor. Benthic communities are well adapted to periods of high suspended sediment concentrations and turbidity associated with frequent peak flows during spring snowmelt and summer/autumn rainfall events. Monitoring of wet cuts indicates that the recovery of communities occurs within one-two years mainly through recruitment from unaffected upstream areas (Reid and Anderson, 1999).

Potential Impact	Mitigation	Residual impact
Adult fish may suffer adverse physiological affects at very high sediment concentrations.	The strategy has been developed to minimise sediment inputs into rivers and therefore the generation of high sediment loadings in the rivers by minimising construction time, applying industry standard practice and use of proper erosion control measures. Group 2 and 3 rivers will be crossed during the winter when fish presence in the main watercourses may be reduced.	Minor. Although the presence of increased sediment concentrations in the watercourses during the winter months is unusual, its effects are unlikely to be significant at the river scale. Many fish will have sought out wintering habitat away from the main channel and in areas that would be less affected by increased sediment in the water column, Fish remaining in the main channel may be able to leave cover and/or temporarily leave the area to seek areas of lower suspended sediment concentration within the river system. It is possible that some mortality of juvenile fish in close proximity to the crossings could occur. Studies of fish population dynamics following wet cut pipeline installation have recorded a reduction in fish abundance in some instances and no observable change in others. Recovery of the fish fauna following construction has been shown to occur within 1-2 years (Reid and Anderson 1999).
Fish migration and spawning behaviour may be impaired by elevated concentrations of suspended solids.	SEIC will not be crossing any rivers of ecological sensitivity during the spawning season, although it is noted that in some years silver salmon may continue spawning through until mid-December.. Watercourses that do not have the potential to impact on downstream spawning areas (e.g. through the downstream transport of suspended sediment) will be crossed all year round The fisheries interests of each Group 2 and 3 river will be evaluated and specific mitigation measures developed.	With the appropriate timing of construction activity and restoration of any habitat connections - no impact.

Potential Impact	Mitigation	Residual impact
Spawning habitat may be damaged and the survival of fish eggs and fry may be reduced during the construction works.	Where possible spawning grounds will be avoided, but some damage to spawning grounds will be unavoidable. It has been estimated via the use of an indicative model that 0.38-1.34% of the total resource in medium-high sensitivity (Group 2 and 3) rivers could be affected. All damaged spawning grounds within the boundary of the ROW will be reinstated after construction through the replacement of gravel over the backfilled pipeline trenches. Where specific connections with wetland or other fluvial habitats at the crossing areas may be impacted by the works the function of these connections with the river will be restored. SEIC will seek to minimise sediment inputs into watercourses during and after construction. Rivers that have a high potential for sediment generation during construction will be constructed during periods of low flow in order to reduce the the extent of subsequent downstream transport. Where appropriate river banks will be stabilised to minimise the potential for longer-term fine sediment inputs. .	Minor.. Spawning grounds at the crossing point and downstream are likely to be adversely affected in the short term (1-3 years) due to the infiltration of fine sand into the gravels and the effect that this can have on egg and larval survival and the future suitability of the beds for spawning. However, competent flows following construction should be sufficient to transport finer material from gravel beds and restore their former productivity. Reinstatement works (e.g. for associated fluvial habitats) and the creation of additional habitat at the crossing sites should also mitigate for this temporary loss in the longer term. Fish damage is being paid to the relevant Russian authorities to compensate for damage to spawning grounds.
HDD		
The release of drilling fluids could result in an interruption to fish migration and increased stress to individuals.	HDD will be performed by a specialist contractor in order to ensure that the potential risk of drilling fluid release is minimised as far as practically possible. For each HDD a specific crossing plan will be developed that includes a description of how an inadvertent release of drilling mud would be contained and cleaned up.	With mitigation – negligible impact.

Potential Impact	Mitigation	Residual impact
Improper operation and screening of water pump intakes might result in injury or mortality of fish.	All pumps will be properly screened.	With mitigation – negligible impact.
Other impacts		
Discharge of hydrotest water	Water will be discharged in settlement pits or surface filter/dissipaters and drained away on the ROW.	With mitigation – minimal impact.
Antifreeze will be used for winter hydrotesting. Antifreeze could leak into or be spilled in a river.	All hydrotest water that contains antifreeze will be discharged into dedicated tanks and transported from site.	Minor. In the unlikely event that there is a hydrotest incident, fish resource damage will be calculated.
Leakages and improper handling of fuel might result in minor oil spills in watercourses.	Implementation of construction and material handling guidelines.	Minor. Appropriate spill response equipment will be available on site in case an oil spill occurs.
With the construction of the ROW, access could be created to previously undisturbed or ecologically important areas.	Implementation of non-hunting, fishing and gathering policy during construction. Illegal/increased access to previously inaccessible areas will be discouraged through the appropriate use of fencing and measures such as barriers across roads. Minimise number of permanent access roads.	Minor. Core areas will be identified where it may be appropriate to undertake additional management measures to limit the potential for future disturbance (e.g. no permanent access roads; removal of temporary access measures and reinstatement etc.). Identification of areas will be undertaken with relevant authorities and other suitable parties (e.g. Wild Salmon Centre). Disciplinary measures will be taken in case of violation of SEIC'shunting policy.

As indicated in Section 3, some of the rivers to be crossed by the pipelines and the fibre optic cable are important for commercial salmon fisheries and many of the mitigation measures described above focus on minimising the potential impact on commercial fish interests and salmonid spawning areas. However, it should also be noted that the measures being adopted with respect to protection of salmonid resources are also effective in reducing potential impact to aquatic ecology and ecosystems as a whole:

The strategy also focuses on the protection of Red Data Book species. Russian legislation prohibits, as stated in Section 2.6, activities that cause death, reduction or disturbance of natural habitats of rare or endangered species listed in the Red Data Book, such as Sakhalin taimen. SEIC have committed to cross all rivers that could contain Taimen in the winter months (December to April), when adult Taimen have moved to their wintering grounds at river mouths and estuaries (i.e. away from the vast majority of crossing areas on rivers). Rivers that may have suitable spawning grounds for taimen will be crossed at the end of the winter, when there is no spawning activity and taimen eggs and alevins will not be present in channel bed sediments. Young fish may be present in rivers during the winter when the works are scheduled to occur and the potential for adverse harm and mortality does exist. However, by the onset of the works, juvenile fish should have sought out suitable over wintering habitat away from the main river channels and which would be likely to be less susceptible to the effects of suspended sediment increases during construction. If still present in channels when the works occur then fish may be able to move into areas of lower suspended sediment concentration and thus avoid potentially chronic effects. Monitoring studies of wet-cut pipeline crossings indicate that recovery times for potentially affected habitats are relatively quick (see Section 4.1.3) and fish populations soon recover to former levels (probably through immigration from unaffected areas).

In recognition of the lack of information on the ecology of the Sakhalin taimen and the potential that harm to this species could occur during the winter crossings, SEIC will develop and instigate a taimen research project. It is envisaged that this will be a research-based project, that will involve Russian, Japanese and other international specialists and which will aim to further describe the ecological requirements, distribution and biology of this enigmatic and important species.

6 MONITORING

Monitoring is an important part of the overall implementation of a successful project and is crucial in determining the scale and magnitude of effects during construction, relating these effects to predicted and observed impacts and ensuring that mitigation measures are successful in either reducing or avoiding impact. The monitoring strategy will therefore focus on the actual effects of pipeline installation (e.g. suspended sediment generation during construction) and the impact of these effects on the receiving environment (e.g. sediment deposition within salmon spawning habitat).

Taking into account the classification process detailed in Section 5.1, and the results of this process, it is considered that monitoring of potential effects and impacts should concentrate on those rivers identified as of a sensitive nature. The monitoring strategy will focus on the actual effects of pipeline installation (e.g. suspended sediment generation during construction) and the impact of these effects on the receiving environment (e.g. sediment deposition within salmon spawning habitat).

The outline for the post-construction programme is provided in Section 6.3. This component of the monitoring programme will be finalised following input and review by hydrological and icthyological specialists in order to ensure that the developed programme is technically robust and can be practically implemented. The post-construction programme will be structured around and build upon the existing pre-construction data, which are summarised in the next section.

6.1 PRE-CONSTRUCTION MONITORING

A significant amount of data regarding the physical and biological characteristics of the watercourses that the pipeline will cross has already been collected (2003-2005) through baseline surveys and pre-construction monitoring (see Table 6-1). These data provide the basis from which potential predicted change to river systems as a result of the works can be assessed and will provide the platform from which a detailed post-construction monitoring programme will be developed.

Table 6-1: Details of pre-construction monitoring

Parameter	Location/site	Description
Hydrology	32 rivers as approved by Sakhrybvod (all classified as of medium or potential high ecological sensitivity, see Table 5-1)) TEOC (Vol 8, Part 1.2, Section 13, Environmental Monitoring)	• River width, flow velocity and channel depth • Geomorphological survey of river bed and flood plain • Installation of monitoring benchmarks and gauges on 10 rivers to determine flow characteristics and lateral bank erosion in areas likely to be prone to meander development. Data currently available from works undertaken in October 2004 and October 2005.
Hydrochemistry	32 rivers as approved by Sakhrybvod (as above) TEOC, Vol 8, Part 1.2, Section 13, Environmental Monitoring	pH, dissolved oxygen, suspended sediment concentration, oil products, water temperature Data is currently available from monitoring performed in Oct 2004, May-June 2005 and July-August 2005.
Ichthyofauna	27 rivers as approved by Sakhrybvod on the basis of TEOC/Expertiza recommendation (all classified as of medium or potential high ecological sensitivity, see Table 5-1)	• Reconnaissance survey to determine most appropriate sampling locations. • Sampling of fish fauna at three selected points; up to 100m upstream of the crossing point (depending on site characteristics), the crossing point and up to 500m downstream of construction site/crossing • Photos of river section
Benthos	27 rivers as approved by Sakhrybvod on the basis of TEOC/Expertiza recommendation (as above)	• Sampling of invertebrate community at 4 locations; 50m upstream, the pipeline crossing point, 20m and 150m downstream • Analysis to species level.
Fishery characteristics	432 rivers as listed by TSUREN / Sakhrybvod	Field reconnaissance survey to determine presence and extent of salmon spawning areas at and in

Parameter	Location/site	Description
		vicinity of the crossing point.
Fishery characteristics	84 rivers approved by Sakhrybvod on the basis of TEOC/Expertiza recommendation (all classified as of medium or potential high ecological sensitivity, see Table 5-1)	• Reconnaissance survey and photos. • Assessment of spawning area location in the channel and size. Survey area • Presence and number of redds at the crossing point. • Sampling of riverbed sediments and particle size distribution analysis from six points – 50 m upstream, at the pipeline crossing, 20, 50, 150, 250 and 500 m downstream of crossing point. • Suspended sediment concentration – 50 m upstream and 500 m downstream of crossing point.

6.2 MONITORING DURING CONSTRUCTION

6.2.1 Fluvial and sediment monitoring

The focus of monitoring during construction will be to obtain data on the extent of sediment generation during the pipeline installation process and to determine the potential fate of this material. For this purpose three parameters will be measured: suspended sediment concentration, turbidity and flow velocity.

Data will be collected for all Group 2 and 3 rivers (see Section 5.1). The scope of the in-construction monitoring programme is, to a large extent, controlled by practical conditions (physical and safety) at the time of monitoring, as all of the sensitive river crossings will be undertaken during the winter.

To fully assess fluctuations in turbidity and suspended sediment concentrations during an individual river crossing, high-frequency sampling will be undertaken during the pipeline installation period (dependent upon the practicability of undertaking the works in the prevailing conditions). Sampling in rivers with ice will take more time and hence the frequency of sampling might be lower than in rivers without ice. Turbidity may be more relatively straightforward to measure in the field using a portable turbidity meter, so that the necessary frequency to quantify magnitude and duration of the turbid responses, including initial turbidity spike during cuts, can be determined. Sampling will be undertaken at points in the river channel 50 m upstream; at the crossing point; 20 m, 150 m, 250 m and 500 m downstream. Given the difficult conditions likely to be prevalent during the winter (i.e. ice covered channel(s), low flows), a pre-assessment will have to be made by the monitoring team in order to determine the most appropriate locations within the river channel(s) from which measurements will be taken. This assessment will also have to take into account health and safety issues The frequency of suspended sediment concentration sampling will be less than that for turbidity. As data becomes available, and throughout the winter period, the results of the suspended sediment monitoring will be compared with those obtained from turbidity monitoring to determine any specific relationship between these parameters. The monitoring programme may be enhanced on the basis of any relevant information that this exercise generates.

For the upstream sampling points, current velocity, suspended sediment concentration and turbidity will be measured once prior to construction and once post-installation of the pipeline. Suspended sediment concentrations will be analysed in line with relevant Russian regulations.

A Russian environmental monitoring Contractor will execute all monitoring. SEIC will review the capacity of the selected company to assess if additional equipment and/or monitors will be necessary. The local monitor will be notified about planned crossing on an agreed timescale (usually a week in advance).

6.2.2 Monitoring of construction technique and mitigation measures

During the installation of the pipelines specific techniques and mitigation measures will be utilised to limit the generation of sediment and its introduction into the watercourse being crossed (see Section 5.3).

As part of the overall monitoring programme, the use of specified techniques and the installation of structures to ameliorate the potential effects of sediment generation for each crossing will be recorded.

Current environmental site supervision by the pipeline construction Contractor and SEIC environmental officers at each of the five construction sections will be reinforced and continued to ensure compliance with respect to the required construction techniques and mitigation measures.

Supervision and monitoring will be a key mechanism through which the Company will ensure that its Contractors follow the required mitigation measures and also to assure the Company that these measures are effective. Sensitive river crossings will only proceed once a detailed execution and monitoring plan for a specific river is in place, is in compliance with the intent of this River Crossing Strategy and good industry practice.

The river crossing execution plan will include a river crossing supervision and monitoring plan. Supervision and monitoring will take place on five levels for those crossings where there is significant potential for adverse environmental impact to occur:

- On-site Contractor supervision at each of the five construction sections. The Contractor will ensure that these supervisors have the appropriate level of experience and effectiveness;
- On-site SEIC supervision at each of the five construction sections. The Company will ensure that these supervisors have the appropriate level of experience, empowerment and effectiveness and will continue to provide training and capacity building where required. Also, more senior site construction representatives will be used at the outset of the crossing programme and will continue until the enhanced control measures described have become routine practice;
- Continued regular environmental monitoring by the subcontracted Russian environmental consultant to ensure a continuity in the monitoring that has already taken place since 2003 in order to build up a long-term baseline. For the sensitive river crossings, this environmental monitoring applies to pre-installation, actual installation and post- installation phases of the crossings;
- Compliance observations during the winter river crossings installation period by a team of external observers. Throughout the period December

2005 to April 2006, these observers (comprising appropriate technical specialists) will be on site to observe and confirm compliance against the detailed river crossing execution plans or to highlight any areas of non-compliance or where actions could be strengthened. The observers will be stationed at each of the five construction sections and will report to the Company's Corporate HSE Department. The Company will require the Contractor to implement all reasonable recommendations put forward by the observers in order to achieve the objectives of the river crossing strategy and crossing plans. To take advantage of the efforts invested in this monitoring strategy, the Company also intends to publish the independent observer reports on its website as each river is completed, in order to provide transparency and accountability; and

- SEIC will make provisions and will commit to enable interested stakeholders to monitor the Company's river crossing sites and activities. Subject to prior discussion and agreement, stakeholder representatives will be able to visit and inspect river-crossing sites during the construction phase.

As part of the monitoring process, reporting of the overall suitability and efficiency of the supervision and monitoring procedures detailed above will be provided to SEIC following each river crossing (i.e. on a daily basis). Where deficiencies in the process or techniques being utilised are registered or potential enhancements noted changes to the process will be considered and if appropriate implemented during subsequent crossings. This adaptive feedback process should enable monitoring and supervision to be enhanced throughout the winter construction works. The mechanism for reporting monitoring results and reviewing performance is illustrated in Figure 6-1

The Environmental monitors will fill in a Daily Record Sheet with the results of the environmental measurements taken (i.e. turbidity, flow, ice-thickness etc.). This, along with photographic and possibly video monitoring, will be submitted to the Contractor's Environmental Advisor (and thence to SEIC River Leader) at the end of every day. At the end of the River Crossing the Daily Sheets will be forwarded to the River Crossing Focal Point and team based in Yuzhno. The on-site River Leaders will also complete a checklist that mirrors that used by the Independent Observers; both these Checklists will be submitted to the River Focal Point.

On completion of the in-stream construction and temporary bank reinstatement a review meeting between SEIC and Contractor will be held on site to review performance. This meeting will be recorded, with 'Lessons learnt' clearly stated and a commitment to improve performance if deemed necessary.

In parallel, there will also be a review meeting of the Yuzhno based team. Full assessment of all of the reports, including 'Site Visit' reports, will be undertaken, including a review of the initial expert assessments, a review of the techniques actually used and an assessment of site training needs. Findings of this meeting will be relayed back to site with any recommendations for performance improvement.

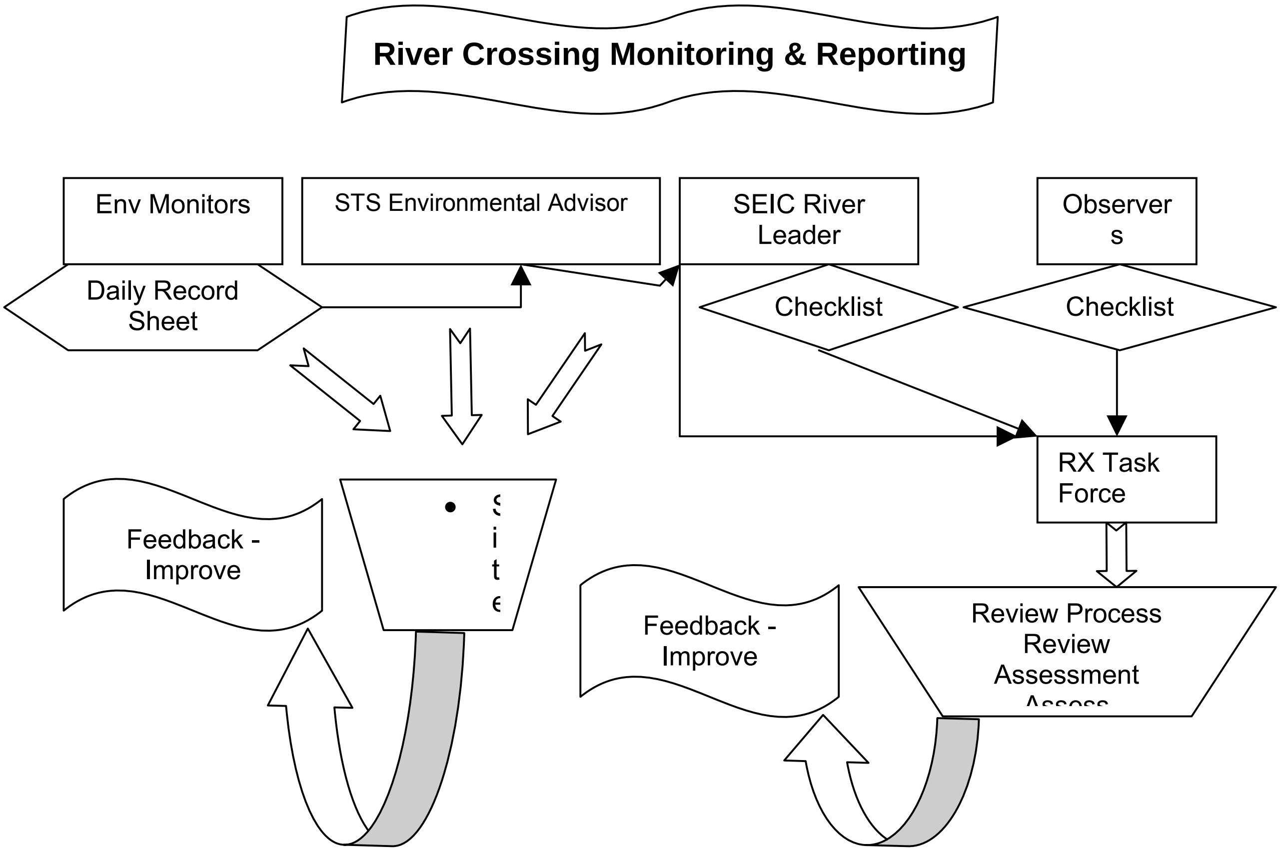

Figure 6-1: Process chart showing river crossing monitoring and reporting procedures during construction

Bank restoration will be monitored using the existing Construction Inspection Report. The environmental monitors will regularly inspect the crossing locations after the in-stream construction and until permanent reinstatement and bank consolidation has taken place. Banks can be vulnerable during this period; especially as construction during mid-winter means that bank reinstatement may effectively amount to replacing frozen blocks of soil. Permanent restoration may therefore have to wait until the spring, but prior to the main thaw, when access and soil handling may become too difficult.

Sedimentation and erosion control measures on slopes adjacent to the river channel will also be monitored during this period. These slopes will have a high priority for permanent reinstatement to ensure that potential sediment input through slope-wash processes are minimised.

6.3 POST-CONSTRUCTION MONITORING

The post-construction monitoring will be implemented following the 2005/2006 winter construction period. The programme will be designed to determine:

- The impact of sediment released during the construction work;
- The effects of the works at the crossing point; and
- The effectiveness of mitigation and restoration measures.

The post-construction monitoring programme will remain in operation for four years following construction. On the basis of data available from other studies (see Section 4.1) it is considered that this time period should be sufficient to document ecological recovery processes. The available data will be analysed on an annual basis to determine if recovery processes have occurred (taking into account natural variation) and whether mitigation measures have been effectively implemented (e.g. minimising longer term sediment inputs at the crossing areas through the use of bank stabilisation techniques). The results of this analysis will be used in refining the monitoring programme, as appropriate (e.g. scope, technique, frequency etc.), in order to ensure that it continues to provide data of value in measuring the recovery process and in highlighting any particular areas or issues where further work/analysis may be required to ameliorate impact.. For fisheries characterisation it will be necessary to take the fluctuation in salmonid spawning behaviour (with particular reference to pink salmon) into account and therefore for rivers included in this programme it will be agreed with relevant Russian authorities if an extended monitoring program is necessary after the initial four years, for example for the fifth, seventh and tenth year after construction. The following studies will be undertaken as part of the post-construction monitoring programme:

- **River morphology:** channel profiles will be taken at appropriate distances upstream and downstream of the crossing point, in line with the data collected during the pre-construction monitoring, in order to determine channel morphological change and the movement of any bedforms downstream of the crossing point. Parameters will include river width, channel depth and flow velocity.
- **Hydrochemistry:** samples will be analysed on pH, dissolved oxygen, suspended solids, oil products and water temperature.
- **Suspended sediment sampling and turbidity monitoring:** samples will be undertaken for all rivers of high and medium ecological sensitivity and for a selected number of rivers where the potential for the longer-term risk of continued sediment input into the system has been identified during the potential impact rating (see Section 5.1). Samples will be taken twice a year (spring and autumn).
- **Ichthyofauna and benthos:** continued annual sampling in line with previous programme.
- **Fisheries characteristics**: field reconnaissance survey to determine presence and extent of salmon spawning areas at and in the vicinity of the crossing point. This survey will also sample riverbed sediments and particle size distribution in spawning areas. Measures and sampling techniques will be specified to ensure that fine material will not be lost in any sampling and analysis procedures.

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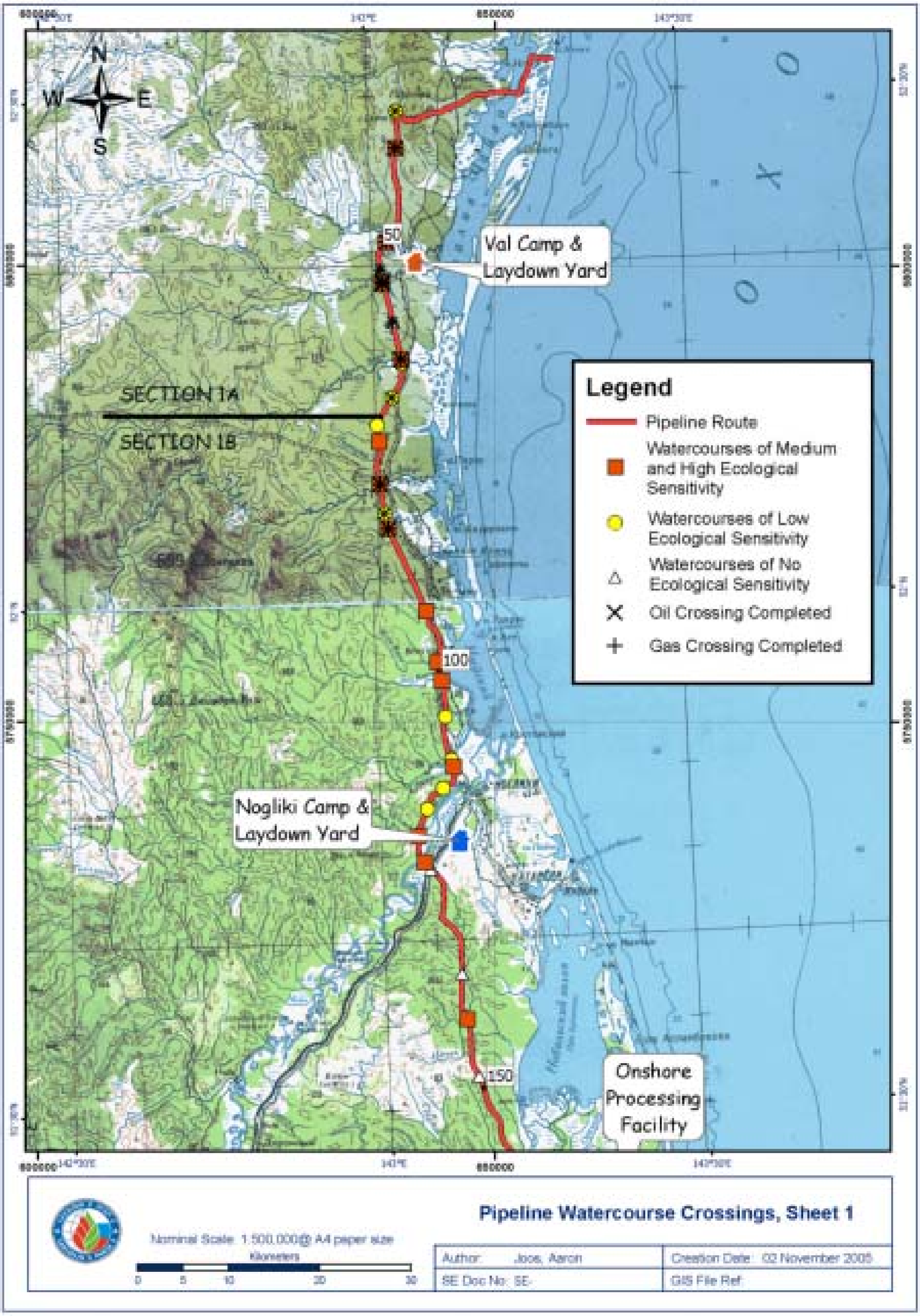
ANNEX A MAP

RCR ANNEX A: SHEET 1



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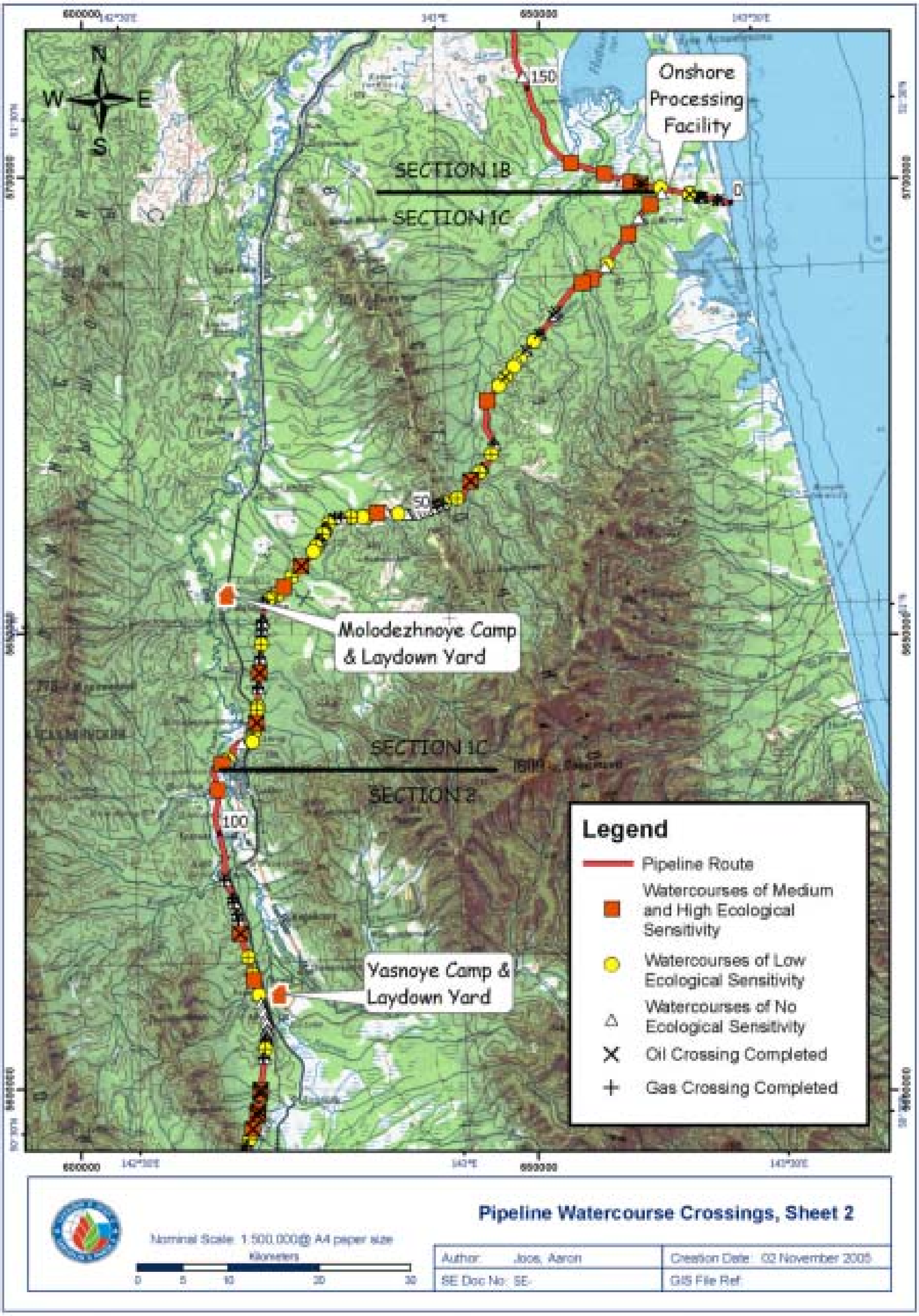

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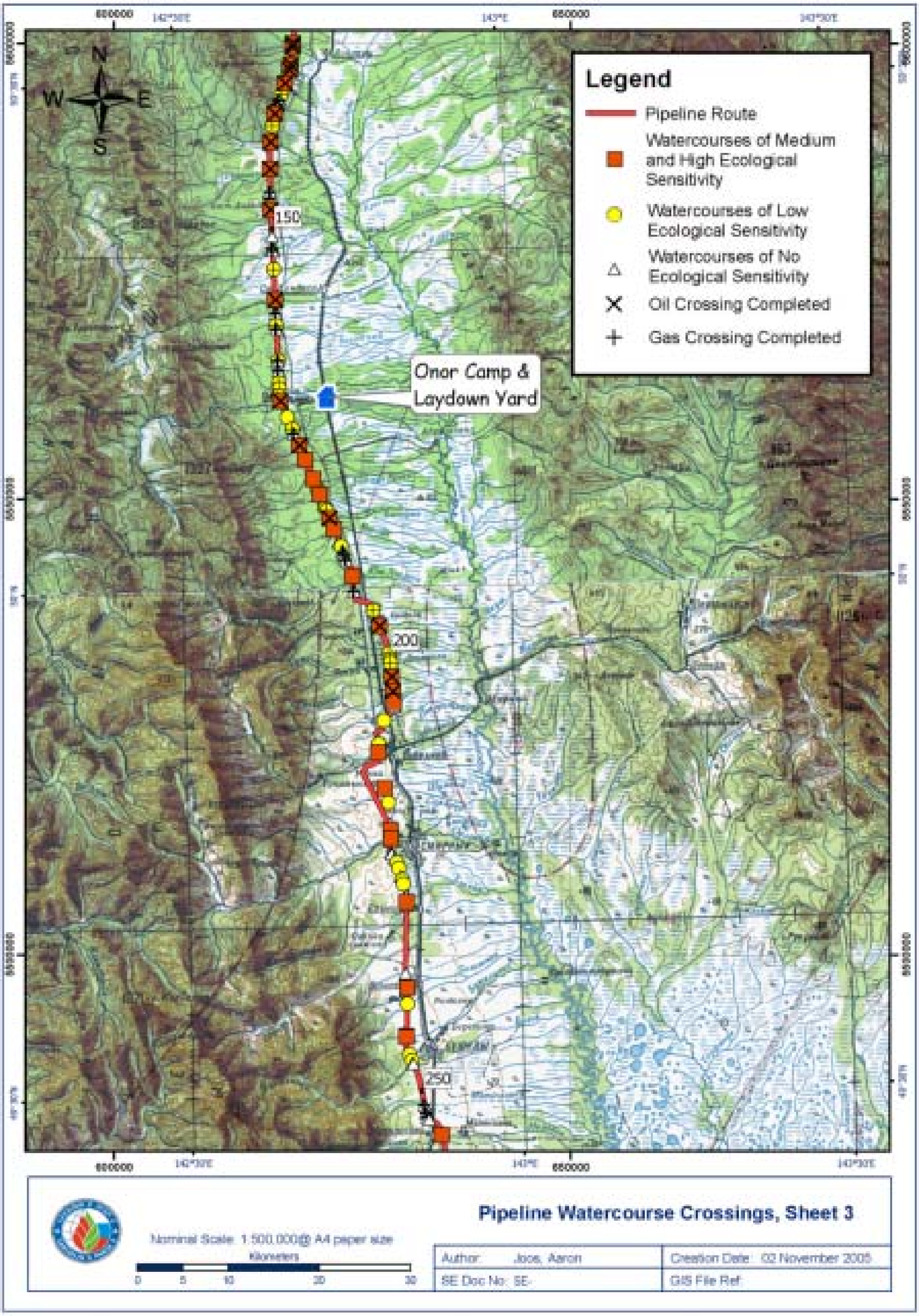

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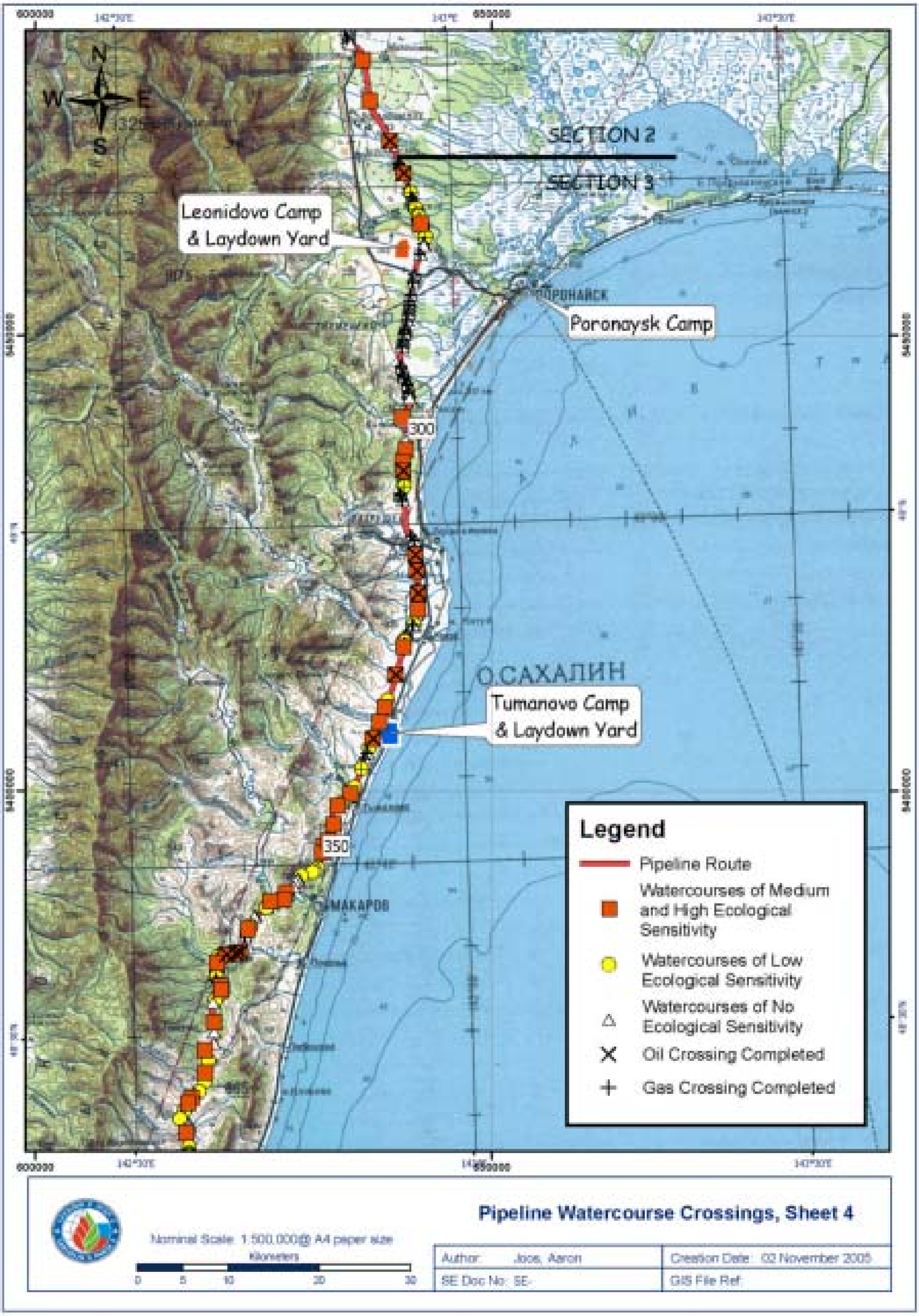

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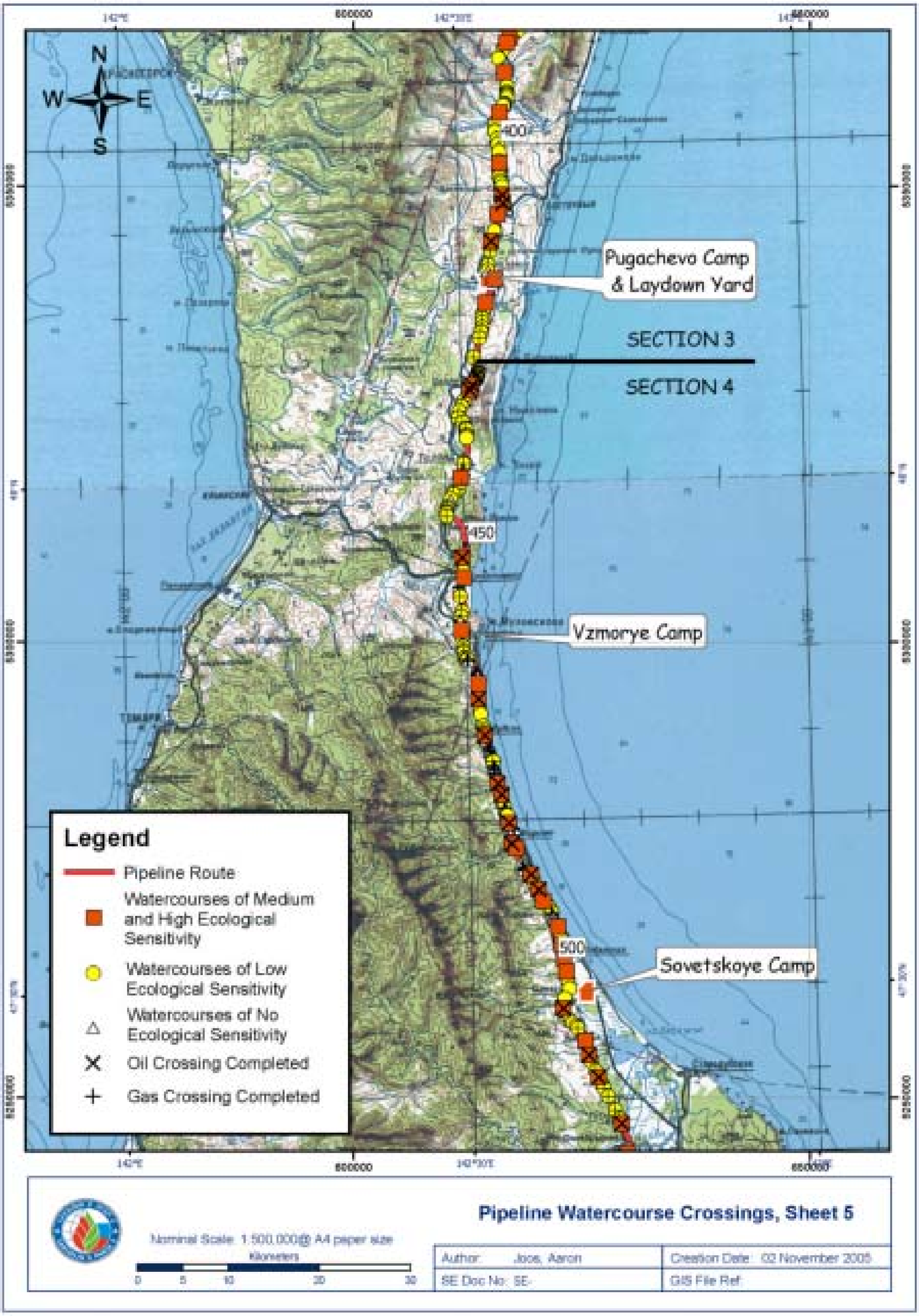

RCR ANNEX A; SHEET 6

ANNEX B LIST OF DOCUMENTS

<u>Approval documentation for pipeline construction at water crossings along Sakhalin II Pipeline (ECMOS reports)</u>

- 5600-K-90-04-T-7001-00-A, Documents for approval of pipeline river crossing construction along Sakhalin-II route
- 5600-K-90-04-T-7002-00-A, Environmental Protection while Kamskaya, Volochek, Emba, Chitinka, Michurinka, Kordon river crossing pipeline construction for
- 5600-K-90-04-T-7003-00-B, Documents for Crossing of Highest Category Fishing Rivers without data on salmon spawning areas
- 5600-K-90-04-T-7004-00-A, Documents for crossing of rivers of 1st fishing category
- 5600-K-90-04-T-7005-00-A, Documents for pipeline construction across rivers of highest fishing category. Team operations. Nogliki region. Group 1 & 2
- 5600-K-90-04-T-7006-00-A, Documents for pipeline construction across rivers of highest fishing category. Team operations. Tymovsk region. Group 4
- 5600-K-90-04-T-7007-00-A, Documents for pipeline construction across rivers of highest fishing category. Team operations. Smirnykh region. Group 5
- 5600-K-90-04-T-7008-00-A, Documents for pipeline construction across rivers of highest fishing category. Team operations. Poronaisk region. Group 7
- 5600-K-90-04-T-7009-00-A, Documents for pipeline construction across rivers of highest fishing category. Team operations. Makarov region. Group 9
- 5600-K-90-04-T-7010-00-A, Documents for pipeline construction across rivers of highest fishing category. Team operations. Dolinsk region. Group 11
- 5600-K-90-04-T-7011-00-B, Documents for pipeline construction across rivers of highest fishing category. Team operations. Smirnykh region. Group 6
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- 5600-K-90-04-T-7017-00-A, Documents for pipeline construction across rivers of highest fishing category. Team operations. Aniva region winter). Group 14
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- 5600-K-90-04-T-7019-00-A, Documents for pipeline construction across rivers of highest fishing category. Individual operations. Askasai River.
- 5600-K-90-04-T-7020-00-A, Documents for pipeline construction across rivers of highest fishing category. Individual operations. Jimdan River.
- 5600-K-90-04-T-7021-00-A, Documents for pipeline construction across rivers of highest fishing category. Individual operations. Mali Veni River.
- 5600-K-90-04-T-7022-00-A, Documents for pipeline construction across rivers of highest fishing category. Individual operations. Taulan River.
- 5600-K-90-04-T-7023-00-A, Documents for pipeline construction across rivers of highest fishing category. Individual operations. Taulanka River.
- 5600-K-90-04-T-7024-00-A, Documents for pipeline construction across rivers of highest fishing category. Individual operations. Ai River.
- 5600-K-90-04-T-7025-00-A, Documents for pipeline construction across rivers of highest fishing category. Individual operations. Evai River.
- 5600-K-90-04-T-7026-00-A, Documents for pipeline construction across rivers of highest fishing category. Individual operations. Bolshiye Veni River.

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- 5600-K-90-04-T-7031-00-A, Documents for pipeline construction across rivers of highest fishing category. Individual operations. Vos'i River.
- 5600-K-90-04-T-7032-00-A, Documents for pipeline construction across rivers of highest fishing category. Individual operations. Uskovo River.
- 5600-K-90-04-T-7033-00-A, Documents for pipeline construction across rivers of highest fishing category. Individual operations. Malaya Tym River.
- 5600-K-90-04-T-7034-00-A, Documents for pipeline construction across rivers of highest fishing category. Individual operations. Orkun'i River.
- 5600-K-90-04-T-7035-00-A, Documents for pipeline construction across rivers of highest fishing category. Individual operations. Palangi River.
- 5600-K-90-04-T-7036-00-A, Documents for pipeline construction across rivers of highest fishing category. Individual operations. Chachma River.
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- 5600-K-90-04-T-7049-00-A, Documents for pipeline construction across rivers of highest fishing category. Individual operations. Goryanka River.
- 5600-K-90-04-T-7050-00-A, Documents for pipeline construction across rivers of highest fishing category. Individual operations. Bolshoi Garomai River.
- 5600-K-90-04-T-7051-00-A, Documents for pipeline construction across rivers of highest fishing category. Individual operations. Orlovka River.

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- Sakhhydromet, 1999. Study of Hydrochemical, hydrologic and radiation-ecological characteristics of watercourses along the pipeline route, the Sakhalin II Project.

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Pre-Construction Surveys

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- Averina, 2004, Combined report on the results of fishery survey in reference watercourses. Pre-construction monitoring of watercourse crossings by Sakhalin-II Project phase 2 pipeline routes." Doc. # 5600-C-63-04-T-0006-00
- Averina, 2004, Hydrological and hydrochemical monitoring of water currents, crossed by Sakhalin-II project pipelines" Doc. # 5600-C-90-04-T-0015-00

Process Charts

- 5600-K-90-59-P-1128-00, Process Chart of Spawning River Crossing from 10 up to 30 m wide (TYPICAL)
- 5600-K-90-59-P-1128-01, Process Chart for Oil & Gas Pipeline Ossoi River Crossing Construction
- 5600-K-90-59-P-1128-04, Process Chart for Oil & Gas Pipeline B.Garomay River Crossing Construction KP 29
- 5600-K-90-59-P-1128-05, Process Chart for Oil & Gas Pipeline Askasay River and Koilsikil brook Crossing Construction, KP 54.3
- 5600-K-90-59-P-1128-06, Process Chart for Oil & Gas Pipeline Evay River Crossing Construction, KP62.63
- 5600-K-90-59-P-2128-01, Process Chart for Oil and Gas Pipeline Dagi River Crossing Construction KP 77.5
- 5600-K-90-59-P-2128-04, Process Chart for Oil and Gas Pipeline Mal. Veni River Crossing Construction KP 98.65
- 5600-K-90-59-P-2128-05, Process Chart for Oil and Gas Pipeline Bol. Veni River Crossing Construction KP 100.75
- 5600-K-90-59-P-2128-07, Process Chart for Oil and Gas Pipeline Chachma River Crossing Construction KP 119.7

- 5600-K-90-59-P-2128-10, Process Chart for Oil and Gas Pipeline Orkun'i River Crossing Construction KP 167.37
- 5600-K-90-59-P-2128-09, Process Chart for two multiphase Pipelines ND 762 mm (30") Vatung River Crossing Construction KP 4.89
- 5600-K-90-59-P-3128-01, Process chart for Oil & Gas pipeline Palanga river crossing Construction, KP 13,67
- 5600-K-90-59-P-3128-04, Process chart for Oil & Gas pipeline Nabil river crossing Construction, KP 41,9
- 5600-K-90-59-P-3128-05, Process Chart for Oil & Gas Pipeline Vos'i River Crossing Construction KP 53.67
- 5600-K-90-59-P-3128-06, Process chart for Oil & Gas pipeline Pilenga river crossing Construction, KP 65,07
- 5600-K-90-59-P-3128-07, Process chart for Oil & Gas pipeline Slavka river crossing Construction, KP 68,0
- 5600-K-90-59-P-3128-09, Process chart for Oil & Gas pipeline Uskovo river crossing Construction, KP 78,7
- 5600-K-90-59-P-4128-00, Process chart for Oil & Gas pipeline Mal Tym river crossing Construction, KP 95,1
- 5600-K-90-59-P-4128-04, Process chart for Oil & Gas pipeline Taulan river crossing Construction, KP 140,5
- 5600-K-90-59-P-4128-05, Process chart for Oil & Gas pipeline Atlanta river crossing Construction, KP 143,4
- 5600-K-90-59-P-4128-08, Process chart for Oil & Gas pipeline Onor river crossing Construction, KP 169,0
- 5600-K-90-59-P-4128-12, Process chart for Oil & Gas pipeline Orlovka river crossing Construction, KP 221,7
- 5600-K-90-59-P-4128-13, Process chart for Oil & Gas pipeline Buklinka river crossing Construction, KP 246,5
- 5600-K-90-59-P-4128-14, Process chart for Oil & Gas pipeline Kamenka river crossing Construction, KP 255,6
- 5600-K-90-59-P-5128-00, Process chart for Oil & Gas pipeline Gorianka river crossing Construction, KP 313,3
- 5600-K-90-59-P-5128-01, Process chart for Oil & Gas pipeline Nitui river crossing Construction, KP 324,0
- 5600-K-90-59-P-5128-03, Process chart for Oil & Gas pipeline Gornaya river crossing Construction, KP 341,2
- 5600-K-90-59-P-5128-04, Process chart for Oil & Gas pipeline Makarova river crossing Construction, KP 357
- 5600-K-90-59-P-5128-06, Process chart for Oil & Gas pipeline Pugachevka river crossing Construction, KP 416,30
- 5600-K-90-59-P-6127-98, Process chart for Oil & Gas pipeline Manui river crossing Construction, KP 453,99
- 5600-K-90-59-P-6127-99, Process Chart for Oil Pipeline Ai River Crossing Construction, KP 505.5
- 5600-K-90-59-P-6128-99, Process Chart for Gas Pipeline Ai River Crossing Construction, KP 505.5
- 5600-K-90-59-P-6128-00, Process Chart for Oil & Gas Pipeline M.Takoi River Crossing Construction, KP 536.06
- 5600-K-90-59-P-6128-04, Process chart for Oil & Gas pipeline Susuya 2 river crossing Construction, KP 584,9
- 5600-K-90-59-P-6128-06, Process chart for Oil & Gas pipeline Mereya river crossing Construction, KP 614,3
- 5600-K-90-59-P-2128-06, Process Chart for Oil & Gas Pipeline Djimdan River Crossing Construction, KP 110.61

ANNEX C FERC GUIDELINES

FERC Guideline	Project Specification
II. PRECONSTRUCTION FILING	
A. The following information shall be filed prior to the beginning of construction:	N/A U.S. specific requirement. Filings are in accordance with RF regulations.
1. The hydrostatic testing information specified in section VII.B.3 and a wetland delineation report as described in section VI.A.1, if applicable.	Conform Hydro-testing conforms with RF regulations
2. A schedule identifying when trenching or blasting would occur within each water body greater than 10 feet wide, or within any designated coldwater fishery. The project sponsor shall revise the schedule as necessary to provide FERC staff at least 14 days advance notice. Changes within this last 14-day period must provide for at least 48 hours advance notice.	NA All coldwater fisheries work done in accordance with RF direction.
B. The following site-specific construction plans required by these Procedures must be filed with the Secretary for the review and written approval by the Director:	NA Requirements are unique to U.S. regulatory framework. See comments below.
1. Plans for extra work areas that would be closer than 50 feet from a water body or wetland;	Conform * Added to River Crossing Strategy where applicable to water body crossings. * Not applicable to work within certain wetlands; ex. push pull pipe laying operation.
2. Plans for major water body crossings;	Conform As agreed with RF regulatory agencies.
3. Plans for the use of a construction right-of-way greater than 75 feet wide in wetlands; and	Conform The FERC Guidelines envisage a single pipeline ROW with pipe diameter 30 inches or less. Given that SEIC is laying two pipelines on adjacent Rights-Of-Way, SEIC conforms with the FERC's intent.
4. Plans for horizontal directional drill (HDD) "crossings" of wetlands or water bodies.	No plans to horizontally drill any wetlands.
III. ENVIRONMENTAL INSPECTORS	
At least one Environmental Inspector having knowledge of the wetland and water body conditions in the project area is required for each construction spread. The number and experience of Environmental Inspectors assigned to each construction spread should be appropriate for the length of the construction spread and the number/significance of resources affected.	Conform Environmental Monitoring Plan.

FERC Guideline	Project Specification
B. The Environmental Inspector's responsibilities are outlined in the Upland Erosion Control, Revegetation and Maintenance Plan (Plan).	Conform Environmental Monitoring Plan.
IV. PRECONSTRUCTION PLANNING	
A. A copy of the Storm water Pollution Prevention Plan (SWPPP) prepared for compliance with the U.S. Environmental Protection Agency's (EPA) National Storm water Program General Permit requirements must be available in the field on each construction spread. The SWPPP shall contain Spill Prevention and Response Procedures that meet the requirements of state and Federal agencies.	N/A U.S. specific Conforming to RF regulations
1. It shall be the responsibility of the project sponsor and its contractors to structure their operations in a manner that reduces the risk of spills or the accidental exposure of fuels or hazardous materials to water bodies or wetlands. The project sponsor and its contractors must, at a minimum, ensure that:	Conform
a. All employees handling fuels and other hazardous materials are properly trained;	Conform
b. All equipment is in good operating order and inspected on a regular basis;	Conform
c. Fuel trucks transporting fuel to on-site equipment travel only on approved access roads;	Conform
d. All equipment is parked overnight and/or fuelled at least 100 feet from a water body or in an upland area at least 100 feet from a wetland boundary. These activities can occur closer only if the Environmental Inspector finds, in advance, no reasonable alternative and the project sponsor and its contractors have taken appropriate steps (including secondary containment structures) to prevent spills and provide for prompt cleanup in the event of a spill;	Conform wherever possible. Some of the wetland crossings are quite long and it will be difficult to move the equipment every evening and reposition the next day.
e. Hazardous materials, including chemicals, fuels, and lubricating oils, are not stored within 100 feet of a wetland, water body, or designated municipal watershed area, unless the location is designated for such use by an appropriate governmental authority. This applies to storage of these materials and does not apply to normal operation or use of equipment in these areas;	Conform
f. Concrete coating activities are not performed within 100 feet of a wetland or water body boundary, unless the location is an existing industrial site designated for such use.	N/A. There will be no concrete pipe coating.
2. The project sponsor and its contractors must structure their operations in a manner that provides for the prompt and effective cleanup of spills of fuel and other hazardous materials. At a minimum, the project sponsor and its contractors must:	Conform
a. Ensure that each construction crew (including cleanup crews) has on hand sufficient supplies of absorbent and barrier materials to allow the rapid containment and recovery of spilled materials and knows the procedure for reporting spills;	Conform
b. Ensure that each construction crew has on hand sufficient tools and material to stop leaks;	Conform
c. Know the contact names and telephone numbers for all local, state, and Federal agencies that must be notified of a spill; and	Conform

FERC Guideline	Project Specification
d. Follow the requirements of those agencies in cleaning up the spill, in excavating and disposing of soils or other materials contaminated by a spill, and in collecting and disposing of waste generated during spill cleanup.	Conform
B. AGENCY COORDINATION	
The project sponsor must coordinate with the appropriate local, state, and Federal agencies as outlined in these Procedures and in the Certificate.	Conform
V. WATER BODY CROSSINGS	
A. NOTIFICATION PROCEDURES AND PERMITS	
1. Apply to the U.S. Army Corps of Engineers (COE), or its delegated agency, for the appropriate wetland and water body crossing permits.	Relevant RF regulations apply
2. Provide written notification to authorities responsible for potable surface water supply intakes located within 3 miles downstream of the crossing at least 1 week before beginning work in the water body, or as otherwise specified by that authority.	Relevant RF regulations apply
3. Apply for state-issued water body crossing permits and obtain individual or generic section 401 water quality certification or waiver.	Relevant RF regulations apply
4. Notify appropriate state authorities at least 48 hours before beginning trenching or blasting within the water body, or as specified in state permits.	Relevant RF regulations apply
B. INSTALLATION	
1. Time Window for construction, unless expressly permitted or further restricted by the appropriate state agency in writing on a site specific basis, in-stream work, except that required to install or remove equipment bridges, must occur during the following time windows:	Conform SEIC is performing stream crossings at a time agreed with RF agencies.
a. Coldwater fisheries - June 1 through September 30; and	
b. cool water and warm water fisheries - June 1 through November 30.	
2. Extra Work Areas:	
a. Locate all extra work areas (such as staging areas and additional spoil storage areas) at least 50 feet away from water's edge, except where the adjacent upland consists of actively cultivated or rotated cropland or other disturbed land.	Conform with relevant RF regulations
b. The project sponsor shall file with the Secretary for review and written approval by the Director, a site-specific construction plan for each extra work area with a less than 50ft setback from the water's edge, (except where the adjacent upland consists of actively cultivated or rotated cropland or other disturbed land) and a site-specific explanation of the conditions that will not permit a 50ft setback.	NA Specific to U.S. legal/regulatory requirements
c. Limit clearing of vegetation between extra work areas and the edge of the water body to the certificated construction right-of-way.	Conform
d. Limit the size of extra work areas to the minimum needed to construct the water body crossing.	Conform
3. General Crossing Procedures	

FERC Guideline	Project Specification
a. Conform with the COE, or its delegated agency, permit terms and conditions.	NA Specific to U.S. legal/regulatory requirement. Relevant RF regulations apply
b. Construct crossings as close to perpendicular to the axis of the water body channel as engineering and routing conditions permit.	Conform
c. If the pipeline parallels a water body, attempt to maintain at least 15 feet of undisturbed vegetation between the water body (and any adjacent wetland) and the construction right-of-way.	Conform
d. Where water bodies meander or have multiple channels, route the pipeline to minimise the number of water body crossings.	Conform
e. Maintain adequate flow rates to protect aquatic life, and prevent the interruption of existing downstream uses.	Conform
f. Water body buffers (extra work area setbacks, refuelling restrictions, etc.) must be clearly marked in the field with signs and/or highly visible flagging until construction-related ground disturbing activities are complete.	Conform
4. Spoil Pile Placement and Control	
a. All spoil from minor and intermediate water body crossings, and upland spoil from major water body crossings, must be placed in the construction right-of-way at least 10 feet from the water's edge or in additional extra work areas as described in section V.B.2.	Conform. Section 8.2.2 of SREPP.
b. Use sediment barriers to prevent the flow of spoil or heavily silt-laden water into any water body.	Conform Section 9.3.2 of SREPP.
5. Equipment Bridges	
a. Only clearing equipment and equipment necessary for installation of equipment bridges may cross water bodies prior to bridge installation. Limit the number of such crossings of each water body to one per piece of clearing equipment.	Conform
b. Construct equipment bridges to maintain unrestricted flow and to prevent soil from entering the water body. Examples of such bridges include:	Conform
(1) equipment pads and culvert(s);	Conform
(2) equipment pads or railroad car bridges without culverts;	Conform
(3) clean rock fill and culvert(s); and	Conform
(4) flexi-float or portable bridges. Additional options for equipment bridges may be utilized that achieve the performance objectives noted above. Do not use soil to construct or stabilise equipment bridges.	N/A
c. Design and maintain each equipment bridge to withstand and pass the highest flow expected to occur while the bridge is in place. Align culverts to prevent bank erosion or streambed scour. If necessary, install energy dissipating devices downstream of the culverts.	Conform

FERC Guideline	Project Specification
d. Design and maintain equipment bridges to prevent soil from entering the water body.	Conform
e. Remove equipment bridges as soon as possible after permanent seeding unless the COE, or its delegated agency, authorises it as a permanent bridge.	Conform
f. If there will be more than 1 month between final cleanup and the beginning of permanent seeding and reasonable alternative access to the right-of-way is available, remove equipment bridges as soon as possible after final cleanup.	Not possible because of timing issues with oil and gas pipeline construction schedules.
6. Dry-Ditch Crossing Methods	*Note: dry crossings are not preferred by the Russian authorities. If SEIC is granted permission to undertake dry crossings it will do so for those water bodies outlined in the River Crossings Report.*
a. Unless approved otherwise by the appropriate state agency, install the pipeline using one of the dry-ditch methods outlined below for crossings of water bodies up to 30 feet wide (at the water's edge at the time of construction) that are state-designated as either coldwater or significant coolwater or warmwater fisheries.	Conform SEIC has committed to go beyond this requirement by using not just width but also depth in defining the practical limits to a dry cut.
b. Dam and Pump	
(1) The dam-and-pump method may be used without prior approval for crossings of water bodies where pumps can adequately transfer streamflow volumes around the work area, and there are no concerns about sensitive species passage.	Conform Dam and pump operations have been considered as an option for dry cuts. However, we may prefer to use other methods that do not necessitate blocking the water body and isolating fauna populations.
(2) Implementation of the dam-and-pump crossing method must meet the following performance criteria:	Conform if dam and pump methods are used.
(i) use sufficient pumps, including onsite backup pumps, to maintain downstream flows;	Conform if dam and pump methods are used.
(ii) construct dams with materials that prevent sediment and other pollutants from entering the water body (e.g. sandbags or clean gravel with plastic liner);	Conform if dam and pump methods are used.
(iii) screen pump intakes;	Conform if dam and pump methods are used.
(iv) prevent streambed scour at pump discharge; and	Conform if dam and pump methods are used.
(v) monitor the dam and pumps to ensure proper operation throughout the water body crossing.	Conform if dam and pump methods are used.
c. Flume Crossing:	
(1) Install flume pipe after blasting (if necessary), but before any trenching;	Conform

FERC Guideline	Project Specification
(2) Use sand bag or sand bag and plastic sheeting diversion structure or equivalent to develop an effective seal and to divert stream flow through the flume pipe (some modifications to the stream bottom may be required in to achieve an effective seal);	Conform
(3) Properly align flume pipe(s) to prevent bank erosion and streambed scour;	Conform
(4) Do not remove flume pipe during trenching, pipe laying, or backfilling activities, or initial streambed restoration efforts; and	Conform
(5) Remove all flume pipes and dams that are not also part of the equipment bridge as soon as final cleanup of the streambed and bank is complete.	Conform
d. Horizontal Directional Drill (HDD): To the extent they were not provided as part of the pre-certification process, for each water body or wetland that would be crossed using the HDD method, provide a plan that includes:	Conform
(1) Site-specific construction diagrams that show the location of mud pits, pipe assembly areas, and all areas to be disturbed or cleared for construction;	Conform
(2) A description of how an inadvertent release of drilling mud would be contained and cleaned up; and	Conform
(3) A contingency plan for crossing the water body or wetland in the event the directional drill is unsuccessful and how the abandoned drill hole would be sealed, if necessary.	Conform
7. Crossings of Minor Water bodies. Where a dry-ditch crossing is not required, minor water bodies may be crossed using the open-cut crossing method, with the following restrictions:	Conform
a. Except for blasting and other rock breaking measures, complete in-stream construction activities (including trenching, pipe installation, backfill, and restoration of the streambed contours) within 24 hours. Stream banks and unconsolidated streambeds may require additional restoration after this period;	Conform
b. Limit use of equipment operating in the water body to that needed to construct the crossing; and	Conform
c. Equipment bridges are not required at minor water bodies that do not have a state-designated fishery classification (e.g., agricultural or intermittent drainage ditches). However, if an equipment bridge is used it must be constructed as described in section V.B.5.	Conform
8. Crossings of Intermediate Water bodies. Where a dry-ditch crossing is not required, intermediate water bodies may be crossed using the open-cut crossing method, with the following restrictions:	
a. Complete in-stream construction activities (not including blasting and other rock breaking measures) within 48 hours, unless site-specific conditions make completion within 48 hours infeasible;	Conform
b. Limit use of equipment operating in the water body to that needed to construct the crossing; and	Conform
c. all other construction equipment must cross on an equipment bridge as specified in section V.B.5.	Conform

FERC Guideline	Project Specification
9. Crossings of Major Water bodies	
Before construction, the project sponsor shall file with the Secretary for the review and written approval by the Director a detailed, site-specific construction plan and scaled drawings identifying all areas to be disturbed by construction for each major water body crossing (the scaled drawings are not required for any offshore portions of pipeline projects). This plan should be developed in consultation with the appropriate state and Federal agencies and should include extra work areas, spoil storage areas, sediment control structures, etc., as well as mitigation for navigational issues. The Environmental Inspector may adjust the final placement of the erosion and sediment control structures in the field to maximize effectiveness.	Conform RF equivalent of this instruction applies.
10. Temporary Erosion and Sediment Control	
Install sediment barriers (as defined in section IV.F.2.a. of the Plan) immediately after initial disturbance of the water body or adjacent upland. Sediment barriers must be properly maintained throughout construction and reinstalled as necessary (such as after backfilling of the trench) until replaced by permanent erosion controls or restoration of adjacent upland areas is complete. Temporary erosion and sediment control measures are addressed in more detail in the Plan; however, the following specific measures must be implemented at stream crossings.	Conform As per River Crossing Strategy
a. Install sediment barriers across the entire construction right-of-way at all water body crossings, where necessary to prevent the flow of sediments into the water body. In the travel lane, these may consist of removable sediment barriers or driveable berms. Removable sediment barriers can be removed during the construction day, but must be re-installed after construction has stopped for the day and/or when heavy precipitation is imminent;	
b. Where water bodies are adjacent to the construction right-of-way, install sediment barriers along the edge of the construction right-of-way as necessary to contain spoil and sediment within the construction right-of-way; and	
c. Use trench plugs at all water body crossings, as necessary, to prevent diversion of water into upland portions of the pipeline trench and to keep any accumulated trench water out of the water body.	
11. Trench Dewatering	
Dewater the trench (either on or off the construction right-of-way) in a manner that does not cause erosion and does not result in heavily silt-laden water flowing into any water body. Remove the dewatering structures as soon as possible after the completion of dewatering activities.	Conform
C. RESTORATION	
1. Use clean gravel or native cobbles for the upper 1 foot of trench backfill in all water bodies that contain coldwater fisheries.	Conform As per River Crossing Strategy
2. For open-cut crossings, stabilize water body banks and install temporary sediment barriers within 24 hours of completing in-stream construction activities. For dry-ditch crossings, complete streambed and bank stabilization before returning flow to the water body channel.	Conform
3. Return all water body banks to preconstruction contours or to a stable angle of repose as approved by the Environmental Inspector.	Conform

FERC Guideline	Project Specification
4. Application of riprap for bank stabilization must Conform with COE, or its delegated agency, permit terms and conditions.	Conform In accordance with relevant RF regulations
5. Unless otherwise specified by state permit, limit the use of riprap to areas where flow conditions preclude effective vegetative stabilization techniques such as seeding and erosion control fabric.	Conform In accordance with relevant RF regulations
6. Revegetate disturbed riparian areas with conservation grasses and legumes or native plant species, preferably woody species.	Conform In accordance with relevant RF regulations
7. Install a permanent slope breaker across the construction right-of-way at the base of slopes greater than 5 percent that are less than 50 feet from the water body, or as needed to prevent sediment transport into the water body. In addition, install sediment barriers as outlined in the Plan. In some areas, with the approval of the Environmental Inspector, an earthen berm may be suitable as a sediment barrier adjacent to the water body.	Conform As per Method Statement
8. Sections V.C.3. through V.C.6. above also apply to those perennial or intermittent streams not flowing at the time of construction.	Conform
D. POST-CONSTRUCTION MAINTENANCE	
1. Limit vegetation maintenance adjacent to water bodies to allow a riparian strip at least 25 feet wide, as measured from the water body's mean high water mark, to permanently revegetate with native plant species across the entire construction right-of-way. However, to facilitate periodic pipeline corrosion/leak surveys, a corridor centred on the pipeline and up to 10 feet wide may be maintained in a herbaceous state. In addition, trees that are located within 15 feet of the pipeline that are greater than 15 feet in height may be cut and removed from the permanent right-of-way.	Conform
2. Do not use herbicides or pesticides in or within 100ft of a water body except as allowed by the appropriate land management or state agency.	Conform
VI. WETLAND CROSSINGS	
A. GENERAL	
1. The project sponsor shall conduct a wetland delineation using the current Federal methodology and file a wetland delineation report with the Secretary before construction. This report shall identify:	Conform Have delineated wetlands according to RF requirements (“swamp inventory”).
a. by milepost all wetlands that would be affected;	Conform
b. the National Wetlands Inventory (NWI) classification for each wetland;	N/A
c. the crossing length of each wetland in feet; and	Conform (in metres)
d. the area of permanent and temporary disturbance that would occur in each wetland by NWI classification type.	Conform SEIC has made calculations to RF classification standards

FERC Guideline	Project Specification
The requirements outlined in this section do not apply to wetlands in actively cultivated or rotated cropland. Standard upland protective measures, including workspace and topsoiling requirements, apply to these agricultural wetlands.	Conform
2. Route the pipeline to avoid wetland areas to the maximum extent possible. If a wetland cannot be avoided or crossed by following an existing right-of-way, route the new pipeline in a manner that minimizes disturbance to wetlands. Where looping an existing pipeline, overlap the existing pipeline right-of-way with the new construction right-of-way. In addition, locate the loop line no more than 25 feet away from the existing pipeline unless site-specific constraints would adversely affect the stability of the existing pipeline.	Conform ROW to the extent possible follows existing power, pipeline, or transport ROW down the island.
3. Limit the width of the construction right-of-way to 75 feet or less. Prior written approval of the Director is required where topographic conditions or soil limitations require that the construction right-of-way width within the boundaries of a federally delineated wetland be expanded beyond 75 feet. Early in the planning process the project sponsor is encouraged to identify site-specific areas where existing soils lack adequate unconfined compressive strength that would result in excessively wide ditches and/or difficult to contain spoil piles.	Conform The FERC Guidelines envisage a single pipeline ROW with pipe diameter 30 inches or less. Given that SEIC is laying two pipelines on adjacent ROW, we are conforming with the FERC's intent.
4. Wetland boundaries and buffers must be clearly marked in the field with signs and/or highly visible flagging until construction-related ground disturbing activities are complete.	Conform Swamp Crossing Method Statement
5. Implement the measures of sections V and VI in the event a water body crossing is located within or adjacent to a wetland crossing. If all measures of sections V and VI cannot be met, the project sponsor must file with the Secretary a site-specific crossing plan for review and written approval by the Director before construction. This crossing plan shall address at a minimum:	NA U.S. specific.
a. spoil control; b. equipment bridges; c. restoration of water body banks and wetland hydrology; d. timing of the water body crossing; e. method of crossing; and f. size and location of all extra work areas.	Conform RF equivalent of this instruction applies.
6. Do not locate aboveground facilities in any wetland [except where the location of such facilities outside of wetlands would prohibit compliance with U.S. Department of Transportation regulations.]	Conform There will be no above-ground facilities within significant wetlands.
B. INSTALLATION	
1. Extra Work Areas and Access Roads	

FERC Guideline	Project Specification
a. Locate all extra work areas (such as staging areas and additional spoil storage areas) at least 50 feet away from wetland boundaries, except where the adjacent upland consists of actively cultivated or rotated cropland or other disturbed land.	Conform Forms a component of the Swamp Crossing Method Statement. It will not be possible to conform if the push-pull method of pipe welding and stringing is used. However, this point is largely irrelevant, as most work will be done in winter when both upland and lowland areas are frozen.
b. The project sponsor shall file with the Secretary for review and written approval by the Director, a site-specific construction plan for each extra work area with a less than 50-foot setback from wetland boundaries (except where adjacent upland consists of actively cultivated or rotated cropland or other disturbed land) and a site-specific explanation of the conditions that will not permit a 50-foot setback.	N/A Conform with relevant RF regulations.
c. Limit clearing of vegetation between extra work areas and the edge of the wetland to the certificated construction right-of-way.	Conform
d. The construction right-of-way may be used for access when the wetland soil is firm enough to avoid rutting or the construction right-of-way has been appropriately stabilised to avoid rutting (e.g., with timber riprap, prefabricated equipment mats, or terra mats). In wetlands that cannot be appropriately stabilized, all construction equipment other than that needed to install the wetland crossing shall use access roads located in upland areas. Where access roads in upland areas do not provide reasonable access, limit all other construction equipment to one pass through the wetland using the construction right-of-way.	Conform Forms a component of the Swamp Crossing Method Statement. Peat bogs will be crossed in winter when frozen. Other low ground pressure areas, peaty soils or saturated soils exhibiting various stages of hydromorphism will be crossed as appropriate, when frozen or when non- frozen on timber mats.
e. The only access roads, other than the construction right-of-way, that can be used in wetlands without Director approval, are those existing roads that can be used with no modification and no impact on the wetland.	N/A Conform with relevant RF regulations.
2. Crossing Procedures	
a. Conform with COE, or its delegated agency, permit terms and conditions	Conform with relevant RF regulations.
b. Assemble the pipeline in an upland area unless the wetland is dry enough to adequately support skids and pipe.	Conform Work will be accomplished mostly in winter or from timber roads/mats.
c. Use "push-pull" or "float" techniques to place the pipe in the trench where water and other site conditions allow.	Conform
d. Minimize the length of time that topsoil is segregated and the trench is open.	N/A. RF regulations do not require the segregation of wetland topsoils.

FERC Guideline	Project Specification
e. Limit construction equipment operating in wetland areas to that needed to clear the construction right-of-way, dig the trench, fabricate and install the pipeline, backfill the trench, and restore the construction right-of- way.	Conform (Swamp Crossing Method Statement)
f. Cut vegetation just aboveground level, leaving existing root systems in place, and remove it from the wetland for disposal.	Conform (Swamp Crossing Method Statement)
g. Limit pulling of tree stumps and grading activities to directly over the trenchline. Do not grade or remove stumps or root systems from the rest of the construction right-of-way in wetlands unless the Chief Inspector and Environmental Inspector determine that safety related construction constraints require grading or the removal of tree stumps from under the working side of the construction right-of-way.	Conform (Swamp Crossing Method Statement)
h. Segregate the top 1 foot of topsoil from the area disturbed by trenching, except in areas where standing water is present or soils are saturated or frozen. Immediately after backfilling is complete, restore the segregated topsoil to its original location	Conform Conform with relevant RF regulations. In peat bogs, the Contractor will segregate upper sphagnum moss cover. (Swamp Crossing Method Statement).
i. Do not use rock, soil imported from outside the wetland, tree stumps, or brush riprap to support equipment on the construction right-of-way.	Conform (Swamp Crossing Method Statement)
j. If standing water or saturated soils are present, or if construction equipment causes ruts or mixing of the topsoil and subsoil in wetlands, use low-ground-weight construction equipment, or operate normal equipment on timber riprap, prefabricated equipment mats, or terra mats.	Conform (Swamp Crossing Method Statement)
k. Do not cut trees outside of the approved construction work area to obtain timber for riprap or equipment mats.	Conform (Swamp Crossing Method Statement)
l. Attempt to use no more than two layers of timber riprap to support equipment on the construction right-of-way.	Conform (Swamp Crossing Method Statement)
m. Remove all project-related material used to support equipment on the construction right-of-way upon completion of construction.	Conform (Swamp Crossing Method Statement)
3. Temporary Sediment Control	
Install sediment barriers (as defined in section IV.F.2.a. of the Plan) immediately after initial disturbance of the wetland or adjacent upland. Sediment barriers must be properly maintained throughout construction and reinstalled as necessary (such as after backfilling of the trench). Except as noted below in section VI.B.3.c., maintain sediment barriers until replaced by permanent erosion controls or restoration of adjacent upland areas is complete. Temporary erosion and sediment control measures are addressed in more detail in the Plan.	Conform (Swamp Crossing Method Statement)

FERC Guideline	Project Specification
a. Install sediment barriers across the entire construction right-of-way at all wetland crossings where necessary to prevent sediment flow into the wetland. In the travel lane, these may consist of removable sediment barriers or driveable berms. Removable sediment barriers can be removed during the construction day, but must be re-installed after construction has stopped for the day and/or when heavy precipitation is imminent.	Conform (Swamp Crossing Method Statement)
b. Where wetlands are adjacent to the construction right-of-way and the right-of-way slopes toward the wetland, install sediment barriers along the edge of the construction right-of-way as necessary to prevent sediment flow into the wetland.	Conform (Swamp Crossing Method Statement)
c. Install sediment barriers along the edge of the construction right-of-way as necessary to contain spoil and sediment within the construction right-of-way through wetlands. Remove these sediment barriers during right-of-way cleanup.	Conform (Swamp Crossing Method Statement)
4. Trench Dewatering	
Dewater the trench (either on or off the construction right-of-way) in a manner that does not cause erosion and does not result in heavily silt-laden water flowing into any wetland. Remove the dewatering structures as soon as possible after the completion of dewatering activities.	Conform (Swamp Crossing Method Statement)
1. Where the pipeline trench may drain a wetland, construct trench breakers and/or seal the trench bottom as necessary to maintain the original wetland hydrology.	Conform (Swamp Crossing Method Statement)
2. For each wetland crossed, install a trench breaker at the base of slopes near the boundary between the wetland and adjacent upland areas. Install a permanent slope breaker across the construction right-of-way at the base of a slopes greater than 5% where the base of the slope is less than 50 feet from the wetland, or as needed to prevent sediment transport into the wetland. In addition, install sediment barriers as outlined in the Plan. In some areas, with the approval of the Environmental Inspector, an earthen berm may be suitable as a sediment barrier adjacent to the wetland.	Conform (Swamp Crossing Method Statement)
3. Do not use fertilizer, lime, or mulch unless required in writing by the appropriate land management or state agency.	Conform (Swamp Crossing Method Statement)
4. Consult with the appropriate land management or state agency to develop a project-specific wetland restoration plan. The restoration plan should include measures for re-establishing herbaceous and/or woody species, controlling the invasion and spread of undesirable exotic species (e.g., purple loosestrife and phragmites), and monitoring the success of the revegetation and weed control efforts. Provide this plan to the FERC staff upon request.	N/A, as U.S. specific Contractors are aware of the need to consult with local land management agencies.
5. Until a project-specific wetland restoration plan is developed and/or implemented, temporarily revegetate the construction right-of-way with annual ryegrass at a rate of 40 pounds/acre (unless standing water is present).	N/A SREPP details how revegetation will be carried out. It has been agreed with Oblast agricultural agencies to use meadow fescue grass mix for temporary revegetation.
6. Ensure that all disturbed areas successfully revegetate with wetland herbaceous and/or woody plant species.	Conform SREPP

FERC Guideline	Project Specification
7. Remove temporary sediment barriers located at the boundary between wetland and adjacent upland areas after upland revegetation and stabilization of adjacent upland areas are judged to be successful as specified in section VII.A.5 of the Plan.	Conform A requirement of the SREPP
D. POST-CONSTRUCTION MAINTENANCE	
1. Do not conduct vegetation maintenance over the full width of the permanent right-of-way in wetlands. However, to facilitate periodic pipeline corrosion/leak surveys, a corridor centred on the pipeline and up to 10 feet wide may be maintained in a herbaceous state. In addition, trees within 15 feet of the pipeline that are greater than 15 feet in height may be selectively cut and removed from the permanent right-of-way.	Conform
2. Do not use herbicides or pesticides in or within 100 feet of a wetland, except as allowed by the appropriate land management agency or state agency.	Conform
3. Monitor and record the success of wetland revegetation annually for the first 3 years after construction or until wetland revegetation is successful. At the end of 3 years after construction, file a report with the Secretary identifying the status of the wetland revegetation efforts. Include the percent cover achieved and problem areas (weed invasion issues, poor revegetation, etc.). Continue to file a report annually until wetland revegetation is successful.	Conform RF regulations apply.
4. Wetland revegetation shall be considered successful if the cover of herbaceous and/or woody species is at least 80 percent of the type, density, and distribution of the vegetation in adjacent wetland areas that were not disturbed by construction. If revegetation is not successful at the end of 3 years, develop and implement (in consultation with a professional wetland ecologist) a remedial revegetation plan to actively revegetate the wetland. Continue revegetation efforts until wetland revegetation is successful.	Conform
VII. HYDROSTATIC TESTING	
A. NOTIFICATION PROCEDURES AND PERMITS	
1. Apply for state-issued water withdrawal permits, as required.	Conform
2. Apply for National Pollutant Discharge Elimination System (NPDES) or state-issued discharge permits, as required.	N/A (U.S. specific)
3. Notify appropriate state agencies of intent to use specific sources at least 48 hours before testing activities unless they waive this requirement in writing.	Conform with relevant RF Law
B. GENERAL	
1. Perform non-destructive testing of all pipeline section welds or hydrotest the pipeline sections, before installation under water bodies or wetlands.	Conform Contractor is committed to 100% X-ray of welds.
2. If pumps used for hydrostatic testing are within 100 feet of any water body or wetland, address the operation and refuelling of these pumps in the project's Spill Prevention and Response Procedures.	Conform Will be addressed in the hydrotest Plan. RF regulations stipulate 25 metres water protection zone in which no refuelling is allowed.

FERC Guideline	Project Specification
3. The project sponsor shall file with the Secretary before construction a list identifying the location of all water bodies proposed for use as a hydrostatic test water source or discharge location.	Conform with relevant RF Law
C. INTAKE SOURCE AND RATE	
1. Screen the intake hose to prevent entrainment of fish.	Conform Will be addressed in the Hydrotest Plan.
2. Do not use state-designated exceptional value waters, water bodies which provide habitat for federally listed threatened or endangered species, or water bodies designated as public water supplies, unless appropriate Federal, state, and/or local permitting agencies grant written permission.	Conform Will be addressed in the Hydrotest Plan.
3. Maintain adequate flow rates to protect aquatic life, provide for all water body uses, and provide for downstream withdrawals of water by existing users.	Conform Will be addressed in the Hydrotest Plan.
4. Locate hydrostatic test manifolds outside wetlands and riparian areas to the maximum extent practicable.	Conform Will be addressed in the Hydrotest Plan.
D. DISCHARGE LOCATION, METHOD, AND RATE	
1. Regulate discharge rate, use energy dissipation device(s), and install sediment barriers, as necessary, to prevent erosion, streambed scour, suspension of sediments, or excessive streamflow.	Conform Will be addressed in the Hydrotest Plan.
2. Do not discharge into state-designated exceptional value waters, water bodies which provide habitat for federally listed threatened or endangered species, or water bodies designated as public water supplies, unless appropriate Federal, state, and local permitting agencies grant written permission.	Conform All discharges of untreated water will be to the ground surface away from surface waters. If antifreeze becomes necessary in the winter, we will develop a plan before any hazardous materials are introduced to hydrotest activities.

ANNEX D OUTLINE OF RIVER CROSSING EXECUTION PLAN

8 INTRODUCTION

8.1 OBJECTIVE

- Objective of the document

8.2 APPROACH

- Reference to River Crossing Strategy and general approach

8.3 SCOPE OF WORK

- Overview of rivers to cross per section
- Indication of those with oil line and/or FOC already installed

9 LICENSE AND PERMITS

- Explanation of approval process and authorities involved
- Reference to approval packages

10 CROSSING CONSTRUCTION TECHNIQUE

- Cross reference to generic method statement(s) and Inspection Test Plan.
- Describe specific approach for the plan period

11 IMPACT MINIMISATION

11.1 POTENTIAL IMPACT RATING

- Explanation of methodology as set out in strategy
- Description of criteria for ecological sensitivity
- Description of process for hydromorphological impact
- Reference to information used
- Reference to listing of impact ratings for rivers per section

11.2 MITIGATION MEASURES

- Description of measures used and why
- 1. Minimising instream construction time
- 2. Time period
- 3. Industry standard construction practices
- 4. Erosion control

11.3 REINSTATEMENT

- Specification of reinstatement requirements, in line with strategy

11.4 MONITORING

- Description of Averina monitoring objectives, scope and methods/reporting
- Specification of monitoring requirements, in line with strategy

11.5 EXTERNAL OBSERVERS

- Description of objectives, scope and methods/reporting

12 ORGANISATION, RESOURCES AND LOGISTICS

12.1 ORGANISATION

- Overview SEIC/Contractor/Sub-contractor set-up

12.2 RESOURCES

- Specification of equipment and materials to be used
- Specification of size and composition of crews

12.3 LOGISTICS

- Overview of any particular logistical aspects

12.4 INTERFACES / THIRD PARTIES

- Interface with Sakhrybvod and other authorities
- Interface with Averina and external observers

13 CROSSING SCHEDULE

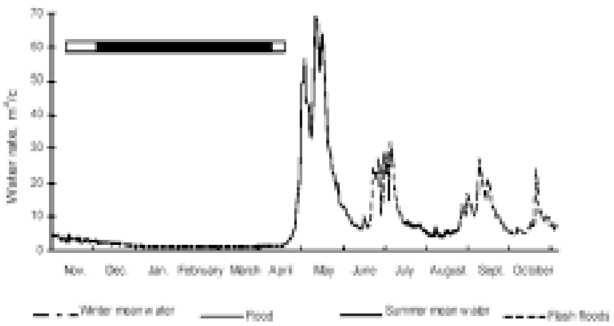
- Explanation of timing and sequence methodology
- Reference to listing timing/sequence for rivers per section

14 REFERENCES

APPENDIX: RIVER CROSSING SUMMARY SHEET

ANNEX E EXAMPLE OF A RIVER CROSSING ASSESSMENT SHEET

Appendix 1 - Hydrogeomorphological Assessment

Orkunie River	KP 166.7	
Step 1: Characterisation of hydrogeomorphology		
Parameter	**Description**	**Data**
Climate and rainfall		
Climate	General Description	Climate in this part of Sakhalin is characterised by cold windy winters and cloudy cold summers with frequent fogs. Snow cover is observed from the end of October and generally disappears in May. Spring is cold, with strong winds and frequent fogs. Temperature increases very slowly due to impact of cold stream; floe can be retained near shore. Development of spring processes can be delayed by 20-25 days, as compared with southern regions of Sakhalin.
	Winter mean temperature ^{o}C	-23.1
	Summer mean temperature ^{o}C	13.5
Rainfall	Mean summer precipitation	185mm
	Mean winter precipitation	515mm
	Annual average precipitation	700mm
Drainage Basin Character		
River Network	Order of tributary	Middle Reaches, Lowland river
	Watercourse length	40 km
	Drainage basin area	132 km^2
	Location of crossing in catchment	The Orkunie River flows northwards into the Nabilski Gulf. The main tributaries are the Spokoiny and Bolotny Streams which join the Orkunie River approx 1.5 and 4km downstream of the crossing in question. There are two crossings on the Orkunie River itself approximately 11.3 km and 18 km from the river mouth. In addition there are 7 other crossings over tributaries to the Orkunie River, including the Spokoiny and Bolotny Streams and their 2nd order tributaries. The crossings lie to the south of a large wetland area, located south of the Nabilski Gulf. The Spokoiny and Bolotny Streams join the Orkunie River approx 1.5 and 4km downstream of the crossing in question. However, these tributaries are also crossed by the pipeline.
	Proximity to coast or main river	11.3km to sea
Coastal system	Mouth of river system	The Orkunie River flows into the Nabilski Gulf.
Topography	Description	The river flows off the northern slopes of Lunskoy ridge at a height of 120m above sea level and flows into Orkunie (Nabil Bay).
Floodplain	Characteristics	The Orkunie river floodplain is wide and high, with clearly marked abrupt benches (1.5–2m). The floodplain is composed of unstable plastic loamy sands with interlayers of sand (thickness 3.2 – 4m), below this layer are gravel/pebble soils with loamy soil filler, uncovered up to depths of 5-10m. Peat is present on the LH floodplain to a depth of 0.7m
	Floodplain width	246m (LH) 0m (RH)
	Hillslope-channel coupling	Channel coupled to the river at a crossing on the right hand bank.
	Floodplain/Riparian vegetation	Shrubs, grassland vegetation, small sections of mixed wood with single fir and larch trees. Alders line watercourse.
Land use	Type	Mixed woodland and coarse grass. Percentage of forest land in river basin – 50%.
Channel Characteristics		
Channel Geometry	**OIL**	
	Bankfull width	14m
	Bankfull depth (max)	2.5m
	Width:Depth ratio	5.6:1
	GAS	
	Bankfull width	25m
	Bankfull depth (max)	3.0m
	Width:Depth ratio	8.3:1
	Bed width	7m
	Bed slope	2 to 2.5%
Flow regime	Low Water Flow width	7 to 8.5m
	Low Water Flow depth	0.47 to 0.62m
	Low Water Flow velocity	0.2m/s
	Maximum flow rate (Q1%)	49.8m^3/s
	Maximum flow rate (Q10%)	35.6m^3/s
	Maximum flow rate (Q50%)	22.8m^3/s
	Average annual water flow rate	1.4m^3/s
	 Typical Drainage Hydrograph for Nobliki District for one hydrological year (River Piltun - Piltun settlement, 1971 - 1972) (Source: Sakhhydromet, 1998)	
	Bed	
	% of fine sediment sample	
	Pebble (>10mm)	-

Boundary conditions	Gravel (10 - 2mm)	-
	Coarse Sand (2 - 0.5mm)	2
	Medium Grainded Sand (0.5 - 0.25mm)	8
	Fine Sand (0.25 - 0.01mm)	23
	Silt (0.1 - 0.005mm)	67
	Clay (<0.005mm)	-
	% of gravel-pebble sample	
	Pebble (>10mm)	35
	Gravel (10 - 2mm)	37
	Coarse Sand (2 - 0.5mm)	9
	Medium Grainded Sand (0.5 - 0.25mm)	3
	Fine Sand (0.25 - 0.01mm)	3
	Silt (0.1 - 0.005mm)	12
	Clay (<0.005mm)	10
	Bank	
	LH	Topsoil, fine sand, with pebble .
	RH	Topsoil, fine sand, with pebble
Morphological activity	Geomorphological processes	Bank erosion noted, active lateral migration of channel across floodplain.
	Planform	Meandering
	30 year Washout zone depth	3.6m
	30 year Washout zone width	36m
	% potential increase in depth	31%
	% potential increase in width	85%

Appendix 2 - Analysis of ichthyology and ecology	
Orkunie River	**KP 166.7**
Fish Category (as agreed with Sakhrybvod)	Highest
Pacific salmon species present	Pink salmon (dominant) [ab], chum salmon [ab], coho salmon [a]
Taimen present	Yes [c]
Potential taimen spawning habitat (within watercourse)	No [c]
Other notable fish species present within watercourse	River dolly varden [ab], East Siberian char [ab]
Total spawning habitat within watercourse	21,600m^2 [ab]
Proportion of total spawning habitat downstream of crossing	50% [a]
Potential spawning habitat within survey area*	600m^{2}(a) - 827m^{2}(b)
Overall spawning habitat (based on known spawn survival calculation rates)	Good [b]
Number of redds recorded within survey area[#]	0 [b]
Area of spawning habitat disturbed within ROW	180m^2 [f]
Area of spawning habitat downstream of crossing affected by siltation	50m^2 [f]
Area of proposed new habitat creation	200m^2 [f]
Adjacent landuse and bank vegetation	Dense coniferous woodland
Sensitivity:	**Type 2**
* survey area - 50m upstream to 150m downstream of crossing point	
[#] survey area - 50m upstream to 500m downstream of crossing point	
a Averina (2003)	
b Averina (2004)	
c Sakhniro expert review (2005)	
d Sakhalin Rybvod (2002)	
e Sakhniro (2002)	
f Ecmos report 7001-051 (7034)	

Appendix 3 – Impact Mitigation

River	**Orkunie**	**Crossing Date: Oil**	**1**	**1-12-05**
KP	**166.7**	**Gas**	**1**	
Category	**Medium – Type 3**	**FOC**	**1**	**1-12-05**

Planning	Construction Technique	Consider HDD	
		Wet Cut	✓
	Timing	Optimal Freezing Conditions (Jan-Feb)	
		Low Flow outside spawning (Dec-April)	✓
		Outside spawning (Oct-April)	
		All year, low flow	
		All year	
	Disturbance reduction	Consecutive/immediate pipe installation	✓
Execution	Technique	Short lay length	✓
		Excavate channel first, keep trench plugged	✓
	In-stream construction time	Within minimal period	✓
		Consider controlled night working	✓
	Erosion Control	Postpone removal of bank vegetation for as long as possible	✓
		Avoid grubbing bank shrubs except on trench line	✓
		Minimise area of bank disturbance as far as possible	✓
		Silt fence/snow bank	✓
		Consider Bank protection	
		Consider Bed protection mat	
		Store Bank and Bed material separately	✓
		When backfilling lower bucket into water before releasing fill	✓
		Avoid disturbance of bank section between pipe trenches	✓
Restoration	Reinstatement Techniques	Clean gravel/cobbles as upper backfill layer of channel	✓
		Banks reinstated within within minimal time	✓
		Early Permanent Restoration *(transfer to Inspection List)*	✓
		Matting and reseeding	
		Salix wattling	✓ 1st
		Wooden stake and revetment	✓ 2nd
		Brush layering	
		Reno mattresses	
		Rip Rap	
		Enkamat	
		Stone Pitching	
WPZ	Erosion Control	Delineate Water Protection Zone	✓
		Install Slope breakers/Track walk on steep slopes	✓
		Retain brush and timber on site for use in erosion control/chipping	✓
		Silt fences at base of slopes	✓
		Early restoration of slopes after pipe installation	✓
		Consider bank erosion control outside crossing area	✓
		Locate Snow stores where they do not create snow-melt erosion	✓
		Grade RoW away from watercourses	✓
		Soil stockpiles > 30m from watercourse	

Notes:
Bank Restoration Team mobilised before snow melt wash out. Inspection of banks every 2 months as per Construction Inspection sheet

Appendix 4 – River Crossing Monitoring Checklist

River	**Orkunie**	**Crossing Date: Oil**		
KP	**166.7**	**Gas**		
Category	**Medium – Type 3**	**FOC**		

	Compliance requirement	Yes	No	Reference	Comments
	Pre works start items.				
1	Approved River Crossing Assessment Sheet plus all appendices are available			River Crossing Assessment Sheet	
2	External observers are present			River Crossing Monitoring Plan	
3	Contractor has Environmental Monitor present and logistics to carry out monitoring tasks			River Crossing Monitoring Plan, annex 1	
4	Environmental Monitor has attended site kick-off meeting			River Crossing Monitoring Plan, annex 1	
5	Environmental Monitor has the required field equipment present and functioning and calibrated			River Crossing Monitoring Plan, annex 1	
6	Environmental Monitor has the required reporting documents			River Crossing Monitoring Plan, annex 1	
7	Refuelling equipment in good			River Crossing	

Appendix 4 – River Crossing Monitoring Checklist

River	**Orkunie**	**Crossing Date: Oil**		
KP	**166.7**	**Gas**		
Category	**Medium – Type 3**	**FOC**		

	Compliance requirement	**Yes**	**No**	**Reference**	**Comments**
	order, free of leaks, pumps have automatic shut off switches, spill response equipment nearby			Construction Guide	
8	Contractor has sufficient stocks of temporary soil erosion mitigation equipment and materials before works start			River Crossing Construction Guide	
9	Contractor applies appropriate temporary soil erosion control measures prior to works start			River Crossing Assessment Sheet Appendix 3	
10	All resources listed in the River Crossing Construction Guide are present			River Crossing Construction Guide	
12	Water Protection Zones were delineated prior to work start			River Crossing Assessment Sheet Appendix 3	
12	All of the above pre start items are present before site works start.				
	Items during site works.				
13	Contractor applies execution erosion control measures			River Crossing Assessment Sheet Appendix 3	
14	Contractor applies appropriate			River Crossing	

Appendix 4 – River Crossing Monitoring Checklist

River	**Orkunie**	**Crossing Date: Oil**		
KP	**166.7**	**Gas**		
Category	**Medium – Type 3**	**FOC**		

	Compliance requirement	**Yes**	**No**	**Reference**	**Comments**
	erosion control measures in the Water Protection Zone			Assessment Sheet Appendix 3	
15	The delineated Water Protection Zones were respected			River Crossing Assessment Sheet Appendix 3	
16	Contractor follows the proper spoil removal/stockpiling techniques			River Crossing Assessment Sheet Appendix 3	
17	Areas of disturbance were minimised as far as possible			River Crossing Assessment Sheet Appendix 3	
18	Contractor adopts appropriate measures to prevent oil spills to the water body			River Crossing Construction Guide	
19	Hazardous materials, including chemicals, fuels, lubricating oils etc were not stored between the designated Water Protection Zone and the water body			River Crossing Construction Guide	
20	Environmental Monitor carried out the field measurements as required in the Scope of Work			River Crossing Monitoring Plan, Appendix 1	
21	The environmental monitoring			River Crossing	

Appendix 4 – River Crossing Monitoring Checklist

River	**Orkunie**	**Crossing Date: Oil**		
KP	**166.7**	**Gas**		
Category	**Medium – Type 3**	**FOC**		

	Compliance requirement	**Yes**	**No**	**Reference**	**Comments**
	measurements have been carried out safely			Monitoring Plan	
22	If a non-compliance was revealed, corrective actions were undertaken			River Crossing Monitoring Plan	
23	Clean gravel/cobbles were used as upper backfill where required.			River Crossing Assessment Appendix 3	
24	Site works were carried out in the time specified			River Crossing Assessment Appendix 1	
25	The second crossing was done consecutive to the first crossing			River Crossing Assessment Sheet	
26	The Contractor executed the site works in the minimum amount of time necessary.			River Crossing Assessment Appendix 1	
27	In the case of any incident, the proper response procedure was followed up			River Crossing Construction Guide	
	Items after crossing has been installed.				
28	Contractor has installed permanent soil erosion mitigation			River Crossing Assessment Appendix	

Appendix 4 – River Crossing Monitoring Checklist

River	**Orkunie**	**Crossing Date: Oil**		
KP	**166.7**	**Gas**		
Category	**Medium – Type 3**	**FOC**		

	Compliance requirement	Yes	No	Reference	Comments
	works as specified in the site execution plan.			3	

RIVER CROSSING ASSESSMENT SHEET	**River:** Orkunie River
	Revision No: A
	Revision Date: 22-11-2005
	Impact Rating: Medium – Type 2

River name:	Orkunie River
KP:	166. 7
Construction Section:	1A/B
CROSSING TECHNIQUE	
Documentation ref:	River Crossing Construction Guide
Oil:	Wet cut
Gas:	Wet cut
FOC:	Conduit to Oil
Remarks:	
NATURE OF BASELINE INFORMATION, IMPACT CHARACTERISATION AND CUMULATIVE IMPACTS	
Documentation ref	Appendix 1: Hydrogeomorphological assessment
Local hydrogeomorphology	Direct sediment supply from hillslope: **High** Potential for morphological change: **Low** Extent of disturbance (surf.area trench:width): **Low** Boundary sediment type (high percentage of fines): **Low** Located on straight section: **Low** No. Crossings: **Low**
Catchment scale assessment	Potential for a cumulative impact in the same river: **High** Potential to add to cumulative impact on downstream tributary: **High** Unaffected tributaries within 5km downstream of crossing: **High** Location in catchment to confluence with main river/sea <10km: **High** Contributing directly to closed coastal system: **Low**
Susceptibility to disturbance	**Medium**
Documentation ref	Appendix 2: Analysis of ichthyology and ecology
Ichthyology and ecology	Highest fish category (pink salmon dominant) Presence of spawning areas in the crossing range, classified as good quality. Possible presence of Sakhalin Taimen, but no suitable spawning grounds Other species include water course dolly varden, East Siberian char, Sakhalin lacustrine minnow and Siberian barberate
Sensitivity	**Type 2**
IMPACT MITIGATION	
Documentation ref:	Appendix 3 : Impact Mitigation Measures
Construction period:	Outside spawning season, low flow (Winter)
Consecutive crossings:	Yes, if practicable
In-stream construction time:	It is estimated that total in-stream construction time for the oil crossing will take 16.9 hours and for the gas crossing 15.9 hours. Taking day-light time in account, the in-stream construction for both oil and gas might exceed 48 hours period, though the intent is to minimise the time as far as practicable.
Execution erosion control measures:	Standard Best Practice
Reinstatement:	Clean gravel/cobbles as upper layer Temporary bank reinstatement within 48 hours of construction Final bank reinstatement in spring Avoid disturbance of bank between pipe trenches Salix wattling or wooden stake and revetment if salix wattling is not possible
Water Protection Zone erosion control measures:	Silt fence at base of slopes Slope breakers
RESIDUAL IMPACT	
Ichthyology and ecology	Disturbance of 180m^2 of spawning grounds in crossing range and 50m^2 outside crossing range Reinstatement will result in 200m^2 new spawning grounds No impact on Sakhalin Taimen

Hydrogeomorphology	With proper mitigation measures minimal impact
Remarks:	Short term impact, post construction monitoring on benthos, ichthyofauna, spawning area assessment Bi-monthly construction inspections, including the assessment of the effectiveness of erosion controls
MONITORING	
Documentation ref:	River Crossing Monitoring Plan
Monitoring requirements:	See Appendix 4: River Crossing Monitoring Checklist
Reporting requirements:	Construction monitoring report by Averina Daily report external observers

ANNEX F OUTLINE OF RIVER CROSSING MONITORING PLAN

1. INTRODUCTION

Sets out reason for plans existence and traces origin with reference to EIA, SEIC HSE policy and RX strategy

2. REQUIREMENTS

Quotes the relevant requirements of the monitoring plan with direct reference to the relevant section of the River crossing strategy.

3. MONITORING PLAN OBJECTIVES

Gives the monitoring plan objectives that need to be achieved in order that SEIC can effectively monitor the river crossing construction and works and mitigation as given in the river crossing execution plan.

4. SEIC RIVER CROSSING MONITORING ORGANISATION AND REPORTING SYSTEM.

Describes, using organigrams, the monitoring organisation and reporting flow of information from the River crossing site level through SEIC CHSE Yuzhno to stakeholders and public disclosure.

5. RESPONSIBILITIES

Based on chapter 4 above, defines in writing the responsibilities and reporting links of each element of the monitoring organisation (RCOT external observer, RCOT Leaders, Contractors env monitor, SEIC site representatives – CSR, Env and H&S officers, SEIC CHSE managers)

6. MONITORING SCOPE OF WORK.

Sets out the specific monitoring tasks for the contractors monitor and the RCOT observers before, during and after the river crossing construction works.

7. CHANGE MANAGEMENT PROCEDURE.

Describes the SEIC change management process by which the monitoring plan and the river crossing environmental performance will be reviewed and continuously improved.

8. SCHEDULE.

Gives the current schedule for the river crossing construction works with the corresponding RCOT deployments to observe.

APPENDICES.

Template for RCOTs site monitoring checklist,

Template for RCOT daily report to RCOTL Yuznho from each active river crossing site,

Template for RCOTL daily report to SEIC CHSE,

Template for Weekly progress report

Template for Monthly report.