AN ASSESSMENT OF THE PROPOSED YUKON PLACER MINING GUIDELINES

by

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Assessment of the Proposed Yukon-Placer Mining Guidelines

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ABSTRACT

Placer mining for gold is presently the second largest industry in the Yukon Territory. An unavoidable consequence of placer mining, as practiced at the present time, is its negative effect on alternate resource values. The government agencies responsible for resource management in the Yukon Territory have been attempting to develop regulations to govern the placer mining industry for more than ten years. The latest set of guidelines, proposed in 1983, are assessed with respect to the criteria of fairness and efficiency. The proposed guidelines are found to be fair when compared to regulations governing similar industries under different jurisdictions. The proposed regulations are not economically efficient. The loss to Canadian society of implementing the guidelines is greater than the gain. In addition, it is doubtful if the guidelines, as proposed can be effectively enforced. It is recommended that the proposed guidelines be modified with respect to the present structure of the Yukon placer mining industry.

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1.0 INTRODUCTION

Placer mining, as currently practiced, disrupts the land surface and natural drainage channels (Madison 1981). The removal of overburden and the processing of placer gravels can release significant quanities of fine sediment into streams with a consequential detrimental effect on downstream water quality (Langer 1980).

The federal government is attempting to implement environmentally appropriate regulations to govern the placer mining industry in the Yukon Terrritory. Since 1975, three sets of interim or proposed regulations have been prepared, numerous public meetings and two public hearings have been held, and many technical studies have been completed (Department of Indian Affairs and Northern Development (DIAND), Department of Fisheries and Oceans (DFO) and Department of Environment (DOE) 1983; Christensen 1983). However, it appears that government and industry are no nearer to agreeing on the form and substance of a regulatory regime than they were in 1975 (Kopvillem 1985).

1.1 Objectives

The major objective of this research paper is to examine the environmental, institutional and economic issues involved in the current attempt to regulate the placer mining industry in the Yukon Territory. Specific objectives include:

1) a review of the environmental concerns and arguments raised by proponents of stricter regulations governing

the placer mining industry;

2) a review of existing economic analyses on the effect of the proposed regulations on the industry;

3) updating of the economic analyses using the most current data;

4) assessment of the feasability of implementing and enforcing the proposed regulations; and

5) assessment of the fairness of the proposed regulations.

Emphasis is placed on assessing the efficiency and fairness of the proposed regulations. Economic efficiency of the proposed regulations is examined first using existing cost/benefit studies and secondly, through the application of mathematical models relating the level of mining activity to the cost of production. Regulations proposed in 1983 would increase the operating costs faced by placer miners because more extensive pollution abatement and reclamation works would be required as part of normal mining practice (Sigma Resource Consultants 1981, DOE and DFO 1983a). Through the use of mathematical models, probable economic consequences of the proposed regulations are predicted. The intent of the models are not to define precisely the effect of the proposed regulations on the level of mining activity, but rather to provide policymakers with a tool which will allow the relative assessment of possible policy alternatives.

The fairness of the proposed regulations is assessed by comparing the conditions that would be imposed on the Yukon placer mining industry to conditions that presently govern similar industries in other jurisdictions.

A brief history of placer mining in the Yukon Territory is presented to show the geographical extent of the industry and to demonstrate the technological evolution that has occurred over the last century. In a large part, the current controversy results from the application of twentieth century methods to the placer mining industry.

The arguments, for and against placer mining are similar to those encountered when attempting to regulate any non-renewable resource based industry. Government wants to impose operational constraints on the industry to moderate what it perceives as unacceptable environmental impacts of present mining methods. The industry counters that it is not significantly affecting other resource values, that the environmental damage done by placer mining is far outweighed by the economic benefits derived from placer mining and further, that many miners cannot afford the additional costs resulting from more regulation.

Like any private industry, placer mining is sensitive to changes in costs of production (DOE 1983). Regulations designed to protect environmental values are perceived by the industry to result in increased operating costs and therefore, have a direct effect on the profitability of mining operations (Christensen 1983). Although the implementation of environmental regulations has not been totally opposed by the mining industry, both individual miners and the Klondike Placer Miners Association (KPMA) (an umbrella organization representing the majority of independent miners) have been very vocal in expressing their concern that the regulations, as proposed, do not consider the economic realities of mining.

1.2 The Importance of the Placer Mining Industry

Placer mining is the second largest industry in the Yukon Territory, only tourism is larger. In 1984 approximately thirty million dollars worth of gold was produced by placer miners in the Yukon Territory (Kopvillem 1985). In 1980, when the price of gold was near its all time peak, almost forty-eight million dollars worth of gold was produced (Fox et al 1983). Operating and maintenace costs were estimated at thirty-eight million dollars, while capital investment in the industry in 1980 was thirty million dollars.

1.3 The Origin and Location of Placer Deposits

Placer mining is the term used to describe the recovery of valuable concentrations of metals or minerals from unconsolidated surficial deposits. Although placer miners can recover materials ranging from tin and tungsten to diamonds, the practice is used in the Yukon to extract gold from stream gravels (Sigma Resource Consultants 1981). Placer gold deposits in the Yukon are thought to have been formed by the weathering and erosion of gold bearing bedrock (Sutherland 1985). As a result of weathering gold, in an almost pure form, as nuggets (coarse gold) and flour (fine gold), is separated from the bedrock. Over time, the free gold is moved downstream as a result of stream transportation. The specific gravity of gold is considerably greater than that of stream gravels and the downstream movement of gold particles by water tends to concentrate the gold (Best and Brayshaw 1985).

Concentrations of placer gold tend to become greater in an upstream direction, towards the original bedrock source. Also, as a result of the density dependent processes that concentrate the gold, concentrations of placer gold are normally greatest at the interface between bedrock and the surficial gravels (Department of Indian and Northern Affairs 1981). Placer miners prospect for, and develop, these areas of concentration.

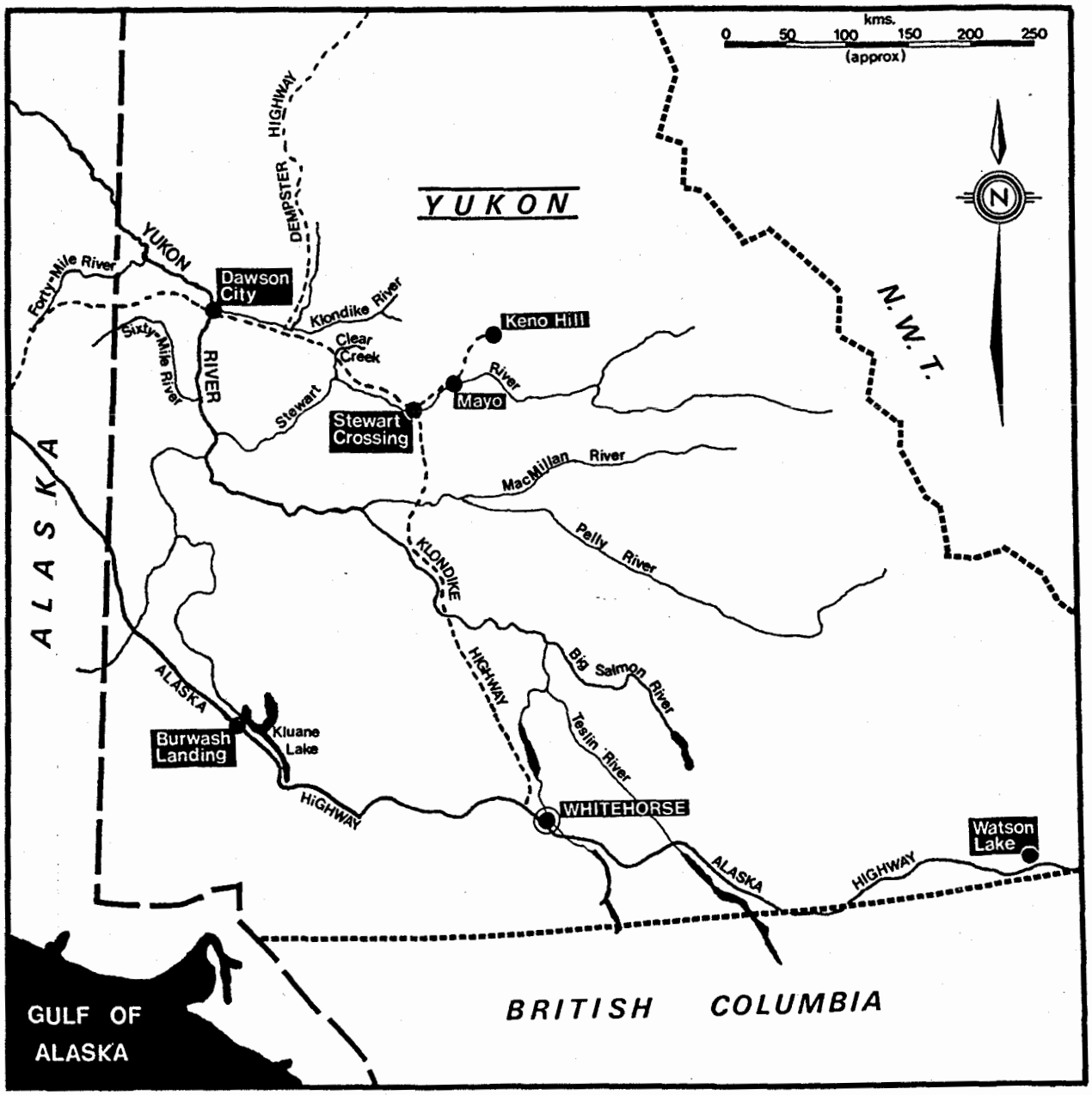
The placer mining activity in the Yukon Territory is mostly concentrated in the Klondike area, southeast of Dawson City (Figure 1.1). Other areas of significant production occur around the town of Mayo and in the headwaters of the Sixty Mile River (DOE 1983). Some placer mining activity occurs in tributaries of the South Big Salmon River, east of Whitehorse, and around the settlement of Burwash Landing (Fox, et al 1983).

1.4 Environmental Impacts of Placer Mining

There are two principal environmental concerns associated with placer mining. Firstly, in the immediate area of the mine site, mining activity significantly alters the natural landscape by removing vegetation and topsoils, redistributing underlying placer gravels, and diverting natural watercourses. In the absence of efforts to rehabilitate the site, the recovery by natural processes may be very slow (Hardy, R. M. and Associates 1978). Secondly, the removal of overburden and the processing of the gold bearing gravels can result in the release of large quantities of fine sediment. If these sediments are not controlled at the mine site they may enter natural stream courses

FIGURE 1.1

Location of Placer Mining Activity in Yukon Territory



and be transported significant distances downstream (Envirocon Ltd. 1986). Fine sediment is a broad spectrum pollutant that can degrade aquatic habitats (DOE and DFO 1983).

It is against this setting that government must try to establish regulations to govern the placer mining industry. The environmental impacts of an uncontrolled industry affect the fisheries resource, the wildlife resource and the wilderness resouce. The regulations which are finally implemented must recognize the trade-offs between the economic benefits derived from the placer mining industry and the adverse environmental effects that are a direct consequence of the technology used in the mining operations.

2.0 HISTORY OF PLACER MINING IN THE YUKON TERRITORY

2.1 The Early Days

Placer gold deposits had been reported by the furtraders in the early nineteenth century, but it was not until the 1870's that prospectors and miners started to drift into the Yukon Territory (Wright 1976). Originally most miners worked the bars of the Stewart River to recover fine gold. The Stewart River bars were abandoned when coarse gold was discovered on the Forty Mile River. By the 1890's the settlement of Forty Mile, at the confluence of the Forty Mile and Yukon Rivers, had been established as a supply center for mining activities in the area (Ogilvie 1913). Also, by this time gold had been discovered in the headwaters of the Sixty Mile River, near the international border(Figure 1.1).

All mining in these early years was done by hand during the frost free months, typically early June through to mid-September, as the claims could only be worked when the ground was unfrozen and there was water available for washing the gold bearing gravels (Ogilvie 1913). William Ogilvie introduced the concept of using underground mining techniques to mine the frozen ground during the winter (Wright 1976). This was an important development in the placer mining industry as it allowed the work to continue almost year round. Shafts would be excavated to the richest gravels and then the gravels were removed by tunnelling. The excavated gravels were stockpiled during the winter and processed in the summer once the creeks were ice free.

2.2 The Klondike Goldrush

In the fall of 1896 coarse gold was discovered in Bonanza Creek, a tributary of the Klondike River, and the great Klondike goldrush was underway. News of the find first reached the mining camp at Forty Mile and the settlement was soon abandonned as the population raced up the Yukon River to stake new ground (Koroscil 1971). By the time that the news of the Klondike find reached the outside world most of the creeks in the region had been staked and the majority of the tens of thousands of men who poured into the region over the next few years ended up working as labourers in the gold fields (Wright 1976). Dawson City, located at the confluence of the Klondike and Yukon Rivers, became the supply center for the region and reached a population of thiry thousand by 1900 (Lotz 1976). By 1905 the richest deposits were mined out and the boom had started to subside (Koroscil 1971).

Mining activity during the period 1896 to 1905 was characterized by manual labour. Although most creeks in the Klondike were completely staked, the amount of gravel that could economically be mined and processed was limited by the available technology and the size of individual claims. Placer claims stretched the entire width of the steam valley but were limited to five hundred feet in length as a result of the Yukon Placer Mining Act (1903) (Ogilive 1913).

2.3 The Era of the Gold Dredge

The high cost of labour combined with the low productivity of hand labour resulted in the highgrading of the easily assessible gold deposits. This scenario was typical of the Californian and Cariboo goldrushes of the mid-1800's (Christensen 1983). As the accessible, high-grade deposits were depleted, the claims were abandonned or sold.

In the early 1900's, the federal government changed the regulations governing the staking of claims to allow one entity the right to assemble groups of claims along a stream. This change in regulation, combined with the availability of unclaimed ground made it possible for well financed companies to secure consecutive claims and introduce mechanical mining technology (Lotz 1976). From the mid-1900's to 1966 placer mining in the Yukon Territory was dominated by the bucket wheel dredge (Carr and Anderson 1968). This type of mining required less labour but much more capital investment (Lotz 1976). The capital intensive nature of a dredging operation usually dictated that only one machine worked on a specific creek. The dredge would start at one end of the drainage and work to the other end over a number of mining seasons (G. Hilchy, mining engineer; pers comm). As a dredge only excavates gravels in the stream channel, other techniques were used to wash bench (terrace) gravels into the stream channel where they could be processed by the dredge. The layer of frozen organic soil that typically covers placer gravels in the Yukon was normally removed by hydraulic mining or ground sluicing. In either case, the overlying materials

were thawed and stripped by directing flowing water across the ground. These material were washed downstream, away from the mine site. Many areas of the Yukon that were mined using dredges still display characteristic unvegetated, windrowed tailing piles (Hardy, R. M. and Associates 1978). The method used to process the placer gravels resulted in the removal of much of the fine materials from the soil and consequently the soil lost the ability to retain moisture and thus to support vegetation. The effect of dredging on downstream water quality is more difficult to determine than its obvious effects on the landscape. As there was normally only one active operation per creek and because a dredge worked in its own self contained settling pond, it is entirely likely that the effect of dredging on downstream water quality was not devastating.

The era of the gold dredge ended when the last dredging operation in the Yukon Territory shutdown in 1966, a victim of increasing costs and the fact that the price of gold was fixed. Placer mining activity remained almost non-existant until the price of gold was allowed to be determined by market factors in 1972 (DOE 1983). Activity in the industry increased quickly in response to the increasing price of gold and peaked in 1981 (Christensen 1983).

The environmental impact of placer mining in the 1890's was constrained by the existing technology. Although there were thousands of men working in the goldfields, the fact that most of the work was done by hand severely limited the area that could be disturbed. From 1905 to 1966, the use of dredges allowed the rate and extent of mining to be increased, but constraints

imposed by the capital investment required to assemble the land and machinery required for a dredging operation limited the extent of activities in any one year. The present day placer mining industry has overcome both of these historical limitations. Modern operations tend to be relatively small but highly mechanized (Envirocon Ltd. 1986).

3.0 THE PRESENT DAY PLACER MINING INDUSTRY

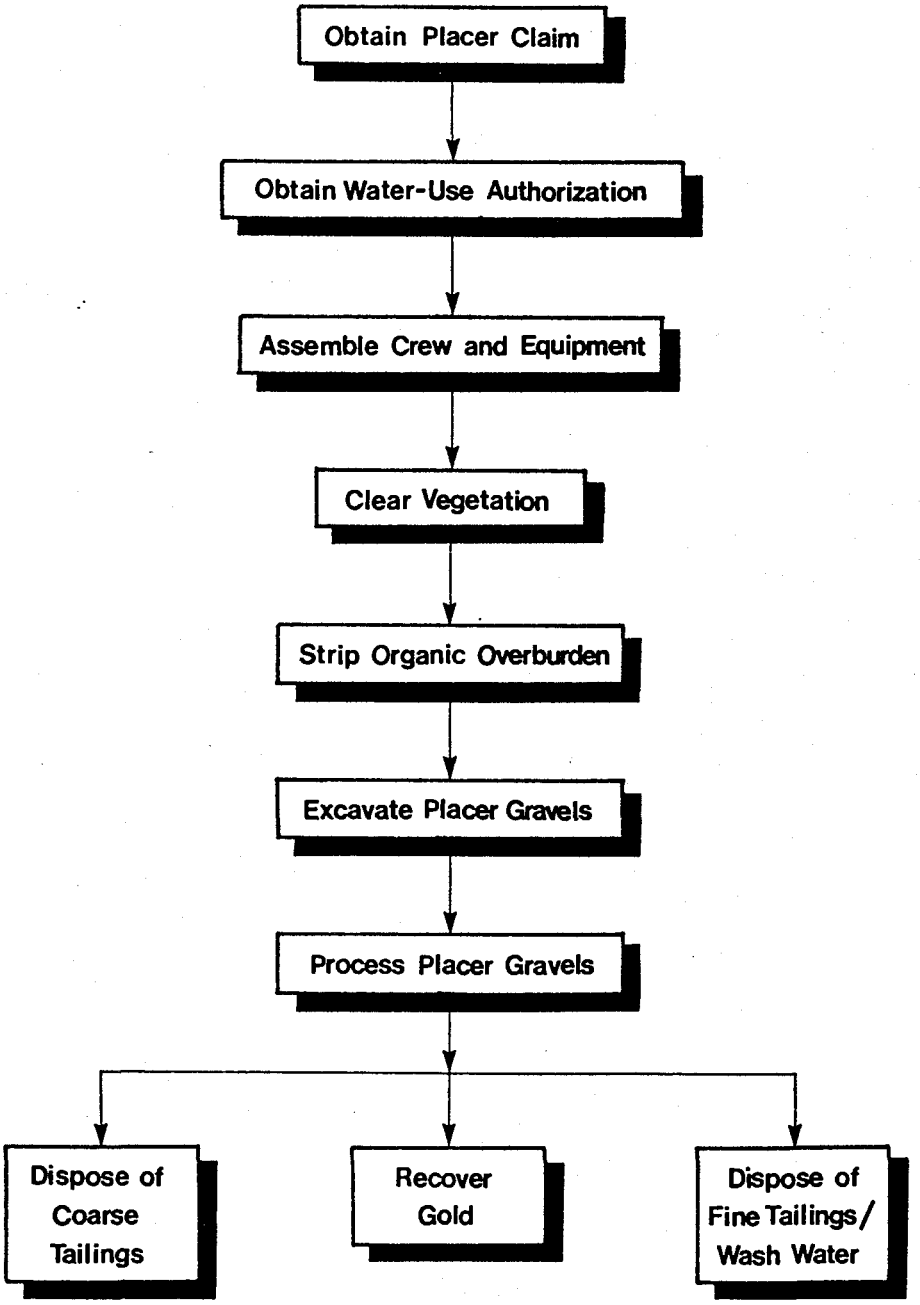
A typical, present day placer mining operation progresses through a number of steps from the initial decision to work a particular site, to the recovery of the gold (Figure 3.1). Once the equipment and crew is on site, the area to be mined must be stripped of vegetation and organic soils. Vegetation, generally consisting of moss, brush and stunted pines in these northern latitudes, is stripped using tracked bulldozers to push the material to the valley sides, out of the way of proposed mining operations (Hardy, R. M. and Associates 1978). The underlying organic soils, commonly referred to as muck, can vary in depth from a few centimeters to tens of meters (Envirocon Ltd 1986). In the Klondike and Sixty Mile regions the muck and underlying gravels are commonly permanently frozen (Sigma Resource Consultants 1981).

3.1 Removal of Overburden

A number of techniques are used to remove the organic soil layer as part of the site preparation work. Once the insulating layer of moss is removed the frozen muck will thaw during the long summer days . Thawing rates of one foot of depth per day during the warmest of the summer months are normal (G. Hilchy, mining engineer, pers comm). The thawed material can be either scraped off daily using heavy earthmoving equipment or it can be washed off by directing water across the surface. The use of flowing water to strip the organic soils is least desirable from

FIGURE 3.1

Steps in a Typical Placer Mining Operation



the point of view of protecting downstream water quality as much of the muck goes into suspension. This material is very difficult to remove from the water column using the water treatment technology presently practiced by the placer mining industry. The use of heavy equipment to move the thawed soil can also generate suspended sediment loadings as the muck is easily washed into the streams because of its very high moisture content (Ross 1976).

The large earthmoving equipment used by some placer miners (eg. Catipillar D-9 bulldozers equipped with rippers) can break out and move the material, even in a frozen state. Whether the muck is excavated in a thawed or frozen state it is disposed of in a similar manner. The material is pushed, by bulldozer, to the edges of the mining property and stockpiled. The frozen material tends to break out in large angular chunks that are then pushed into high piles. When the material thaws during the summer these stockpiles become unstable, with the possible consequence of organic soils entering natural watercourses. If the organic soils are removed in a thawed state, control of the material becomes more difficult as working of the thawed material with heavy equipment causes a slurry to form that will naturally run down slope.

The other common method of removing the oganic muck is to wash it away. Hydraulic mining, the use of high pressure monitors to direct jets of water on mucks overlying bench deposits, and ground sluicing, where all, or part, of a stream's flow is diverted across the ground to be stripped, are the most common techniques (Sigma Resource Consultants 1981). The advantages of hydraulic mining and ground sluicing are in lower costs per unit

of material moved and in the increased rate of thaw. However ground sluicing and hydraulic mining require large quantities of water, which are not always available due to the dry climate of the Yukon (Fox et al. 1983). Organic muck tends to contain a high proportion of fine grained sediments, which become suspended in water easily (Envirocon Ltd. 1986).

As a result of the large quantity of water and the fine grained nature of the organic material, the effluent resulting from hydraulic stripping or ground sluicing is difficult, if not impossible, to treat for the removal of suspended sediments (Sigma Resource Consultants 1981).

3.2 Processing of Placer Gravels

Vegetation and organic sediment are stripped from the site to expose the gold bearing gravel deposits. These gravels are then excavated and transported to a processing facility where the gold is separated. Gold bearing gravels are commonly referred to as pay gravels or simply as pay. Most miners continuously monitor the value of the material they are working to determine whether or not to continue in that area or to try a different spot. This ongoing day-to-day assessment work performed by the placer miner results from very little detailed exploration work being done to define the extent of the gold bearing deposit prior to the start of mining operations.

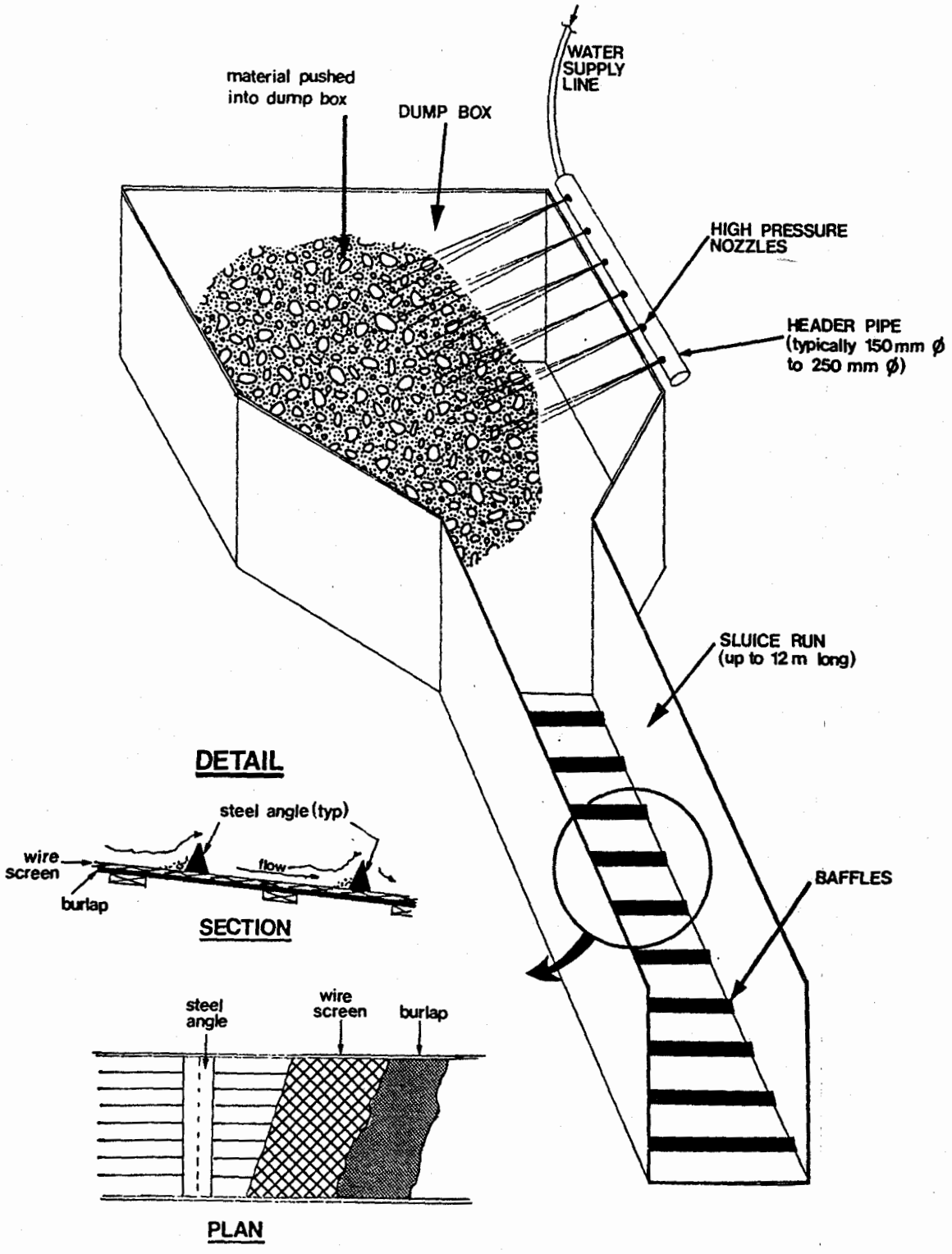
Gravels that are judged by the operator to be worth processing are transported to the sluice box. Typically the gravels are either pushed into the box using a tracked bulldozer

or carried to the box using a rubber tired loader. The choice of equipment will depend on the resources available to the operator, the properties of the materials being mined, and the physical layout of the mine site.

There are many variations of the sluice box presently used in the Yukon (Envirocon Ltd.1986). However, the general principal by which all sluices operate are the same. The gravels are mixed with water in a hopper at the top end of the sluice box to form a slurry. The slurry is then allowed to run down through the sluice box which, in its simplest form, is a long downward sloping trough, open at the downstream end, and with a series of baffles across its bottom (Figure 3.2). The heavier gold particles settle through the slurry and are trapped in the baffles while the gravels pass through the box. The size and sophistication of sluicing equipment varies greatly, ranging from small units that use less than 1100 lpm of water and are capable of processing ten to fifteen cubic meters of gravel per hour to large plants using 15000 lpm of water and capable of processing more than 100 cubic meters of gravel per hour (Envirocon Ltd. 1986).

The methods used by placer miners to obtain water vary from operation to operation depending on the elevation of the active mine pit relative to the water supply (the quanity and quality of water available to the miner). Mines located in the headwaters of a drainage are normally limited by available water yeild during part of the mining season and must develop some form of storage facility that will allow the retention of the stream flow. When a mine is limited by the available water supply, a recirculating system may be used. Water is pumped from the storage

FIGURE 3.2 : Simple Sluice Box



pond, through the sluice box, and returned to the storage pond (Figure 3.3a).

When water is not limiting, miners normally take their water directly fom the stream, pass it through the sluice box, or use it for hydraulic stripping, and then return it to the stream. If the local topography is appropriate miners will normally develop a gravity fed water supply. If there is insufficcient vertical drop to develop a gravity water supply, diesel pumps are used to supply water to the mine site (Figure 3.3b).

3.3 Disposal of Mine Wastes

The cobbles, gravels, and coarse sands, remaining after processing, collect at the downstream end of the sluice box and are removed mechanically on a regular basis. These coarse gravels, referred to as tailings, are disposed of in stockpiles located out of the way of on going mine operations. As a result of the sluicing process the material disposed of in these tailings piles contain a small fraction of fine sediment (Hardy, R. M. and Associates 1980). Most of the fine sediments are carried downstream with the effluent flow from the sluicing operation. Most placer mining operations have some form of treatment facility, usually settling ponds, to reduce the concentration of suspended sediment in the sluice effluent prior to its entering a natural watercourse (Envirocon Ltd. 1986).

The effectiveness of settling facilities varies as a function of the size and design of the pond(s), the rate of flow and sediment concentration, the material properties of the suspended

FIGURE 3.3(a)

Typical Recirculating Water Supply System

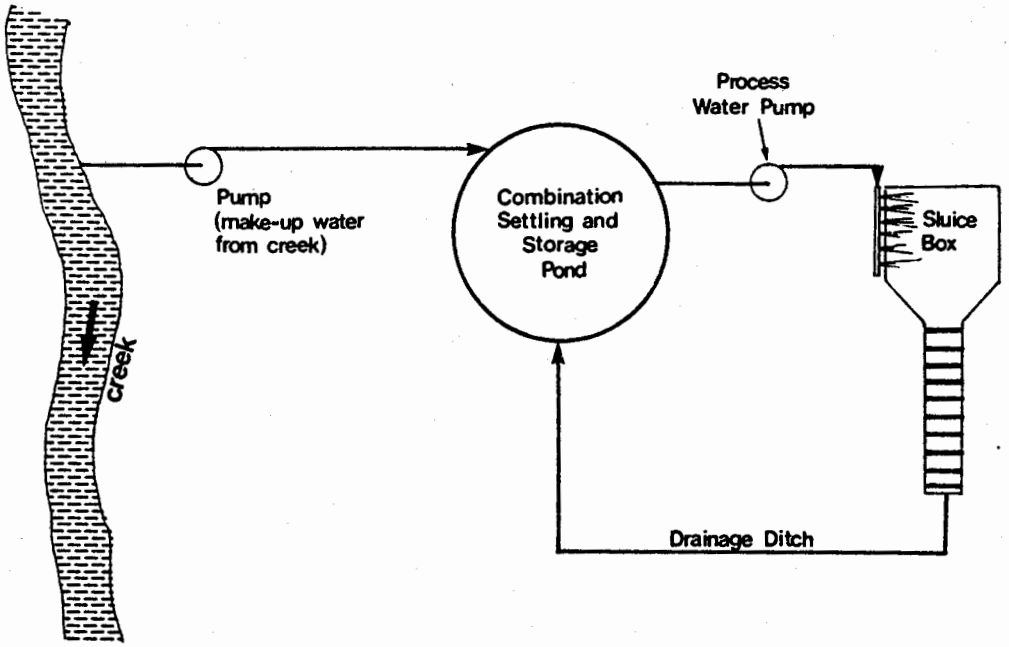
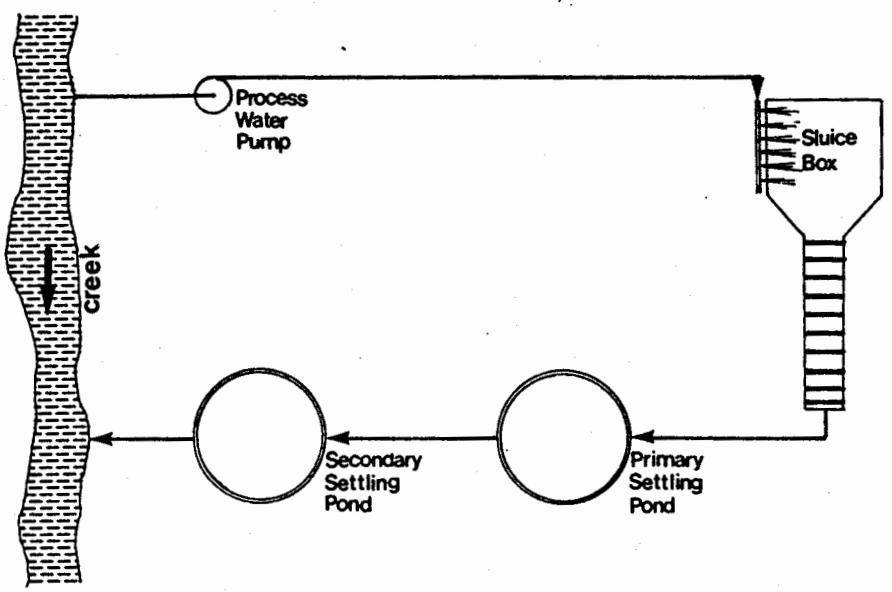


FIGURE 3.3(b)

Once Through Water Supply System



sediment, and the maintenance of the pond. In its simplest form, the operation of a settling pond is governed by Stoke's Law, which states that, in a still fluid, the speed at which a spherical particle will settle is determined by the diameter and specific gravity of the particle and the viscosity and specific gravity of the fluid (Clark et al. 1971). With all other variables held constant, the settling velocity of a particle varies inversely as the square of its diameter (Figure 3.4). To design a settling facility to remove a specified proportion of the suspended sediment in the sluice water effluent requires knowledge of the particle size distribution of the materials being processed by the mine. The specific gravity of the soils being processed and the specific gravity and viscosity of the process water can be assumed to be constant over the range of conditions to be found in the field (Sigma Resource Consultants 1981). Once the particle size that must be removed to meet a specified effluent quality is determined, the settling facility is designed to allow sufficient time for the material to settle before the flow is discharged.

In addition to providing sufficient volume in the settling pond to allow all material greater than the selected particle size to settle, sufficient space must be provied to store the settled material. Normal practice is to provide two or more settling ponds in series (Figure 3.3b). The first pond is relatively small and traps the coarser sediment, the second and subsequent ponds are much larger and retain the fine sediment (British Columbia; Ministry of Energy, Mines and Petroleum Resources 1985). In reality, the operation of a settling facility

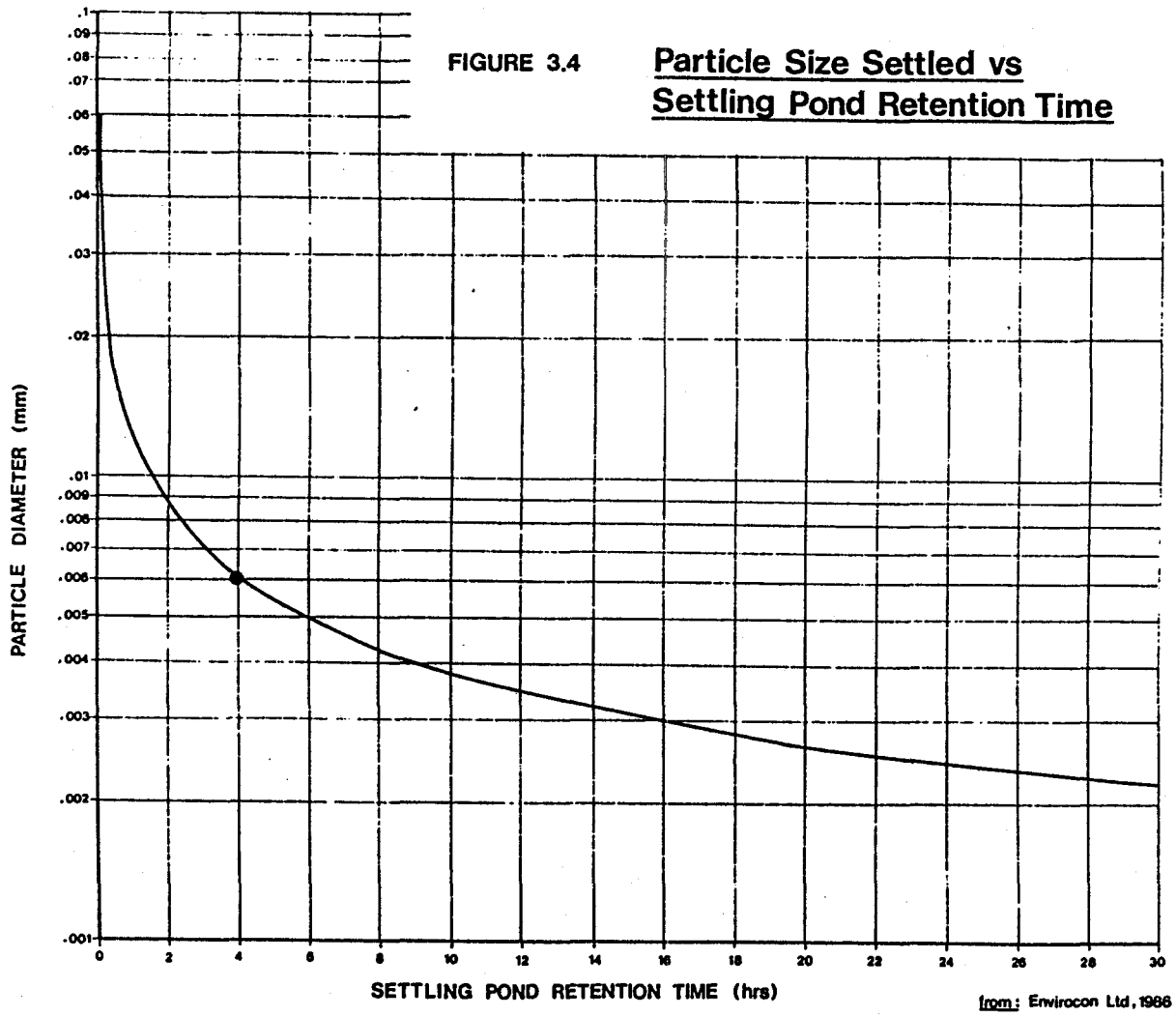


FIGURE 3.4 **Particle Size Settled vs Settling Pond Retention Time**

from: Envirocon Ltd, 1986

only approximates the conditions required of Stoke's Law. Movement of water in the pond, resulting from flow or wind induced turbulence, violates the condition of a still fluid and may cause very fine particles to remain in suspension. Pond designs that result in "short-circuiting", the non-uniform flow of water through the pond, can reduce the theoretical retention time and allow larger than designed for particles to escape with the pond effluent flow (Clark et al. 1971).

Several studies have been undertaken to assess the use of flocculants in treating placer mining effluents (Weagle, Ken Environmental Consultant Ltd. 1984, Myazin et. al. 1977). Flocculants can cause discrete particles to join together and thus increase their effective diameter. Although flocculants have been used successfully to treat placer mining effluent on an experimental basis, they are not used as part of normal mining practice in the Yukon Territory.

Another technique used by Yukon placer miners to dispose of their sluice water is simply to discharge the effluent to a previously mined area and allow the water to seep through the spent tailings. Suspended sediments are removed both by settling and by filtration as the water percolates through the soil. The effectiveness of this method of disposal is difficult to assess as the effluent enters adjacent streams as a non-point source pollutant. Measurement of receiving stream water quality upstreaam and downstream of operations using this method of treatment indicated very little change (Envirocon Ltd. 1986).

Envirocon Ltd. (1986) found that of 81 settling ponds inspected in August and September of 1985, only fourty-two

percent were operating efficiently. Checks made by staff of DIAND's Water Resouces Branch of all active placer mining operations in the Yukon in 1985 indicated that only twenty-one percent of miners were meeting the present, recommended effluent water quality standard (O. Langer, DFO Habitat Biologist, pers com. 1986).

3.4 Other Mining Practices

There are two other placer mining technologies that are currently used in the Yukon Territory. These are hydraulic mining and dredge mining (Envirocon 1986). Similar to the practice of stripping the organic mucks with flowing water, hydraulic mining can be used to wash pay gravels from bench deposits into the valley bottom where they are directed through a sluice box to recover the gold.

As mentioned earlier, dredging dominated the placer mining industry in the Yukon from around 1905 until 1966. In 1983 one of the old dredges was recommissioned and put into operation on Clear Creek, a tributary of the Stewart River (Envirocon Ltd.1986). Gold dredges are large machines, mounted on floats, that excavate and process the pay gravels and dispose of the tailings in one operation. A typical gold dredge consists of a long boom which projects from the front of the machine, a central buliding that houses the processing equipment and control room, and a discharge conveyor (Figure 3.5). A bucket wheel conveyor runs out over the front boom and excavates the gravels. The gravels are dumped from the conveyor into a trommel, a rotating,

FIGURE 3.5

Gold Dredges

Operating Gold Dredge on Clear Creek
Dredge sits in its own excavation. The course tailings can be seen in the berm deposited behind the dredge. The bucket wheel is shown lowered into the pool.

One of the largest gold dredges to operate in the Yukon, now a museum piece near Dawson City. The bucket wheel ran along the ramp in the foreground.

circular screen that removes the coarse gravels for disposal by the discharge conveyor. The fine gravels pass through the trommel screen and are diverted into a sluice arrangement where the gold is separated. The fine gravels and sediment remaining after sluicing are discharged into the dredge pond at the back of the machine. A dredge floats in its own pond created by the excavation of the pay gravels. The coarse tailings are deposited behind the machine in windrows that serve as berms to maintain the water level in the dredge pond.

The principal factor affecting the profitability of present day placer miners is the volume of material processed during the mining season. Within his economic constraints an efficient miner will employ the largest available machinery. Time spent on activities other than the excavation and processing of pay gravels due to maintenance of water treatment facilities (ie. settling ponds) decrease the time available for actual mining activities and therefore decrease the volume of materials that can be processed. The present day industry is so efficient that miners can make a profit reworking areas that have been mined once or more in the past.

4.0 CHARACTERISTICS OF THE PRESENT DAY PLACER MINER

4.1 Size of Placer Mining Operations

The present day Yukon placer mining industry is once again dominated by the small operator. A study of 197 placer miners, in production in 1980, classified fifty-one percent of miners as single operators, forty-one percent of the miners were classified as medium companies, with two to nine employees, and only eight percent were considered large companies with ten or more employees (DOE 1983). A similar assessment undertaken by the Department of Indian Affairs and Northern Development, Mining Engineering Branch, found 195 active placer mining operations in 1984 (R. Whittingham, Mines Inspector, Dawson City, Yukon; per com.). Of these 195 mines, 91 employed two or less people, 79 employed three to five people, 19 employed six to nine, and only six mines employed more than ten people.

The majority of small to middile sized operations are either owned by an individual or a family (DOE 1983, Envirocon Ltd. 1986). Individual and family owned mines tend to be owner operated, that is the owner is on site and actively participates in the operation of the enterprise (Envirocon Ltd. 1986).

4.2 Comparison to the Hardrock Mining Industry

There are few similarities between the placer and hardrock mining industries. The capitalization of an average placer mining operation is typically an order of magnitude less than that

required to put even a small hardrock mine into production (Thompson and Crommelin 1974 and IEC Beak 1983). Placer miners often combine prospecting, exploration, and production activities at the same time and on the same property. With a limited amount of detailed information concerning the value and extent of placer gravels underlying his claim, a placer miner will set up his equipment and work the claim. If the results are not satisfactory the operator will move his equipment to another location and try again. Unlike the hardrock miner, the modern placer miner is very mobile and the whole operation can be dismantled, loaded on trucks, taken to a new site and set up again in a matter of days.

Prospecting, exploration and development are discrete components in the development of a hardrock mine (MacKenzie and Bilodeau 1982). A typical hardrock mine has associated with it very high fixed costs (Thompson and Crommelin 1974). The hardrock miner wants to be very certain as to the quantity and quality of his ore reserves because the large non-recoverable costs required to start-up a hardrock mine make errors in the estimation of mine reserves very expensive.

4.3 Comparison to the Fishing Industry

Placer mining in the Yukon Territory is more similar to the commercial fishing industry than it is to hardrock mining. Although there is corporate ownership in both industries, the individual or family enterprise makes up the majority of the industry. To be successful the placer miner, like the commercial fisherman, must be competent in all aspects of the business. He

must be able to operate and maintain the equipment of his trade, understand the natural processes that influence his resource, and be able to deal with financing, accounting, and marketing. Similar to the position of the fisherman, the placer miner can lose everything as a result of one bad year, be it through his own misjudgement or through chance.

The placer miner tends to be an independent individual (Christensen 1983). This characteristic is no doubt influenced by the folklore of the Yukon that pits man against nature in his battle to secure his reward (Lotz 1976). To successfully operate a placer mine requires the ability to make correct decisions. An individual who cannot operate with limited financial resources will not succeed.

5.0 THE ENVIRONMENTAL CONCERN

5.1 Cause of the Concern

Two factors combined in the early 1970's to raise concerns with respect to the environmental appropriateness of regulations governing the Yukon placer mining industry. The first factor was the increase in North American society's awareness of the consequence of many of man's actions on the environment (Whitman and Fahringer 1973). Passage of environmental protection legislation in both Canada and the United State was in response to the desire that external effects of development be assessed as part of the decision making process.

The second factor giving rise to the present controversy was the decision by the government of the United States, in 1972, to allow the price of gold to be determined by market factors. (Christensen 1983). The price of gold increased rapidly, peaking near $900(Cdn.) per troy ounce in 1980 (DOE 1983). The rapid increase in the price of gold initiated a similar increase in placer mining activity (DIAND, DFO, DOE 1983).

The conflict resulting from these two concurrent trends was inevitable. The placer mining industry was rapidly expanding at the same time that government agencies were responding to the increased public demand for environmental protection. Negative environmental effects, resulting from placer mining, are obvious when placed against the background of the Yukon wilderness. The scars, created by mining the stream bottoms and the adjoining bench lands, stand out against the almost constant green foliage.

The sediment laden waters originating from active placer mines muddy previously clear Yukon streams.

This conflict is escalated further by the personal outlook of the people involved. On one hand are the environmentalists, who are often articulate in their criticisim of the industry;

> "Most threatening of all is the cumulative effect of all the scattered placer gold mining operations, mostly southern based, and southern funded. Placer mining involves bulldozing off the trees and soils, and ploughing the underlying gravels to a sluice box. Roads must be built for the heavy equipment. Streams are gutted and fish die. Mining debris is left to rust. With the prices of gold and silver running wild, the days of '98 are here again." (Theberge 1983).

On the other hand is the modern placer miner, a self perceived rugged and independent individual who is going to make his own wealth and who cannot understand that he is doing anything wrong. He argues that he is not polluting the stream because only naturally occurring materials are released as a result of his operation and that natural processes result in the release of the same materials and in greater amounts:

> "Under the present water quality standards considered acceptable by the EPA (and also by many state agencies), Mother Nature could be subject to heavy fines (and a court order closing down her operations) for polluting most rivers and streams, over a good part of each year. It is doubtful, however, that Nature will allow herself to be regulated so harshly. Insofar as placer miners are concerned, there seems to be no available recourse to alleviate this new burden." (Parkhurst 1985)

The miners and the environmentalists obviously share different views with respect to the development of the non-renewable resources of the Yukon Territory. The various government agencies responsible for managing the resources of the

Territory also have differing views as to the overall objectives of the proposed regulations. Included in the draft Yukon Placer Mining Guidelines released by the federal government in 1983 were position papers issued by the three departments which authored the proposed regulations. The Department of Indian Affairs and Northern Development:

> "...recognizes the value of the Yukon placer mining industry to the economic base of the Territory and encouages a trend towards more efficient mineral management, production of increased social and economic benefits and more effective environmental conservation."

and

> "DIAND affirms the principle of integrated resource management as an objective to be obtained through an ongoing process of resource evaluation (renewable and mineral), determination of significant environmental impacts, development planning, provision of mitigative measures, and rehabilitation.

DIAND is the federal department responsible for economic and social development in the Yukon Territory. As such, their position paper emphasizes the need for integrated resource management and presents the concept that regulation of the placer mining industry must be accomplished with full recognition of both the positive and the negative effects of any revisions in the present regulatory regime.

The Department of Fisheries and Oceans (DFO) and the Department of Environment (DOE) issued a joint position paper that makes no reference to the value of the placer mining industry to the Yukon economy and does not speak of integrated resource management. Instead the joint DFO and DOE position paper focuses on the maintenance of the renewable resource base:

> "It is recognized by the Department of Fisheries and Oceans (DFO) and the Department of Environment (DOE) that placer mining in the Yukon in its present form is

incompatible with the maintenance of certain renewable resources, such as fish, and wildlife."

and

"Where mining activities occur they must be conducted in a manner which protects the natural environment and provides for the rehabilitation of any damages which may occur."

The difference of position on the placer mining issue indicated by the three federal government departments is a reflection of their individual mandates (Fox et al. 1983). While DFO and DOE focus primarily on the preservation of terrestial and aquatic resources, DIAND must consider the socioeconomic consequence of changes in policy. One of the fundamental difficulties hampering the development of policy to govern the placer mining industry stems directly from the conflicting mandates of the federal departments responsible for drafting the regulations.

5.2 Effects of Placer Mining on the Land Resource

The environmental impacts of placer mining are well documented and relate to site specific changes to the landscape and to downstream changes in water quality and substrate composition (Hardy, R. M. and Associates 1978; Langer 1980). Placer mining as presently conducted frequently requires the excavation of the stream channel from valley wall to valley wall (Envirocon Ltd. 1986). In addition, bench deposits, perched on the side of the valley walls may also be mined. The site specific effects of placer mining are similar to those expected as the result of any surface mining activity (Marshall 1982). Important wetland and riparian habitats are destroyed by mining activities

and, without treatment, the mining site after operations have ceased is slow to revegetate (State of Alaska 1981; Hardy, R. M. and Associates 1978, and DOE 1983). The problem of revegetating mined areas is made more difficult due to the nature of the coarse tailings which are normally disposed of in steep piles (Figure 5.1). These coarse tailings contain very few fine particles as a result of the sluicing operation and do not retain moisture (Marshall 1982). The knowledge of the most suitable techniques and species for revegetation of mine sites in the far north is limited (Marshall 1983).

A report prepared for the Yukon Territory Water Board by R. M. Hardy and Associates in 1979 recommended guidelines for the stabilization and rehabilitation of placer workings after mining operations were completed. The recommended guidelines differentiated between operations situated in narrow valleys and those situated in the bottom of wide valleys. The major recommendations in the report concerned the need to recontour the tailings piles and mine pit to achieve stable slopes that would not continue to slough and the need to retain the organic soil layer to spread on the site after operations and recontouring were completed. Revegetation of the site with a mixture of grasses (to be determined based on analysis of soil conditions) was also recommended.

5.3 Effects of Placer Mining on Aquatic Resources

Placer mining can effect the aquatic resources both within and downstream of the mine site. Within the active mine site, the

FIGURE 5.1

EFFECTS OF PLACER MINING ON THE LANDSCAPE

Newly developed placer mining pit. Topsoil has been stripped (foreground) and material are being stockpiled prior to processing

Active placer mining operation. Topsoil and overburden has been pushed to the valley side.

regulation of streamflow, the diversion of the stream channel and the removal of gravels from the stream channel effect the aquatic resources of the immediate area (Madison 1981; Parkhurst 1981). Mining activities can disturb or destroy habitat for rearing and spawning fish and habitat for the aquatic invertabrates on which the fish feed. Alterations to the stream channel or flow regime can result in obstructiions which prevent the movement of fish through the mine site . Also, changes in the physical characteristics of the stream channel can result in long-term instabilities that hinder the establishment of the stable conditions which tend to increase biological productivity.

Some effects of placer mining may benefit aquatic resources in the area. Studies in California have shown that the area of gravel suitable for spawning can be increased as a result of the removal of fine sediments during the gold recovery process (Prokopovoch and Nitzberg 1982). The redistribution of gravels as a result of mining activities can increase the diversity of the habitat, at least in the short-term, thus leading to increased productivity (Parkhurst 1981).

The downstream effects of the fine sediments released as a result of placer mining are not as obvious as the alteration of the landscape at the mine site because the sediment stays within the stream channel. While the deposition of fine sediment might encourage the growth of riparian vegetation (Church and Rood 1982), it has a generally negative impact on aquatic habitats (Rieser et al. 1985; Langer 1980). In the document A Rationale for the Suspended Solids Standards for Yukon Streams Subject to Placer Mining, prepared by Department of Fisheries

and Oceans and Department of Environment (1983) as backup to the proposed placer mining guidelines, the effects of fine sediments on aquatic habitats and aquatic populations were summarized:

> "Sediment is a broad spectrum pollutant that can degrade water quality and have severe negative impacts on aquatic habitat as well as cause damage to fish and associated aquatic populations. Natural levels of sediment can be limiting to production in many streams and any significant increase in sediment levels over natural levels in a stream can cause much more significant decreases in aquatic life."

Fine sediment discharged into natural streams and rivers can affect aquatic populations in a number of ways. Sediments can settle out on the stream bottom covering the stream gravels and reducing the production of benthic invertebrates, which are an important component of the diet of many species of fish (Langer 1980). Sedimentation of spawning gravels used by salmon and trout can directly reduce the survival rate of eggs and alevin (Cooper 1965). Fine sediments suspended in the water column (Figure 5.2) increase turbidity and reduces light penetration, thus reducing primary production (DFO and DOE 1983b). Suspended sediments can also directly affect fish:

> "including abrasion and disease suscepibility, changes in ventilation rate, feeding behavior, avoidance, growth, and acute toxicity." (DFO and DOE 1983b).

Few specific studies, designed to determine the effects of deposited and suspended sediments on aquatic habitats and fish populations of the Yukon Territory, have been attempted. Most conclusions with respect to the effect of fine sediment on fish and habitat are based on scientific studies done in the southern latitudes. One set of studies were undertaken to assess the effects of short-term and prolonged exposure to increased levels

FIGURE 5.2

EFFECTS OF PLACER MINING ON WATER QUALITY

Sluicing operation. The fine soil particles are carried off with the process water, while the course particles are deposited at the base of the sluice box. Course tailings can be seen stockpiled behind the sluice.

Typical settling pond. A large portion of the clay/silt fraction is not removed and passes through the settling pond and downstream.

of suspended sediments on artic grayling, native to Yukon placer mining streams (McLeay et al. 1983, McLeay et al. 1984). These studies found that the grayling could survive short-term exposures to levels of suspended solids greater than 50,000 mg/l in labatory tests. Field studies with caged fish indicated that grayling could survive exposure to suspended sediment concentrations of up to 1200 mg/l for a period of four to five days. Prolonged exposure to sediment concentrations of up to 1000 mg/l did not effect suvival but did reduce growth rate.

In summary, there is no doubt that placer mining operations, as currently practiced in the Yukon Territory alters the natural landscape in the vicinity of the mine site and that sediments released as a result of various placer mining practices adversely effect aquatic habitats and populations in downstream receiving waters. The significance of these impacts on wildlife and aquatic populations is more difficult to ascertain.

5.4 Habitat Recovery

A study of the rate at which fish and wildlife habitats recovered from the effects of placer mining activity used the habitat requirements of moose, the red backed vole and artic grayling as indicators of the rate of recovery (Hardy, R. M. and Associates 1980). The findings of this study indicated that big game habitat recovered to pre-mining levels in less than twenty years in areas that had been mined using heavy equipment. The length of time required for natural rehabilitation of the site depended on the ability of the soils to retain moisture and

thus, support plant growth.

Aquatic habitats were found to recover to pre-mining levels of productiviy within thirty to seventy-five years of the disturbance. Water quality recovered to pre-mining levels within twenty years of the termination of mining activities. An important factor affecting the rate of recovery of aquatic habitats was the stability of the stream channel.

5.5 Important Species

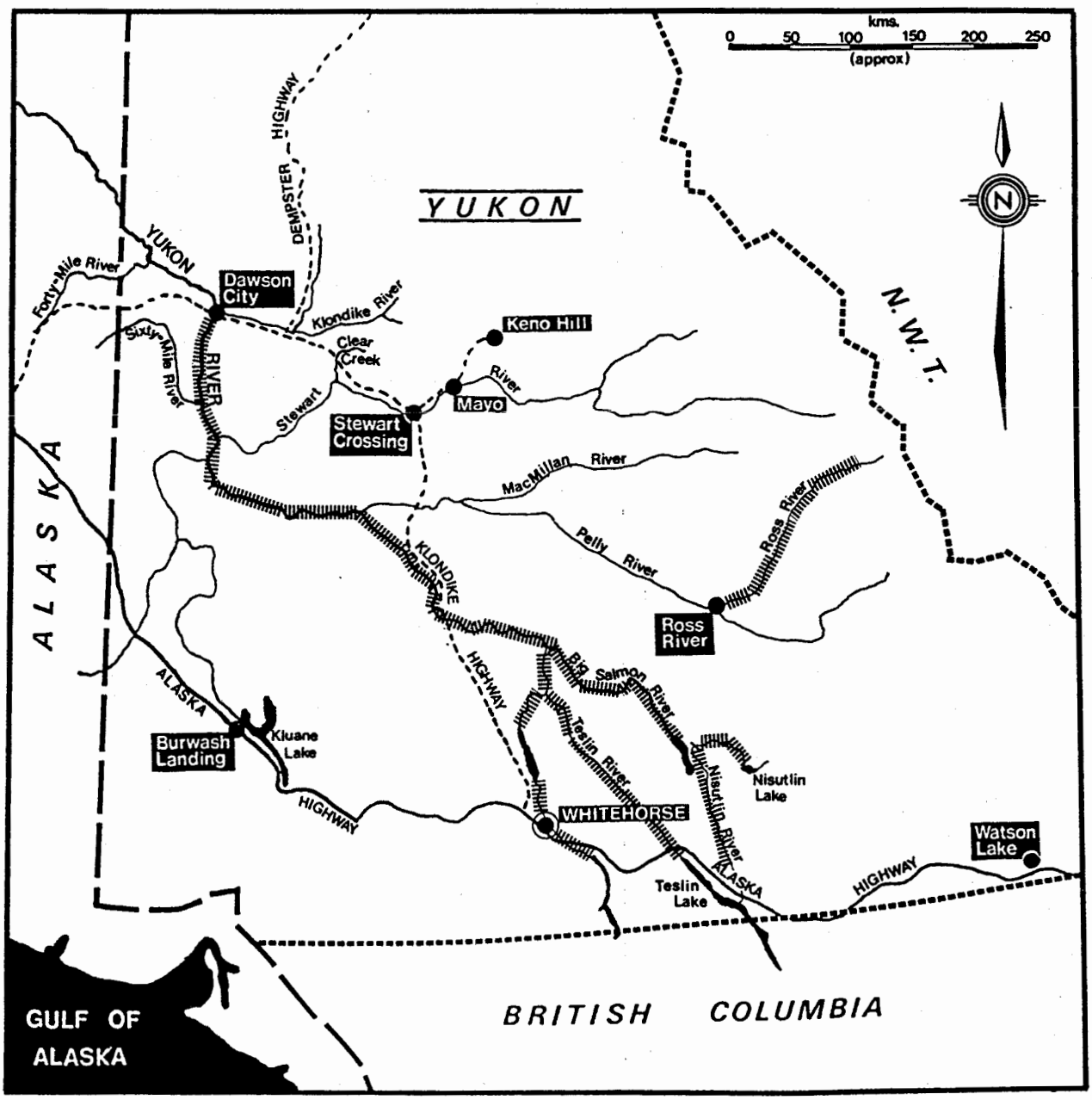
Salmon and trout are considered the most important species threatened by placer mining operation because of their value to the commercial, sports, and subsistence fisheries (DOE 1983). Two species of the Pacific salmon, the chinook salmon and the chum salmon, are native to the Yukon River and many of its tributaries (Pearse 1982). The chinook salmon, in particular, is considered important because it is the most valuable species to the commercial, subsistence, and sports fisheries (Fox et al. 1983). Chinook salmon spawning is primarily limited to the large, lake-fed tributaries of the upper Yukon River drainage. Yukon River tributaries that support large spawning populations of chinook salmon include the Big Salmon River, Nisutlin River, Teslin River, Ross River and the mainstem of the Yukon River upstream of the Klondike River confluence (Figure 5.3). Although good data with respect to the numbers of spawning chinook salmon ultilizing the different areas of the upper Yukon River are not available, it is believed that the most important spawning grounds are located in the mid-Yukon sub-basin, which includes

FIGURE 5.3

Major Salmon Spawning Rivers in Yukon Territory

KEY

documented or likely spawning areas



the mainstem Yukon River from the Stewart River confluence to the Hootalinqua River confluence. This sub-basin includes the Big Salmon, Little Salmon, and Nordenskiold Rivers and Tatchum Creek.

6.0 DEVELOPMENT OF REGULATIONS GOVERNING PLACER MINING

The regulatory regime governing the operation of placer mines in the Yukon Territory has evolved over the last century in response to social and economic factors. Up to the end of the 1960's public attitudes and economic conditions resulted in government attempting to encourage expansion of the industry through various policy initiatives.

Initially, regulation was directed towards the orderly development of the industry (Ogilvie 1913). Early regulations were directed towards establishing procedures for staking and registering placer mining claims. Regulations affecting water use were limited to dealing with conflicts between miners with respect to water allocation (Yukon Placer Mining Act 1903).

6.1 Federal Legislation

The passing of the Northern Inland Waters Act (NIWA) in 1972 resulted in the formation of the Yukon Territorial Water Board. The Water Board is given the mandate to licence water use in the Yukon Territory (DOE 1983). The right to use surface water for any purpose can be granted through the issuance of a water licence or through the issuance of an authority to use water without an licence. Since 1984 all placer miners have been issued a water licence by the Water Board. Prior to 1984 authorizations were issued by the Controller of Water Rights, a DIAND employee. The Controller of Water Rights operates under guidelines established by the Water Board. Sections of the Yukon Placer

Mining Act that dealt with water use were revoked with the implentation of the Northern Inland Waters Act.

The Water Board, subject to the approval of the Minister of DIAND, has the authority to attach conditions to any water licence that it issues. Similarily, the Controller of Water Rights can attach conditions to authorizations. Conditions, typically attached to a licence or authorization, include the requirement for: the provision of settling facilities, the provision of fish passage, the maintenance of minimun stream flows, prohibition of specific practices, (DOE 1983).

The Fisheries Act (1977), administered by the Department of Fisheries and Oceans also regulates water use by placer miners. Three sections of the Fisheries Act affect water use practice (Appendix 1.0). Section 20 requires the provision of fish passage facilities as determined by the Fisheries Officer. Section 31 prohibits the harmful alteration or destruction of fish habitat and Section 33 prohibits the release of deleterious substances into Canadian waters unless permitted by federal government regulations under the Fisheries Act or some other act.

The Yukon Placer Mining Act (1903 revised 1972) is the third piece of federal legislation affecting the placer mining industry. As the sections of the Placer Mining Act relating to water use were revoked with the introduction of NIWA in 1972, this piece of legislation is of limited use in attemptin to regulate the environmental effects of placer mining.

6.2 Background to the Present Controversy Over Environmental Regulation

The licencing process was inadequate to handle the large number of applications for water licences that resulted from the rapid expansion of the placer mining industry in the years after the price of gold was allowed to float (Williams 1979). To expedite the processing of licence applications Authorizations to Use Water Without a Licence were issued, as allowed for under NIWA (DOE 1983). This decision gave the the Water Controller discretionary powers with respect conditions assigned to specific water use permits. Starting in 1973, public meetings were conducted by the Water Board for the purpose of solicting input to the development of guidelines to govern water use by the placer mining industry. Interim guidelines were implemented for the 1976 mining season (Appendix 2.0). These guidelines were brief and somewhat vague:

> "All operations are to provide, where practicable effective settling facilities to the satisfaction of the Controller."

This type of wording in the guidelines caused difficulties in their implementation as objective criteria defining words such as "practicable" or "effective" were not provided. The controller had to determine whether or not it was practicable to construct and maintain settling facilities and to decide whether or not such settling facilities were operating effectively. The practicability of providing settling facilities can be assessed from many point of views including:

1) Is it technically possible to construct and maintain a settling facility at a specific location?
2) Is it economically practicable to construct and maintain a settling facility at the particluar site?

3) Is the use of a settling facility the most effective form of effluent treatment under site specific conditions?

It appears that the vague wording of the 1976 guidelines gave the Controller of Water Rights and the Water Resources Branch of DIAND (the group providing technical support to the Controller) serious difficulties:

> "Government is concerned that the present guidelines do not adequately protect the environment and that the absence of clearly defined standards presents serious administrative problems in the areas of interpretation and enforcement. (DOE 1983).

In an address to the Alaska Mining and Water Quality Symposium, the president of the KPMA stated that the industry could "live with" the 1976 quidelines (Ross 1979). The industry's supportive position resulted in part from the flexibility of the guidelines which allowed the water use authorization to be fitted to site specific conditions.

In an attempt to address the critisisms directed at the 1976 guideline, the Yukon Territorial Water Board developed a new set of more detailed guidelines in 1979:

> "The federal government, frustrated by multiple legislation requirements, interpreted the demands as a need for more comprehensive regulation, and so in 1978/79 steps were taken to draw up new guidelines which would give direction for new regulation." (Christensen 1983).

These guidelines tried to meet the needs of both government and industry and were presented for review at a public hearing conducted in fall of 1979 (DOE 1983). The guidelines proposed in 1979 were opposed both by the placer mining industry and by the Department of Fisheries and Oceans (Christensen 1983). The industry complained that the comprehensive quidelines did not

allow consideration of site specific concerns. DFO argued that the guidelines were in contradiction with the Fisheries Act as adequate protection to the fisheries resouce was not provided.

> "The federal bureaucrats from the three departments -Indian Affairs and Northern Development, Environment and Fisheries and Oceans - tried to reconcile the differences with the industry, and to involve the Government of Yukon, but the situation was not conducive to compromise. And so the Federal Government went its own way and developed a set of draft guidelines." (Christensen 1983)

The three federal government departments formed the Placer Enviromental Studies Technical Committee (PEST committee) to commission and coordinate a number of technical studies required to provide scientific information on the effects of pacer mining operations on variuous components of the environment. Various studies completed under the PEST committee's mandate were completed including; the assessment of the effect of placer mining effluent on fish (McLeay et al. 1983, McLeay et al. 1984) and the rehabilitation of placer mined areas (Hardy, R. M. and Associates 1979). The PEST committee was disbanded in January 1982 (DOE 1983).

6.3 The Proposed Guidelines

The PEST Committee was replaced with the Interdepartmental Committee on Placer Mining (ICOPM). ICOPM was responsible for the drafting of the Yukon Placer Mining Guidelines that were presented in draft for discussion in 1983 (Appendix 3.0). The guidelines proposed in 1983 are similar to those drafted by the Territorial Water Board in 1979 with the one major difference being the inclusion of effluent water quality standards based on

suspended sediment concentrations of the water discharged from the mining operation.

The guidelines proposed in 1983 consisted of three components. Firstly, miners would be required to provide a detailed development plan as part of their application for a water use permit. Secondly a stream classification system, ranking the environmental sensitivity of a particular site, would be introduced. The third component of the proposed guidelines would be a series of environmental standards which would be attached to a miner's water use permit. The standards would vary depending on the classification of the stream being mined.

6.3.1. Guideline Requirements for Development Plans

Miners would be required to submit a detailed "Development Plan" with their application for a water licence or an authorization:

> "A development plan will be required by DIAND with the water-use application and would identify all the proposed activities and phases of operation for the proposed life of the project. It will, in essence, consist of a number of sub-plans to show how the operation will progress at all stages and how the project will meet the required standards and mitigate the environmental impact."

As proposed in the guidelines the miner would have to provide a description of his project which included not only the type and size of operation proposed but also data on surficial and bedrock geology, the type of exploration program conducted or planned, estimation of stream hydrology, and plans for rehabilitating the mine site. Although not explicitly stated in the proposed

guidelines it is assumed that once the development plan is submitted and the water use authorization or water licence is issued, the operator will be required to conform to the plan.

6.3.2 The Stream Classification System

The second component of the proposed guidelines is the establishment of a stream classification system. This classification system was developed by the Department of Fisheries and Oceans and recognizes that not all streams or sections of streams are capable of supporting significant fishery resources:

> "To allow placer mining operations to occur and yet to ensure the fisheries resource of the Yukon is protected, a priority protection schedule has been developed. This separates the important commercial, sports or subsistence fish species in Yukon into two groups as outlined below. This classification is in accordance with the habitat protection policy of the Department of Fisheries and Oceans which calls for no net loss of fish and fish habitat required to maintain Canada's economically and socially important fish resources."

The priority protection schedule identifies two classifications of fish. Fish species that bury their eggs in the stream gravels are given the highest priority. These species include all salmon, artic char, Dolly Varden char, and rainbow trout. The second priority group consists of fish species which are broadcast spawners including: artic grayling, whitefish, burbot, northern pike, and cisco. Lake trout, a broadcast spawner, is given a high priority because it requires coarse substrate to incubate its eggs (DFO 1983).

The priority schedule is used in conjunction with the life

cycles, known abundance, and habitat requirements to develop the stream classification system. Streams or part of streams (stream reaches) are given an "A", "B", "C", "D", or "X" classification.

> "An "A" category stream would have the highest biological importance rating, a "B" stream would have a high rating a "C" stream would have a moderate rating, and a "D" stream would have the lowest biological importance rating. An interim "X" rating would be applied to those streams that have been severely degraded by past mining activity." (DOE 1983).

In a strict sense, the stream classification system does more than consider the biological importance of a particular watercourse. The economic and social importance of the fish species utilizing that water is implicitly included in the rating system. A salmon spawning stream is given the highest rating (Class A) because salmon are considered the most valuable species as well as the species most sensititive to the suspended sediment generated by placer mining activities. Other fish species, such as Artic grayling, are of lesser economic importance and are more tolerant of suspended sediment. Streams that support grayling and not salmon are given a lower classification (Class B or C).

To support the stream classification system DFO (1983) prepared a document entitled A Rationale for the Classification of Rivers, Streams, and Lakes in the Yukon Territory in Relationship to the Placer Mining Guidelines.

Provision is provided in the proposed guidelines for a miner to challenge the classification assigned to any particular stream or stream section:

> "If the proponent accepts the classification specified for his particlular operation no baseline environmental data will need to be collected. However, if the operator requests a downgrade in classification on his stream or reach, he will need to gather the baseline information on the area." (DIAND, DFO, DOE 1983).

The data required under the proposed guidelines before a miner could request a reclassification includes: water quality information collected every two months over the open water season, an assessment of area hydrology including estimation of flood magnitude and frequency, and a fisheries assessment including species abundance estimates and quantification of habitat, by type. In short, the proponent would be required to undertake a major research program that would require the use of consultants.

In presenting the rationale for the stream classifcation system, DFO (1983) states:

> "Limited access to many of the streams has not permitted a complete inventory of the resource. Where resource data is lacking in a system, habitat assessment and similarity to other areas has been used as the basis for classification."

This statement effectively qualifies the DFO position on the stream classification system. In many instances the Department of Fisheries and Oceans has relied on limited data and judgement in arriving at the classification of specific streams. DFO has assumed that, if habitat and access appear appropriate, that fish will utilize a particular location. To downgrade the classification assigned to a particular reach, a miner will have to scientifically prove that the assumptions made by DFO in arriving at the initial classification are wrong.

6.3.3 Guideline Requirements for Environmental Standards

The third component of the proposed guidelines consists of a

series of standards that would be attached to a miner's water licence or authorization. These standards are divided into two groups, the first group is comprised of general standards that could apply to all placer mining operations regardless of their stream classification. The second group of standards are site specific. The severity of the site specific standards decrease with the decreasing biological importance of an area. The authors of the 1983 guidelines state:

> "The intent of the guidelines is not to restrict any mining activiy as long as as mining practices and rehabilitation standards are met."

General standards proposed in the 1983 guidelines include provisions for mine site rehabilitation, fuel storage and handling, and the disposal of domestic garbage and sewage. The site specific standards specify the mining methods and effluent quality criteria that must be achieved according to the classification of the stream being mined. Operational standards for mines in high significance areas (Stream Classification "A") specify that the operation will be completely removed from the active stream channel and that a "leave strip" 30 meters wide will be provide between the mine site and the stream. Stream diversions to access pay gravels within the active channel are not permitted and water used for sluicing or hydraulic mining must be completely recycled. Surface discharge of sediment contaminated water is not permitted.

For areas of moderate to high significance (Classification "B") diversion of the stream is not permitted and mine process water returned to the stream must have a suspended sediment concentration of 100 mg/l or less. Leave strips of 15 meters are

required between the stream and the mine site. Mines operating on class "C" streams (moderate significance) are allowed to divert the stream channel either to gain access to underlying gravels or to establish the mine water supply. An effluent water quality standard for suspended sediment of 100 mg/l is specified.

Standards for low significance areas (Stream Classification "D") include the ability to divert stream flows. Suspended sediment concentrations in the mine effluent are set at either 100 mg/l or 1000 mg/l, depending on whether or not the receiving stream enters into a class A, B, or C stream. The "X" classification is an interim ranking that may be upgraded as the stream recovers from past mining activities. Site specific standards are similar to those applied to class "D" waters.

6.3.4 Implementation Schedule

Mining practice and rehabilitation standards are to be phased in over a number of years. The length of time until the standards become fully in force varies with the stream classification. Class "A" areas must meet an effluent standard of 100 mg/l in the first year the standards are implemented. Class "D" and "X" areas have up to four years before the standards are fully enforced.

The proposed guidelines are not considered by the author departments to be fixed, but rather a starting point:

> "The guidelines set conditions of operation in accordance with a rationale that considers renewable resources. While it is anticipated that in the future, issues such as wildlife, vegetation, downstream users, and compatability of present or planned water use in the area will be formally incorporated into the guidelines, at present only the fisheries resource aspects have been developed in detail."

Although the presently proposed guidelines are much more restricting of placer mining practice than the guidelines originally introduced in 1976, which the industry still operates under, the federal departments are stating their intention to possibly make the standards stricter in the future.

6.4 Public Review of the Proposed Guidelines

In March of 1983 the Minister of Indian Affairs and Northern Development announced a public review of the proposed gudelines (Christensen 1983). A four member public review committee was struck with Mrs. Ione Christensen as chairperson. The committee was directed to address the following:

1) the concerns of various interest groups;
2) the difficulties anticipated by the placer mining industry or other interested groups resulting from the implementation of the proposed regulations;
3) recommendations for revisions to the proposed guidelines; and
4) recommendations regarding the implementation schedule.

The Committee conducted public hearings for fifteen days in the fall of 1983. Hearings were conducted in Whitehorse, Dawson City, Mayo, Destruction Bay, and Carmacks. Twenty-seven groups and individuals were registered as official interveners and over 100 presentations were received. The Interdepartmental Committee on Placer Mining represented the Federal Government's interests and acted as the proponents of the proposed guidelines.

The Committee made a number of general recommmendations as to the implentation and administration of any new guidelines. Included in these were:

1) the recommendation that the Yukon Territorial Water Board become the single agency responsible for issuing water authorizations;
2) the recommendation that regulations under the Fisheries Act and the Northern Inland Waters Act be amended to allow placer miners to legally discharge effluent from their sluicing operations to streams;
3) the recommendation that the government undertake a number of initiatives to improve its credibility with the public. The Committee suggested that these initiatives should include a clear policy statement which acknowledges the importance of the placer mining industry to the Yukon's economy and that the placer mining industry and environmental interests should have an ongoing role in the development and implementation of regulations; and
4) the recomendation that regulation of the placer mining industry eventually be incorporated into a resource use planning process for the Yukon.

Four components of the proposed guidelines were considered in detail by the Committee:

1) the development plan;
2) the stream classification system;
3) the rationale for the suspended sediment standards; and
4) the compliance schedule.

The Committee expressed its general support for the concept of the development plan but acknowledged the concern expressed by the mining industry that the wording in the proposed guidelines was vague as to the level of detail required of the plan. To indicate the extent and detail required of the development plan, the Committee recommended:

> "That government in consultation with the industry should develop model development plans which can be used by industry members as a guide to estimate the cost of and prepare their plans."

The principle of a stream classification system that provides for different levels of environmental protection based on an assessement of the resource values and sensitivities assocciated with a specific stream or stream reach was accepted by the Committee. However, the Committee did not agree with the proposed guidelines as to the need for or extent of specific sections of the draft guidelines. Recommendations to allow diversions on all classes of streams as long, as it could be shown that such diversions would not adversely affect fish populations, were included in the Committee's report. As well, the Committee recommended that the provision for leave strips be reduced to only include Class A and B streams and only then when it could be proven by DFO, on a site specific basis, as necessary.

Likely the most significant recommendation made by the Committee with respect to the stream classification system was:

> "Revisions to the stream classification system should be made so that the emphasis of the system is on proven resource values rather than on potential resource values."(Christensen 1983 p. 66).

This recommendation is significant because it implies a shift

from the current DFO Habitat Protection Policy that focuses on maintaining not only the living fish resource but also fish habitat (Pearse 1982). The protection of suitable fish habitat, in some cases, ignores the fact that fish do not utilize all the habitat that appears to be appropriate. For example, there may factors other than the availability of suitable habitat that limit the size of a fish population. If such factors will always prevent the habitat from being utilized by fish, it makes little sense to protect the area. The recommendation to base the stream classification system on existing and/or historical resource use also acknowledges that many assumptions were required, because of the limited fisheries database, in developing the stream classification system.

The Committee, while accepting the reasons for implementing effluent water quality standards based on suspended sediment concentrations, recommended that the proposed standards be revised to be 0 mg/l (no return flow) on class A streams, 100 mg/l on class B streams, and 1000 mg/l on all other streams. It was recommended that streams flowing into class A or B receiving streams meet an effluent standard of 100 mg/l above background levels.

The Committee ignored the compliance schedule outlined in the draft guidelines and recommended a different approach to the phasing in of the new guidelines. A "grandfather" system was proposed by the Committee whereby the vast majority of existing operators would be allowed to continue mining under the current regulatory system for the next twelve years. The only exceptions to this rule would be for miners presently operating on class A

or B streams. DFO could require these individuals to conform to the new guidelines if it could prove the existance of the salmon resource. Existing operators forced to upgrade their effluent treatment systems by DFO order would require financial compensation.

6.5 Present Status of Regulations Governing the Industry

The Christensen Committee's report, Resources, Regulation, and Reality was released to the public in December of 1983. A number of the Committee's recommendations were acted upon by the Federal Government following the release of the report. A transition period, during which the Yukon Terrritorial Water Board will assume increasing control over the regulation of the placer mining industry was initiated, as was the formation of a joint industry and government research committee (Kopvillem 1985). The research committee was to develop and oversee specific studies designed to answer some of the outstanding technical questions with respect to the environmental effect of various mining practices. Also, it was hoped that this joint committee would increase public confidence in the government decision-making process.

With the release of the Christensen Committee"s report, John Munro, Minister of Indian Affairs and Northern Development, announced a three year moratorium on the implementation of a new regulatory regime for the Yukon placer mining industry (Davidson 1985). The moratorium was to allow time for additional scientific data to be collected and analysed by both government and industry

(under the auspices of the joint government/industry research committee). By establishing a database that all parties agreed on, the government hoped that consenus on the form of regulations affecting the industry could be obtained. During the period of the moratorium the industry was to be governed by the original 1976 guidelines.

A voluntary effluent standard, based on a maximum settable solids concentration of 2ml/l in the effluent entering a natural watercourse, was promoted by DIAND, but there was no legal requirement for miners to meet the standard (D. Robinson, DINAD, pers com., August 1985). Basing the standard on the measurement of settable solids was a departure from the criterion based on suspended sediment proposed in the draft 1983 guidelines. However, settable solids are much easier to measure under field conditions than are suspended sediment concentrations.

A number of studies were undertaken under the direction of the research committee including; an investigation of the potential for using flocculants for treating sluice effluent, various projects to assess different methods to increase the rate of fine gold recovery, and a study of the downstream distribution of fine sediments generated by placer mining activies. These studies were to be completed in 1986, to allow time for the drafing of new regulations to govern the placer mining industry, starting with the 1987 mining season.

In September, 1985 the Klondike Placer Miners Association withdrew from the joint research committee (Kopvillem 1985). In a series of letters written to J. Crombie, Minister of Indian Affairs and Northern Development, M. Morison, Director General of

Northern Affairs in Whitehorse, and D. Granger, Chairman of the Yukon Territorial Water Board, the KPMA accused DIAND officials in Whitehorse of imposing more severe regulations, even while the moratorium is in effect (Davidson 1985). The KPMA also complained that the new (Progressive Conservative) government had not issued a clear policy statement with respect to the importance of the placer mining industry to the Yukon's economy and of a government bias towards tourism and environmental interests.

The immediate government response to the KPMA's withdrawl from the research committee was express regret that the mining industry had chosen that course of action and to state that the industry must be willing to suffer the consequences of less input into the development of regulations governing their industry (VanSickle 1985). It seems that little progress has been made towards the implemenation of new regulations to govern the placer mining industry. The mining industry and government are not able to develop regulations that are mutually acceptable. With the withdrawl of the KPMA from the research committee, federal bureaucrats are off developing rules on their own, again.

The recently completed Royal Commission on the Pacific Fisheries addressed the resource use conflict in the Yukon Territory between the placer mining industry and government (Pearse 1982). The Commission concluded:

> "While we recognize the recent progress much, remains to be done. How the placer mining industry is to be regulated within the broader context of land and water management remains to be determined, yet this is critical to the Yukon's entire resource management regime. We emphasize the importance of this problem for water management, and urge the parties invloved to maintain their efforts to resolve it."

7.0 REGULATION UNDER DIFFERENT JURISDICTIONS

This section outlines current regulations governing placer mining and similar industries in juristictions other than the Yukon Territory. This information will be used to determine whether or not the presently proposed guidelines for the regulation of the Yukon placer mining industry are similar to those enforced elsewhere.

Regulations governing the placer mining industry are discussed seperately from regulations governing other industries which pose similar environmental concerns. This discussion addresses two questions. Firstly, are the proposed guidelines more or less restrictive than regulations currently governing placer mining outside of the Yukon Territory? Secondly, is the placer mining industry, in general, regulated in a manner consistent with the regulation of other industries?

7.1 Regulation of Placer Mining Under Different Jurisdictions

The proposed Yukon Placer Mining Guidelines were compared to regulations governing placer mining in other areas of North America to determine whether or not the guidelines put forth in 1983 are more or less severe than regulations affectting placer mining elsewhere. Only North American locations were considered as it was assumed that sociological and political attitudes are similar across the continent. The specific jurisdictions considered in making the comparisons were:

1) the State of Alaska;

2) the State of California; and

3) the Province of British Columbia.

7.1.1 Alaska

Alaska has the largest number of operating placer mines in North America. There were more than 500 active operations in 1985 that are licenced to operate in 1986 (J. Krohn, Alaska State Department of Environmental Conservation; pers comm.). There are an additional 108 new applications being processed for 1986.

Water quality standards are established by the individual state legislatures in the United States, while effluent quality standards for industrial wastes are set by the Environmental Protection Agency (EPA) under the Federal Water Pollution Control Act and the Clean Water Act (Lamoreux 1979). Each placer mining operation is required to have an Authorization to Discharge Under the National Pollution Dischagre Elimination System (NPDES). The NPDES permit specifies standards for both effluent quality and receiving water quality and is issued by EPA. Before the NPDES permit beomes effective it must be certified by the state (EPA 1985).

The effluent water quality standard is currently defined in terms of the maximun allowable instantaneous concentrations of settable solids. Settable solids concentrations are measured by allowing a one litre sample of the effluent water to settle in a standardized cone for a period of one hour (Standard Methods). The volume of sediment that has collected in the bottom of the cone at the end of the one hour period is measured in ml/l. The

current standard is set at 0.2 mg/l (EPA 1986). The receiving water quality standard is defined in terms of the allowable increase in turbidity compared to background (upstream of any placer mining operations). The current receiving water quality standard set by the State of Alaska allows for a maximun increase in turbidity of 5.0 NTU's (EPA 1986). The state's receiving water quality standard is normally only enforced on streams having multiple resouce uses as established by a state tri-agency committee (DEC 1986a). This committee is composed of represenatives from the Department of Environmental Conservation (DEC), the Department of Fish and Game (DF&G), and the Department of Natural Resources (DNR).

The NPDES permit also specifies the frequency of monitoring, reporting proceedures, and maximum fines for violation of the conditions of the permit (Appendix 4.0). The application form for a NPDES permit requires that the miner provide only minimal information concerning his proposed operation (Appendix 5.0). The indiviual mine operators are responsible for monitoring their own discharge and its resulting affect on receiving water quality and failure to comply can result in very substantial fines (EPA 1985). Failure to submit the required year end report results in the automatic cancellation of a mines NPDES permit for the following year (DEC 1986b).

The effluent quality standard of 0.2ml/l settable solids was rationalized in discussions between EPA and the state's tri-agency committee (B. Loisell, EPA, Seattle, pers comm). The agencies involved in the discision-making process believe that the 0.2mg/l criteria is obtainable using the "Best Available

Technology" (BAT) and that by achieving 0.2mg/l the State's water quality standard will also be achieved. The designation of an effluent treatment technology as the BAT is only made after an assessment of the economic and technical feasibility of alternative methods. EPA believes that:

> "Detailed economic evaluations were conducted to determine the BAT treatment technologies which are economically achievable. Based on the evaluations, the level of treatment which can be universally afforded by them placer mining industry to control waste water discharges has been determined to be simply settling ponds. By utilizing simple settling ponds and routine pond maintenance, there should be no apparent serious economic impact to the industry." (EPA 1986).

Reclamation of placer mining workings is required by both Federal and State Legislation. The Federal requirements apply only to lands managed by the Bureau of Land Management (BLM) and require that the site be returned to a stable condition that is readily revegetated (BLM 1986). The regulatory requirements require the site to be graded to contours that match the natural slopes and that topsoils be stockpiled as part of mining activities and then spread across the disturbed portion of the site once mining is complete. State requirements for reclamation, although required by law, have yet to be specified for placer mining (J. Zuke; Alaska Department of Natural Resources; pers com.).

7.1.2 California

Similar to the situation in Alaska, both federal and state water quality standards are applied to the placer mining industry

in California. However, as California State requirements allow no discharges to natural watercourses, all mines must totally recycle their process water (B. Loisell; pers com).

7.1.3 British Columbia

The placer mining industry in British Columbia is controlled by a number of federal and provincial acts. Pieces of legislation applicable to this discussion include the provincial Water Act, the Waste Management Act, and the Mines Act. Information in this section was obtained from A Guide to Legislation and Approvals in Placer Mining (Ministry of Energy Mines and Petroleum Resources 1985).

The Water Act requires that all diversions, impoundments or withdrawls of surface waters in the province be licenced. A placer miner must post a copy of his application at the point of diversion and provide technical information concerning the method, rate and purpose of the proposed works to the Water Management Branch of the Ministry of Environment. The application is referred to other government agencies for comment before a Water Licence is issued. The application may be denied because of potential resource conflicts.

All mines discharging into a natural watercourse must obtain a permit from the Waste Management Branch of the Ministry of Environment. This permit will specify the required quality and maximun allowable rate of discharge for mine effluent.

Provisions under the Mines Act to submit a Notice of Work and Reclamation Program, Placer Operations (Form 6/7P) prior to the

start and finish of mining operations. A bond of up to $2500 per hectacre must be posted by each miner before approval to start mining will be issued. The value of the bond required of any specific operator will depend on a number of factors including; past performance, historical mining activity, and the environmental sensitivity of the area to be mined.

The Province of British Columbia, in conjunction with the Federal Department of Fisheries and Oceans, have developed a colour-coded, stream classification system. The system has three classifications:

1) Red - Streams and lakes that contain spawning grounds or are highly utilized by fish;
2) Yellow - Streams and lakes which contain rearing areas, resident populations, and comprise migratory routes, or discharge into waters which have these values; and
3) Green - Streams and lakes with no or low fish values.

Specific restrictions, depending on the stream classification, are attatched to the Placer Lease issued by the Ministry of Energy, Mines and Petroleum Resources (MEMPR). Restrictions on "Red" streams are most severe, requiring leave strips, no diversion of streams, and that all wash (sluice) water be recycled. A "Yellow" designation requires leave strips adjacent ot the stream, prohibits work within the wetted channel, but allows for the discharge of process water back into the

stream, if it meets the water quality standard required by Level A of the Pollution Control Objectives for the Mining, Mine-Milling and Smelting Industries of British Columbia (MOE 1979). The Pollution Control Objectives specify the allowable concentration of suspended solids, discharged to freshwaters as a range, from 25 mg/l to 75 mg/l. Level A is interpretted by the Waste Management Branch as referring to the low side of the range. Miners working on "Yellow" streams may remove gravels from below the high water mark if the work is completed and the area is stabilized before inundation.

"Green" classified streams are offered the least protection. There are no requirements for leave strips and gravels can be removed from the wetted stream channel. Currently, effluents must meet the Level A standards described above. Most streams with a "Green" classification are located around Atlin, B.C., and have a long history of placer mining activity (B. Gordon; M.E.M.P.R., Prince George, pers com.). In March, 1986, Tony Brummet, The Minister of Energy Mines and Petroleum Resources, announced changes to the waste water standards applicable to certain watersheds in the Atlin area. Water quality standards are to be relaxed:

> ... where placer mining activity has been going on for a long time and where fish values are deemed to be non-existant." (Vancouver Sun 1986).

In British Columbia, Placer Mining Coordinating Committee's (PMCC's) have been formed to act as "one window" to the placer mining industry. A placer miner only has to deal with the PMCC for his region and not all the individual government departments involved in the approval process. MEMPR takes the lead role on

the committee. Other member departments include; Ministry of Environment, Ministry of Forests, Ministry of Lands, Parks, and Housing, and the Federal Department of Fisheries and Oceans (only when salmon utilize the stream in question). The PMCC's are felt to be very useful and effective as decisions and the subsequent permitting occur at the regional level and site specific problems are more easily addressed (B. Gordon; pers com.). MEMPR's position as chair for the PMCC's allow the government department most familar with the operational constrainsts affecting the placer mining industry to act as unofficial arbitrators between the industry and other government departments.

7.1.4 Comparison With the Proposed Yukon Placer Mining Guidelines

The guidelines proposed in 1983 to govern the Yukon placer mining industry are in many ways similar to the regulations governing placer mining in British Columbia. Both utilize stream classification system that affords different levels of protection to specific streams based on their specific resource values, sensitivities and past history of mining activity. The stream classification system proposed for the Yukon Territory has more subdivisions than that currently used in British Columbia. This may make the proposed Yukon system more difficult to administer as there are more possible choices. However, if the administrative difficluties can be overcome it should provide a more efficient management tool, as a specific stream can be classified into a narrower category. The Alaskan's have a much

simpler stream classification system. Either a stream is judged to support multiple resourse use or it does not support multiple resource use. Existing water quality standards are only routinely enforced on those streams determined to support multiple resource uses, these streams are assigned a priority status (DEC 1986). The stream classification system used in Alaska is, administratively, the simplest of the three. Given the American legal system which makes it relatively easy for a member of the public to challenge government regulations in court, an uncomplicated classification system is likely much easier to defend as all the State has to prove is that there are alternate resource uses for the particular stream.

The British Columbian, the Alaskan, and the proposed Yukon regulations all specify requirements for reclamation of the mine sites. Again the situation in British Coumbia is similar to that proposed for the Yukon Territory. The miner is required to outline reclamation proceedures in the mining plan that is approved by the government before work on the site is allowed to start. Although reclamation is required in Alaska by both Federal and State law, the requirement is not enforced (J. Zuke; Alaska Department of Natural Resourses, per comm). In 1985 the Seirra Club took the Federal Bureau of Land Management to court in an attempt to force the enforcement of regulations requiring reclamation of placer mining sites. As the court action threatened to prevent placer mining on Federal lands during the 1986 mining season, the Governor of Alaska intervened with the result that the Sierra Club and the Bureau of Land Management are presently attempting to reach an out of court settlement (K.

Woolworth; Bureau of Land Management, Anchorage, Alaska; pers com).

In all three jurisdictions examined, regulations requiring the reclamation of placer mining sites exist. The fundamental difference between the situation in British Columbia and Alaska relates to the enforcement of existing regulations. While acknowledging that the extent of reclamation required should vary with site specific factors, the British Columbian regulations require that every miner post a bond to ensure that reclamation work is undertaken at the end of mining operations. The Alaskan requirements are currently not being enforced because the number of active placer mining operations far exceed the resources available to State and Federal enforcement agencies and because bonding is not required and thus, there is little financial incentive for placer miners to perform the required site reclamation before abandonning the location.

Although the proposed Yukon Placer Mining Guidelines include the requirement that a bond or other form of financial security be posted by miners before the start operating at a specific site, details as to the value of the bond are not provided. The British Columbian method of matching the extent of bonding requied on a per hectacre basis to the past performance of the applicant, the mining history of the site, and the biological sensitivity and value of the surrounding and downstream environment is a logical and likely enforcable approach.

Regulatory requirements for mine site reclamation exist for most provinial jurisdictions in Canada (Marshall 1983). The specific nature of the regulations vary from province to province

but the basic principles are apparent in all. Mine sites and quarries must be left in a stable condition so that the threat of on-going environmental degradation is minimized.

7.2 Regulation of Water Quality: A Cross-Industry Comparison

The general approach to protecting water quality varies from jurisdiction to jurisdiction. Basically, two different types of standards are imposed on industry: the first type of standard seeks to regulate effluent quality (MOE 1979, Franson et al 1982); the second type of standard attempts to regulate the ultimate quality of the receiving waters (DEC 1979). Standards based on receiving water quality implicitly realize that different streams have different capacities to absorb pollutants.

The effluent quality standards proposed as part of the Yukon Placer Mining Guidelines are less severe for streams of moderate or low biological significance than standards enforced on other industries. For example, British Columbian regulations governing the hardrock mining industry set the allowable concentration of suspended sediment in mine effluent at between 25 mg/l and 75 mg/l (MOE 1979). Discharges from pulpmills in British Columbia are limited to suspended sediment concentrations of 30 mg/l (Franson et al 1982).

The requirements for mine site reclamation set out in the proposed guidelines are consistent with those applied to the hardrock mining industry in British Columbia and the Yukon and Northwest Territories (Marshall 1983, DINA 1982).

Although the proposed guidelines are consistent with regulations governing other major industries in Canada, the nature of the placer mining industry is sufficiently different to question the appropriateness and enforcability of the guidelines, as presently proposed. The placer mining industry is composed of many small operators scattered throughout large areas of the Yukon Territory, while most effluent quality standards are intended to control large, point source discharges.

The incremental effect of many small mines on water quality may be significant but the cost of enforcement may make consistent application of the standards over the mining season impossible. The costs associated with the collection and analysis of water samples will be high and the results obtained may not be representative of average or worst case conditions (Envirocon Ltd. 1986, Oguss and Erlebach 1976).

8.0 ECONOMIC EVALUATION OF THE PROPOSED YUKON PLACER MINING GUIDELINES

A number of economic assessments of the proposed placer guidelines were prepared prior to the public review in 1983. These studies came to such remarkably different conclusions that the Christensen Committee commissioned one further study in an attempt to rationalize some of the differences (DPA Consultants Ltd. 1983). The first part of this section will highlight the results and conclusions reached by the various studies and will comment on some of the assumptions and methods used by the different authors in arriving at their conclusions.

Major assumptions made by the authors of the earlier economic assessments were that the current (1980-81) trend in the price of gold would continue and the placer mining industry would continue to grow as a function of the price of gold. These assumptions have proven to be wrong. Also, in 1982, there was little direct data relating the price of gold to factors such as the number of operations or the number of people directly employed by the placer mining industry. These data are now available for the years 1978 through to 1985.

The second part of this section will use the most current data to estimate the effect of the proposed Yukon Placer Mining Guidelines on the level of mining activity, on the number of people directly employed in mining, and on the level of placer gold production.

8.1 A Review of Previous Studies

Four studies have attempted to assess the benefits and costs that would occur as a result of implementing the proposed placer mining guidelines. Two of these studies were undertaken by federal government departments, one by the Klondike Placer Mining Asssociation, and one by the Yukon Conservation Society. This paper reviews the following reports:

1) Socioeconomic Impact Analysis for the Yukon Placer Mining Guidelines, prepared by DOE (1983);
2) Benefit-Cost Analysis of the Proposed Yukon Placer Guidelines, prepared by Marvin Shaffer and Associates (1983), for DFO; and
3) An Assessment of the Proposed Yukon Placer Mining Guidelines, prepared by IEC Beak Limited (1983), for the Klondike Placer Miners Association.

The fourth economic evaluation, Discussion of Benefit Cost Analysis of Yukon Placer Mining Guidelines, prepared by R. K. House and Associates for the Yukon Conservation Society could not be obtained and therefore was not reviewed. However, the summary of the methods, assumptions and findings of all four studies, prepared for the Christensen Committee, was reviewed.

The DOE and KPMA studies examine the effect of the proposed guidelines on employment and wealth generation. The DOE study is broadest in scope, considering both the costs to the placer mining industry and the benefits to the fish resource resulting from implementation of the guidelines. The study commissioned by the KPMA focuses on the economic and social costs to the

placer mining industry. The remaining two studies consider only the pure economic effects of the proposed guidelines. All four studies use benefit-cost analysis as an indicator of the value of the proposed guidelines to society.

Although the socioeconomic impact assessment prepared by DOE calculates benefit-cost ratios under a number of different assumptions, DFO chose to prepare their own analysis due to, what were considered to be, errors in the methodology used by DOE. The errors relate to the way in which the authors of the DOE assessment calculated benefit and cost values:

> "What must be emphasized here is that economic benefits and economic costs have very specific meanings in benefit-cost analysis. They refer to the increase or decrease in the net value of the output of an industry. ... However it (the DOE analysis) focused primarily on the gross values of the increase in fisheries activities and the gross value of the decrease in placer mining production" (Marvin Shaffer and Associates 1983).

All four studies used a similar approach to calculating the benefits and costs resulting from the implementation of the proposed Yukon Placer Mining Guidelines. The benefits of implementing the proposed regulations are compared to the costs imposed on society as a result of the regulations. As a result a benefit/cost ratio is calculated to indicate, in economic terms, the value of the proposed regulations to Canadian society. Only benefits accruing to the fish resource and its subsequent exploitation are quantified in the assessments. Costs are determined by adding a predicted decrease in the value of gold production and the sum of the incremental increase in operating costs faced by the industry.

The DOE study provides most of the data used by the other authors (DPA Consulting Limited 1983). DOE and Shaffer both state that other, unquantified, benefits would be expected to occur as a result of the guidelines, including increases in wildlife and aesthetic values and improvements in water quality.

The following sections will summarize the conclusions reached by the different studies and will highlight some of the differences in assumptions and methods used. Four major components will be emphasized: benefits to the fish resource, costs to the placer mining industry, the benefit-cost analyses and the effect of the guidelines on employment.

8.1.1 The Fish Resource

Benefits to the fish resource resulting from implementation of the proposed guidelines result from two sources (DOE 1983). Firstly, active mines would be forced to alter or eliminate practices that adversely affect fish habitat, leading to increased fish production in streams presently degraded by placer mining. Secondly, the restricting of placer mining activity in new areas would prevent future, negative impacts by providing increased protection to the fish resource.

Benefits Due to Habitat Rehabilitation

Benefits resulting from improvements to the fish resource are allotted to four components of the fishery:

1) the commercial fishery;

2) the domestic fishery;

3) the native food fishery; and

4) the sports fishery.

The four fisheries were divided into freshwater and anadromous components and annual economic values for each component of each fishery were calculated (Table 8.1). In addition to the calculated value of production of the fisheries to the Canadian economy, the studies included, as a benefit, a credit for salmon that were spawned in Canada but captured by Alaskan fishermen. The inclusion of this credit was based on the assumption that, as part of the ongoing Canadian/ American fishery negotiations, an agreement on the division of salmon in the Yukon River would be reached. To the present date, no such agreement has been obtained and Canada does not receive any credit for Yukon River salmon taken by the Alaskan commercial fishery (K. Petri; Troll Biologist, DFO; pers com).

Shaffer decreased the wholesale price received by fish processors by thirty-five percent to account for capture and processing costs. The thirty-five percent reduction to calculate net benefits was rationalized as it is the same value used by DFO for estimating the benefits of the Salmon Enhancement Program (Shaffer 1983). In addition Shaffer used a value of twenty dollars per angler day, instead of the DOE value of fifteen dollars per day, in calculating the economic benefit attributable to the sport fisheries.

All studies calculated the present worth of the incremental increase in value of the four fisheries, resulting from implementation of the proposed guidelines at discount rates of

TABLE 8.1
ANNUAL VALUE OF THE FISH RESOURCE[1]

	Status Quo	Optimistic
Commercial Fishery	400,160	800,320
Domestic Fishery	180,190	360,000
Native Fishery	687,070	1,374,140
Sports Fishery	5,269,755	3,960,000
Alaskan Credit	1,000,000	2,000,000
Total	approx. 7,500,000	approx. 9,000,000

1) from DOE (1983)

five, ten and fifteen percent (Table 8.2). Various sensitivity tests were performed by the different authors to test the effect of changing their assumptions on the present value calucations. Two fish production scenarios were used by DOE, the first, assumed the level of production remained similar to that reported for 1982 and is referred to as the "Status Quo" Scenario. The second scenario, referred to as the "Optimistic Scenario" assumed increased fish production, compared to 1982 levels. Shaffer and the KPMA developed three scenarios for evaluating the effect of the proposed guidelines on the fish resource. All three scenarios were based on the assumption that the amount of mining activity was positively related to the price of gold and higher gold prices would result in more damage to fish habitat and therefore, decreased fish production.

Benefits to the fish resource were assumed by DOE and Shaffer to commence immediately upon the implementation of the proposed guidelines. The real value of the fish resource was assumed to increase at an annual rate of one percent. The KPMA assumed that benefits resulting from increased fish production would not be realized until four years after the implementaion of the proposed guidelines because, on average, there is a four year lag between fish spawning and the return of mature adults which are the target of the fisheries.

Habitat Protection Benefits

Implementation of the proposed guidelines is argued for in order to prevent future habitat degradation as a result of placer

TABLE 8.2
PRESENT WORTH OF THE INCREMENTAL INCREASE IN THE VALUE OF THE YUKON FISHERIES ($ millions 1983 Cdn.)

		DOE[1]	Shaffer[2]		KPMA[3]		
	Status Quo	Optimistic	Low	High	Low	Med	High
Discount Rate							
@5%	5.2	10.3	14.2	17.5	3.1	3.1	3.26
@10%	2.4	4.3	6.6	8.1	2.3	2.3	2.5
@15%	1.6	2	4.4	5.9	1.8	1.8	1.9

1) from DOE (1983) based on gross values of the fisheries but does not include credit for Alaskan catch. Benefits assumed to accrue indefinitely into the future. Inludes only habitat rehabilitation benefits

2) from Shaffer (1983) based on net value of fisheries but allowing a 31.5% credit for Alaskan caught salmon. Benefits assumed to accrue indefinitely into the future. Includes both habitat rehabilitation and habitat protection benefits.

3) from IEC Beak Limited (1983) based on net value of fisheries, including a 31.5% credit for Alaskan caught fish. Realization of benefits assumed to start four years after implementation of guidelines and continuing for thirteen additional years. Includes both habitat rehabilitation and habitat protection benefits.

miners moving into areas not previously mined (DOE 1983). The extent and timing of habitat protection benefits would occur as a function of the rate of growth in the placer mining industry with high gold prices implying a faster rate of growth.

Based on two different scenarios for the price of gold and, hence the level of activity in the placer mining industry, DOE estimated the annual habitat protection benefit to equal between two and one half percent and five percent of the total value of the fish resource. Shaffer used the same percentages, but applied them to his calculated net values (Table 8.3).

DOE and Shaffer assumed that habitat protection benefits would commence immediately upon implementation of the proposed guidelines. The KPMA argued that benefits resulting from habitat protection would not begin until the industry had expanded into new areas and assumed that these benefits would not occur until ten years after implementation of the proposed guidelines. Further, the KPMA assumed that any benefit resulting from habitat protection would not be realized until four years after it occurred because of the life history of the fish.

8.1.2 Costs to the Placer Mining Industry

Costs to the placer mining industry are argued to result from two separate effects. Firstly, some present operations might not be able to meet the standards set out in the guidelines because of site specific constraints. These operations are assumed to cease operation with an accompanying reduction in gold production. Secondly, those operators left in business would be

TABLE 8.3
PRESENT WORTH OF THE INCREMENTAL INCREASE IN THE VALUE OF THE YUKON FISHERIES RESULTING FROM HABITAT PROTECTION BENEFITS ($ millions 1983 Cdn.)

		DOE[1]	Shaffer[2]		KPMA[3]		
	Status Quo	Optimistic	Low	High	Low	Med	High
Discount Rate							
@5%	3.3	6.5	-	-	-	-	-
@10%	1.5	2.5	-	-	-	-	-
@15%	1.0	1.6	-	-	-	-	-

1) from DOE (1983) based on gross values of the fisheries but does not include credit for Alaskan catch. Benefits assumed to accrue indefinitely into the future

2) included in values reported in Table 8.2

3) included in values reported in Table 8.2

faced with higher costs of production, as a result of increased expenditures to treat their effluent.

Reduction in the Number of Operators

The study undertaken for the KPMA predicted that at least fourty-four percent of current placer mining operations would be forced to cease operations if the guidelines were implemented as proposed. This conclusion was based on the assumption that all operators on streams with either "A" or "B" classifications would be forced to quit. DOE estimated that approximately sixteen percent of current operators would not be able to continue at their present site and thus would be forced out of business. The estimated sixteen percent reduction put forth by DOE was based on the results of a "risk model" The risk model assessed the likelihood of a specific operation continuing based on consideration of the following variables:

1) size of operation (assumed to reflect the resources available to the operator);
2) years of experience (an experienced operator is to be more capable of adjusting to new rules);
3) valley width (narrow valleys restrict the operators flexibility with respect to modifying his mining practices); and
4) stream classification (miners working on "A", "B" or "C" streams have to meet more stringent requirements than those on "D" or "X" streams).

The number of mining operations that would be affected by the

proposed guidelines was assumed by all authors to be a function of the price of gold. Lower gold prices would reduce the number of operators, with the greatest reduction occurring amongst operators working new, unproven ground.

A model was developed by DOE (1983), based on a linear regression of the price of gold against gold production. This model was used by DOE and Shaffer to predict the reduction in the present value of annual income resulting from some operators being forced out of business (Table 8.4). The KPMA used the same model but with their higher estimate of the number of operators that would be forced out of business, to calculate the reduction in industry income. R. K. House and Associates used the DOE model as well as two alternatives in evaluating the effect of a reduction in the number of miners on the generation of income(DPA Consulting Ltd. 1983). R. K. House made an attempt to separate the income accruing to Canada from the total income. Present values for the reduction in industry income were calculated at five, ten and fifteen percent discount rates.

Costs to Operators Remaining in Business

Operators remaining in business after the implementation of the proposed guidelines would be faced with higher operating costs. These higher costs would reduce the incomes of the miners. DOE calculated the increased cost to miners based on the effluent standard individual operations would be required to meet, on the need to have diversions designed by professional engineers, and on the cost of meeting the rehabilation standards. Shaffer and

TABLE 8.4
PRESENT WORTH OF THE INCREMENTAL DECREASE IN THE VALUE OF PLACER GOLD PRODUCTION RESULTING FROM MINERS BEING FORCED OUT OF BUSINESS ($ millions 1983 Cdn.)

		DOE[1]	Shaffer[2]			KPMA[3]		
	Status Quo	Opt.	Low	Med	High	Low	Med	High
Discount Rate								
@5%	19.7	118.4	3.7	6.1	22.6	10.3	16.9	62.0
@10%	15.6	93.8	2.8	4.7	17.1	7.8	12.8	46.9
@15%	12.8	77.0	2.2	3.6	13.5	6.1	10.0	36.8

1) from DOE (1983) based on costs starting immediately and continuing for thirteen years.

2) from Shaffer (1983) based on costs starting immediately and continuing for thirteen years.

3) from IEC Beak (1983) based on costs starting immediately and continuing for thirteen years.

R. K. House used the DOE estimates for increased costs to the industry (DPA Consulting Ltd. 1983). The KPMA argued that the cost estimates used by DOE were low and did not quantify all significant factors. All authors calculated the effect of these increased operating costs on industry income and used the calculated decrease in income as the cost to the remaining mining industry of inplementing the propsed guidelines. Similar to the method used in calculating the fish resource benefit, Shaffer reduced gross incomes to net income by allowing for the cost of production. In the case of placer mining, it was assumed that operating costs equal eighty percent of gross revenues and that increases in costs due to guideline requirements would be added to existing operating costs.

The present value of the incrementral increase in operating costs to existing miners for three different gold price scenarios were calculated at discount rates of five, ten and fifteen percent (Table 8.5).

8.1.3 Benefit-Cost Ratios

Using the quantified benefits accruing to the fish resource and the quantified costs to the placer mining industry, all authors calculated benefit-cost ratios (Table 8.6). Although the calculations were based on a number of different assumptions, all but one of the values were less than one. Therefore, based on economic considerations, implementation of the guidelines, as proposed in 1983, would be inappropriate as society suffers a loss that is greater than the offsetting benefits. Certainly,

TABLE 8.5
PRESENT WORTH OF THE INCREMENTAL INCREASE IN COSTS FACED BY MINERS REMAINING IN BUSINESS ($ millions 1983 Cdn.)

		DOE[1]		Shaffer[2]			KPMA[3]		
	Status Quo	Opt.	Low	Med	High	Low	Med	High
Discount Rate								
@5%	20.6	39.8	11.3	15.0	31.1	19.2	26.0	56.2
@10%	14.9	30.4	8.5	11.3	23.5	14.5	19.6	42.5
@15%	12.5	25.0	6.7	8.9	18.4	11.4	15.4	33.4

1) from DOE (1983) based on costs starting immediately and continuing for thirteen years.

2) from Shaffer (1983) based on costs starting immediately and continuing for thirteen years.

3) from IEC Beak (1983) based on costs starting immediately and continuing for thirteen years.

TABLE 8.6
BENEFIT-COST RATIOS

	DOE[1]		Shaffer[2]			KPMA[3]		
Discount Rate	Status Quo	Opt.	Low	Med	High	Low	Med	High
@5%	.21	.12	.95	---	.32	.1	.07	.03
@10%	.13	.05	.58	---	.20	.1	.07	.03
@15%	.10	.035	.37	---	.17	.16	.12	.03

1) from DOE (1983) based on costs starting immediately and continuing for thirteen years.

2) from Shaffer (1983) based on costs starting immediately and continuing for thirteen years.

3) from IEC Beak (1983) based on costs starting immediately and continuing for thirteen years.

there are other, unquantified costs and benefits that may be judged important enough to ignore the purely economic analysis. However, based on the information in the economic assessments, the proposed guidelines should be revised if not scrapped altogether.

8.1.4 Employment

Employment in the fishing sector is argued to increase as a result of the increased number of fish available for capture (DOE 1983). The increase in employment in the fishing industry was based on the number of licences issued for the 1981-1982 fishing season and, in the case of the domestic, native, and commercial fisheries the number of fishermen is adjusted upwards to include family members who fish but are not licenced. Fishing in the Yukon Territory is a seasonal occupation, with the majority of the activity occuring over the two to three months that the salmon are migrating upstream to spawn (DOE 1983). DOE estimates an increase in the number of people involved in fishing but makes no attempt to translate this number into years of employment (Table 8.7). A decrease of employment in the placer mining industry is calculated by both DOE and the KPMA. Both estimates are based on the respective decreases in the number of operating mines. For an unspecified reason, DOE does not include the mine owner/operator as being employed by the enterprise while at the same time they consider a fisherman that operates his own boat as employed.

These figures, when adjusted to reflect annual employment,

TABLE 8.7
EFFECTS ON EMPLOYMENT OF IMPLEMENTING THE PROPOSED GUIDELINES

	DOE[1]		KPMA[2]
	Status	Optimistic	
Fisheries	11-16	15-20	n.a.
Placer Mining			
direct employment	(20-24)	(48-56)	(131-254)
indirect employment	(10-12)	(24-28)	(508-659)
TOTAL	(19-20)	(57-64)	n.a.

1) from DOE (1983). Employment figures for fisheries adjusted to employment years by assuming the average job in the industry lasts for three months.

2) fom IEC Beak (1983)

indicate that jobs will be lost if the guidelines are implemented as currently proposed (Table 8.7). This estimate of the number of person-years of employment that will be lost is conservative as it does not include owners who work directly on the mine site.

8.2 Additional Economic Analysis

Since the original economic assessments were completed in 1983, the price of gold has fallen to reach what appears to be a steady value of between $330 and $350 US per ounce. As the earlier studies used only data from the period from 1972 to 1981, the inclusion of the now available data up to 1985 results in a longer database and hence may provide a more accurate model. Also, the database used by the previous studies was significantly affected by the rapid escalation in the price of gold that occurred in 1979 and 1980 (Appendix 6.0).

A mathematical model, relating the price of gold to the level of mining activity is developed here using linear regression techniques. This model is constructed in the same manner as used by the previous studies.

Since 1978, the Department of Northern Affairs, in Whitehorse, has also kept a record of the number of active mining operations and the number of people directly employed in the industry. This new data allows the development of additional models that relate not only gold production to the price of gold but also the number of operators and number of employees to the price of gold. Use of these models allows some of the employment and social effects of implementing the proposed regulations to be

assessed.

8.2.1 Assumptions

The fundamental assumptions required to use the models put forth in this section include:

1) Placer miners are profit seekers and will operate if they can make a profit over and above normal returns to capital, labour and land and with an allowance for risk;
2) Placer miners are more or less free to enter or leave the industry;
3) The existing data accurately reflects the response of the placer mining industry to changes in the price of gold;
4) Placer miners will react the same way to increased costs as they will to decreased revenues. That is, profit, defined as the difference between revenues and costs, are what determines the actions that placer miners will take; and
5) The price of gold will remain relatively stable.

These assumptions allow the use of regression equations to model the relationships between the price of gold as the independant variable, and the level of gold production, number of operations and number of employees as dependant variables

8.2.2 The Models

A number of possible relationships between the price of gold and the level of production were tested (Appendix 6). The most significant relationship (r^2=0.94) was obtained by regressing the level of production, in ounces, against the price of gold in the previous year. This is reasonable as it takes some time for a placer miner to mobilize the equipment, labour, and supplies required for a mining season and an operator cannot be expected to respond instantly to changes in the price of gold. The relationship is given by the equation:

$$y = 131x - 1160 \qquad (1)$$

where:

x is the average price of gold in the previous year;

y is the amount of gold produced.

Similarily equations relating the price of gold to the number of operators and the number of employees were derived (Appendix 6). The most significant relationship between the price of gold and the number of operations (r^2=0.85) was found to be:

$$y = .25x + 70 \qquad (2)$$

where:

x is the average price of gold in the previous year;

y is the number of operating placer mines.

The most significant relationship between the price of gold and the number of employees in the placer mining industry (r^2=0.88) was found to be:

$$y = .99x + 200 \qquad (3)$$

where:

x is the average price of gold in the current year:

y is the number of people employed placer mining.

8.2.3 The Effect of Increased Costs on the Placer Mining Industry

The incremental costs associated with the implementation of the proposed placer mining guidelines were estimated based on existing data (Appendix 7). These incremental costs are expressed in terms of ounzes of gold produced (Table 8.8).

Implementation of the guidelines is predicted to result in a decrease of between 22 and 47 placer mining operations with an accompanying reduction in direct employment of between 78 and 185 jobs (Table 8.9). Assuming a four month mining season, annual employment will be reduced between 26 and 62 person-years. Using the employment multiplier, put forth by DOE, of 1.5, between 13 and 31 indirect person-years of employment would be lost as a result of implementin the proposed guidelines. Thus, between 39 and 93 years of employment will be lost as a result of the reduction of mining activity to gain 11 to 20 years of employment in the fishery related jobs.

The decrease in the annual production of placer gold is predicted to be between 11,397 oz. and 24,497 oz. The value of the predicted loss in production ranges between $5.6 million (Can.) and $12.1 million (Can.). Increased annual costs faced by miners remaining in business would range between $800,000 and $2.4 million.

TABLE 8.8
RANGE OF ESTIMATED COSTS ASSOCIATED WITH IMPLEMENTATION OF THE PLACER MINING GUIDELINES[1]
($/ounze of gold produced)

Production per Operation	Incremental Cost per Operation	
	36,400/operation	51,600/operation
276 oz./operation	132	187
416 oz./operation	87	124

1) see Appendix 7.0 for details

TABLE 8.9
PREDICTED PRODUCTION, NUMBER OF OPERATIONS AND EMPLOYMENT LEVELS BASED ON THE INCREMENTAL COST OF PRODUCTION RESULTING FROM IMPLEMENTATION OF THE PLACER MINING GUIDELINES[1]

Increase in the Cost of Production	Number of Operators	Number of Employees	Production (oz.)	Value of Production ($ million)
$0/oz.	194	691	63,816	31.6
$87/oz.	172	613	52,419	26.0
$124/oz.	163	568	47,572	23.6
$132/oz.	161	560	46,524	23.1
$187/oz.	147	506	39,319	19.5

1) value of gold assumed to be $496 per ounze

The total annual cost to the mining industry would be between $6.4 million and $14.5million. Discounting these annual costs over a thirteen year period at discount rates of five, ten and fifteen percent leads to a range of present values of between $35.7 million and $136.1 million (Table 8.10). These present values are most strongly influenced by the cost of lost gold production and are considerably higher than the values obtained by previous studies.

As the regression line used in this analysis is flatter than that used by DOE and Shaffer in their analyses, the difference in the calculated present values of the guidelines result from the higher cost estimate for meeting the proposed environmental standards.

Several of the assumptions used by DOE and Shaffer in calculating the benefits of the proposed guidelines to the fish resource likely lead to an overestimate of the value of the benefits. These are:

1) the assumption that all fish production is lost from streams that are affected directly by placer mining. Milligr (1985) reports significant chinook salmon escapements into the Stewart and Klondike rivers, both of which have extensive histories of placer mining activiy;
2) the assumption that the value of fish taken by the native and domestic fisheries is most appropriately determined by wholesale or retail prices. A more appropriate price would be that paid commercial fishermen on the Yukon River. This price is

TABLE 8.10
PRESENT VALUE OF INCREASED OF COSTS TO THE PLACER MINING INDUSTRY RESULTING FROM IMPLEMENTATION OF THE PROPOSED PLACER MINING GUIDELINES[1]

	Annual Cost to the Placer Mining Industry[2] ($million Can.)			
Discount Rate	6.4 - 8.0	8.8 - 10.4	9.3 - 10.9	12.9 - 14.5
@5%	60.0 - 75.0	83.0 - 98.0	87.0 - 102.0	121.0 - 136.1
@10%	45.4 - 57.0	62.5 - 73.8	66.0 - 77.4	91.6 - 103.0
@15%	35.7 - 44.6	49.1 - 58.0	51.9 - 60.8	72.0 - 80.9

1) Discount Period = thirteen years.

2) Annual cost to the placer mining industry equal to the lost production (Table 8.9) plus the increase in costs faced by miners remaining in business (range of $800,000 to $2.4 million).

approximately one half the wholesale price used by Shaffer and a quarter of the retail price used by DOE; and

3) the assumption that benefits to the fish resource occur indefinitely into the future, while the costs to the placer mining industry are only discounted for thirteen years. This difference in discounting period leads to higher present values, especially at low discount rates.

If the fishery benefits were decreased as a result of re-evaluating the assumptions discussed above, the resulting benetit-cost ratios would be reduced further.

8.3 Current Trends in the Placer Mining Industry

Much of the previous analysis of the Yukon placer mining industry was based on the assumption that the price of gold would continue to increase and, subsequently so would the level of activity in the industry (DOE 1983). The dip in gold prices observed in 1981, the last year of data avaialable to the previous studis was assumed to be temporay (Appendix 6). However, the price of gold has continued to decline and over the last two years and appears to be settling in at around $350 US to $400 US.

Gold production dropped in 1981 but has since recovered to pre-recession levels (Figure 8.1). The value of gold produced has decreased as a result of the lower unit price (Figure 8.2). The most interesting trend over the last eight years has been the increase in production per mine (Figure 8.3). It appears,

FIGURE 8.1

Trend in Gold Production

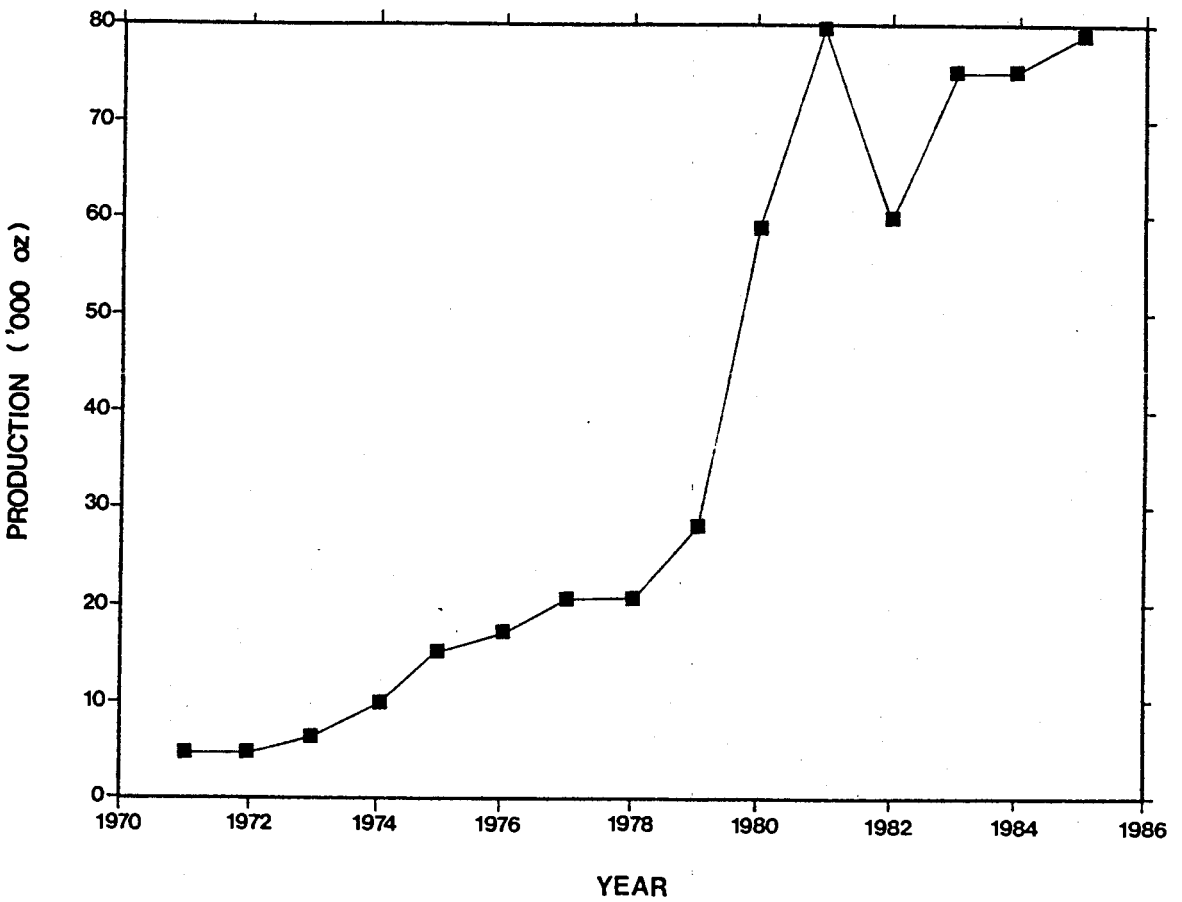


FIGURE 8.2

Trend in Gold Value

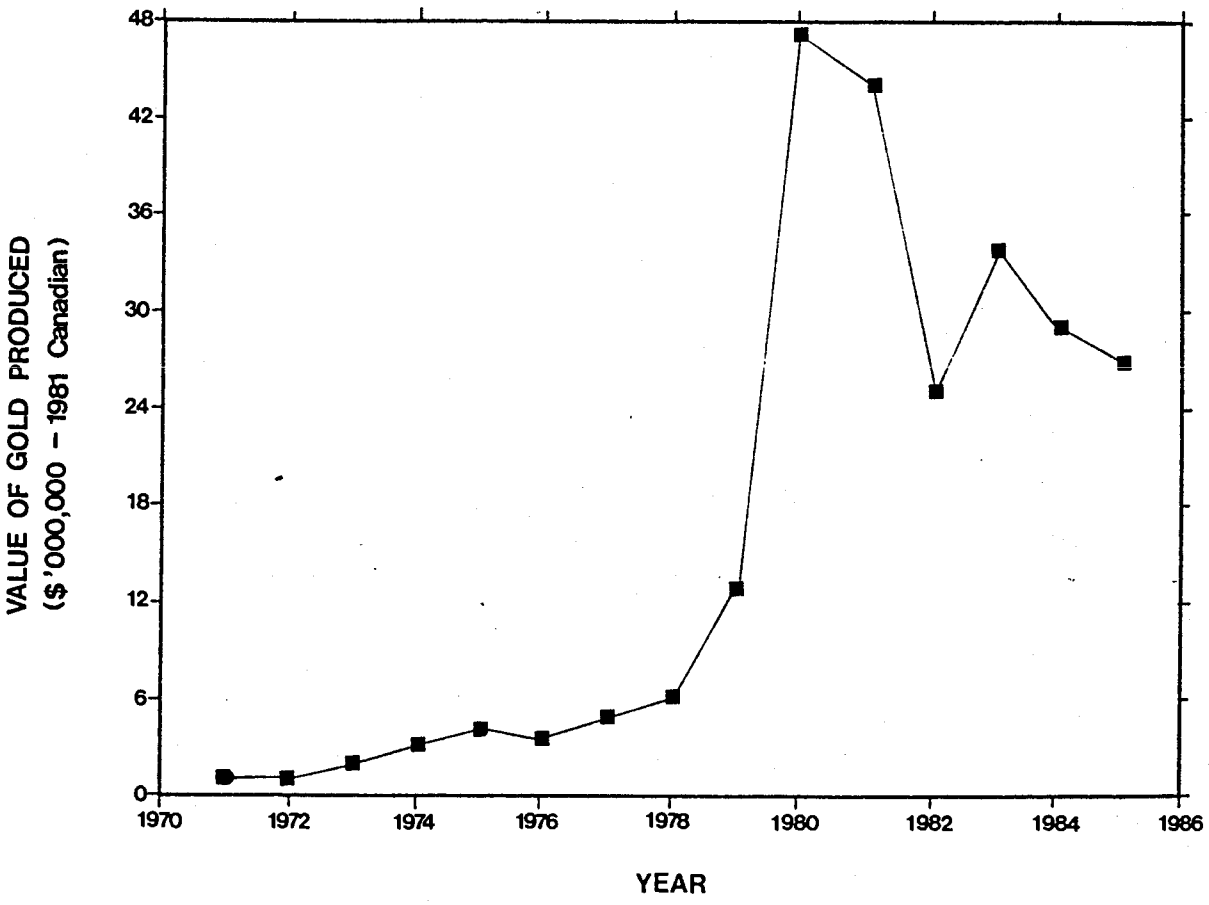
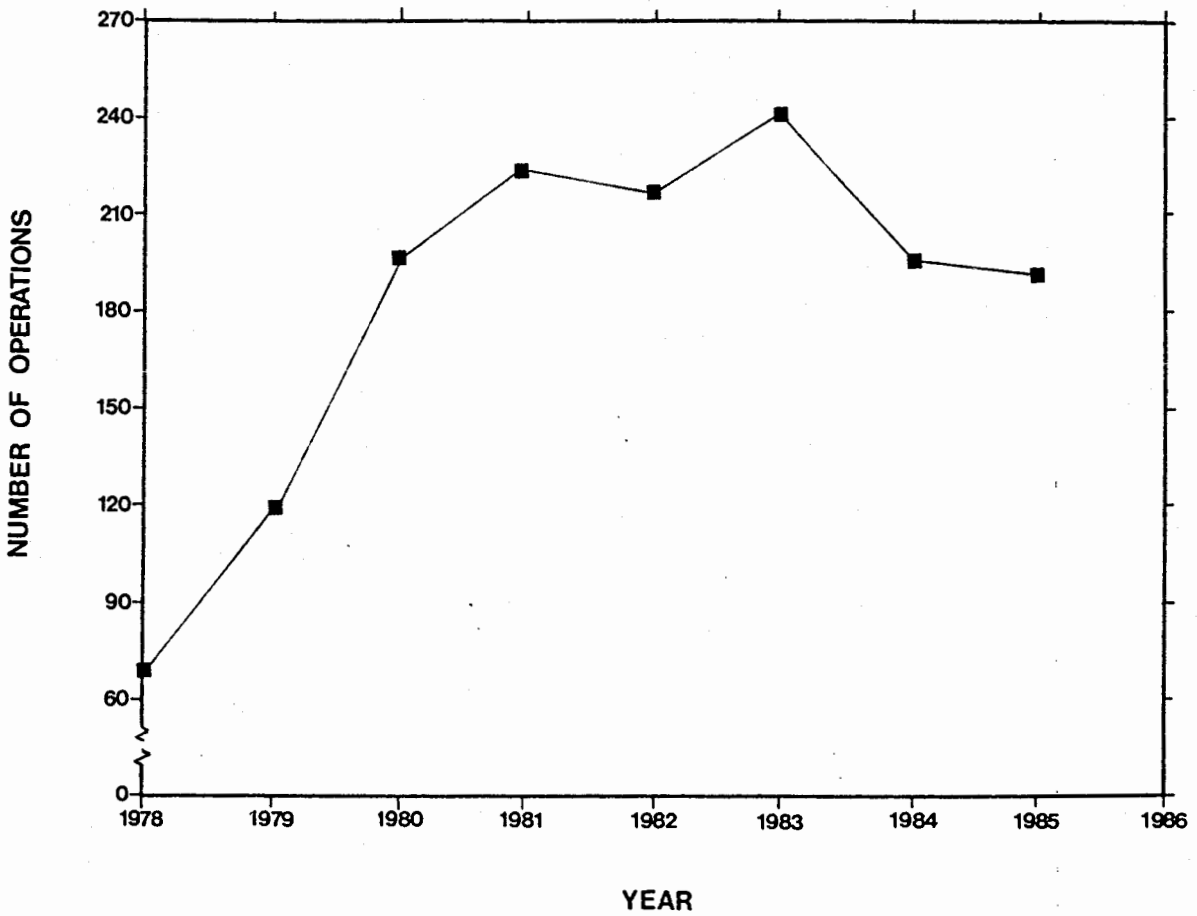


FIGURE 8.3

Trend in Number of Operations

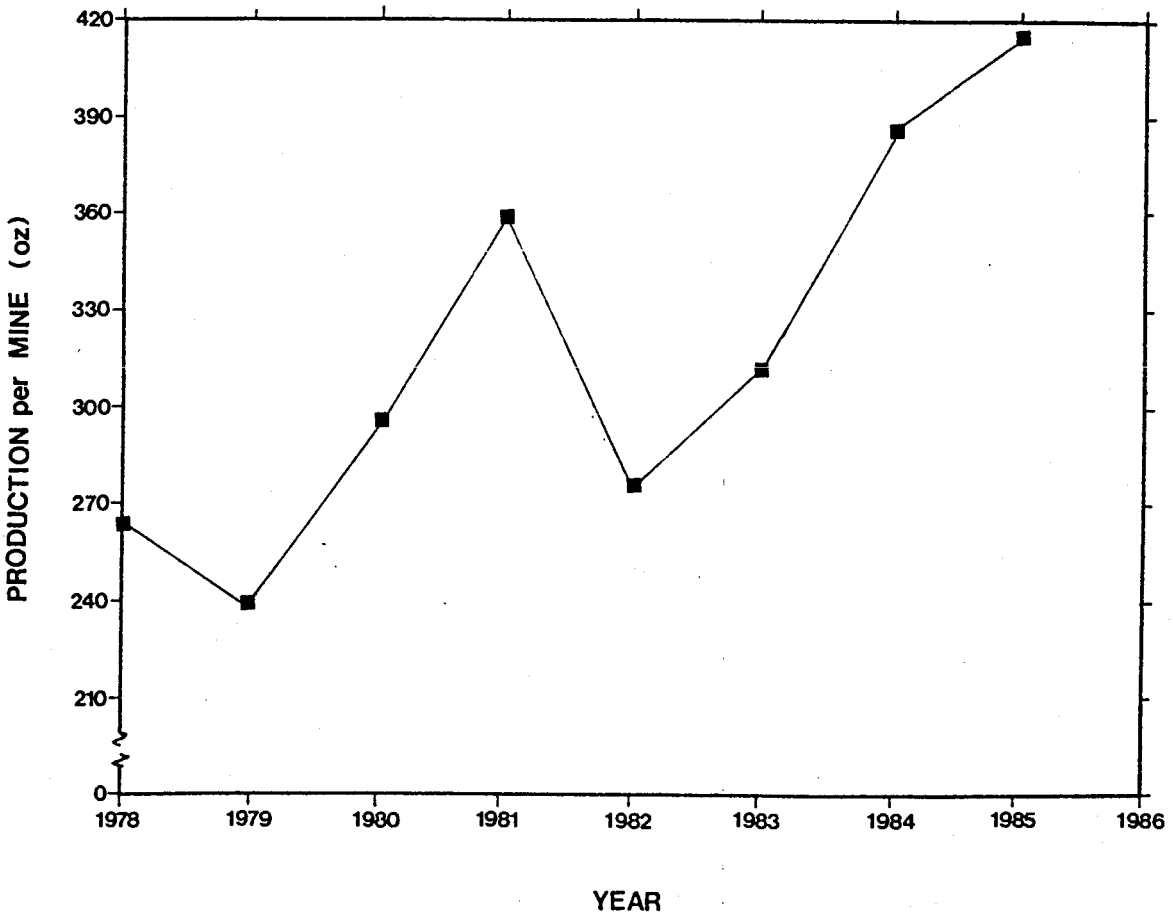


although the total number of placer mining operations has decreased, those mines remaining active have become more efficient (Figure 8.4).

These trends suggest that the placer mining industry is, at present, not in equilibrium with the market forces that determine the price of gold. The regression equations used to predict the effect of price on gold production are useful tools, but it must be acknowledged that the predictions are not exact. The presently predicted relationship betweent the price of gold and the level of production is flatter than that put forward by DOE in 1983 (Appendix 6). The change in slope of the equations results from the observed increase in production, even at lower gold prices.

FIGURE 8.4

Trend in Production per Mine



9.0 DISCUSSION

The proposed Yukon placer mining guidelines, if formed into regulations, will assuredly have a negative effect on the mining industry. This paper has looked at some of the factors that policymakers should consider before turning these guidelines into law. Factors to be considered include fairness, efficiency, and enforcability.

9.1 Fairness

The proposed guidelines are fair when compared to the regulations governing the placer mining industry in other jurisdictions. The effluent quality standards appear to be stricter than the situation in Alaska but this is difficult to determine with certainty as different criteria were used. Alaska specifies a maximun value of settable solids in the effluent while the proposed guidelines for the Yukon specify allowable levels of suspended sediment. The effluent standards set in British Columbia are stricter than the case proposed for the Yukon or presently enforced in Alaska. California allows no discharge to natural streams.

It would appear that the severity of effluent quality standards are directly related to the nearness of the area to centers of populations and inversely related to the level of mining activity.

Placer miners repeatedly argue that they are not polluting streams with the effluent from their operations as the suspended

sediment is a naturally occurring material and eventually will enter the stream as a result of erosion. This argument is weak, as there is sufficient scientific evidence indicating the negative effect of suspended sediment on fish. However, the evidence does not suggest that a small amount of suspended sediment will result in the total destruction of a fish resource. There is not enough site specific data to accurately predict the incremental impact of placer mining induced sediment on the fish resource. Also, the environment will eventually recover to a productive state after mining activities cease but it is again uncertain as to how long this recovery will take. The policymaker should realize that the mining versus fish debate is not black and white, the two do co-exist and any action affecting one will affect the other.

All jurisdictions responsible for regulating placer mining agree that the use of settling ponds can be effective in treating mine effluents. Regulations requiring the construction and maintenance of appropriately sized settling ponds can be rationalized, based on their cost and demonstrated effectiveness.

Similar to the case of the effluent quality standards, the requirements for mine site rehabilitation and development plans, as contained in the proposed Yukon placer mining guidelines, are consistent with the requirements in Alaska and British Columbia. However, the proposed guidelines for the Yukon Territory are much more specific than regulations in British Columbia, this may make it difficult to adapt to site specific constraints. If a mechanism could be put in place that would allow individual operators to negotiate site specific variances to the regulations

it should be possible to protect the aquatic resource while at the same time fostering the growth of the mining industry.

The proposed guidelines would regulate the Yukon placer mining industry in a manner similar to other resource extraction industries. If anything, the proposed guidelines are more lenient than present regulations governing other forms of mining. This is reasonable, as individually placer operations are much smaller than hardrock mines and do not pose the same environmental threat as would a multi-million dollar hardrock mine. However, the policymaker must keep in mind the cumulative effect of many small mines. Part of the difficulty in regulating the Yukon placer mining industry arises from the fact that there are many small mines operating over a large geographical area.

It can be argued that the placer mining industry is being harshly dealt with, for the purpose of benefitting the fishing industry in the Yukon Territory. This is particularly true if economic efficiency is used as a criteria. It appears that the authors of the proposed guidelines feel that the mining industry should suffer to benefit the fishery. This is understandable given that the authoring departments are DOE, DFO and the Water Resources Section of DIAND. More input from government groups responsible for economic development or the mining industry in the drafting of the proposed guidelines may have resulted in a more flexible approach to regulating the placer mining industry. The government officials responsible for drafting the guidelines do not seem to appreciate that placer miners are essentially small businessmen. As such, most placer miners do not have the fiscal and technical resources to respond to the guideline

requirements in the same way that a large company could respond.

Much of the rational behind the proposed guidelines seems to have been based on the assumptions that the explosive growth of the industry seen in 1980 and 1981 would continue and that the industry would become dominated by large companies. This simply has not occurred. The size of the industry has declined since 1981 although gold production has increased. The number of large mines has also decreased, leaving one to conclude that the smaller, family operated enterprises are more efficient. The proposed guidelines should be reviewed in light of the current make-up of the industry and in light of the way in which small businesses in other industries are regulated.

As recommended by the Christensen Committee, the classification of a stream should be a function of its proven fishery value. It does not appear to be fair to the placer mining industry, that in the case of limited data, a stream is assumed to support significant populations of fish and therefore must be provided the maximum level of protection, while at the same time assuming that all placer mining activities will have a significant negative impact on aquatic resources. If a section of stream is proven to support important fish resources, it should be protected from the adverse effects of placer mining. If it cannot be proven that there are significant fish resources at risk, the section of stream should be offered less protection.

The final item under the topic of fairness, has to do with the uncertainty factor of the proposed guidelines. Throughout the documentation of the proposed guidelines reference is made to possible future ammendments to the guidelines that would, in

effect, increase their scope to include the protection of additional resource values. To the placer miner this may mean that business decisions, based on the current rules, may be adversely affected by future changes in regulations.

9.2 Efficiency

It is clear that, purely from the point of view of economic efficiency, the guidelines should not be implemented in their present form. Only under assumptions that are very optimistic with respect to the future development of the Yukon fisheries was a benefit-cost ratio greater than unity obtained. Also, the assumptions used in deriving the base case benefits to the fish resource seem to be generous, likely resulting in an overestimation of the value of the resource.

More person years of employment would be lost in the placer mining industry than gained in the fishing industry if the proposed guidelines are implemented. In the chronically depressed Yukon economy, employment is an important factor in the policymaking process. Erosion of employment generated by the placer mining industry would have a negative effect on the economy of the Yukon Territory.

The guidelines seek to provide the greatest protection to areas that have not been mined to date. This means that a miner wishing to operate in a new area will be forced to face much higher costs than those working claims in historic mining areas. This requirement will likely lead to a long term decline in the placer industry as the traditional mining areas are worked out.

This discouragement of exploration and development of new placer deposits may be counter to government's objectives for economic expansion.

9.3 Enforcement

Government has sought to specify in detail the conditions placer miners must meet in an attempt to have enforcable regulations. It is likely that their specific nature will make the guidelines more difficult to enforce rather than less difficult.

Alaska have somewhat simpler regulations and yet can only enforce the environmental standards on streams that are judged to have high multiple use values. It is likely with the number of small operators in the Yukon Territory, the extent of the geographical area that is presently being mined and the limited number of inspectors (there are currently five water inspectors for the whole of the Yukon Territory) that it will not be possible to inspect all mines on a routine basis. The occasional spot inspection will likely not give a true indication of whether or not a specific operator is meeting the specified effluent quality standards.

Basing the effluent standard on the concentration of suspended sediments has a number of practicable difficulties that will cause problems with its use to monitor compliance. Firstly, suspended sediment concentrations are normally determined in the laboratory. There may be a significant turn around time from when the sample is taken and when the results of the analysis

are returned from the laboratory. Secondly, suspended sediment concentrations are sensitive to the sampling technique used and therefore are difficult to accurately replicate. Finally, suspended sediment analyses are reasonably expensive, costing $10 or more per sample (Chemex Labs, Calgary, pers com).

The proposed guidelines do not specify what happens if a miner is found to be in violation of the effluent quality standard specified in his water use permit. Any regulations resulting from the present policymaking process should include a range of penalties. The Alaskan system would provide a model. Infrequent and accidental exceedances of the effluent quality standards would result in no or small penalties while frequent and deliberate exceedances are treated much harsher.

The environmental standards for mine site rehabilitation should be relatively easy to enforce as one inspection at the end of mining would determine compliance. Initially, bonding, in an amount equal to the cost of a third party being retained to rehabilitate the site, should be required. The British Columbian example of decreasing bonding requirements based on an individual's past performance is reasonable.

10 CONCLUSIONS

The proposed Yukon Placer Mining Guidelines represent an attempt by certain federal government departments to institute a regulatory regime to govern the operation of the placer mining industry. The proposed guidelines are meant to protect terrestial and aquatic resource values, while at the same time allowing the mining industry to operate in a defined, legal atmosphere.

The concept of providing for alternate resource uses is commendable but it is not clear that the resource values to be protected are of sufficient significance to justify imposition of a considerable cost on a viable, existing industry. The policymakers must realize that there is a very real cost associated with the decision to increase the level of protection offered to the fish resource. Government bureaucrats and both industry and environmental lobby groups have been attempting to reach decisions on the form and substance of regulations to govern the placer mining industry for more than ten years. The political arena is the appropriate forum for society to decide what level of compromise is acceptable. Politicians need to determine policy direction, based on their perception of society's desires, and communicate that direction to the government officials responsible for its implementation.

The proposed guidelines are similar to regulations governing placer mining in other jurisdictions. Placer miners in the Yukon Territory would be regulated in a fair manner when compared to their counterparts in other parts of North America.

The proposed guidelines appear to be inflexible. A system

similar to the Board of Variance in the municipal setting should be considered as some leeway could be allowed the regional resource management agencies in arriving at site specific exceptions to the general regulations. This could provide for the achievement of environmental protection objectives while at the same time allowing mining to continue. Any such board or committee should have representation from the agencies responsible for economic development and the mining industry as well as representatives from Water Management, DOE and DFO.

Settling ponds, if properly designed, constructed and maintained, appear to be effective in protecting downstream resource values in all but the most biologically sensitive streams. The problem in the past with the use of settling ponds seems to result from poor design and lack of maintenance. Given the large number of small operators in the placer mining industry, regulations that specified the design and maintenance of settling ponds, as a function of the flow rate of water licenced, might be more acceptable to the industry and certainly would be more enforcable. This suggestion would shift the responsibility for deciding the settling pond retention times required to provide the desired level of environmental protection back to government. The system would work within the proposed stream classification system as miners working streams with higher environmental significances would be required to provide larger and more effective settling facilities. There would likely still exist situations where the aquatic, or other, resource values were sufficiently important as to preclude the discharge of any sediment. Such situations should be dealt with on a case by case basis.

As proposed the Yukon Placer Mining Guidelines are likely to negatively effect the long term viability of the placer mining industry. The expressed intent to require higher levels of environmental protection for areas that have not previously been exploited will limit the prospecting and development of new areas. A system that allowed small mines to operate with minimal effluent treatment on streams with no significant history of prior mining activity would allow the continuation of the exploration process. Small, isolated mines using settling ponds would likely have no significant long-term effect on the productivity of a stream. The implementation of such a policy would acknowledge the fact that watercourses have some resiliency in adjusting to changes in sediment loading. The proposed Board of Variance might be the appropriate body to administer such a system

The requirement of mine site rehabilitation is appropriate as is the stipulation that some form of financial bonding be provided by the operator. The extent of rehabilitation and the amount of bonding required should be matched to site specific conditions and past performance of the operator. Thus, a new miner could work in an area with an extensive history of mining and be required to provide a minimal level of financal bonding. On the other hand, a miner wanting to work in a previously unmined area would be required to post suffient security to ensure the reclamation of the site.

As a result of the fact that basic assumptions made by the authors of the 1983 guidelines concerning the growth of the placer mining industry have proven to be incorrect, the need for

the extensive regulatory regime implied by the proposed guidelines should be reassessed. Given the present size of the industry and its potential for growth in the near future a less formal form of control is more appropriate and likely more acceptable. A more rigorous form of regulation could be implemented in the future if justified by a significant increase in mining activity.

11 RECOMMENDATIONS

As a result of the predicted negative effect of the proposed guidelines on the economy and employment in the Yukon Territory, it is recommended that:

1) The proposed guidelines should be modified to reflect current economic trends in the placer mining industry.
2) If effluent quality standards are introduced, they should reflect proven fishery resource values and not potential values.
3) As an alternate to effluent quality standards, consideration should be given to adding, as a condition of the water use permit, specific requirements for the size and maintenace of settling facilities.
4) Rehabilitation and bonding requirements should be based on specific resource values and the past performance of of the operator.
5) Some form of appeal process should be implemented whereby an individual miner can argue for exception or modification of specific regulatory requirements.

It is suggested that a Board of Variance be established to deal with site specific exceptions to the general regulations. Such a board must have access to the technical expertise required to assess site specific proposals. Representation from all concerned government agencies, the industry and community would increase the creditability of such a body.

APPENDIX 1.0

RELEVANT SECTIONS OF THE FISHERIES ACT

CHAPTER F-14

An Act respecting fisheries

SHORT TITLE

Short title

1. This Act may be cited as the *Fisheries Act*. R.S., c. 119, s. 1.

INTERPRETATION

Definitions

2. In this Act

"Canadian fisheries waters" «eaux...»

"Canadian fisheries waters" means all waters in the fishing zones of Canada, all waters in the territorial sea of Canada and all internal waters of Canada;

"close time" «temps...»

"close time" means a specified period during which fish to which it applies, may not be fished;

"fish" «poisson»

"fish" includes shellfish, crustaceans and marine animals;

"fishery" «pêcherie»

"fishery" includes the area, locality, place or station in or on which a pound, seine, net, weir or other fishing appliance is used, set, placed or located, and the area, tract or stretch of water in or from which fish may be taken by the said pound, seine, net, weir or other fishing appliance, and also the pound, seine, net, weir, or other fishing appliance used in connection therewith;

"fishing" «pêcher»

"fishing" means fishing for or catching fish by any method;

"fishing vessel" «bateau...»

"fishing vessel" means any vessel used, outfitted or designed for the purpose of catching, processing or transporting fish;

"lawful excuse" «excuse...»

"lawful excuse" means

(*a*) ability to prove that fish in possession during the close time therefor at the place of possession were legally caught, or

(*b*) the unintentional or incidental catching of any fish that may not then be taken,

CHAPITRE F-14

Loi concernant les pêcheries

TITRE ABRÉGÉ

Titre abrégé

1. La présente loi peut être citée sous le titre: *Loi sur les pêcheries*. S.R., c. 119, art. 1.

INTERPRÉTATION

Définitions

2. Dans la présente loi

«bateau de pêche» "fishing vessel"

«bateau de pêche» désigne tout navire utilisé, équipé ou conçu pour la prise, le traitement ou le transport du poisson;

«eaux des pêcheries canadiennes» "Canadian fisheries..."

«eaux des pêcheries canadiennes» désigne toutes les eaux des zones de pêche du Canada, toutes les eaux de la mer territoriale du Canada et toutes les eaux intérieures du Canada;

«excuse légitime» "lawful..."

«excuse légitime» signifie

a) l'aptitude à prouver que le poisson possédé en temps prohibé à l'endroit de possession a été légalement capturé, ou

b) la capture involontaire ou fortuite de tout poisson qui ne peut être alors capturé, pendant que se fait légalement la pêche d'un autre poisson;

«Ministre» "Minister"

«Ministre» signifie le ministre des Pêches et Forêts;

«pêcher» "fishing"

«pêcher» signifie pêcher ou capturer du poisson par quelque mode que ce soit;

«pêcherie» "fishery"

«pêcherie» comprend l'étendue, la localité, l'endroit ou la station où un parc ou rets à enclos, une seine, un filet, une nasse, ou un autre engin de pêche est employé, tendu, placé ou localisé, et l'étendue ou nappe d'eau dans laquelle le poisson peut être pris au moyen desdits parc ou rets à enclos, seine, filet, nasse ou autre engin de pêche, et aussi le parc ou rets à enclos, la seine, le filet, la nasse ou autre engin employé pour

on a form provided by the Minister a statement under oath showing,

(*a*) the number of fishermen employed, and of the lobster traps used in connection with his factory or canning establishment;

(*b*) the number of persons employed in such factory or canning establishment, distinguishing the sexes;

(*c*) the number of cases of lobsters, and the weights thereof, packed during the legal lobster fishing season last concluded and ended; and

(*d*) such other details and particulars as are required by the Minister. R.S., c. 119, s. 16.

son district, sur la formule fournie par le Ministre, une déclaration sous serment indiquant

a) le nombre des pêcheurs employés et des pièges à homard utilisés pour son usine ou conserverie;

b) le nombre de personnes employées dans cette usine ou conserverie, avec mention des sexes;

c) le nombre et le poids des caisses de homard emballées pendant la dernière saison de pêche légale qui a pris fin; et

d) tous autres détails et renseignements que peut exiger le Ministre. R.S., c. 119, art. 16.

Licences for lobster pounds

18. (1) No one shall maintain a pound or enclosure in which lobsters, legally caught during the open season, shall be retained for sale during the close season at a place where the pound or enclosure is located, or for export therefrom, except under a licence from the Minister, and no lobsters shall be taken from any such pound or enclosure, and disposed of during the close season at the place where it is located, except under a certificate from a fishery officer or fishery guardian, setting forth the pound from which the lobsters were taken and that they had been legally caught during the open season.

Permis d'enclos à homard

18. (1) Sans un permis du Ministre, il est interdit à qui que ce soit de maintenir un parc ou un enclos où les homards, légalement pris pendant la saison de pêche, sont retenus pour la vente en temps prohibé, à l'endroit où est situé le parc ou l'enclos, ou pour en être exportés; et nul ne doit enlever de homard de ce parc ou enclos ni en disposer à cet endroit en temps prohibé, si ce n'est sous l'autorité d'un certificat d'un fonctionnaire des pêcheries ou d'un garde-pêche mentionnant le parc d'où a été enlevé le homard et attestant qu'il a été capturé légalement durant la saison de pêche.

Marking of pounds

(2) Each such pound or enclosure shall be marked with the name of the licensee and the number of his licence; such marking shall be in black on a white ground, and the letters and figures shall be at least six inches in height.

Marques du parc ou enclos

(2) Chaque parc ou enclos doit être marqué du nom du porteur de permis et du numéro de son permis. Ces marques doivent être en noir sur fond blanc, et les lettres et chiffres doivent avoir au moins six pouces de hauteur.

Fee

(3) The annual fee for such licence shall be seventy-five dollars. R.S., c. 119, s. 17.

Droit

(3) Le droit annuel à verser pour ce permis est de soixante-quinze dollars. S.R., c. 119, art. 17.

POSSESSION OF FISH

POSSESSION DU POISSON

Possession or sale of fish prohibited

19. No one, without lawful excuse, the proof whereof lies on him, shall fish for, buy, sell or have in his possession any fish, or portion of any fish, at a place where at that time fishing for such fish is prohibited by law. R.S., c. 119, s. 18.

Possession ou vente de poisson en temps prohibé

19. Il est interdit à qui que ce soit, sans excuse légitime dont la preuve lui incombe, de pêcher, acheter, vendre ou avoir en sa possession aucun poisson ou partie d'un poisson à un endroit où, à cette époque, la pêche de ce poisson est prohibée par la loi. S.R., c. 119, art. 18.

CONSTRUCTION OF FISHWAYS

CONSTRUCTION D'ÉCHELLES À POISSON

Fishways to be made as fishery officer directs

20. (1) Every slide, dam or other obstruction across or in any stream where the Minister determines it to be necessary for the public

Échelles à poisson aux endroits et sur le modèle prescrits par le garde-pêche

20. (1) Tout barrage, glissoire ou autre obstacle en travers d'un cours d'eau ou dans un cours d'eau où le Ministre juge nécessaire

interest that a fish-pass should exist, shall be provided by the owner or occupier with a durable and efficient fishway, or canal around the slide, dam or other obstruction, which shall be maintained in a good and effective condition by the owner or occupier, in such place and of such form and capacity as will in the opinion of the Minister satisfactorily permit the free passage of fish through the same; where it is determined by the Minister in any case that the provision of an efficient fishway or canal around the slide, dam or other obstruction is not feasible, or that the spawning areas above such slide, dam or other obstruction are destroyed, the Minister may require the owner or occupier of such slide, dam or other obstruction to pay to him from time to time such sum or sums of money as he may require to construct, operate and maintain such complete fish hatchery establishment as will in his opinion meet the requirements for maintaining the annual return of migratory fish.

dans l'intérêt public qu'il existe une échelle pour le poisson, doit être muni par le propriétaire ou l'occupant d'une échelle à poisson durable et efficace, ou passe migratoire contournant le barrage, la glissoire ou autre obstacle. Le propriétaire ou occupant est tenu de les maintenir en bon état de fonctionnement et de les établir à l'endroit, sur le modèle et suivant les dimensions que le Ministre juge propres à y permettre le libre passage du poisson. Si, à l'occasion, le Ministre juge qu'il est impossible de pourvoir à l'établissement d'une échelle à poisson ou passe migratoire efficace contournant la glissoire, le barrage ou autre obstacle, ou que les frayères en amont de ces glissoire, barrage ou autre obstacle sont détruites, il peut exiger que le propriétaire ou l'occupant de ces glissoire, barrage ou autre obstacle lui verse, de temps à autre, la somme ou les sommes d'argent dont il peut avoir besoin pour construire, mettre en service et entretenir l'établissement complet de pisciculture qui, à son avis, suffira au maintien du retour annuel des poissons migrateurs.

Place, form, etc.

(2) The place, form and capacity of the fishway or canal to be constructed must be approved by the Minister before construction thereof is begun; and immediately after the fishway is completed and in operation the owner or occupier of any dam or obstruction shall make such changes and adjustments at his own cost as will in the opinion of the Minister be necessary for its efficient operation under actual working conditions, if such are found to be needed.

Endroit, modèle, etc.

(2) L'endroit, le modèle et les dimensions de l'échelle à poisson ou passe migratoire à construire doivent être approuvés par le Ministre avant que leur construction soit commencée; et immédiatement après que l'échelle à poisson est terminée et mise en service, le propriétaire ou l'occupant d'un barrage ou obstacle doit faire à ses frais les changements et ajustements qui, de l'avis du Ministre, sont nécessaires à son exploitation efficace dans des conditions réelles de fonctionnement, si ces changements et ajustements sont tenus pour indispensables.

To be kept open

(3) The owner or occupier of every fishway or canal shall keep it open and unobstructed and shall keep it supplied with such sufficient quantity of water as the Minister considers necessary to enable the fish frequenting the waters in which such fishway or canal is placed to pass through the same during such times as are specified by any fishery officer; and, where leaks in a dam cause a fishway therein to be inefficient, the Minister may require the owner or occupier of such dam to prevent such leaks therein.

Doivent être libres

(3) Le propriétaire ou l'occupant d'une échelle à poisson ou passe migratoire doit la tenir ouverte et libre de toute obstruction et la pourvoir d'une quantité d'eau suffisante que le Ministre estime nécessaire pour permettre au poisson qui fréquente les eaux où ladite échelle ou passe est placée d'y passer pendant les périodes spécifiées par tout fonctionnaire des pêcheries; et, lorsque des fissures dans un barrage rendent l'échelle à poisson inefficace, le Ministre peut exiger que le propriétaire ou l'occupant de ce barrage remédie à ces fissures.

Minister may pay one-half of cost

(4) The Minister may authorize the payment of one-half of the expense incurred by

Le Ministre peut payer la moitié du coût

(4) Le Ministre peut autoriser le paiement de la moitié des frais que la construction et

such owner or occupier in constructing and maintaining any fishway or canal; and after a fishway or canal that has been duly approved by the Minister has been built at the cost of the owner or occupier of any slide, dam or other obstruction, or after such owner or occupier has paid one-half the cost thereof and such fishway or canal thereafter proves to be ineffective, except as provided in subsection (2), the total cost of any change in such fishway or canal or any new fishway or canal required to enable the fish to pass by such slide, dam or other obstruction, shall be paid by Her Majesty.

l'entretien d'une échelle ou passe migratoire occasionnent au propriétaire ou à l'occupant; et lorsqu'une échelle ou passe migratoire qui a été dûment approuvée par le Ministre a été construite aux frais du propriétaire ou occupant d'une glissoire, barrage ou autre obstacle, ou lorsque ce propriétaire ou occupant en a payé la moitié du coût et que cette échelle ou passe est dans la suite jugée inefficace, sauf les dispositions du paragraphe (2), le coût total de toute réfection de cette échelle ou passe ou de toute nouvelle échelle ou passe nécessaire pour permettre au poisson de franchir cette glissoire, ce barrage ou autre obstacle, doit être payé par Sa Majesté.

May construct and recover the cost in certain cases

(5) The Minister, in order to procure the construction of any fishway or canal, pending proceedings against any owner or occupier for the penalty imposed by this Act, may make and complete the same forthwith, and may authorize any person to enter upon the premises with the necessary workmen, means and materials for such purpose and may recover from the owner or occupier the whole expense so incurred by action in the name of Her Majesty.

(5) Dans le but d'assurer la construction d'une échelle à poisson ou passe migratoire, lorsque des poursuites sont pendantes contre le propriétaire ou occupant pour le recouvrement de l'amende imposée par la présente loi, le Ministre peut l'établir et terminer sans retard, et il peut autoriser toute personne à se rendre sur les lieux avec les ouvriers, l'outillage et les matériaux nécessaires à cette fin; et, par une action au nom de Sa Majesté, il peut recouvrer du propriétaire ou occupant tous les frais ainsi déboursés.

Construction et recouvrement des frais en certains cas

May remove or destroy after notice

(6) Where unused slides, dams, obstructions, or anything detrimental to fish exist, and the owner or occupier thereof does not after notice given by the Minister remove the same, or if the owner is not resident in Canada, or his exact place of residence is unknown to the Minister, the Minister may, without being liable to damages, or in any way to indemnify the said owner or occupier, cause such slide, dam, obstruction, or thing detrimental to fish life to be removed or destroyed and in cases where notice has been given to the owner or occupier, may recover from said owner or occupier the expense of so removing or destroying the same.

(6) Lorsque se trouvent inutilisés des barrages, glissoires, obstacles ou toutes choses nuisibles au poisson, et que le propriétaire ou occupant, après avis donné par le Ministre, ne les fait pas disparaître, ou que ce propriétaire ne réside pas au Canada, ou que le lieu exact de sa résidence est inconnu du Ministre, ce dernier peut, sans se rendre passible de dommages-intérêts et sans indemniser en aucune façon ledit propriétaire ou occupant, faire enlever ou détruire lesdits barrages, glissoires, obstacles ou choses nuisibles à la vie du poisson, et si un avis a été donné au propriétaire ou occupant, le Ministre peut recouvrer dudit propriétaire ou occupant les frais de cet enlèvement ou de cette destruction.

Enlèvement ou destruction après avis

Minister may require fish stops or diverters

(7) The Minister may require the owner or occupier of any slide, dam or other obstruction to install and maintain such fish stops or diverters, both above and below any dam or obstruction as will in his opinion be adequate to prevent the destruction of fish or to assist in providing for their ascent.

(7) Le Ministre peut obliger le propriétaire ou l'occupant d'une glissoire, d'un barrage ou autre obstacle à installer et entretenir, tant en amont qu'en aval d'un barrage ou obstacle, les appareils pour arrêter ou détourner le poisson qui, de l'avis du Ministre, suffiront à empêcher la destruction du poisson ou aider à assurer sa montée.

Le Ministre peut exiger des appareils pour arrêter ou détourner le poisson

Water for the descent of fish

(8) At every slide, dam or other obstruction, where the Minister determines it to be necessary the owner or occupier thereof shall, when required by the Minister, provide a sufficient flow of water over the spillway or crest, with connecting sluices into the river below to permit the safe and unimpeded descent of fish.

Pourvoir de l'eau pour la descente du poisson

(8) A chaque glissoire, barrage ou autre obstacle, où le Ministre le juge nécessaire, le propriétaire ou occupant, lorsqu'il en est requis par le Ministre, doit pourvoir à un débit d'eau suffisant au-dessus de la passe-déversoir ou crête, avec canaux raccordeurs dans la rivière en aval afin de permettre au poisson de descendre sans danger et sans difficulté.

Protection during construction

(9) The owner or occupier of any slide, dam or other obstruction shall make such provision as the Minister determines to be necessary for the free passage of both ascending and descending migratory fish, during the period of construction thereof.

Protection durant la construction

(9) Le propriétaire ou l'occupant d'une glissoire, d'un barrage ou autre obstacle doit prendre les dispositions que le Ministre juge nécessaires pour le libre passage du poisson migrateur, tant à sa montée qu'à sa descente, pendant que sont construits les ouvrages susdits.

Sufficient water for river bed below dam

(10) The owner or occupier of any slide, dam or other obstruction shall permit to escape into the river bed below the said slide, dam or other obstruction, such quantity of water, at all times, as will, in the opinion of the Minister, be sufficient for the safety of fish and for the flooding of the spawning grounds to such depth as will, in the opinion of the Minister, be necessary for the safety of the ova deposited thereon. R.S., c. 119, s. 20.

Eau nécessaire pour le lit de la rivière en aval du barrage

(10) Le propriétaire ou l'occupant d'une glissoire, d'un barrage ou autre obstacle doit voir à ce qu'il s'échappe en tout temps dans le lit de la rivière en aval de cette glissoire, de ce barrage ou autre obstacle, la quantité d'eau qui, de l'avis du Ministre, suffit à la sécurité du poisson et à l'immersion des frayères à la profondeur nécessaire pour la sécurité des œufs y déposés, selon que l'estime le Ministre. S.R., c. 119, art. 20.

GENERAL PROHIBITIONS

PROHIBITIONS GÉNÉRALES

Fishing in limits leased to another prohibited

21. No one shall fish for, take, catch or kill fish in any water, or along any beach, or within any fishery described in any lease or licence, or place, use, draw or set therein any fishing gear or apparatus, except by permission of the occupant under such lease or licence for the time being, or shall disturb or injure any such fishery. R.S., c. 119, s. 21.

Défense de pêcher dans les limites louées à d'autres

21. Il est interdit de pêcher, prendre, capturer, tuer du poisson dans une nappe d'eau ou le long d'une grève, ou dans les limites d'une pêcherie décrite dans un bail ou permis, ou d'y placer, employer, tirer ou tendre quelque engin ou appareil de pêche, sans la permission de l'occupant en vertu du bail ou du permis alors en vigueur, et il est également interdit de troubler ou endommager pareille pêcherie. S.R., c. 119, art. 21.

Seines, nets, etc., not to obstruct navigation

22. Seines, nets or other fishing apparatus shall not be set or used in such manner or in such place as to obstruct the navigation of boats and vessels and no boats or vessels shall destroy or wantonly injure in any way seines, nets or other fishing apparatus lawfully set. R.S., c. 119, s. 22.

Les rets, etc., ne doivent pas gêner la navigation

22. Les seines, rets et autres engins de pêche ne doivent pas être tendus ni employés de manière à nuire, ni en des endroits où ils pourraient faire obstacle, à la circulation des navires et bateaux; et il est interdit aux navires ou bateaux de détruire ou endommager malicieusement de quelque manière que ce soit les seines, rets ou autres engins de pêche légalement tendus. S.R., c. 119, art. 22.

Stakes to be removed

23. Every person using stakes, posts, buoys or other materials placed for fishing purposes in any water shall remove the same within forty-eight hours after ceasing to use them,

Enlèvement des piquets

23. Tout individu qui emploie des piquets, pièces de bois, bouées ou autres matériaux placés dans l'eau pour la pêche doit les enlever dans les quarante-huit heures après

fish from the operation of this section or any part of this section, and may at any time by a notice similarly published, withdraw such exception. R.S., c. 119, s. 29.

Canada, soustraire toute espèce ou toutes espèces de poissons à l'application du présent article ou de l'une de ses parties, et peut, en tout temps, au moyen d'un avis publié de la même manière, retirer cette exception. S.R., c. 119, art. 29.

Eggs and fry

30. The eggs or fry of fish on the spawning grounds, shall not at any time be destroyed. R.S., c. 119, s. 30.

Œufs et frai

30. Les œufs ou le frai du poisson dans les frayères ne doivent jamais être détruits. S.R., c. 119, art. 30.

Fish outside Canadian fisheries waters

31. No one shall leave any port or place in Canada to fish outside Canadian fisheries waters for fish the catching of which is at such time prohibited in the Canadian fisheries waters opposite to or nearest the place where such person proposes to fish, and no one shall bring into Canada any fish caught outside Canadian fisheries waters when fishing for such fish is prohibited inside the Canadian fisheries waters opposite or nearest to the place where such fish was caught, or shall bring into Canada any vessels, boats, nets, fishing gear, implements or appliances used in such fishing. 1964-65, c. 22, s. 12.

Pêche en dehors des eaux territoriales

31. Il est interdit à qui que ce soit de quitter un port ou endroit du Canada pour pêcher, en dehors des eaux des pêcheries canadiennes, du poisson dont la capture est à cette époque prohibée dans les eaux des pêcheries canadiennes vis-à-vis ou à l'endroit le plus rapproché du lieu où cette personne se propose de pêcher, et nul ne peut emporter au Canada du poisson capturé en dehors des eaux des pêcheries canadiennes, lorsque la pêche de ce poisson est prohibée dans les eaux des pêcheries canadiennes situées vis-à-vis ou près de l'endroit le plus rapproché du lieu où ce poisson a été capturé, ou de faire entrer au Canada des vaisseaux, bateaux, rets, engins de pêche, appareils ou dispositifs utilisés pour cette pêche. 1964-65, c. 22, art. 12.

Purse seine

32. No one shall use a purse seine in any Canadian fisheries waters, except under licence from the Minister for the taking of salmon, pilchard, herring, smelts, mackerel and pollock. 1964-65, c. 22, s. 12.

Usage de l'esaugue

32. Personne ne doit se servir d'une essaugue dans quelqu'une des eaux des pêcheries canadiennes, sauf en vertu d'un permis du Ministre, pour capturer du saumon, pilchard, hareng, éperlan, maquereau et merlan. 1964-65, c. 22, art. 12.

INJURY TO FISHING GROUNDS AND POLLUTION OF WATERS

DÉTÉRIORATION DES PÊCHERIES ET POLLUTION DES EAUX

Throwing overboard of certain substances prohibited

33. (1) No one shall throw overboard ballast, coal ashes, stones, or other prejudicial or deleterious substances in any river, harbour or roadstead, or in any water where fishing is carried on, or leave or deposit or cause to be thrown, left or deposited, upon the shore, beach or bank of any water or upon the beach between high and low water mark, remains or offal of fish, or of marine animals, or leave decayed or decaying fish in any net or other fishing apparatus; such remains or offal may be buried ashore, above high water mark.

Le jet par-dessus bord de certaines substances est prohibé

33. (1) Il est interdit de jeter par-dessus bord du lest, des cendres de charbon, des pierres ou d'autres substances nuisibles ou délétères dans une rivière, un port, une rade, ou dans des eaux où se fait la pêche, ou de laisser ou déposer ou faire jeter, laisser ou déposer sur la rive, la grève ou le bord de quelque cours ou nappe d'eau, ou sur la grève entre les marques des hautes et des basses eaux, des restes ou issues de poissons ou d'animaux marins, ou de laisser du poisson gâté ou en putréfaction dans un filet ou autre engin de pêche. Ces restes ou issues de poissons peuvent être enterrés sur la grève, au-delà de la marque des eaux à marée haute.

Lime, etc., prohibited

(2) No person shall cause or knowingly

(2) Il est interdit à qui que ce soit de faire

Pollution des eaux défendue

permit to pass into, or put or knowingly permit to be put, lime, chemical substances or drugs, poisonous matter, dead or decaying fish, or remnants thereof, mill rubbish or sawdust or any other deleterious substance or thing, whether the same is of a like character to the substances named in this section or not, in any water frequented by fish, or that flows into such water, nor on ice over either such waters.

passer ou déposer, ou de permettre sciemment de faire passer ou déposer dans les eaux fréquentées par le poisson ou qui se jettent dans ces eaux, ni sur la glace qui recouvre les unes ou les autres de ces eaux, de la chaux, des substances chimiques ou des drogues, des matières vénéneuses, du poisson mort ou gâté ou des débris de ce poisson, des déchets de scieries ou de la sciure de bois, ou toute autre substance ou chose délétère, qu'elle soit ou non de même nature que les substances mentionnées au présent article.

Slash, stumps, etc., prohibited

(3) No person engaging in logging, lumbering, land clearing or other operations, shall put or knowingly permit to be put, any slash, stumps or other debris into any water frequented by fish or that flows into such water, or on the ice over either such water, or at a place from which it is likely to be carried into either such water.

(3) Il est interdit à quiconque fait l'abattage ou la coupe de bois, le défrichement ou autres opérations de déposer ou de permettre sciemment de déposer des déchets de bois, souches ou autres débris dans une eau fréquentée par le poisson ou qui se déverse dans cette eau, ou sur la glace qui recouvre l'une ou l'autre de ces eaux, ou de les déposer dans un endroit d'où il est probable qu'ils soient entraînés dans l'une ou l'autre de ces eaux.

Déchets, souches, etc., prohibés

Order of Governor in Council

(4) The Governor in Council may by order deem any substance to be a deleterious substance for the purposes of subsection (2).

(4) Au moyen d'une ordonnance, le gouverneur en conseil peut tenir toute substance pour délétère aux fins du paragraphe (2).

Ordonnance du gouverneur en conseil

Offences and penalties

(5) Every person who violates any provision of this section is guilty of an offence and is liable upon summary conviction,

(*a*) for the first offence, to a fine of not less than one hundred dollars and not more than one thousand dollars or to imprisonment for a term of not less than one month and not more than six months, or to both such fine and imprisonment; and

(*b*) for a second and each subsequent offence, to a fine of not less than three hundred dollars and not more than two thousand dollars or to imprisonment for a term of not less than two months and not more than twelve months, or to both such fine and imprisonment. R.S., c. 119, s. 33; 1960-61, c. 23, s. 4.

(5) Quiconque enfreint une disposition du présent article est coupable d'une infraction et encourt, sur déclaration sommaire de culpabilité,

a) pour la première infraction, une amende d'au moins cent dollars et d'au plus mille dollars ou un emprisonnement d'au moins un mois et d'au plus six mois, ou à la fois l'amende et l'emprisonnement susdits; et

b) pour une deuxième infraction et chaque infraction subséquente, une amende d'au moins trois cents dollars et d'au plus deux mille dollars ou un emprisonnement d'au moins deux mois et d'au plus douze mois, ou à la fois l'amende et l'emprisonnement susdits. S.R., c. 119, art. 33; 1960-61, c. 23, art. 4.

Infractions et peines

REGULATIONS

RÈGLEMENTS

Regulations

34. The Governor in Council may make regulations for carrying out the purposes and provisions of this Act and in particular, but without restricting the generality of the foregoing, may make regulations

(*a*) for the proper management and control of the seacoast and inland fisheries;

34. Le gouverneur en conseil peut édicter des règlements concernant la réalisation des objets de la présente loi et l'application de ses dispositions et, en particulier, peut, sans restreindre la généralité de ce qui précède, édicter des règlements

a) concernant la gestion et la surveillance

Règlements

APPENDIX 2.0

PLACER MINING GUIDELINES (1976)

(Source: Christensen 1983)

PLACER MINING OPERATING GUIDELINES
IN REGARD TO WATER USE AUTHORIZATIONS

The Yukon Territory Water Board has directed that the Controller of Water Rights may issue Authorizations to Use Water Without a Licence for placer mining operations under Section 11(b) of the Northern Inland Waters Regulations (the proposed use will continue for a period of less than 270 days). The Board adopts the following criteria as guidelines for the issuing of authorizations:

1. All operations are to provide, where practicable, effective settling facilities to the satisfaction of the Controller.

2. In streams or parts thereof which are determined to be critical for sustaining fish stocks or for the protection of other water users, it may be mandatory to provide the following:
    a) fish passage facilities.
    b) uninterrupted minimum discharges.
    c) effective settling facilities.
    d) screens on water intakes in which the stripping methods of ground sluicing, monitoring, and the use of automatic gates is practised.

    The Controller will maintain a list of creeks that are not considered critical for sustaining fish stocks or critical for the protection of other water users. This list will be subject to review from time to time in consultation with the Fisheries Service.

3. Stabilization of the tailings and stripped areas to prevent a detrimental impact on the stream may be required.

4. Where the Water Board deems it necessary, an applicant will be required to provide an environmental impact statement or any other relevant information.

5. A Water Use Licence, rather than an authorization, will be required by a placer mining operation where the Board is satisfied that it will be in the public interest.

An appeal may be filed with the Board within ten days from any written notice, direction or order given by the Controller in applying these guidelines.

APPENDIX 3.0

SELECTED SECTIONS OF PROPOSED YUKON PLACER MINING GUIDELINES (1983)

(Source: DIAND, DFO and DOE 1983)

III THE DEVELOPMENT PLAN

A development plan will be required by DIAND with the water-use application and would identify all the proposed activities and phases of operation for the proposed life of the project. It will, in essence, consist of a number of sub-plans to show how the operation will progress at all stages and how the project will meet the required standards and mitigate the environmental impact.

The development plan or changes thereto will be assessed by the regulatory agencies, through a "one-window" review process, as to its adequacy and when the information presented is accepted as satisfactory, DIAND will approve the plan. If the information is determined to be incomplete DIAND will request more information. When the development plan is evaluated and approved a water use authorization may be issued by the Controller. Similar information should be provided for the YTWB for their review of water use licence applications.

OUTLINE FOR THE PREPARATION OF A DEVELOPMENT PLAN

A. DESCRIPTION OF THE PROJECT

A thorough description of the planned project, the methods to be used for mining, water diversions, wastewater treatment, the scheduling and duration of the operation, and mine site and stream rehabilitation shall be developed as outlined below. Every miner will be required to produce a description of the project. However, only those operators involved in testing their ground will be required to develop a description under Section B - Placer Testing Programs.

Likewise, only those operators actually mining must develop Section C - Placer Mining Programs.

1. Property Size and Location

A detailed description of the size and location of the property shall be provided as follows:

1.1 Location and Description

Shall be detailed on a map of no smaller scale than 1:50,000. A general description and photographs of the property focusing on vegetation types, surface water and drainage conditions are essential where soil and vegetation maps are not available.

1.2 Specific Details

Shall be detailed on maps of appropriate scale (1:100 to 1:2000) showing:

1.2.1 Number of claims with claim numbers and number of leases with their lease numbers;

1.2.2 All streams and intermittent streams on or near the property;

1.2.3 Proposed access routes and all proposed facilities: camps, cabins, roads, airstrips, etc.

2. Equipment

A description of the equipment including numbers and sizes of pumps, models of dozers, scrapers and backhoes, front-end loaders shall be provided.

3. Basic Geology

A general description of the geological features of the area must be provided.

B. PLACER TESTING PROGRAMS

The exploration work will assist the proponent in evaluating the economic constraints involved in developing the property and the constraints that certain environmental conditions will impose on the developer.

The specific information required is:

1. A brief history of past workings on the property.

2. A description of the method of exploration, proposed access and extent of exploration being proposed.

3. The proposed scheduling.

4. Water requirements - sources and methods of obtaining water, rate of water acquisition, design of stream diversions and waste water treatment systems and other intended uses.

5. Use of any chemicals in the process.

6. Anticipated environmental impacts and proposed control measures.

7. Rehabilitation plans for explored areas if mining not carried out.

C. PLACER MINING PROGRAMS

1. Operations.

The operations phase in a development plan will consist of several components:

A detailed layout, on a map of appropriate scale (1:100 to 1:2000), of the mining operation showing the area to be mined, stream location, water supply, disposal area, ponds, campsite, fuel storage, and any other details of the operation.

A detailed description of these maps to explain the layout is necessary.

More specifically, the types of information that will be required in the maps and accompanying description for each set-up and phase are identified below:

1.1 Description of Deposit and Mining Methods

1.1.1 Description of soil material types and characteristics.

1.1.2 An outline of the extent of paydirt zone, estimating volumes of paydirt and estimating volumes of overburden to be removed.

1.1.3 Depth and extent of permafrost.

1.1.4 Method of soils material removal and storage, including volumes and location.

1.1.5 Method of debris removal and storage.

1.1.6 Details of paydirt handling and storage prior to sluicing.

1.1.7 Details (mapped at a scale of 1:100 - 1:2000) of debris and soil material storage.

1.2 Water Sources and Volumes

1.2.1 Proposed water sources and their storage location.

1.2.2 Estimated low, mean and peak stream flows.

1.2.3 Effects of operations on downstream water users.

1.2.4 A determination of the potential for glaciations (aufeis) and their anticipated location shall be provided.

1.2.5 Method of obtaining water and delivery method.

1.2.6 Rate of water acquisition required for sluicing, domestic use and any other uses.

1.2.7 Use of any chemicals associated with the process.

1.2.8 Frequency of water use.

1.2.9 Where applicable, plans for stream diversions and their timing.

1.2.10 Size and design of sluice box or gold recovery device and the rate of water use required.

1.2.11 Any changes in water usage that may be planned.

1.3 Water Treatment

1.3.1 Quantity and quality of process water to be treated.

1.3.2 Method of treating process water.

1.3.3 Detailed specifications of the treatment facility and process.

1.3.4 Expected suspended solids concentration to be achieved.

1.3.5 Maintenance schedule of treatment facility.

1.3.6 Point of discharge for treatment facility.

1.3.7 Any planned changes in treatment facilities.

2. Rehabilitation

The development plan must address this prior to the operational phase for new operations or during the operational phase for existing mines. The rehabilitation process will be continual and progressive with the operational phase.

Specifically, the items that shall be addressed with respect to rehabilitation are:

2.1 Rehabilitation plan submitted on a yearly basis, for the worked-over areas including the tailings and stored debris areas and where applicable, to provide for re-establishment of aquatic habitat.

2.2 Detailed plans for any revegetation to be done.

2.3 The disposal of surplus equipment, buildings or supplies.

IV FISHERIES CLASSIFICATION RATIONALE

To allow placer mining operations to occur and yet to ensure the fisheries resource in Yukon is protected, a priority protection schedule has been developed. This separates the important commercial, sport or subsistence fish species in Yukon into two groups as outlined below. This classification is in accordance with the habitat protection policy of the Department of Fisheries and Oceans which calls for no net loss of fish and fish habitat required to maintain Canada's economically and socially important fisheries resources.

SCHEDULES OF FISH SPECIES

Schedule I

Chum salmon (*Oncorhynchus keta*)
Chinook salmon (*Oncorhynchus tshawytscha*)
Coho salmon (*Oncorhynchus kisutch*)
Sockeye/kokanee (*Oncorhynchus nerka*)
Rainbow trout (*Salmo gairdneri*)
Arctic char (*Salvelinus alpinus*)
Lake trout (*Salvelinus namaycush*)
Dolly Varden (*Salvelinus malma*)

Schedule II

Arctic grayling (*Thymallus arcticus*)
Inconnu (*Stenodus leucichthys nelma*)
Humpback (Lake) whitefish (*Coregonus clupeaformis*)
Broad whitefish (*Coregonus nasus*)
Least cisco (*Coregonus sardinella*)

Arctic cisco (Coregonus autumnalis)
Burbot (Lota lota)
Northern pike (Esox lucius)
Round whitefish (Prosopium cylindraceum)

The distinction between schedules of fish is made by the way in which the fish spawn. Schedule I fish dig pits or "redds" in the stream gravels to deposit their eggs. These fish then "backfill" the pit or "redd" with excavated gravels.

Schedule II fish, however, merely "broadcast" their eggs onto the surface of the stream bed. No depressions are made nor are the eggs covered up by the fish.

Because Schedule I fish lay their eggs in, rather than on, the streambed, siltation of these eggs and consequent smothering of them is more of a concern than siltation of eggs laid on the gravels. Therefore, in the classification system, Schedule I fish are afforded more protection.

Superimposed on the scheduled species valuation is the consideration of life cycle sensitivities. The spawning life cycle phase, from egg deposition through incubation to emergence is considered to be the most sediment-sensitive life phase for a fish. Rearing, that life cycle aspect involving growth from a juvenile into an adult, is considered to be less sensitive.

The classification system designates portions of streams as "reaches", rather than an entire stream or watershed. The reaches are classified or evaluated on a habitat quality basis, generally, rather than on a population size basis by using the physical characteristics of the terrain in each stream in conjunction with

the known presence and life history of each fish species. To do this, the following criteria were used:

1) D.F.O. staff knowledge of the area.
2) Stream reach habitat type within a system.
3) Relationship to known fisheries resources.
4) Similarity to other systems with known fisheries resources.
5) Stream slope.
6) Elevation.
7) River or stream width.
8) Available food sources.
9) Life histories of each species.
10) Migratory patterns of each species.
11) Habitat overwintering capabilities.
12) Length of stream from source to probable fish utilization.
13) Continuous or intermittent nature of stream flow.
14) Connections from one lake to another.
15) Valley shape: "V", "U" and wide flat-bottomed.
16) Association to known marshes, bogs and beaver dams.
17) Known barriers such as waterfalls.
18) Potential for enhancement.

The resultant reach classification then is:

1) A designation - Schedule I spawning area.
2) B designation - Schedule I rearing area.
3) C designation - Good Schedule II habitat.
4) D designation - Other Schedule II habitat (or total absence of habitat)
5) X designation - Previously designated placer mining area.

V. OPPORTUNITY TO CHALLENGE CLASSIFICATION

If the proponent accepts the classification specified for his particular operation no baseline environmental data will need to be collected. However, if the operator requests a downgrade in classification on his stream or reach, he will need to gather the baseline information for the area.

As new information becomes available, the Department of Fisheries and Oceans reserves the right at any time to upgrade or downgrade stream reach classification. DFO intends to justify all changes in classification in a manner similar to that required of the placer operator.

Biophysical information should be based on relevant scientific reports and on-site investigations. The data requested in this section will allow the biological importance and significance of the aquatic resources to be evaluated by the regulatory agencies. The following outline of areas which the proponent should address serves as a guide, but the proponent should consult the regulatory agency for additional details relating to the scope and magnitude of investigations to be carried out.

1. Water

One of the most significant impacts of placer operations is on water quality. The following information is therefore necessary:

1.1 Water Quality

Data on the following water quality parameters obtained every second month during the open water period for pre-operation conditions should be supplied for stations upstream and downstream of the operation:

- temperature
- pH
- conductivity
- dissolved Oxygen
- non-filterable residue
- total residue
- Arsenic (Dissolved)
- Mercury (Total)

Additional water quality parameters may be necessary depending on the geological nature of the area to be disturbed.

1.2 Hydrology

Estimates or measurements of flood frequency and of base or low flow are required for diversion design, retaining dykes and water use conflicts. Locations of domestic and industrial water supply intakes downstream of the operation and the effects of operations on downstream users must be addressed.

2. Fish

Information must be provided on the fish habitat in all relevant reaches. The evaluation will be determined by collecting information on the benthic invertebrate population, water depth and velocity, substrate composition, stream side vegetation, and reach characteristics.

Where the habitat indicates fish should be present in some life cycle phase in the reach and where no fish are found, an explanation of their absence will be required (e.g. there is a waterfall or other impediment to fish passage downstream; fish have moved downstream into larger tributaries).

A suggested acceptable method for collecting data and providing a description is illustrated in "A British Columbia Stream Habitat and Fish Population Inventory System" by A.D. De Leeuw.

VI MINING PRACTICES AND REHABILITATION

Watercourses will be divided into five classifications (A, B, C, D and X). The proposed guidelines are designed to consider environmental sensitivity levels in the five orders of classification that take into consideration their relative renewable resource and environmental value. **The guidelines for each** classification are listed in Section B - Site Specific Mining Practices. **A table showing a summary of these is located on** page 41.

There are certain guidelines generally applicable to any placer mining operation, regardless of the stream reach classification. Such standards are listed below. The intent of the guidelines is not to restrict any mining activity as long as mining practices and rehabilitation standards are met.

A. GENERAL

1. REHABILITATION

The following operating conditions apply to high, moderate and low significance areas:

1.1 A bond or security deposit will be required from the operator to ensure rehabilitation is carried out.

1.2 Tailings and other materials shall be bladed to meet the contour of the valley walls. Conical or other mounds of tailings or gravels shall not be left in valley bottom. Slopes on all remaining low relief piles should be less than 2:1 (Microtopography of mounds less than 1 to 2 meters in height are best).

1.3 Smooth tailings ramps with long slope lengths shall be modified to provide mounds or contours perpendicular to the ramp slope (maximum mound height should be less than 1 meter).

1.4 Topsoil and other suitable soil materials shall be salvaged, prior to any mining activity and stored for use in rehabilitation. The purpose of this material is to provide, where possible, a minimum of 10 centimeters of cover to aid in revegetation.

1.5 Streams (natural and man-made) shall be maintained or constructed in accordance with design criteria specified under operating conditions. In low significance areas the constructed channel slopes shall be reduced by zig-zagging or creating sinuous channels compatible with the erosion resistance of the soils in which they are constructed.

2. FUEL STORAGE AND HANDLING

2.1 The operator shall establish storage and handling sites for fuel and hazardous material to minimize any contamination of any surface or ground water and the threat to wildlife, fish habitat or fish harvesting area.

2.1.1 The operator shall establish procedures to contain and cleanup fuel or other hazardous material spilled, misused or allowed to escape during normal fuel transfers and for unanticipated events involving loss of fuel.

2.1.2 The operator shall locate fuel storage areas containing an above ground tank exceeding 2300 litres in capacity at least 30 meters from the annual high water level of a waterbody and surrounded by an impermeable dyke (synthetically lined or constructed with impervious materials) to contain and retain the product.

2.1.3 The operator shall locate fuel storage sites where less than 2300 litres capacity is stored at least 30 meters from the annual high water level of a waterbody.

2.2 The loss of fuel from a storage facility or during transfer must be reported to the regulatory agency immediately (24 hour Spill Report phone number is 667-7244).

2.3 All operators will comply with the provisions of the Yukon Territory Gasoline Handling Act.

3. DOMESTIC WASTE WATER

3.1 The Holder shall obtain a permit(s) for sewage, refuse and garbage disposal at his camp(s) pursuant to Commissioner's Order(s) 1974-65 and 1961-3B, Public Health Act R.O. 1958, c.92, s.1.

3.2 Sewage treatment facilities shall not be located less than 30 meters from any water supply, lake, stream or other watercourse without prior approval of the Controller.

4. GARBAGE

All garbage and refuse shall be removed from the site or where appropriate, totally incinerated at locations not less than 30 meters from any water supply or stream and buried under not less than 1 meter of compacted soil.

5. ALL OTHER SOLID WASTE MATERIAL

The Holder shall remove to an appropriate location, all other waste material from operations including but not limited to scrap metal, discarded machinery and parts, barrels and kegs; prior to the expiry date of the authorization; or with prior approval upon site abandonment.

6. FISH PASSAGE

Where an operation is located downstream of an A, B or C reach classification, water withdrawal methods shall not prevent fish passage.

7. MONITORING

Regular monitoring of effluent and receiving water quality is the responsibility of the authorization holder.

B. SITE SPECIFIC

OPERATIONAL STANDARDS FOR HIGH SIGNIFICANCE AREAS (A)

1. Rate and Method of Water Acquisition

All water acquisitions for placer operations, shall be by pumping. If water is withdrawn from a fish

bearing stream, the pump must be screened to prevent the intake of fish.

2. Quality of Waste Water Discharge

There shall be no surface flow discharge of sediment contaminated waters to any stream (i.e. total recycle).

2.1 No discharge shall be toxic to fish.

3. Diversions

There will be no diversions of the stream.

4. Leave Strips

A vegetated strip 30 meters wide, shall be left intact on each side of the stream. A berm, where required, shall be constructed immediately adjacent to the leave strip, between the leave strip and the worked ground.

5. Equipment

Machinery and equipment shall not be operated within the wetted perimeter of the stream unless authorized.

OPERATIONAL STANDARDS
FOR MODERATE SIGNIFICANCE AREAS (B)

1. Rate and Method of Water Acquisition

All water acquisitions for placer operations shall be by pumping. If water is withdrawn from a fish bearing stream the pump shall be screened to prevent the intake of fish.

2. Quality of Waste Water Discharge

All discharges shall not exceed the following criteria at point of discharge:

Parameter	Maximum Concentration of Any Sample
Suspended Solids	100 mg/l* (see Compliance Schedule)
Oil & Grease	5 mg/l
Arsenic (Dissolved)	0.10 mg/l
Mercury (Total)	0.005 mg/l

* Above background - measured at headwaters (i.e. upstream of grounds disturbed by mining activity).

2.1 No discharge shall be toxic to fish.

3. Diversions

There will be no diversions of the stream reach.

4. Leave Strips

A vegetated strip 15 meters wide, shall be left intact on each side of the stream. A berm where required shall be constructed, immediately adjacent to the leave strip, between the leave strip and the worked ground.

5. Equipment

Machinery and equipment shall not be operated within the wetted perimeter of the stream unless authorized.

OPERATIONAL STANDARDS
FOR MODERATE SIGNIFICANCE AREAS (C)

1. Rate and Method of Water Acquisition

Water acquisitions for placer mining require fish screens to prevent the intake of fish, when water is withdrawn from a fish bearing stream and shall be located and protected in accordance with stability criteria specified under "Diversions."

2. Quality of Waste Water Discharge

All discharges shall not exceed the following criteria at point of discharge:

Parameter	Maximum Concentration of Any Sample
Suspended Solids	100 mg/l* (see Compliance Schedule)
Oil & Grease	5 mg/l
Arsenic (Dissolved)	0.10 mg/l
Mercury (Total)	0.005 mg/l

* Above background - measured at headwaters (i.e. upstream of grounds disturbed by mining activity.

2.1 No discharge shall be toxic to fish.

3. Diversions

3.1 If streamside cover is removed, other precautions must be undertaken to prevent unintentional non-point sediment discharges into the stream. Berming, site grading or any other method of accomplishing the above should be identified and approved prior to stream cover removal.

3.2 Design plans for any stream diversion should be developed by professional consultants and approved by DIAND through the "one-window" approach prior to implementation.

3.3 Stream diversions must be stable and, should additional A, B or C habitat exist upstream, be able to guarantee fish passage around the claim.

3.4 Efforts should be made to ensure that stream diversions are undertaken in such a manner that stream bank vegetation is preserved along at least one bank. This will ensure that the entry of nutrients in the form of leaf litter, detritus, and terrestrial insects into the aquatic environment is not interrupted.

3.5 Stream diversions are not to be made through areas where the depth of overburden precludes establishment of a stable channel.

3.6 Diversion channel construction may be undertaken at any time provided that this is done in isolation of streamflow. Initial flushing and diversion of streamflow should be undertaken during the short period of time during spring breakup when suspended solids concentrations are naturally high.

3.7 Rediversion of the stream channel to a position of long term stability and fish habitat rehabilitation is to be undertaken on a progressive basis so that each section of stream is stablized and made habitable to fish within two seasons after mining.

3.8 Diversions shall be designed to contain the one in ten year flood event.

OPERATIONAL STANDARDS FOR LOW SIGNIFICANCE AREAS (D)

1. Rate and Method of Water Acquisition

Water acquisition works shall be located and protected in accordance with stability criteria specified under, "Diversions."

2. Quality of Waste Water Discharge

All waste water discharges shall not exceed the following criteria at point of discharge:

Parameter	Maximum Concentration of Any Sample
Suspended Solids	100 mg/l or 1000 mg/l* (see Compliance Schedule)
Oil & Grease	5 mg/l
Arsenic (Dissolved)	0.10 mg/l
Mercury (Total)	0.005 mg/l
Settleable Solids	Less Than .1 ml/l

* Where a D category stream flows into an A, B or C category stream, the suspended solids content of the effluent shall be no greater than 100 mg/l above background measured at the headwaters (i.e. upstream of ground disturbed by mining activity). If a D category stream discharges into a major D category stream the suspended solids content of effluent to that stream shall not exceed 1000 mg/l.

2.1 No discharge shall be toxic to fish.

3. Diversions

Diversions shall be designed to contain the one in five year flood event.

4. Stream Stability

Stream hydraulic stability will be maintained to the same level of protection as is specified for diversions.

OPERATIONAL STANDARDS FOR DESIGNATED AREAS (X)

All standards for Low Significance Areas (D), except for water effluent standards, will apply for this classification. Water effluent standards which will be "phased-in" are presented in the Compliance Schedule on page 41.

VII SUMMARY OF SITE SPECIFIC MINING PRACTICES

REACH CLASSIFICATION	WATER ACQUISITION	ULTIMATE SUSPENDED SOLIDS EFFLUENT STANDARD	DIVERSIONS	LEAVE STRIPS
A	1) Taken by pumping only. 2) Screening required.	1) 0 mg/l suspended solids. 2) No toxic discharge.	Not permitted.	1) 30 meters wide, on both sides of stream. 2) A berm may be required.
B	1) Taken by pumping only. 2) Screening required.	1) 100 mg/l suspended solids. 2) No toxic discharge.	Not permitted.	1) 15 meters wide on both sides of stream. 2) A berm may be required.
C	Screening required.	1) 100 mg/l suspended solids. 2) No toxic discharge.	1) Must contain one in ten year flood. 2) Provision of fish passage. 3) Opened during spring freshet.	One bank to remain vegetated.
D	Screening required if fish present.	1) 100 mg/l if to A, B, C or D. 2) 1000 mg/l suspended solids if flowing into a major D. 3) No toxic discharge.	1) Must contain one in five year flood. 2) Fish passage if A, B or C upstream.	Not required.
X	Screening required if fish present.	1) 100 mg/l if to A, B, C or D. 2) 1000 mg/l suspended solids if flowing into a major D. 3) No toxic discharge.	1) Must contain one in five year flood.	Not required.

VIII COMPLIANCE SCHEDULE

All conditions of the guidelines package will become effective during the first year of guidelines implementation with the exception of the effluent standards. Operators on creeks presently being mined will be required to meet the water standards, on their particular reach, as outlined below. Operators who intend to begin new operations on creeks not mined before, will be required to commence their operations with the ultimate effluent standard being required during their first year of operation.

REACH CLASSIFICATION	SUSPENDED SOLIDS CRITERIA COMPLIANCE DATE
A	1984 - 100 mg/l 1985 - 0 mg/l
B	1984 - 100 mg/l
C	1984 - 1000 mg/l 1985 - 500 mg/l 1986 and 1987 - 300 mg/l 1988 - 100 mg/l
D	1984 - 1000 mg/l *1985 - 500 mg/l *1986 and 1987 - 300 mg/l *1988 - 100 mg/l
X	1984 - 1000 mg/l *1985 - 500 mg/l *1986 and 1987 - 300 mg/l *1988 - 100 mg/l

* These "phase-in" requirements are applicable to those reach classifications that do not discharge directly to major D reaches.

Another presentation of the Compliance Schedule is illustrated on page 42.

REACH CLASSIFICATION AND COMPLIANCE
SCHEDULE FOR SUSPENDED SOLIDS CRITERIA

REACH CLASSIFICATION	1984	1985	1986	1987	1988
A	100	0	0	0	0
B	100	100	100	100	100
C	1000	500	300	300	100
D to Major D	1000	1000	1000	1000	1000
D to all others	1000	500	300	300	100
X to Major D	1000	1000	1000	1000	1000
X to all others	1000	500	300	300	100

APPENDIX 4.0

NATIONAL POLLUTION DISCHARGE ELIMINATION SYSTEM PERMITTING INFORMATION

(Source: Environmental Protection Agency 1986)

Fact Sheet

United States Environmental Protection Agency
Region 10
1200 Sixth Avenue
Seattle, Washington 98101
(206) 442-1646

Date:

PROPOSED ISSUANCE OF NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMITS TO DISCHARGE POLLUTANTS PURSUANT TO THE PROVISIONS OF THE CLEAN WATER ACT

Region 10 has tentatively determined to issue 108 NPDES permits to individual placer miners in the State of Alaska. This fact sheet includes (a) the tentative determination of the Environmental Protection Agency (EPA) to issue the permits, (b) information on public comment, public hearing and appeal, (c) the description of the industry and proposed discharges, (d) other conditions and requirements.

Persons wishing to comment on the tentative determinations contained in the proposed permits may do so by the expiration date of the Public Notice. All written comments should be submitted to EPA as described in the Public Comments Section of the attached Public Notice.

These draft permits are identical to the 538 permits that were valid for the 1985 mining season. Since there are no new issues contained in these proposed permits, EPA has tentatively determined that a public hearing will not be necessary. In accordance with 40 CFR 124.12, a hearing may be granted by the administrator if requests reveal a significant degree of public interest or if substantive new data is presented during the comment period that was not considered during the development of draft permits.

After the expiration date of the Public Notice, the Director, Water Division, will make final determinations with respect to issuance of the permits. The tentative determinations contained in the draft permits will become final conditions if no substantive comments are received during the public comment period.

The permits will become effective 30 days after the final determinations are made, unless a request for an evidentiary hearing is submitted within 30 days after receipt of the final determinations. An evidentiary hearing request must meet all the requirements of 40 CFR 124.74 and set forth material issues of fact relevant to the permit issuances.

The proposed NPDES permits and other related documents are on file and may be inspected and copies made in Room 10C, 1200 Sixth Avenue, Seattle, Washington 98101, at any time between 8:30 a.m. and 4:00 p.m., Monday through Friday. Copies and other information may be requested by writing to EPA at the above address to the attention of the Water Permits Section, M/S 521, or by calling (206) 442-1646. This material is also available from the EPA Alaska Operations Office, Room E551, Federal Bldg., 701 C Street, Anchorage, Alaska 99513 or EPA Alaska Operations Office, 3200 Hospital Drive, Suite 101, Juneau, Alaska 99801. A copying machine is available in the Seattle Office for public use at a charge of 20 cents per copy sheet. There is no charge if the total cost is less than 25 dollars.

I. Activity

The process of placer mining involves the removal of placer gold from alluvial deposits both in existing stream beds and ancient stream deposits. The placer mining process uses gravity and water to wash and separate gold in a sluice box and/or washing plant. Operations may consist of simple suction dredges, large mechanized operations, or large continuous bucket line floating dredges. These operations are all similar in that they recover free gold and other precious metals from placer deposits by washing the material through trommels, screens, and sluices.

In addition to the sluicing phase of mining operations, many operators must remove overlaying materials from the placer deposit. Depending on practices employed, such as mechanical stripping with heavy equipment or hydraulic stripping, some of this material may enter the receiving water. Direct discharges occurring as a result of overburden removal are not authorized by this permit.

Larger commercial operations include a wide range of systems for handling the placer deposits. Mechanical means include the normal range of earthmoving equipment and the more specialized floating dredges. The gold separation phase involves a gravity process of sluicing with the sluicing apparatus located either on a dredge, an elevated structure, or on bedrock. the sluicing phase may be preceded by separating the gravel into various classifications.

Placer deposits found in the stream beds may be located below or above the current stream channel. The deposits themselves are located immediately above the bedrock layer where significant flows of groundwater commonly occur. Groundwater flows which are intercepted at the mine pit contribute to the discharge.

II. Effluent Characteristics

Discharges from placer mining operations consist of water and the materials found in the alluvial deposits (sand, silt, clay, trace minerals and metals, etc.). Some of the minerals and metals which have been measured include zinc, manganese, magnesium, iron, copper, lead, chromium, molybdenum, strontium, zirconium, antimony, boron, mercury, beryllium, selenium, phosphate, potassium, sodium, sulfate, barium, chloride, calcium, and cyanide. Most of these parameters are found in small concentrations and are of little significance. The pollutant discharges of primary concern are settleable solids, turbidity, and arsenic. The only toxic pollutant of concern is arsenic.

III. Types of Placer Operations Covered by the Permit

EPA is proposing to issue permits for Alaska commercial placer mining operations, which are defined as facilities processing more than 20 cubic yards per day. This limit excludes small scale operations that are not appropriately covered under these permits.

IV. Statutory Requirements

The terms and conditions of these permits were developed pursuant to Sections 301(b)(1)(C), 301(b)(2)(A), (C), & (D), and 402(a)(1) and (2) of the Clean Water Act.

V. Basis for Effluent Limitations

The Act requires industries to apply treatment technology representing Best Available Technology (BAT) that is economically achievable by July 1, 1984. EPA has not promulgated Effluent Guidelines for the Placer Mining Segment of the Ore Mining and Processing Point Source Category for BAT. Therefore, as provided in Section 402(a)(1) of the Act, EPA used best professional judgement to determine BAT limits contained in these permits.

In an effort to determine BAT limitations for the Alaska placer mining industry, EPA conducted a detailed analysis of the industry. Treatment technologies were evaluated for pollutant removal efficiencies, costs, and practicability. Technologies evaluated include settling ponds, flocculant addition, and partial and full recycle of process water. The technical and economic information collected during field visits to mining operations during the 1983 and 1984 operating seasons are the primary sources of data used in the analyses.

Detailed economic evaluations were conducted to determine the BAT treatment technologies which are economically achievable. Based on the evaluations, the level of treatment which can be universally afforded by the placer mining industry to control wastewater discharges has been determined to be simple settling ponds. By utilizing simple settling ponds and routine pond maintenance, there should be no apparent serious economic impact to the industry.

Data collected in previous years indicates that settleable solids, turbidity, and arsenic are the primary pollutants associated with the placer mining industry in Alaska. To determine the general efficiency of individual operations in relation to pollution abatement, EPA has determined that the permittee is responsible for the monitoring and reporting of these parameters.

The effluent limitations specified in Part I. of the draft permit includes a settleable solids limit of 0.2 ml/l (instantaneous maximum). In 1985, the Alaska Department of Environmental Conservation (ADEC), certified the previously proposed NPDES permits with the stipulation that the allowable instantaneous effluent limit for settleable solids not exceed 0.2 ml/l. This requirement superceded EPA's 1985 proposed permit limit of 1.5 ml/l daily maximum and 0.7 ml/l monthly average. The State required a more stringent settleable solids limit in order to provide reasonable assurance for compliance with several water quality criteria listed in State Statutes 18AAC 70.020(b) that protect contact recreation, growth, and propagation of fish and wildlife, and water supply sources that require no measurable increase in concentrations of sediment above natural conditions. Additionally, the ADEC certification letter cited several data sources that support their contention that 0.2 ml/l of settleable solids is an achievable limit for the placer mining industry.

EPA supported the ADEC certification that 0.2 ml/l settleable solids is an achievable limit. EPA, therefore issued the 1985 permits with the 0.2 ml/l settleable solids limit and modified all other placer mining permits as well.

The following is a brief discussion of several documents and data bases in support of a 0.2 ml/l settleable solids effluent limit:

1. Evaluations of Settleable Solids Removal - Alaska Gold Placer Mines; July 11 - 21, 1977; National Enforcement Investigations Center, Denver, Colorado; U.S. EPA - 330/2-77-021. Data from this study show that settleable solids can be reduced to levels below 0.2 ml/l with adequately designed and maintained settling ponds.

2. Evaluation of Wastewater Treatment Practices Employed At Alaskan Gold Placer Mining Operations; July 17, 1979; Calspan Advanced Technology Center; U.S. EPA 68-01-4845. Data from this study show that adequately designed and maintained settling ponds can achieve a settleable solids concentration of less than 0.1 ml/l.

3. In 1984, EPA - Region 10 conducted a Trend Analysis Study at seven placer mines in Alaska. At six of the sites, the average achievable settleable solids limit was less than 0.1 ml/l. The average achievable limit at the remaining site was 0.2 ml/l.

4. 1984 Alaskan Placer Mining Study and Testing Summary Report (preliminary draft); September 21, 1984; U.S. EPA Effluent Guidelines Division; U.S. EPA 68-01-6700. This study showed that operations utilizing well designed and maintained treatment facilities are capable of achieving settleable solids concentrations of less than 0.2 ml/l.

5. In July 1985, the U.S. EPA Industrial Technology Division in Washington, D.C. conducted a review of the Discharge Monitoring Reports (DMR's) submitted by Alaskan placer miners for the 1984 mining season. They recorded that 107 facilities submitted

wastewater quality data. Twenty-one facilities achieved a settleable solids level of 0.2 ml/l or less. Ten facilities achieved less than 0.2 ml/l for a period of one month. From the 107 DMR submissions, there were 2,610 data points that were less than 0.2 ml/l.

6. Treatment of Placer Mining Effluents Using Settling Ponds; December 1984; Government of Yukon, Department of Economic Development and Tourism; Contract No. 5-4-0276. This study surveyed 22 representative placer mines in Canada. Study results show that sixty percent of the mines met the objective of achieving 0.2 ml/l settleable solids.

7. ADEC field sampling results from the Fortymile District in Alaska during 1984 show that 60% of the ten mines sampled could meet the settleable solids limit of 0.2 ml/l. In 1985, fifteen mines were sampled with a 53% compliance rate with 0.2 ml/l settleable solids.

8. Placer Mining Wastewater Treatment Technology Project (phase 3 final report); March 1985; State of Alaska, Department of Environmental Conservation. Results from this study show that the three best performing recycle sites had a final pond effluent which averaged 0.1 ml/l settleable solids.

9. The instantaneous maximum settleable solids limitation proposed in the EPA Development Document for Proposed Effluent Limitations Guidelines and New Source Performance Standards for the gold placer mining subcategory is 0.2 ml/l. In the development document, a summary of long-term averages from treatability tests show that settling ponds with between 3 and 6 hours of retention will achieve concentrations of settleable solids below 0.2 ml/l.

10. A preliminary evaluation of the 1985 data from EPA-Region 10 compliance inspections show that those operations utilizing effective treatment systems can achieve a 0.2 ml/l settleable solids effluent limit.

    Specifically, 53 data points are available from discernible and confined effluent sources. Of those 53 data points, 31 show values of greater than 0.2 ml/l settleable solids and 22 data points are at or below the 0.2 ml/l permit limit. This analysis shows that 58% of the settleable solids data points are out of compliance and 42% are in compliance. This analysis alone should not be construed to mean that 0.2 ml/l settleable solids is not achievable by more than half of the placer miners sampled in 1985.

A closer look at the data reveals a different statistical value. For example, 17 of the 31 data points that were out of compliance were from operations that were not utilizing off-stream (bypass) treatment systems. In other words, they were direct discharges to receiving streams without prior treatment. Thirteen of the 31 were from operations with ineffective treatment systems, e.g., settling ponds full of sediment, limited retention time, lack of pond maintenance, short-circuiting, poor design, etc. One of the 31 data points that was out of compliance is questionable and there is no explanation as to why.

A statistical analysis of the 22 data points that were in compliance with the 0.2 ml/l settleable solids limit show the following. Twenty of the 22 data points were less than 0.2 ml/l settleable solids, 18 of the 20 were less than 0.1 ml/l, and 2 of the 22 were 0.2 ml/l. Another analytical approach from the data points that were in compliance show that 91% of the settleable solids values from operations utilizing effective treatment systems should be less than 0.2 ml/l, or 89% should be less than 0.1 ml/l, and around 9 - 10% should be 0.2 ml/l.

EPA has concluded that a settleable solids limit of 0.2 ml/l is achievable if properly designed, constructed, and maintained treatment systems are utilized.

In addition to the effluent limitations reflective of BAT, the permit includes effluent limitations which will ensure compliance with Alaska water quality standards for turbidity and arsenic (see Alaska Administrative Code 70.020).

The turbidity and arsenic limitations contained in the proposed permit are the same as those limitations contained in all previously issued Alaska placer mining permits. EPA has concluded that to meet the State of Alaska's Water quality standards, for rivers and streams that are designated as drinking water sources, the effluent limitation for turbidity must be 5 NTU's above background, and the limit for arsenic is 0.05 mg/l. Both of these parameters are measured in the effluent prior to entering the receiving stream (end-of-the-pipe). If a placer mining facility meets the end-of-the-pipe limits it will be in compliance with State water quality standards.

The turbidity limit does not allow for the dilution effect of the receiving water which would take place within the 500 foot mixing zone allowed by State standards, because that kind of site specific information is not now available to EPA. Upon receipt of information demonstrating that the dilution effect of the receiving water justifies a less stringent limit, EPA would incorporate such a limit in the final permit. During the comment period on the 1985 permit issuance and modification, EPA received information from 72 placer mining permittees. EPA issued final permits to these facilities with a higher turbidity limit. Such information should be provided prior to the close of the public comment period. It should be recognized, however, that in most cases the dilution factor would result in only a nominal increase in the allowable turbidity number.

This permit does not authorize discharge from operations where mercury is used to recover gold. Discharges from operations utilizing chemicals to improve gold recovery in the process are not authorized under these permits.

VI. Basis for Monitoring and Reporting Requirements

All self-monitoring requirements considered the remoteness of the mining operations, the magnitude of the pollutants discharged, and the practicability of maintaining a valid quality assurance program.

Based on the applicability of settling ponds to BAT, the measurement of settleable solids is an indication of overall treatment efficiency. The permit requires monitoring for settleable solids twice per day during sluicing. The frequency is established because sampling for this parameter is relatively easy and it does not require the use of sophisticated equipment. Also, settleable solids sampling results can give the operator an immediate indication of the overall effectiveness of the treatment system.

EPA has concluded that the monitoring frequency for turbidity and arsenic shall be once per season. Monitoring for the pollutants has been established at less frequent intervals because this monitoring is more difficult and costly. Arsenic and turbidity samples are to be collected at the same time in an attempt to establish a site-specific correlation between these two parameters. Samples for monitoring purposes must be taken during sluicing at a time when the operation has reached equilibrium. For example, samples should be taken when sluice paydirt loading and effluent discharge are fairly constant. With this stipulation, EPA believes that the required monitoring frequencies will be sufficient to determine compliance with permit limitations.

EPA has concluded that permittees should not be required to monitor for mercury. This conclusion is based on data received during the 1982 and 1983 field seasons. Samples collected showed very low (below water quality criteria) values in almost all cases. Whenever mercury was found in process water influent, it was substantially removed with settling ponds. Based on these data, it is assumed that mercury would only appear in excess concentrations if it was used for enhanced gold recovery.

The results of all monitoring or notice of no discharge shall be reported to EPA by November 30 of each year.

VII. State Certification

Section 301(b)(1)(C) of the Act requires that an NPDES permit contain conditions which ensure compliance with applicable State water quality standards or limitations. The limitations for turbidity and arsenic were established pursuant to State water quality standards. Section 401 requires that States certify that Federally issued permits are in compliance with State law.

These permits are for operations within waters (inland waters) of the State of Alaska. EPA is requesting State officials to review and provide appropriate certification to these draft permits pursuant to 40 CFR 124.53.

APPENDIX 5.0

NATIONAL POLLUTION DISCHARGE ELIMINATION SYSTEM PERMIT APPLICATION

(Source: Environmental Protection Agency 1974)

Form Approved
OMB No. 158-R0096

..IONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
APPLICATION FOR PERMIT TO DISCHARGE - SHORT FORM C

FOR AGENCY USE

APPLICATION NUMBER								
DATE RECEIVED								
YEAR			MO.			DAY		

To be filed only by persons engaged in manufacturing and mining

Do not attempt to complete this form before reading accompanying instructions

Please print or type

1. Name, address, location, and telephone number of facility producing discharge

A. Name _____

B. Mailing address

1. Street address _____

2. City _____ 3. State _____

4. County _____ 5. ZIP _____

C. Location:

1. Street _____

2. City _____ 3. County _____

4. State _____

D. Telephone No. _____ _____
Area Code

2. SIC ☐☐☐☐
(Leave blank)

3. Number of employees _____

If all your waste is discharged into a publicly owned waste treatment facility and to the best of your knowledge you are not required to obtain a discharge permit, proceed to item 4. Otherwise proceed directly to item 5.

4. If you meet the condition stated above, check here ☐ and supply the information asked for below. After completing these items, please complete the date, title, and signature blocks below and return this form to the proper reviewing office without completing the remainder of the form.

A. Name of organization responsible for receiving waste _____

B. Facility receiving waste:

1. Name _____

2. Street address _____

3. City _____ 4. County _____

5. State _____ 6. ZIP _____

5. ☐ Principal product, ☐ raw material (Check one) _____

6. Principal process _____

7. Maximum amount of principal product produced or raw material consumed per (Check one)

Basis	Amount							
	1-99 (1)	100-199 (2)	200-499 (3)	500-999 (4)	1000-4999 (5)	5000-9999 (6)	10,000-49,999 (7)	50,000 or more (8)
A. Day								
B. Month								
C. Year								

EPA Form 7550-8 (Rev. 3-74) PREVIOUS EDITION MAY BE USED UNTIL SUPPLY IS EXHAUSTED

8. Maximum amount of principal product produced or raw material consumed, reported in item 7, above, is measured in (Check one):

A.☐ pounds B.☐ tons C.☐ barrels D.☐ bushels E.☐ square feet

F.☐ gallons G.☐ pieces or units H.☐ other, specify _____

9. (a) Check here if discharge occurs all year ☐, or

(b) Check the month(s) discharge occurs:

1.☐ January 2.☐ February 3.☐ March 4.☐ April 5.☐ May 6.☐ June

7.☐ July 8.☐ August 9.☐ September 10.☐ October 11.☐ November 12.☐ December

(c) Check how many days per week: 1.☐ 1 2.☐ 2-3 3.☐ 4-5 4.☐ 6-7

10. Types of waste water discharged to surface waters only (check as applicable)

Discharge per operating day	Flow, gallons per operating day					Volume treated before discharging (percent)				
	0.1-999 (1)	1000-4999 (2)	5000-9999 (3)	10,000-49,999 (4)	50,000- or more (5)	None (6)	0.1-29.9 (7)	30-64.9 (8)	65-94.9 (9)	95-100 (10)
A. Sanitary, daily average										
B. Cooling water, etc. daily average										
C. Process water, daily average										
D. Maximum per operating day for total discharge (all types)										

11. If any of the three types of waste identified in item 10, either treated or untreated, are discharged to places other than surface waters, check below as applicable.

Waste water is discharged to:	Average flow, gallons per operating day				
	0.1-999 (1)	1000-4999 (2)	5000-9999 (3)	10,000-49,999 (4)	50,000 or more (5)
A. Municipal sewer system					
B. Underground well					
C. Septic tank					
D. Evaporation lagoon or pond					
E. Other, specify					

12. Number of separate discharge points: A.☐ 1 B.☐ 2-3 C.☐ 4-5 D.☐ 6 or more

13. Name of receiving water or waters _____

14. Does your discharge contain or is it possible for your discharge to contain one or more of the following substances added as a result of your operations, activities, or processes: ammonia, cyanide, aluminum, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, phenols, oil and grease, and chlorine (residual). A.☐ yes B.☐ no

I certify that I am familiar with the information contained in the application and that to the best of my knowledge and belief such information is true, complete, and accurate.

Printed Name of Person Signing _____ Title _____

Date Application Signed _____ Signature of Applicant _____

18 U.S.C. Section 1001 provides that:

Whoever, in any matter within the jurisdiction of any department or agency of the United States knowingly and willfully falsifies, conceals, or covers up by any trick, scheme, or device a material fact, or makes any false, fictitious, or fraudulent statements or representations; or makes or uses any false writing or document knowing same to contain any false, fictitious, or fraudulent statement or entry, shall be fined not more than $10,000 or imprisoned not more than 5 years, or both.

EPA Form 7550-8 (Rev. 3-74) (Reverse)

APPENDIX 6

REGRESSION MODELS OF PLACER MINING INDUSTRY

APPENDIX 6

Regression Models of the Placer Mining Industry

This appendix presents the data used to generate the linear regession equations used to predict the effect of increased operating costs on the placer mining industry. All equations were tested for significance useing the r^2 statistic (Harnett and Murphy 1974). The equation giving the highest r^2 was chosen as the model for the specific relationship. Mathematical models, based on linear regression analysis, were developed to predict the effect of the price of gold (as the independant variable) on the following factors:

1) production of gold in ounces;
2) the number of active mining operations: and
3) the number of persons directly employed in the placer ming industry.

Gold production, the number of active mines, and employment data was obtained as unpublished data from the Mines Engineering Branch of DIAND in Whitehorse (Table A6.1). This analysis used the period from 1971 to 1985 to determine the relationship between the price of gold and production. 1971 was chosen as the start of the period as it is immediately prior to the price of gold being allowed to float on the international market.

Due to data limitations, the period 1978 to 1985 was used to model the relationship between the price of gold and employment in the placer mining industry and the relationship between the price of gold and the number of active mining

TABLE A6.1

Year	Production (oz.)	Value ($Can 1000)	Value (con 1981$ 1000)	Price ($US/ oz.)	Price ($Can 1981/ oz.)
1971	4390	180	426	41	98.1
1972	4230	254	574	59	132.1
1973	6810	661	1388	97	203.8
1974	9710	1583	2998	159	294.5
1975	15500	2449	4186	161	279.9
1976	17050	2165	3442	125	192.4
1977	20550	3226	4751	148	231.7
1978	20620	4536	6138	193	297.7
1979	28060	10074	12483	307	445.7
1980	58420	41887	47117	613	806.1
1981	79670	43978	43978	460	551.5
1982	59230	27483	24804	376	414.8
1983	75400	39887	34033	424	445.7
1984	75700	35385	28933	360	380.9
1985	79170	34360	27125	317	338.9

Year	# operations	# employees	Prod/Operation (oz./op.)	Emp/Op
1978	78	335	264.4	4.3
1979	118	489	237.8	4.1
1980	197	788	296.5	4.0
1981	223	781	357.3	3.5
1982	215	650	275.5	3.0
1983	241	769	312.9	3.2
1984	195	734	388.2	3.8
1985	190	700	416.7	3.7

operations.

Price vs Production (oz.)

The relationships were tested using the price of gold in $US, $Canadian and constant 1981 $Canadian. Regressions were also tested using both data pairs for the same years and for data pairs with the price of gold lagged by one year. The following relationships, of the form y = mx + b, were obtained:

1) Prod = 81430 x Price (1981 $Can) - 11,638,349

   r^2 = 0.885

2) Prod = 153 x Price ($US) - 2373

   r^2 = 0.85

3) Prod = 127 x Price ($Can) -1497

   r^2 = 0.89

4) Prod = 131 x Price (Can_{n-1}$) -1160

   r^2 = 0.94

Relationship number 4 was selected for use in the economic analysis (Figure A6.1). By way of comparison DOE (1983) used the following regression equation:

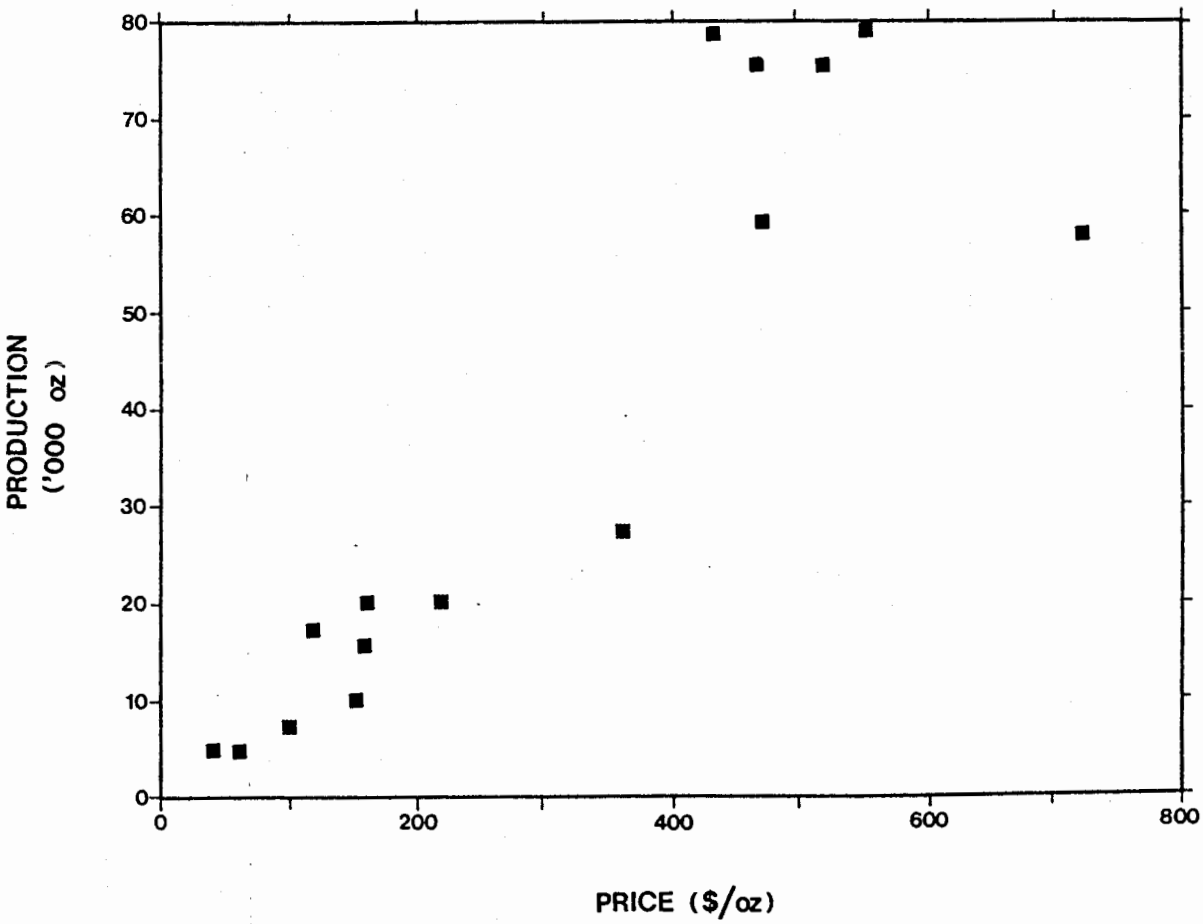
Prod = 180 x Price (US_{n-1}$) - 18,392

r^2 = 0.92

The relationship selected by DOE (1983) is steeper than that selected for use in this analysis. The DOE relationship will predict greater changes in the level of production than the model calculated in this appendix, given the same change in the price of gold. The DOE relationship is biased by the rapid growth in the placer mining industry between 1978 and 1981, extending the

FIGURE A6.1

Production vs Price



database from 1982 to 1985 moderates the relative effect of the boom in 1980 and 1981.

Price vs. Mining Activity

The following models for the relationship between the price of gold and the level of mining activity were determined and tested for significance:

1) No. Ops = 0.29 x Price ($Can) + 46

$r^2 = 0.75$

2) No. Ops = 0.25 x Price (Can_{n-1}$) + 70

$r^2 = 0.85$

Relationship number 2 was selected for use in the analysis. The scatter diagram for the selected data set is presented in Figure A6.2.

Price vs. Number of Employees

The following models were determined and tested in the process of selecting a relationship between the price of gold and the number of mine employees:

1) No. Emp = 0.99 x Price ($Can) + 200

$r^2 = 0.88$

2) No. Emp = 0.69 x Price (Can_{n-1}$) + 354

$r^2 = 0.78$

The first relationship was selected for use in the analysis. The scatter diagram for the selected data set is presented in Figure A6.3.

FIGURE A6.2

Price vs Number of Operations

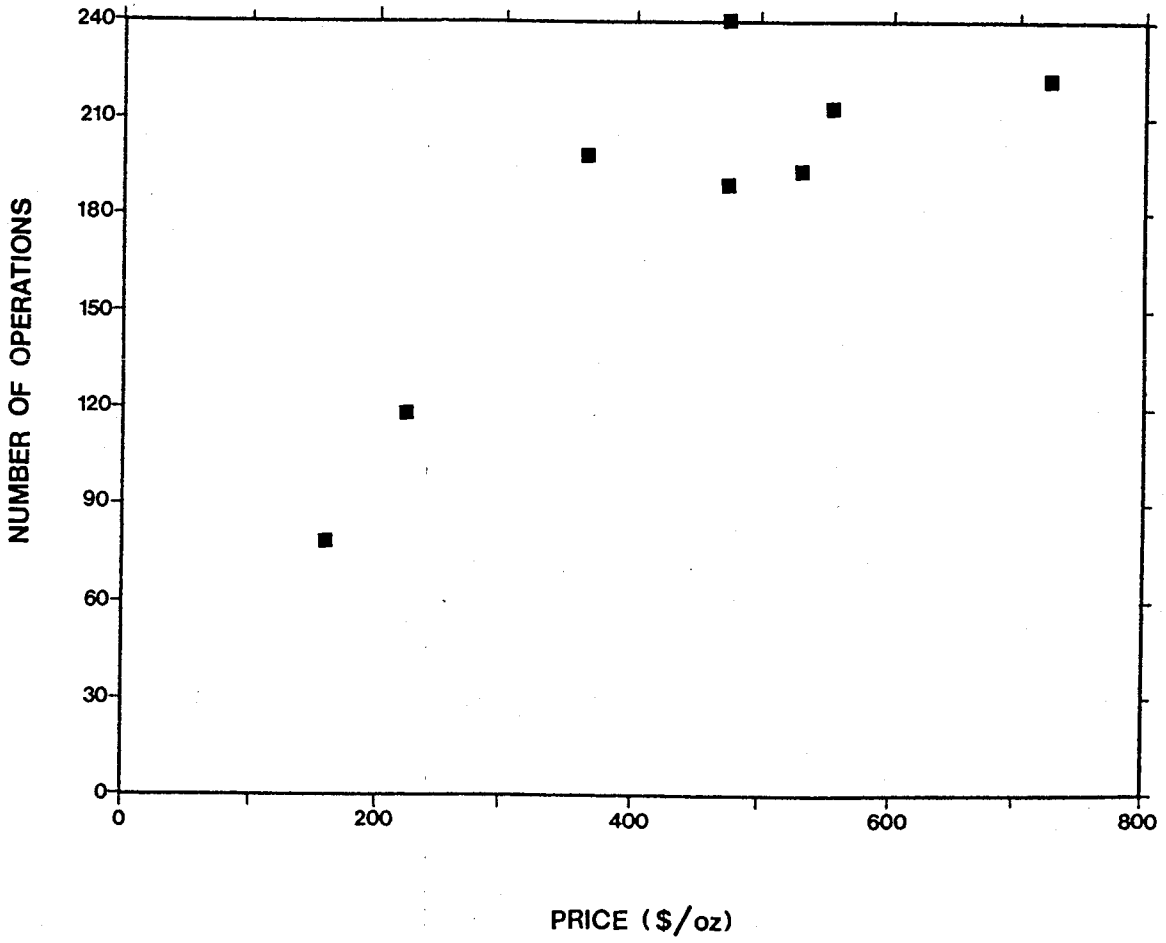
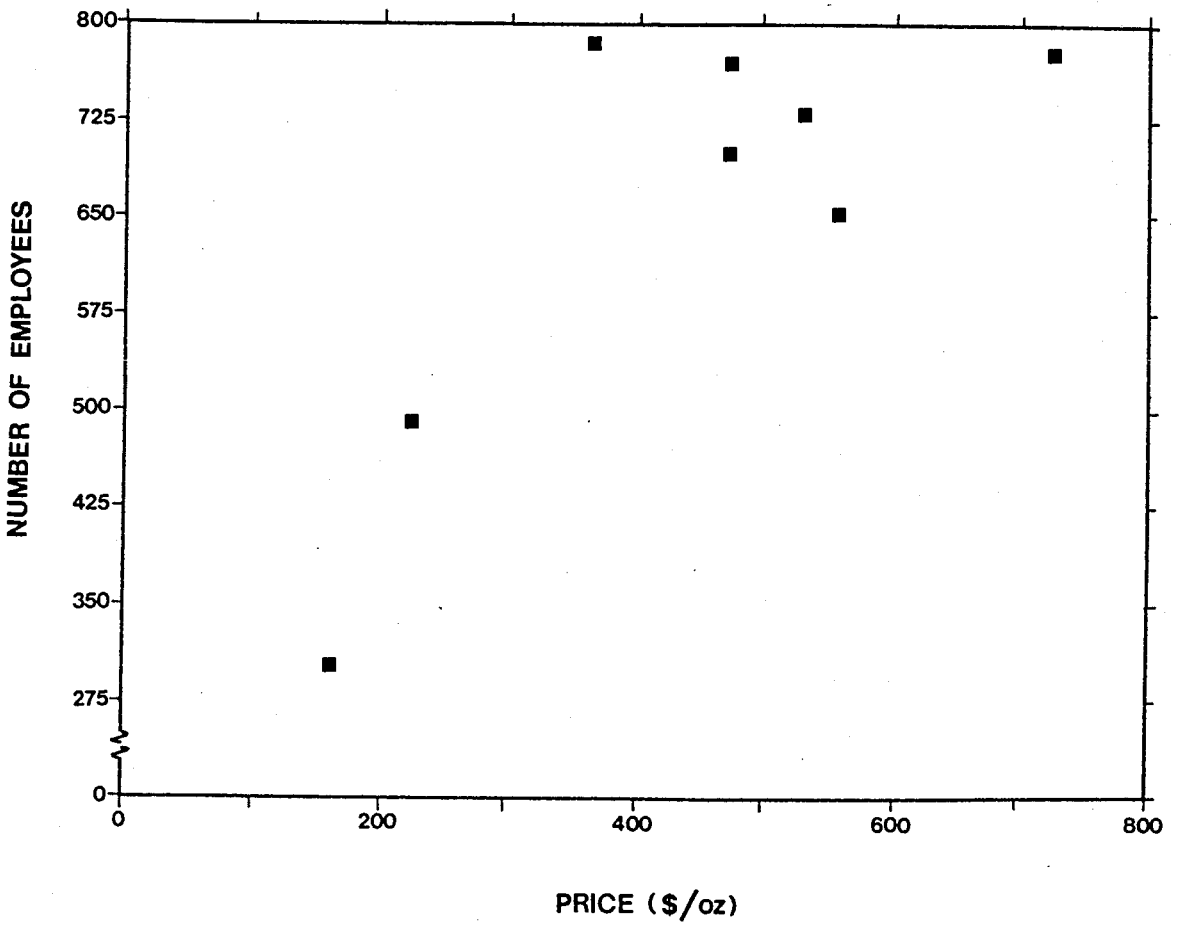


FIGURE A6.3

Price vs Number of Employees



It is interesting to note that the most significant relationships between price and production and price and the number of active operations are obtained by advancing the price of gold data one year forward. This may mean that a miner decides to operate based on the previous year's data. This is reasonable as there is certainly a requirement for lead time to secure mining claims and ready equipment.

On the other hand, the most significant relationship between the number of employees and the price of gold was obtained using current data. This may result from the operators ability to adjust his labour force almost immediately in reponse to changes in the price of gold.

APPENDIX 7

INCREMENTAL COST TO PLACER MINING INDUSTRY OF IMPLEMENTING PROPOSED GUIDELINES

APPENDIX 7

Incremental Cost to Placer Mining Industry of Implementing Proposed Guidelines

To estimate the impact of the proposed placer mining guidelines, using the regression equations developed in Section 8.2, requires the determination of the incremental costs to the industry resulting from implementation of the guidelines. These incremental costs must be expressed in terms of Canadian dollars per ounce of gold produced.

Increased costs of production result from the following factors:

1) the need to meet specified effluent quality standards;
2) the need to rehabilitate the mine site after mining is completed;
3) The need to have diversions on "C" classified streams designed by professional engineers;
4) the need to provide detailed development plans; and
5) the loss of recoverable gold because of the requirements for of diversions and leave strips on "A" and "B" classified streams.

WATER TREATMENT

DOE and DFO (1983) estimate the cost per operator of meeting the effluent quality standards as:

	Capital Cost	Operating Cost
1) no discharge	$44,500	$504/yr
2) 100 mg/l	$32,500	$360/yr
3) 1000 mg/l	$6,500	$84/yr

Operating costs assume that the mine operates eight hours/day and 75 days/year.

The above estimates include the cost of building settling ponds which are reported as $6,500, $12,000, and $12,000 respectively, for the 1000mg/l, 100 mg/l and 0 mg/l effluent standards. The cost of construction of these ponds is based on the size required to achieve a specified retention time, the length of time required with a specified piece of equipment to build the ponds, and an hourly equipment cost. I feel that the length of time rerquired to construct the settling ponds is underestimated. If settling pond berms are to last the season, they must not only be pushed into place, they must be shaped and compacted. The cost of constructing the settling ponds will be doubled to reflect the increased machine time rerquired to properly construct the berms.

Also, some form of outlet control/overflow structure will be required to prevent downcutting of the berm. The installed cost of the control structure is estimated at $10,000 per mine.

The useful life of an effluent treatment system is assumed to be three years. The annual cost of meeting the effluent quality standards become:

1) no discharge $22,500

2) 100 mg/l $18,500

3) 1000 mg/l $7,600

DOE (1983) states that 0.9% of existing operators would have to meet the "no discharge" standard, 47.8% would be required to meet the 100 mg/l standard and 59.3% would be required to meet the 1000 mg/l stnadard. Weighting the cost per standard by the proportion of miners required to meet that standard gives an annual incremental cost per operation of approximately $13,600.

REHABILITATION

There are two rehabilitation costs to be considered:

1) the cost of recontouring the mine site to match natural contours; and

2) the cost of storing and respreading topsoil.

DOE (1983) estimated the cost of recontouring as a range, from $6,230 to $12,180 ($9,205 average) per operation. IEC Beak Ltd. (1983) estimated a weighted average cost of recontouring at $21,500 per operation (range from $4,500 for small operations to $90,000 for very large operations).

Similarily, the annual cost associated with the storage abd respreading of topsoil were estimated at $2,500 per operator by DOE and $4,400 per operator by IEC Beak.

This paper will assess the range of annual site

rehabiltiation costs, from $11,705 per operator to $25,900 per operator.

DIVERSIONS

The requirement that diversions on "C" classified streams be designed by professional engineers results in two additional costs to the placer miner:

1) the cost of the engineering design; and
2) the additional cost of constructing the diversion to the specifications of the design.

DOE estimates that fifteen percent of the mines presently operating would require stream diversions to be professionally designed. The cost for such designs are expected to range from $2,500 to $10,000.

While DOE (1983) acknowledges that there would likely be additional construction costs associated with the installation of designed diversions, no attempt is made to estimate the amount. This paper assumes that the additional cost of constructing the diversions to engineering specifications will be $3,500 per operation (3 days of machine time and 3 days for layout and inspection).

Engineered diversions are assumed to last one year. Therefore, the annual, weighted, incremental cost associated with the requirement to have professionaly designed diversions will range from $900 to $1900.

DEVELOPMENT PLANS

DOE (1983) admits that the cost of preparing and updating development plans may be substantial but does not provide an estimate of the incremental cost. KPMA estimates an average cost per operation associated with the need to provide development plans as $8,000 (IEC Beak Ltd. 1983).

LOST GOLD

On "A" and "B" classified streams some recoverable gold will be lost as a result of the requirements for no diversions and leave strips. DOE (1983) states that 2.3% of existing operators were on "A" classified streams and 3.6% were on "B" streams. Leave strips on "A" streams are 60 meters wide while leave strips on "B" streams are 30 meters wide.

"A" and "B" classified streams are most likely to be in relatively wide valleys because streams with high fishery values must have significant year round flow. If a wide valley is assumed to have a minimun width of 300 meters, the required leave strips reduce the useable area by a maximun of 33% on an "A" stream and 16% on a "B" stream.

Assuming the average mine produces 350 ounces of gold per year (DOE 1983), the requirements for no diversions and leave strips will result in an annual loss of gold production of 120 ounces from mines on "A" streams and 60 ounces from mines on "B" streams. Weighting the projected lost in production by the

proportion of mines on "A" and "B" streams and multiplying by the price of gold (assumed to be $470/oz. Can.), gives an average annual cost of $2200.

TABLE 1

ADJUSTED PRICE OF GOLD REFLECTING INCREASED OPERATING COSTS DUE TO IMPLEMENTATION OF THE PROPOSED PLACER MINING GUIDELINES

	Incremental Cost/Operator	
Production/Operation (ounzes)	$36,400	$51,600
276	$132/oz	$187/oz
416	$87/oz	$124/oz

BIBLIOGRAPHY

BIBLIOGRAPHY

American Public Health Association. 1976 Standard Methods for the Examination of Water and Wastewater: Including Bottom Sediments and Sludges, 14th Edition.

Best, J. L. and A. C. Brayshaw. 1985 Flow separation - a physical process for the concentration of heavy minerals within alluvial channels. The Journal of the Geological Society, Vol. 142, Part 5. pp 747-756.

British Columbia; Ministry of Energy, Mines and Petroleum Resources. 1985 Guide to Legislation and Approvals in Placer Mining. Prepared by the Mineral Resources Division, Inspection and Engineering Branch.

British Columbia; Ministry of Environment. Pollution Control Board. 1979 Pollution Control Objectives for the Mining, Smelting and Related Industries of British Columbia. B. C.

Bureau of Land Management. 1986 H-3809-1 - Surface Management Handbook. Alaska State Office.

Carr, D. W. and F. W. Anderson. 1968 The Yukon Economy: Its Potential for Growth and Continuity. Volume 1, Final Report. D. W. Carr and Associates, Ottawa.

Christensen, I., 1983 Resouces, Regulation, and Reality: Report of the Yukon Placer Mining Guidelines Committee 1983. Prepared for the Yukon Territorial Water Board. Whitehorse.

Church, M. and K. M. Rood. 1982 Peace River Surveys, 1979 and 1981. Unpublished report, Department of Geography, University of British Columbia.

Clark J. W., W. Viessman, M. J. Hammer. 1971 Water Supply and Pollution Control. International Textbook Company. New York, New York.
1971

Cooper, A. C. 1965. The Effect of Transported Stream Sediments on the Survival of Sockeye and Pink Salmon Eggs and Alevins. International Pacific Salmon Commission. Bulletin XVIII, New Westminster, B. C.

Davidson, D. 1985. Placer Miners Fire Salvo at feds: Pull out of research group. The Whitehorse Star, Monday September 9,1985. Whitehorse.

Department of Indian Affairs and Northern Development (DIAND), Department of Fisheries and Oceans (DFO) and Department of Environment (DOE), 1983 Yukon Placer Mining Guidelines, Draft Report. Prepared by the Interdepartmental Committee on Placer Mining. Vancouver.

Department of the Environment. 1983 Socioeconomic Impact Analysis for Yukon Placer Mining Guidelines. Prepared by Environmental Protection Service, Environmental Strategies Directorate and Canadian Resourcecon Ltd.

Department of Environmental Conservation. 1986a Placer Mining Highlights. Juneau Alaska.

Department of Environmental Conservation. 1986b Interagency Placer Mining Enforcement Priorities. Juneau Alaska.

Department of Fisheries and Oceans and Department of Environmnet. 1983a A Rationale for the Suspended Solids Standards for Yukon Streams Subject to Placer Mining. New Westminster, B. C.

Department of Fisheries and Oceans and Department of Environment. 1983b The Attainment and Cost of Placer Mining Effluent Guidelines. New Westminster, B. C.

Department of Fisheries and Oceans, 1983 A Rationale for the Classification of River, Streams, and Lakes in the Yukon Territory in Relationship to the Placer Mining Guidelines.

Department of Fisheries and Oceans. 1984 Habitat Protection Policy, Draft. Ottawa.

Department of Indian Affairs and Northern Development. 1981 Yukon Placer Mining. Ottawa.

Department of Indian and Northern Affairs. 1983 Land Use Guidelines Mineral Exploration: Yukon and Northwest Territories. Prepared for Supplies and Services Canada. Ottawa.

DPA Consulting Ltd. 1983 Summary of Analysis of Econommic Reports for the Yukon Placer Mining Guidelines Public Review Committee, Final Report. Prepared for the Yukon Placer Mining Guidelines Public Review Committee.

Envirocon Ltd. 1986 Investigation of the Magnitude and Extent of Sedimentation From Yukon Placer Mining Operations: Summary. Draft Report. Prepared for the Department of Indian Affairs and Northern Development. Vancouver, B. C.

Environmental Protection Agency. 1986 Fact Sheet: Proposed issuance of National Pollution Discharge Elimination System (NPDES) Permits to discharge Pollutants to the provisions of the Clean Water Act. Seatle, Washington

Environmental Protection Agency. 1974 National Pollution Discharge Elimination System Application for Permission to Discharge - Short Form C. Washington, D. C.

Fisheries Act. Revised 1977.

Fox, I. K., P. J. Eyre and W. Mair. 1983 Yukon Water Resource Management Policy and Institutional Issues. Westwater Research Center, University of British Columbia.

Franson, M. A. H., R. T. Franson and A. R. Lucas. 1982 Environmental Standards: A Comparitive Study of Canadian Standards, Standard Setting Processes and Enforcement. Prepared for Environment Council of Alberta. Edmonton, Alberta

Hardy, R. M. and Associates (1978) Ltd. 1978 Fish and Wildlife Habitat Recovery in Placer Mined Areas of the Yukon. Prepared for the Department of Indian Affairs and Northern Development.

Hardy, R. M. and Associates (1978) Ltd. 1979 Guidelines for Reclamation of Placer Mining Operations - Klondike Region. Prepared for Yukon Territorial Water Board. Calgary, Alberta.

Harnett, D. L. and J. L. Murphy, 1975 Introductory Statistical Analysis. Addison-Wesley Pubishing Company Inc. Reading, Massachusettts.

IEC Beak Consultants Ltd. 1983 An Assessment of the Proposed Yukon Placer Mining Guidelines. Prepared for the Klondike Placer Miners Association. Richmond, B. C.

Kopvillem, Peter, 1985 Mining for Regulations. MacLeans Magazine, Nov. 11, 1985. Toronto, Canada.

Koroscil, P. M. 1971 The Changing Landscape of the Yukon Territory and the Settlement of Whitehorse. Ph. D. Thesis, University of Michigan.

Lamoreaux, Bill, H. 1976 Mining and Water Quality - Federal Perspective. In Alaska Mining and Water Quality Symposium Proceedings. University of Alaska, April 1979.

Langer, O., 1980 A Rational for Standards Relating to the Discharge of Sediments into Yukon Streams for Placer Mines. Draft Report. Department of the Environment, Environmental Protection Services. West Vancouver.

Lotz, J. 1975 Northern Realities: The Future of Northern Development in Canada. New Press. Toronto.
1976

Madison, R. J. 1981 Effects of Placer Mining On Hydrologic Systems in Alaska -- State of Knowledge. U. S. Geological Survey. Open - File Report 81-217. Anchorage, Alaska.

Marshall, I. B. 1982 Mining, Land Use, and the Environment: I. A Canadian Overview. Environment Canada, Lands Directorate. Land Use in Canada Series, No. 22. Ottawa.

Marshall, I. B. 1983 Mining, Land Use, and the Environment: II. A Review of Mining Reclamation Activities in Canada. Environment Canada, Lands Directorate. Land Use in Canada Series, No 23. Ottawa.

Marvin Shaffer and Associates, 1983 Benefit-Cost Analysis of the Proposed Yukon Placer Mining Guidelines. Prepared for the Department of Fisheries and Oceans. Vancouver, B. C.

Mcleay D.J., D. L. Ennis, I. K. Birtwell, G. F. Hartman, 1984 Effects on Artic Grayling of Prolonged Exposure to Yukon Placer Mining Sediments. Department of Fisheries and Oceans, West Vancouver.

Mcleay, D. J., A. J. Knox, J. G. Malick, I. K. Birtwell, G. Hartman and G.L. Ennis, 1983 Effects on Artic Grayling of Short-Term Exposure to Yukon Placer Mining Sediments: Laboratory and Field Studies. Department of Fisheries and Oceans, West Vancouver.

MacKenzie, B. W. and M. L. Bilodeau. 1982 Economic Guidelines for Small Mineral Deposits. Working Paper No. 25, Center for Resource Studies. Queens University.

Milligan P. A., W. O. Rublee, D. D. Cornertt and R. A. C. Johnston. 1985 The Distribution and Abundance of Chinook Salmon (Oncorhynchus tshawytscha) in the Upper Yukon River Basin as Determined by a Radio-Tagging and Spaghetti Tagging Program: 1982-1983. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1352. New Westminster, B. C.

Myasin V. P., T. S. Potapova and A. S. Kustov. 1977 Measures On Protecting Rivers From Pollution When Mining Placer Deposits. Translated from Vodyne Resursy, No. 5, pp 179-182

Northern Inland Waters Act. 1972.

Ogilvie, W., 1913 Early Days on the Yukon, Thorburn and Abbott, Ottawa.

Oguss, E. and W. E. Erlebach. 1976 Limitations of Single Water Samples in Representing Mean Water Quality: I. Thompson River at Shaw Springs British Columbia. Environment Canada, Inland Waters Directorate, Pacific Region. Technical Bulletin No. 95. Vancouver.

Parkhurst, D. 1981 Placer Mining and Stream Bed Movement. California Journal of Mining. Vol. 51 No. 2, October 1981, pp. 51-52.

Parkhurst, D. 1985 Placer Mining vs. Natural Erosion. California Journal of Mining,.Vol. 54, No. 10, June 1985, pp. 47-51.

Pearse, P. H. 1981 Conflict and Opportunity: Towards a New Policy for Canada's Pacific Fisheries. The Commission on Pacific Fisheries Policy. Preliminary Report. Vancouver.

Pearse, P. H. 1982 Turning the Tide: a New Policy for Canada's Pacific Fisheries. The Commission on Pacific Fisheries Policy. Final Report. Vancouver.

Prokopovich, N. P. and K. A. Nitzberg. 1982 Placer Mining and Salmon Spawning in America River Basin, California. Bulletin of the Association of Engineering Geologists, Vol. XIX, No. 1, pp. 67-76.

Reiser, D. W., M. P. Ramey and T. R. Lambert. 1985 Review of Flushing Flow Requirements in Regulated Streams. Prepared for Pacific Gas and Electric Company, San Ramon, California

Ross, L. 1979 A Placer Miner Looks At Environmental Concerns. In Alaska Mining and Water Quality Symposium Proceedings, University of Alaska April 1979.

Sigma Resource Consultants. 1981 Water Use Technology for Placer Mining Effluent Control. Prepared for the Department of Indian and Northern Affairs. Whitehorse.

State of Alaska. 1979 Water Quality Standards. Department of Environmental Conservation. Juneau, Alaska.

State of Alaska, 1981 Wetlands Management in Alaska: A Report to the Alaska Coastal Policy Council. Office of Coastal Management. Juneau, Alaska.

State of Alaska. 1986 Interagency Placer Mining Enforcement Priorities, Draft. Prepared by the Department of Environmental Conservation.

Sutherland, D. G. 1985. Geomorphological controls on the distribution of placer deposits. The Journal of the Geological Society. Vol. 142, Part 5, September 1985. pp. 723-734.

Thompson, A. R and M. Crommelin, ed. 1977 Mineral Leasing as an Instrument of Public Policy. The British Columbia Institute for Economic Policy. University of British Columbia Press. Vancouver.

Theberge, J. B. 1983 The Yukon Wilderness: going, going ... gone. Outdoor Canada. April 1983, 11 (3), pp.46-51.

Vancouver Sun. 1986 Brummet to update placer mining rules. March 6, 1986.

VanSickle, R. 1985 Pull-out counter-productive -- fed. The Whitehorse Star. Monday September 9, 1985. Whitehorse.

Weagle, Ken Environmental Consultant Ltd. 1984 Treatment of Placer Mining Effluents Using Settling Ponds, Volume 1: Technical Report. Prepared for Government of Yukon, Department of Economic Development and Tourism. Whitehorse.

Whitman, I. and D. Fahringer. 1973 An Environmental Evaluation System for Water Resouce Planning. Water Resources Research, Vol. 9, No. 3. pp.523-535.

Williams, C. N. 1979 The Impact of the NIWA on Placer Mining. In Alaska Mining and Water Quality Symposium Proceedings. University of Alaska, April 1979.

Wright, A. A., 1976 Prelude to Bonanza, Gray's Publishing Ltd., Sidney, British Columbia.

Yukon Placer Mining Act. 1903, revised 1972.