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# Oil and Water Don't Mix: Risk on Tap in Western Siberia

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**Abstract**

In common with other areas throughout the Russian Federation, western Siberia faces formidable environmental pollution, a problem that in part is the legacy of the highly centralized Soviet era when meeting production quotas was the *raison d'être* for many managers of economic enterprises. In this region, over the last thirty years the near singular focus on short term oil production has led to severe contamination of the area's surface and groundwater supplies, threatening both human and ecological health. At the same time, revenues from continued oil extraction may provide the means to address some of the environmental problems. In light of the struggling economy and potential political instability, however, it is particularly critical that authorities prioritize environmental investments, as well as cultivate public support for such investments. This paper reports on a recent investigation of this problem by a team of American and Russian scientists, under the sponsorship of the U.S. National Research Council, U.S. National Academy of Sciences, and the Russian Academy of Sciences. The chief recommendation from that investigation is that the region develop an environmental program based on human health risk assessment and management.

Keywords: transitional economies, drinking water, oil contamination, health risk, prioritization, least cost planning, Russia, Siberia

JEL Classification Nos.: I18, Q25, Q28

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# Oil and Water Don't Mix:
# Risk on Tap in Western Siberia

Kris Wernstedt*

## 1. BACKGROUND

For many Americans, Siberia, the scene for the 1996 Young Investigator Program on *Urban Water Quality Management*,[1] conjures up gloomy images of barren tundra, vast featureless spaces with only isolated human settlements, forbidding Soviet gulags, and sub-zero temperatures with months of darkness and howling winds -- a destination definitely missing from the typical traveler's itinerary. At the same time, it is a place that without exaggeration can be described in less damning superlatives. Spanning over twenty-five degrees of latitude and fifty degrees of longitude, it is over two-thirds the size of the United States, yet has scarcely more than one-tenth of the U.S. population (Dewdney, 1990). It is a region with one-third of the world's known natural gas reserves, an area that boasts over one-fifth of the world's fresh water lake reserves and two five-thousand kilometer long rivers, a fantastically

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* Fellow, Quality of the Environment Division, Resources for the Future. This paper reports on a U.S. National Research Council (NRC) and National Academy of Sciences (NAS) sponsored trip to the Russian cities of Moscow and Nizhnevartovsk, which the author participated in as a member of an interdisciplinary research team of Americans and Russians. Thanks are due to Craig Woolard for comments on this paper, and to all members of the research team, the Russian Academy of Sciences, the Nizhnevartovsk Environmental Committee, the NRC and NAS, and numerous other professionals who shared their time and expertise. Although the work of many inform this paper, the opinions expressed here are those of the author alone and should not be ascribed to any other individuals or institutions.

[1] The author took part in this program, which is sponsored by the U.S. National Academy of Sciences and National Research Council in cooperation with the Russian Academy of Sciences, in July 1996. The immediate objective of the Young Investigator Program is to encourage collaboration between American and Russian scientists on pressing problems, while the long term goal is to create a cadre of American experts in technical areas critical to the welfare and future development of central and eastern Europe, the former Soviet Union, and other areas of the globe. As described below, this paper is part of a larger trip report.

resource rich territory that contains one-third of the world's remaining old growth forests (Scherbakova and Monroe, 1995; World Wide Web 2).

As isolated and immense as Siberia may appear, however, man made air, land, and water pollution -- including some of the most serious radioactive contamination in the world -- is threatening both ecosystem and economic health. Many of the problems are the legacy of the Soviet era, when production was the mantra above all else. Environmental degradation that resulted from such production was largely irrelevant for meeting production quotas and as such was underemphasized or ignored altogether. And unlike western market economies, which certainly had their own share of pollution and externalities to deal with, no strong constituency either inside or outside the government consistently forced enterprises to confront the pollution that they were causing. Since *perestroika* and the shift toward a market economy the problem in some cases has worsened, because many authorities and citizens are reluctant to impose regulatory burdens on firms in the flailing economy.

The problem is particularly acute in the Siberian oil and gas industry. By most measures, this industry wreaks environmental havoc on Siberian territory, but at the same time it provides a significant source of energy, government revenues, and critical hard currency. For example, enterprises in the Tyumen oblast, an Alaska-sized administrative region in western Siberia, produce nearly two-thirds of the country's oil and ninety percent of its gas (Dewdney, 1990; Bulantsev and Worgotter, undated). Within this oblast, the Khanty Mansi autonomous region, a semi-independent territory with over one-half of Russia's oil production, has provided roughly eight percent of the 1996 federal budget revenues. This amount is the second highest of any region in the entire country (after Moscow City and ahead of the

Moscow oblast and St. Petersburg), a remarkable feat given that the autonomous region has only three percent of Russia's land area and less than one percent of the country's population (Rutland, 1996; Dewdney, 1990).[2]

Unfortunately, the oil sector has followed the same downward path as the general economy since liberalization in the early 1990's, and production in Russia has dropped from nearly 10.4 million barrels per day in 1990 -- the highest in the world -- to roughly 6.2 million barrels per day in 1995 (Knapp, 1995). According to some estimates, the major high yield deposits in Russia are sixty to ninety percent depleted. This problem is particularly apparent in Siberia, where the average production of new wells in the Tyumen region fell from 1975 to 1992 from over 1,000 barrels per day per well to less than a hundred barrels per day per well (Konoplyanik, 1993). More modern technology and processes have improved the situation in some newer fields (*e.g.*, the Russian-American joint venture "Chernogorskoye" is producing eleven thousand barrels per day with thirty new wells, or over 360 barrels per day per well [Hendricks, 1996]), but overproduction and inefficient technology and recovery methods continue to hinder production and have increased the water yield of wells. Some water yields

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[2] The Khanty Mansi region (an autonomous "okrug" in the Russian hierarchy of administrative units) has indicated that it may try to withdraw from the Tyumen Oblast so that it can keep the 20 percent of oil taxes that currently go to the oblast government. Under Russian law, oil and gas enterprises pay up to 70 percent of their income in taxes. 60 percent of this goes to the local and okrug levels of government, while the remaining 40 percent is split evenly between the federal and oblast levels. Both Khanty Mansi and Yamal-Nenets, another energy rich autonomous okrug in the Tyumen Oblast (with nearly 90 percent of Russia's gas), are wrestling with the oblast for control over the natural resources within the borders of each okrug. The Yamal-Nenets legislature has claimed that it is not subordinate to the Tyumen Oblast, and refuses to participate in the oblast election. While the legislature of Khanty Mansi recently has stated that it will participate in the Tyumen election, it has imposed the condition that it will consider the election valid only if 25 percent or more of the Khanty Mansi electorate participates. If Khanty Mansi deems the oblast elections invalid, it will not repeat the voting and thus effectively withdraw from the Tyumen Oblast (Orttung, 1996; Paretskaya, 1996; Sasaki, 1996)

are reported to be above ninety percent in the region (*i.e.*, the volume of extracted liquid is over ninety percent water and less than ten percent oil [Zybin, 1996]).

The high water content poses a daunting environmental problem, insofar as once the water is separated, it is reinjected into the oil formation to maintain pressure, or in some cases is spread over the ground. As a result, the pumping operations threaten both surface and ground water quality, and large areas of the countryside are contaminated. The problem is compounded by the oil and gas pipeline infrastructure, which is prone to breakdown in the harsh environment, is too vast and expensive to replace quickly, and is poorly maintained. In the late 1980's, for example, pipeline breaks in the Tyumen oblast reportedly leaked over seven million barrels of oil, almost thirty times the amount spilled by the Exxon Valdez in Alaska. Such breaks resulted in widespread contamination and, in some cases, devastating fires (Anonymous, 1992; Feshbach and Friendly, 1992; Scherbakova and Monroe, 1995). Idled or abandoned wells, numbering over 50,000, also pose problems if they are improperly capped (World Wide Web 1).

In the face of the declining oil production and the clear environmental degradation, Siberia and Russia need to walk a fine line between strict enforcement of environmental laws and promotion of economic activity. The extreme choices -- to shut down the oil and gas industry completely, or to turn a blind eye to all industry practices -- in all likelihood are not palatable. Strict enforcement leading to a shutdown of the industry probably would cause at least a short-term catastrophe for the local economy, severely retard Russia's attempt to transition into a market economy, and potentially open the country to political upheavals. At the same time, unfettered, unregulated oil production probably would worsen the ecological

catastrophe that one already can observe in Siberia, promote a type and scale of economic activity that likely is unsustainable in anything but the short-term, and pose unacceptable human health and ecological risks to the region.

It is this last factor – specifically the concerns over negative human health impacts resulting from an inadequate drinking water supply -- that frames the 1996 Young Investigator Program (YIP) investigation on water quality problems in the Nizhnevartovsk region, the center of western Siberia's oil industry. That YIP investigation stresses the need for scientists and water quality managers in the region to prioritize environmental problems around issues that local residents and government officials believe are important problems that warrant the commitment of scarce financial resources. The report from the investigation, which is available from the author, provides background details and recommendations for water and wastewater treatment, site assessment and remediation, and geoenvironmental aspects of water quality in the Nizhnevartovsk area.

This paper is part of that larger report. It serves primarily as an introduction to the broad human health and ecological concerns in the area, stressing the importance of prioritization throughout the presentation. After this background section, Section 2 continues with an introduction to the Nizhnevartovsk region. Section 3 places the risk and prioritization themes that ground the YIP report in the Nizhnevartovsk context and briefly explains our objectives behind these themes. Section 4 develops the central tenets of effective environmental management, stressing the human health risk framework, prioritization, and least-cost planning that should lie at the core of such management. Section 5 concludes with summary comments.

## 2. INTRODUCTION TO NIZHNEVARTOVSK

The Nizhnevartovsk region, an area over two-thousand kilometers to the northeast of Moscow, occupies roughly 130,000 square kilometers in western Siberia (see Figure 1). Straddling the Ob River and in the center of Siberia's oil producing area, the region offers a microcosm of many of the problems identified above with the oil industry. Production in the region's main oil field, Samlotor, has dropped from roughly two million barrels per day at the beginning of the decade to less than one-half million barrels per day today, and over 1,500 oil wells in the region have been abandoned (Nizhnevartovsk Environmental Committee, 1996). Ninety-two to ninety-eight percent of the liquid extracted from many wells in the main field is water (Zybin, 1996), which as suggested above contributes both directly to water quality problems through reinjection and runoff, and indirectly through the corrosive effects of the high-water content oil on the region's oil pipelines.

With over 11,000 kilometers of pipeline in the area, it is this latter stress that is particularly problematic. The harshness of the climate, the relatively low level of technology used in oil-water separation and transport, and poor maintenance conspire to require roughly twenty-five percent of the pipeline to be replaced every year. Oil pipeline leaks that might make front page news in other parts of the world occur with frightening regularity. For instance, over the two year period from 1994 to 1995 the Nizhnevartovsk Environment Committee (Committee), a territorial committee under the Ministry of the Environment and Natural Resources Protection of Russia, recorded over 3,000 pipeline leaks in the region, which spilled nearly 60,000 barrels of oil. In all likelihood, the real number of leaks was much

higher: one Committee staff member estimated actual leaks were ten times the number reported.

As a result of the pipeline leaks and spills, large areas of the Nizhnevartovsk region's surface water are covered by oil, a state of affairs that can easily be observed from afar as a telltale shiny glean or rainbow colors in the rivers, lakes, and marshes. The large volumes of water that, as noted above, need to be separated from the oil drilling and extraction processes also contribute to the contamination. Local authorities from the Committee estimate that over 60 water purifying systems are needed to service the oil enterprises, but only 12 systems are operating. Furthermore, sludge that accumulates from oil storage tanks at the drilling or separation sites needs to be cleaned from the tanks every four or five years, but the single plant capable of remediating the sludge is far too small to service the demand for remediation. Consequently, the untreated sludge is disposed of on the land or in the water, often in an ad-hoc fashion.

Other problems of adequate water quality come from the fact that the primary settlement in the region, the City of Nizhnevartovsk, has increased in population fifteen fold in the last quarter-century. When oil was first discovered in the 1960s in the Samlotor oil field, Nizhnevartovsk was only a small village, and even as late as 1970, had only 16,000 residents (Mellor, 1990). Today, the city boasts nearly one-quarter-million residents, with the region as a whole claiming 350,000 inhabitants. The explosive growth in population has required a concomitant growth in public and private infrastructure to keep up -- apartments for the workers and their families, roads, water, sewer, and electricity services. Despite the fact that

Nizhnevartovsk and the surrounding area has a relatively high per capita income,[3] funds for these kinds of infrastructure improvements are limited -- user charges are relatively low and do not adequately cover operation and maintenance costs, let alone capital improvements, and general tax revenues are limited and competing demands high.

The city water supply, the ostensible focus of our YIP study, is a case in point. The drinking water treatment capacity of the city is roughly 120,000 cubic meters per day, where estimated demand is closer to 200,000 cubic meters per day. As is typical, this demand is not constant throughout the day, so the city faces an additional problem in maintaining adequate water pressure during peak demand times (morning and evenings). Although it can store roughly 30,000 cubic meters of water during the night when demand is low (and is adding an additional 50,000 cubic meters of storage), the daytime peak is high enough that water is effectively shut off to much of the city during portions of the day. Even when water pressure is adequate to service all buildings, pressure is inadequate to service upper floors in a building (those above the third floor, generally). Unfortunately, most of the residents of Nizhnevartovsk reside in eight and sixteen story high rise apartment blocks. Many of the 16 story buildings have their own pumps to move the water to higher floors, but as a concession to the waterless reality that many upper floor residents face, the cost of water is set lower for them, presumably to adjust for the inferior service that they receive.

Drinking water is monitored for quality at both the intake where the water enters the treatment system on the River Vax, as well as in the treatment plant which is closer to the city

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[3] According to a recent estimate cited in the OMRI Russian Regional Report, average personal income in the Tyumen oblast is over twice the Russia-wide average (OMRI, 1996).

itself, but this does *not* include monitoring for some potentially serious acute waterborne diseases, such as *Giardia lamblia* and *Cryptosporidium*. Testing for these protozoa are beyond the financial reach of the city. In addition, the state of the distribution system is unclear. Conveyance loss from the intake to the treatment plant is estimated as fifteen percent (Nizhnevartovsk Water Department, 1996), but the lack of metering at the demand points make the estimation of conveyance loss from treatment to consumption little more than guesswork. It is quite possible that contaminants enter the water system after treatment and before consumption because of breaches in the distribution system. Such breaches are not unlikely, given the low quality infrastructure in much of the area. In any case, as with many other urban areas of Russia, bottled or in-home filtered water appears to be the water of choice for those who can afford it.

It was unclear from our visit to Nizhnevartovsk whether poor water quality was negatively affecting the health of local residents. Certainly, the very obvious presence of oil in surface waters gives rise to concerns about health effects posed by direct (*i.e.*, through drinking) and indirect (*i.e.*, through consumption of products contaminated by the water) means. Kluchnikov (1994) suggests that the persistence of oil products in drinking water has contributed to reproductive problems and endocrine disorders, but we could not independently confirm this finding. However, it did seem clear to us that the problem of water quality points to a larger issue in the region, namely how to sort out which existing and potential environmental problems to tackle first. In fact, the chief finding from our visit is that more effective prioritization of problems is needed. We turn now to a discussion of why we believe this.

### 3. SORTING OUT OBJECTIVES

Although the primary goals of the YIP visit to Nizhnevartovsk were to work with Russian counterparts to identify water quality problems and recommendations to address these problems, and to develop longer-term collaborations with these counterparts, it is fair to say that the group that hosted our visit in Nizhnevartovsk -- the Nizhnevartovsk Environmental Committee -- had a slightly different objective. From our discussions with the Committee, it became readily apparent during our visit that the primary motivation behind the Committee's support of the YIP was to enlist the support of the YIP members for local environmental improvements; that is, the Committee believed that our identification of environmental problems and our recommendations on how to address these problems would help it gain the support of local, federal, and international entities for environmental improvements in the area. From the Committee's perspective, our contribution was not so much to help it identify any new problems, since it already understood the major problems far better than we could hope to in our brief visit, but rather to see for ourselves what the Committee had targeted as the major problems and to sanction its recommendations for addressing these.

The Committee's objective, while certainly understandable and innocuous in its own right (the problems and recommendations that it wanted us to sanction were legitimate, and we did support its efforts), nonetheless did not mesh completely with our goals of fostering Russian-American scientific collaboration and problem solving in the natural, social, political, and economic milieu of the day. In the world of tradeoffs -- a world to which both Russia, with a struggling economy and the United States, with a relatively robust economy, belong -- committing resources to one problem means that resources are not available for other

competing demands. Consequently, for decision makers it is not just a matter of doing good science or documenting environmental degradation. As is all too apparent, the perceived short-term needs of the economy often outweigh the longer-term needs of both the economy and the environment, so decision makers may be reluctant to support environmental improvement that threaten short-term economic needs even when faced with convincing evidence of ecological catastrophe.

Therefore, rather than stopping with a straightforward rubber stamping of the Committee's description of environmental problems and recommendations for combating these, we took the following more general objective as our charge:

*to draw on our and our Russian colleagues' expertise to help the Committee to define, prioritize, and address the pressing problems of environmental quality in Nizhnevartovsk.*

This charge served to organize our written, independent recommendations to the Committee while we were still in Nizhnevartovsk, as well as the YIP trip report that this paper comes from. At its core, the charge requires us to prioritize environmental goals and target regulatory efforts and environmental investments through some metric that decision makers responsible for funding such improvements can understand and accept. We chose to use risk as the measure to accomplish this, as the following section on human health risk highlights.

## 4. EFFECTIVE ENVIRONMENTAL MANAGEMENT THROUGH A HUMAN HEALTH RISK FRAMEWORK

The central elements of defining, selling, and addressing environmental quality problems, we believe, are two-fold. First, any effort that hopes to gain support and resource commitments in a society that has even a modicum of public involvement in decision-making

should show that a demand for environmental quality exists among the population. Authorities need some sense that regulatory efforts and environmental investments will be supported, or at least not actively opposed by the bulk of the population. Second, assuming that decision makers support the concept of environmental protection, the efforts to provide this should be targeted as efficiently as possible; that is, by addressing the most serious problems first and at lowest cost.

With respect to the first problem, one needs to tie a degraded environment to the life of the citizenry, to something that is important to people or to something that has value for them. An obvious choice, particularly in the Nizhnevartovsk context, is the negative human health impacts that might result from a degraded environment. Such impacts often can galvanize a population to support environmental regulation and investments and force public agencies to actively confront environmental problems. In the United States, they have been used to motivate some of the most stringent environmental laws at the federal level. For instance, a critical factor in drawing Congressional attention to hazardous waste sites was that through extensive media coverage, the public became concerned that two waste sites -- one where a number of childhood leukemia cases were alleged to have been caused by contamination of a local drinking water supply from tannery operations and the other involving contamination from an abandoned industrial waste dump seeping into suburban basements -- posed threats to human health. In the face of public scrutiny and pressure, Congress passed legislation that not only requires the cleanup of such sites but also provides a funding mechanism for paying for the cleanups.

With respect to the second problem of efficient protection efforts, two points merit attention. First, at the heart of targeting investments lies the prioritization of problems; that is, identifying those problems that cause the greatest harm, however "harm" may be defined, and tackling those problems first. Second, once problems are identified, one needs to identify alternatives to address these problems and estimate the economic costs associated with implementing these strategies. Although the least costly strategy might not always be acceptable because of non-economic considerations, it is important to develop an understanding of the costs of the alternatives. Clearly in some cases, the most obvious approach to address an environmental problem may require higher expenditures than another lower-cost option that is equally effective but less obvious. We construct an example below of such a situation in Nizhnevartovsk.

In our experience, the Nizhnevartovsk Environmental Committee has not rigorously addressed either of the two components of an effective environmental program just described: that is, the identification of a demand for environmental quality and the development of an efficient program for regulation and environmental investments. This is not surprising given that analogous agencies in the United States, where a much longer history of regulation in a democratic society exists, are arguably still in the early stages of developing formal procedures for identifying the demand for environmental quality and in using efficient mechanisms for meeting this demand. Our following comments about the shortcomings in the Committee's efforts should keep this latter point in mind.

### 4.1 Human Health

In light of work that suggests that air and water pollution may threaten the health of many Russians, including residents of the oil and gas region of Siberia (Fox, 1996; Freimuth, 1995; Scherbakova and Monroe, 1995), it surprised us somewhat that human health considerations remained vague or largely in the background in the Committee's advocacy for environmental improvements. Instead, the Committee's clarion call for increased environmental protection seems to rest more squarely on providing evidence of environmental degradation and appealing to intrinsic or aesthetic values (*e.g.*, "the disheartening pollution of the countryside") to support improvements. An exception to this general response was a short discussion that we had with a parasitologist from the Laboratory of Sanitary and Epidemiological Hygiene, who expressed alarm over health effects associated with water-borne parasites.

It appears to us that the Committee is missing an important opportunity to garner public and government support for its environmental protection efforts by not fully developing the public health angle of environmental degradation. We unfortunately did not have the opportunity to talk with public health experts, but from our conversation with the Committee and others (*e.g.*, representatives of the city's water and wastewater treatment facilities), we gained the impression that the Committee does not coordinate closely with the agency(ies) responsible for public health. This is unfortunate, since closer coordination and analyses of public health data *may* yield new insights into the relationship between environmental degradation and public health and provide support for environmental improvements. Admittedly, we are uncertain as to the availability and quality of public health data in the region that may shed light on environmentally-driven health effects -- the incidence of diarrheal

diseases, for instance -- but even without well-established records, one can investigate health effects through other means. For example, in the absence of good public health data in many developing countries in which it works, the World Bank has supported household surveys to examine the link between environmental conditions and household diseases.[4]

Studies that explore such links can be extended beyond a straightforward reporting of the incidence of diseases to a more sophisticated valuation of the disease impacts. For example, in an outbreak of *Giardia lamblia*, individuals may or may not become sick. For those who do become sick, an economic valuation of the losses due to the outbreak include the value of work and leisure time lost, medical costs for treatment, the costs of measures taken to avoid the contamination, the value of pain and suffering, and the value of other foregone activities that can not be rescheduled. For those who do not become sick, the cost of the outbreak predominately entails the cost of finding an alternative water supply (Harrington, Krupnick, and Spofford, 1991). A valuation study that incorporates these costs clearly would go beyond a standard human health risk assessment, but it may be fruitful for developing support for water quality and other environmental improvements, and therefore an approach that the Committee may wish to explore.

### 4.2 Prioritizing Environmental Protection Efforts

In addition to an underemphasis of the potential ties between public health and environmental degradation, we also found that the Committee apparently does not have any formal prioritization scheme in place to direct its regulatory efforts. In an extensive discussion

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[4] See, for example, Alberini *et al*. (1996).

with the Deputy Director of the Committee, we identified more than fifteen environmental problems in the region, including mercury contamination, poor recycling of automobile tires, low quality drinking water, solid waste disposal problems, noxious emissions from automobiles, oil spills, and a host of other environmental troubles. These were largely an unordered laundry list of problems, except for the Committee's particularly vocal interest in constructing a new solid waste landfill. Even after several direct questions about problem prioritization, we still do not understand what are the most important environmental issues for the Committee, let alone have a sense of the process through which it might go about developing a list of priorities.

Numerous ways exist to prioritize problems and target investments, including cost-benefit analysis, cost-effectiveness analysis, formal decision analysis, risk analysis, or simply by formally or informally soliciting expert opinion. In the context of the YIP report, risk analysis is a natural choice for a prioritization scheme. Such an approach can entail simply arraying problems from highest to lowest relative risk along some metric, such as the expected number of cancer deaths or number of years of human life lost due to some environmental problem. More applicable to the Committee's mission, however, would be a comparative risk analysis that allows the Committee's to set programmatic priorities across a wider range of problems and impacts that involve different kinds of risks (deaths, illnesses, lost work time, acres of lost wetland, *etc*.).

Terminology is risk analysis is scarcely standardized and is still evolving, but a common typology organizes such analysis into three parts: risk assessment, risk management, and risk communication. Risk assessment, the set of analytical techniques for assessing the expected

damage or injury associated with a particular activity, is the part of the analysis that much of the scientific community feels most comfortable with. The classic four steps of this assessment as described in Davies (1996) are:

- identifying the hazard, the problem that may cause some kind of harm (*e.g., Giardia lamblia* in the drinking water)
- assessing the dose-response relationship, the relationship between the exposure to the harmful substance and the resulting harm (*e.g.*, consuming *x* units of water per day from a source contaminated with *y* units of *Giardia lamblia* leads to *z* additional reports of childhood gastrointestinal illness)
- assessing the exposure of a target population to the hazard (*e.g., n* children will be exposed to water contaminated with *Giardia lamblia*)
- characterizing the risk by combining the dose response exposure assessments (*e.g., k* additional cases of intestinal illnesses will occur among children)

From our visit to Nizhnevartovsk, it appears that the Committee has not consistently progressed beyond the first stage of the risk assessment, the hazard identification. Without the latter three stages, however, it is difficult to prioritize. Nizhnevartovsk is left with the question *Why does the hazard matter?*

The second and third components of the risk analysis -- risk management and risk communication -- relate to the processes by which scientific assessments of risk are taken out into the larger political, economic, and social communities, and actions to address the risk are selected and implemented (risk management), and by which information about risk is shared with the community (risk communication). As such, these elements are critical for both

building support for environmental regulation and investments and for evaluating what risks may be important to society and what strategies for addressing the risks may be acceptable.

Importantly, these latter two parts of risk analysis, particularly risk communication, are being given increasing emphasis in the United States. The President's Commission on Risk Assessment and Risk Management -- a bipartisan panel with representatives from industry, academics, environmental groups, and government -- recently has advocated a environmental risk management framework that puts public input at the center of decision making (Anonymous, 1996). The U.S. National Research Council (NRC) also recently has issued a report that places an increasing emphasis on stakeholder participation in risk characterization. According to the NRC report, while risk characterization certainly must continue to include strong scientific analysis, it also needs to emphasize the losses, harms, and consequences that are relevant to the interested and affected parties and address what stakeholders "*believe* to be at risk in the particular situation." (Stern and Fineberg, 1996, p. 3, emphasis added) Consistent with the tenets of these two influential reports, we believe that it is the beliefs and values of the public and of other government agencies in the Nizhnevartovsk region that warrant far more consideration in the Committee's environmental protection efforts. Only by understanding and addressing the beliefs and values can the Committee hope to build a constituency that will support environmental improvements.

### 4.3 Least-Cost Planning

In addition to a sharper focus on human health and greater effort at prioritization, we also would urge the Committee to develop a better understanding of the economic costs of its

existing and proposed actions, and to minimize these costs when appropriate. This is hardly an insightful recommendation, yet as is the case in the United States, it is not always the case that the least expensive solution to an environmental problem is the one that is implemented. Institutions are often biased in favor of a particular approach for environmental quality protection that is not lowest cost. For instance, those responsible for designing and codifying regulations often rely on technology-based standards (the best available control technology, for instance), while the actual regulating agencies themselves often view the costs of compliance as outside their purview. Alternatives that may show promise in lowering the economic costs associated with addressing an environmental problem -- such as the use of low-technology processes or the use of economic measures to alter enterprise or consumer behavior -- are often formally prohibited or restricted by agency practice.

Without question, lower-cost alternatives may have other qualities that make them unattractive or infeasible, or may have perversities of their own. For example, the Committee currently can fine enterprises that violate pollution standards. Although these fines are not designed as an economic instrument *per se* -- only by chance would they be set at anything near economically efficient levels -- they do penalize excessive pollution and therefore provide some incentive to enterprises to limit their pollution. According to the system of charges and fines set up under the Russian Law on Environmental Protection, ten percent of the revenue from fines by the Committee goes directly to the state budget (and is supposed to be used to pay for the activities of the territorial environmental units), and the remaining ninety percent is divided among three different environmental funds at different levels within the Russian Federation. Of the ninety-percent going to these three funds, the Federal Environmental Fund

receives ten percent, the Khanty Mansi okrug regional level fund gets thirty percent, and, at the district or city level, the Nizhnevartovsk Ecological Fund keeps sixty percent (OECD, 1995). Thus, the fines can provide a significant amount of revenue to the Committee, who administers the Nizhnevartovsk Ecological Fund (the Municipal Council actually allocates the funds). Last year, for example, the Committee issued eighty fines for nearly 2.5 million dollars. However, as is true in many other places in the world that impose fines for environmental protection, the revenue raising properties of the fines often outweigh the incentive effects for enhancing environmental quality. As a result, a somewhat perverse incentive may be provided to the regulator to set fines at levels that will maximize revenues over the short-term rather than at levels that will provide the ideal signals for environmental protection.

Notwithstanding such potential perversities, however, in our opinion it is incumbent upon a regulatory agency to appreciate the economic costs associated with its efforts and to evaluate a range of technological and economic measures for meeting environmental goals. It is not clear to us that the Committee consistently does this. For instance, in the realm of drinking water quality, the Committee plays an important regulatory role. In conversations with the Committee and with staff in the Nizhnevartovsk Water Department, it became clear as mentioned earlier that the Water Department currently can not provide the quantify of water demanded by the City's residents and enterprises. From these conversations and other discussions, it also is apparent that many if not most of the city residents do not drink water that comes directly from the tap. These are problems that presumably fall under the programmatic purview of the Committee. The proposed actions to address these problems that we heard from both the Committee and the Water Department entail adding additional

capacity to the water treatment plant and developing new groundwater sources, two obvious choices that address the quantity problem. However, the Committee and the Water Department apparently have overlooked two other important features of the problem.

First, they either ignored or discounted the possibilities of using demand side management to bring the level of demand closer to the available supply. The relatively high consumption of drinking water among residential customers in Nizhnevartovsk (as high as 700 liters per day per capita), absence of water metering of individual apartments, and subsidized water rates (residential customers pay roughly forty percent of full cost recovery) suggest that better economic incentives *could* dampen demand and shorten the gap between the level of supply and demand, perhaps at a significantly lower cost than adding capacity. Clearly, the lack of metering would be both a technical and financial (roughly $8 installed cost per meter, and two meters are needed per apartment) barrier to implementing such incentives, but the approach merits further investigation (Nizhnevartovsk Water Department, 1996).

Second, the inability to deliver to the tap water that many residents perceive to be of drinkable quality is something that also merits further study. Residents mistakenly may perceive that the water quality is low when by all biological and chemical standards it is high, the water quality in fact may be inadequate, or it may be a matter of cultural preferences for drinking bottled water, but in any case a better understanding of the preferences for water is desirable. The potential social costs of lacking access to readily-accessible drinking water can be quite high, and it is this kind of information that may be useful for developing public support for environmental objectives and financial support for efficient environmental investments.

Both of these features -- the apparently limited attention to demand side options and the inadequate understanding of consumer preferences -- suggest to us that the Committee may not be attaining as much from its programs as is realistically possible. We believe that this potential shortfall in efficiency, along with the Committee's largely missing effort in prioritizing environmental goals -- our two pillars of an effective environmental program -- are areas that the Committee might benefit from addressing more rigorously. The addition of an economist to the Committee's staff, which we were told is likely to happen in the near future, may ameliorate some of these problems.

## 5. SUMMARY

Gilbert S. Omenn (1996), chairperson of the President's Commission on Risk Assessment and Risk Management, has aptly noted that "[r]isk is the coin of the realm in environmental, health, and safety regulation . . ." Recent efforts around the world, including the U.S., to give risk a more central role in environmental statutes and regulations, exemplify just what important coinage it is. Perhaps most notably in the just concluded 104$^{th}$ Congress, such efforts also demonstrate how contentious risk can become, what its limitations are, and how it moves quickly beyond narrow technical definitions or questions of science, to embrace a much wider set of economic, political, and cultural concerns. This broader milieu of risk has been recognized for decades (see Renn [1992] for an interesting overview of different risk concepts and how they have evolved), and is just as critical for informing environmental decision making in Russia as it is in the United States and other western countries with arguably more developed traditions of public input in decision making.

Clearly, the different culture, history, and socio-political-economic environment of Russia and the Nizhnevartovsk region must qualify all of the simple observations and recommendations that we have made here. In a country where consumers face world prices for many commodities, and earn incomes that are nearly an order of magnitude lower than western country counterparts, the resources to prioritize and manage risk are extremely limited and the opportunities to design and implement economic incentives may be quite problematic.[5] Conceptual appealing alternatives such as those that we have outlined here and in our larger report, may be inappropriate for a number of very good reasons.

Notwithstanding this, Nizhnevartovsk appears to us to offer a prime opportunity to integrate risk more centrally into environmental decision making. Because of its oil reserves, it may have a financial capability to address some of the environmental problems it faces, as well as a degree of independence from the federal (*i.e.*, Moscow) and oblast (*i.e.*, Tyumen) levels of government, that other regions can only dream of. We encourage the Nizhnevartovsk Environmental Committee to explore the opportunities for prioritizing risk and for understanding the concerns of the residents whose environment the Committee is obliged to protect.

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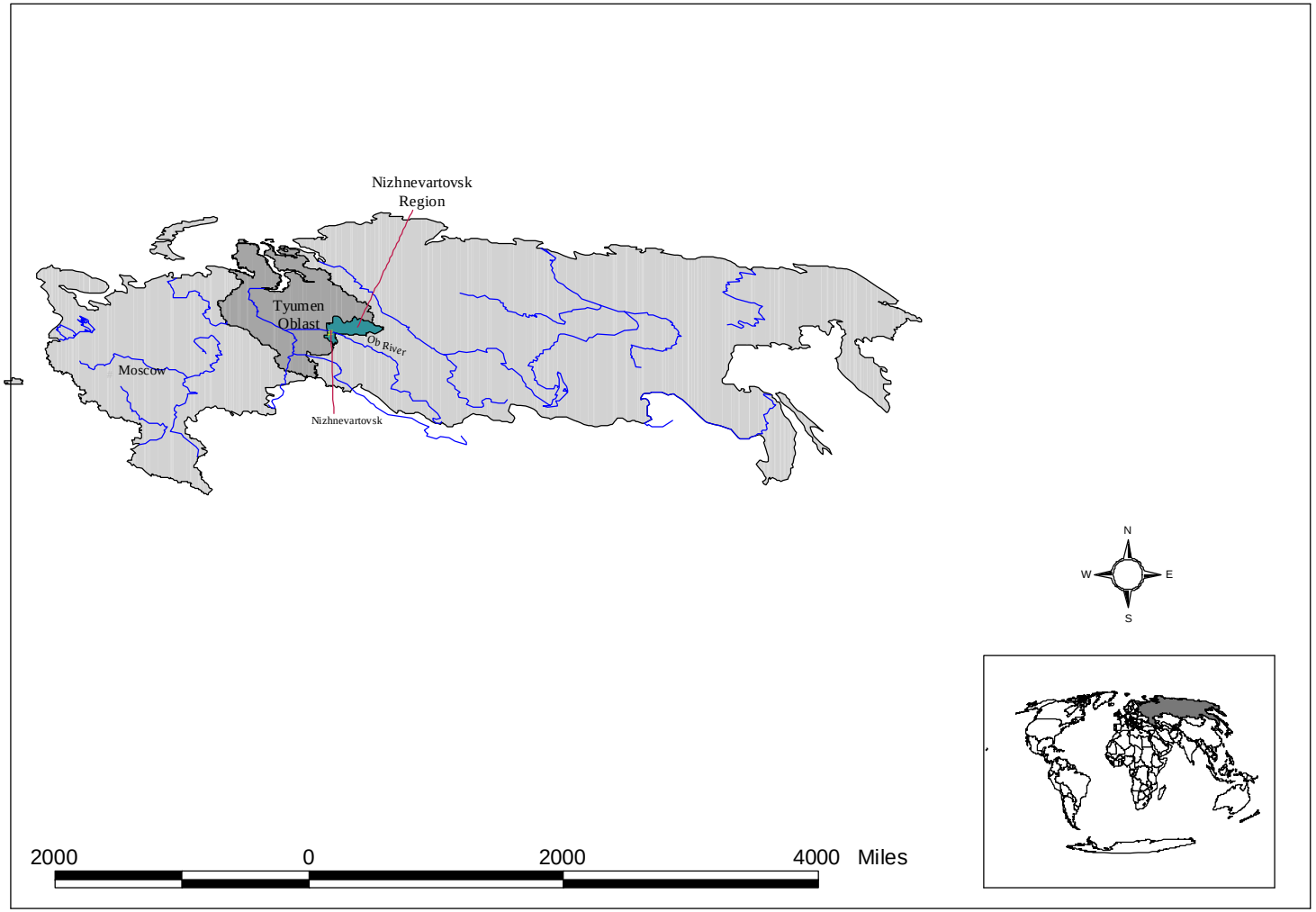
[5] Recent reports from Russia indicate a 6 percent drop in GDP in the first ten months of 1996 (compared to the first ten months of 1995), the continuation of a downward trend in GNP since the dissolution of the Soviet Union. As a sign of the financial problems at the household level, the federal legislature recently voted to *increase* the minimum pension (which a large number of pensioners depend on) to roughly $14 per month, a ridiculous pittance in light of current prices. Even at this low level, the government is hard pressed to find the revenues to fund the pension program and it currently owes pensioners nearly $3 billion in back payments. (Morvant, 1996; Gurushina, 1996)

Figure 1
Nizhnevartovsk, Russia



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