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Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Ore Mining and Dressing Point Source Category

Final

Gold Placer Mine Subcategory

DEVELOPMENT DOCUMENT
FOR FINAL
EFFLUENT LIMITATIONS GUIDELINES AND
NEW SOURCE PERFORMANCE STANDARDS
FOR THE
ORE MINING AND DRESSING POINT SOURCE CATEGORY
GOLD PLACER MINE SUBCATEGORY

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SECTION I

SUMMARY

This development document presents the technical data base developed by EPA to support effluent limitations guidelines and standards for the Gold Placer Mining Subcategory of the Ore Mining and Dressing Point Source Category. The Clean Water Act (CWA) designates various levels of technology as the basis for effluent limitations: best practicable technology (BPT), best available technology economically achievable (BAT), best conventional pollutant control technology (BCT), and best available demonstrated technology (BDT). Effluent limitations guidelines based on the application of BPT, BAT, and BCT are to be achieved by existing sources. New source performance standards (NSPS) based on BDT are to be achieved by new facilities.

The effluent limitations guidelines and standards described in this document are required by Sections 301, 304, 306, 307, and 501 of the Clean Water Act (the Federal Water Pollution Control Act Amendments of 1972, 33 USC 1251 et seq., as amended by the Clean Water Act of 1977, P.L. 95-217 and the Water Quality Act of 1987, P.L. 100-4) ("the Act"). This regulation is being promulgated in conformance with the Consent Decree in Trustees for Alaska v. Thomas, (No. A85-440 (D Alaska, May 7, 1986)), and augments the regulation promulgated on December 3, 1982 for the ore mining industrial category. To recognize inherent differences in ore mining, the 1982 regulation was divided into 11 major subcategories. Twenty-seven subdivisions were created within the 11 subcategories based largely on whether the discharge was from a mine or a mill. Further divisions were based upon the process employed at the mine or mill. Gold placer mining was included initially in the subcategory under gold ores; however, it was not included in the 1982 regulations because EPA did not have sufficient technical or economic data on which to base an appropriate regulation. Further consideration led to the establishment of a separate subcategory (outside of gold ores) specifically for gold placer mining.

To gather the technical and economic information necessary to promulgate a regulation, an extensive sampling and analysis effort was undertaken during the 1983, 1984, 1985, and 1986 mining seasons. As part of this effort, 69 placer mines were visited by EPA. Sampling was conducted at all 69 of these mines, and treatability testing of wastewater was performed on 63 of them. A total of 106 treatability tests were performed, including 47 simple settling and 59 chemically assisted settling tests. Four of these mines also were included as part of a ten-site Method Detection Limit Study for Settleable Solids conducted in 1985. In addition, two studies were conducted in 1984 and 1986 on small particle gold recovery to determine the effect of high suspended solids concentration in wash water on sluice box operation. Many mining operations, including those visited in these investigations, provided economic and technical operating information. Data collected includes National Pollutant Discharge Elimination System (NPDES) data and discharge monitoring reports (DMRs) as well as information submitted by EPA Regions VI, VIII, IX, and X and the Alaska Departments of Environmental Conservation, Natural Resources, Fish and Game and Commerce and Development.

During the 1986 mining season there were over 450 active commercial gold placer mines in the United States. The number of operations including recreational and assessment mines could be in excess of 1,000. Approximately 42 percent of these commercial mines are located in Alaska. Promulgation of this regulation is expected to have greatest impact on the industry in Alaska, as substantial water discharge regulations are in place for the gold placer mines in the lower 48 states.

SUBCATEGORIZATION FOR GOLD PLACER MINES

EPA has created a separate subcategory in the ore mining and dressing point source category known as "gold placer mine" to regulate operations which mine or process gold placer ore by gravity separation methods, bucket-line dredge mining, and all mechanical mining practices. EPA separated gold placer mines from the subcategory regulating other gold ores (i.e., hard rock ores), and established this new subcategory because the mining and processing methods employed in gold placer mines are substantially different from hard rock mining methods. The Agency considered further subcategorization of gold placer mining on the basis of size of facilities, mining method, ore processing method, wastewater treatability (including mineralogy), topography, location, control technologies, climate (including rainfall), water use, solids waste generation, number of employees, reagent use, and age of facilities.

The final regulation does not apply to the following segments:

1. Mines processing less than 1,500 cu yds per year.
2. Dredges processing less than 50,000 cu yds per year.
3. Dredging operations conducted in open waters.

The 1,500 cu yds per year cutoff excludes the small recreational, hobby or assessment operations which discharge a very low volume of process water. Dredges, processing less than 50,000 cu yds per year, are not covered by this regulation because the Agency does not have adequate data, both technical and economic, to prepare a model. This regulation also does not apply to mining in open waters (i.e., marine waters, in the coastal zone (beach), or in very large rivers) because: (1) the Agency does not, at present, have a data base adequate to address this group; and (2) the limitations that might be developed may require different conditions because of uncertainty about the technology employed, the reasonableness of various treatment alternatives, and the potential need to protect certain marine water resources.

After a thorough review of all available data, EPA determined this level of subcategorization of gold gold placer mining was appropriate for this regulation.

OVERVIEW OF THE LIMITATIONS AND STANDARDS

The effluent limitations and standards supported by this document are intended to control the discharge of process wastewater pollutants from mining and gold placer recovery efforts. In addition, other excess waters, including mine surface drainage, melting snow or permafrost, and groundwater infiltration, are unavoidably commingled with process water as a result of these activities. Under BAT and NSPS of this regulation, process water would be recirculated in its entirety with a discharge allowed for commingled excess process wastewater after treatment.

The presence or absence of the 126 toxic pollutants and one nonconventional pollutant, e.g., settleable solids, was determined in EPA's sampling and analysis program. All 126 toxic pollutants have been excluded from regulation in the gold placer mine subcategory based upon one of the following criteria: (1) they were not detected, (2) they were present at levels not treatable by known technologies, or (3) they were effectively controlled by technologies upon which other effluent limitations are based. Two toxic pollutants, arsenic and mercury, were identified in treatable amounts in the untreated discharges from gold placer mines. However, EPA is not promulgating limitations for these pollutants because they will be adequately controlled by the BPT and BAT limitations on settleable solids.

This regulation also includes a storm exemption when there is excessive precipitation. Treatment systems are to be designed, constructed, and operated to contain and treat the volume of flow that would result from a 5-year, 6-hour rainfall plus the normal volume or flow from the gold recovery process including any excess waters. Because of pond design and site differences, the design condition is based on a 5-year, 6-hour rainfall rather than the 10-year, 24-hour rainfall required for the rest of the ore mining category.

BEST PRACTICABLE TECHNOLOGY (BPT)

The factors considered in defining BPT include the total cost of application of BPT in relation to the effluent reduction benefits. In general, BPT represents the average of the best performance of existing operations with common characteristics and focuses on end-of-pipe treatment rather than in-process controls. Three effluent control technologies were considered for BPT: (1) simple settling, (2) simple settling with recirculation of process water, and (3) chemically assisted settling. While the 1977 date for compliance with BPT has passed, BPT is being promulgated for use as a baseline from which the Agency evaluates other segments of the CWA. BPT for all mines covered by this regulation is based on simple settling to achieve 0.2 ml/l settleable solids.

BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE (BAT)

The factors considered in assessing BAT include the age of equipment and facilities involved, the process employed, process changes, and non-water quality environmental impacts. The statutory assessment of BAT includes cost considerations, but the primary determinant of BAT is effluent reduction capability. Water recirculation with simple settling has been selected as the basis for BAT. This technology achieves substantial removal of the process wastewater pollutant generated during the operation of a gold placer mine. No more advanced technology has been demonstrated which can be applied to reduce the discharge of process wastewater pollutants. The commingled wastewater provision and storm exemption would be applicable under BAT.

BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY (BCT)

BCT replaces BAT for control of the conventional pollutants: total suspended solids (TSS), pH, biochemical oxygen demand (BOD), oil and grease (O&G), and fecal coliform. Fecal coliform, BOD, and O&G were not found in significant concentrations above the background of the intake water at gold placer mines. The pH of the discharges was also very similar to the pH of the intake water, which was approximately neutral. However, solids in the wastewater discharges from gold placer mines have long been identified as the major pollutant in placer mine discharges. TSS, a conventional pollutant, is the parameter which measures solids. The same three technologies considered for BPT were considered for BCT. No BCT limitations are being promulgated for this subcategory because no more stringent technology for additional removal of conventional pollutants has been demonstrated for universal application in gold placer mining.

NEW SOURCE PERFORMANCE STANDARDS (NSPS)

New facilities have an opportunity to implement the best and most efficient ore mining and milling processes and wastewater treatment technologies. Accordingly, Congress directed EPA to consider the best demonstrated process changes and end-of-pipe treatment technologies capable of reducing pollution to the maximum extent feasible through a standard of performance which includes, "where practicable, a standard permitting zero discharge of pollutants."

The complete elimination of the discharge of process wastewater pollutants is not possible for gold placer mining since water in excess of that required for processing is unavoidably commingled with process water, as described above. Standards for new source gold placer mines are being promulgated based on the same technology as promulgated for BAT. The same general characteristics of wastewater, costs to treat, and percentages of pollutant removals are expected in new sources as found in existing sources. New source standards equivalent to existing source limitations would not pose a barrier to entry.

PRETREATMENT STANDARDS FOR EXISTING AND NEW SOURCES

All existing gold placer mines are point sources and direct dischargers; there are no known existing indirect dischargers and no new source indirect dischargers are anticipated. (Indirect dischargers are those facilities which discharge to a publicly owned treatment works.) Consequently, pretreatment standards, which control the level of pollutants that may be discharged from an industrial plant to a publicly owned treatment works, are not included in this final regulation.

BEST MANAGEMENT PRACTICES (BMP)

The Clean Water Act authorizes EPA to prescribe "best management practices" to prevent the release of toxic and hazardous pollutants from plant site runoff, spillage or leaks, sludge or waste disposal, and drainage from raw materials storage associated with the manufacturing or treatment process. In gold placer mines, infiltration, surface drainage and runoff, and mine drainage are associated with mining and beneficiation operations and may contribute significant amounts of pollutants to navigable waters. Accordingly, EPA is including five BMP's in this regulation which represent good mining practices typical of well-run mining operations. This rule requires the inclusion of BMP in gold placer mine permits, to the extent applicable in each permit.

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SECTION II

FINAL REGULATIONS

SUBCATEGORY M

EPA has added a Gold Placer Mine Subcategory, Subpart M to the Ore Mining and Dressing Point Source Category for the purpose of establishing effluent limitations and standards for the process wastewaters from this segment of the mining industry.

APPLICABILITY

The following gold placer mining operations are not regulated under this rule:

a) Operations processing less than 1,500 cu yds per year of ore

b) Dredges processing less than 50,000 cu yds per year of ore

c) Dredging operations working in open waters

EFFLUENT LIMITATIONS

The following effluent limitations are promulgated for all sources:

BPT

The following effluent limitations represent the degree of effluent reduction attainable by the application of the best practicable control technology currently available (BPT).

Except as provided in 40 CFR 125.30-125.32, any existing point source subject to this subpart must achieve the following effluent limitations representing the degree of effluent reduction attainable by the application of the best practicable control technology currently available (BPT):

(a) The concentration of pollutants discharged in process wastewater from an open-cut mine plant site shall not exceed:

	Effluent Limitations
Effluent Characteristics	Instantaneous Maximum
Settleable Solids	0.2 ml/l

(b) The concentration of pollutants discharged in process wastewater from a dredge plant site shall not exceed:

	Effluent Limitations
Effluent Characteristics	Instantaneous Maximum
Settleable Solids	0.2 ml/l

BAT

The following effluent limitations representing the degree of effluent reduction attainable by the application of the best available technology economically achievable (BAT).

Except as provided in 40 CFR 125.30-125.32, any existing point source subject to this subpart must achieve the following effluent limitations representing the degree of effluent reduction attainable by the application of the best available technology economically achievable (BAT):

(a) The volume of process wastewater which may be discharged from an open-cut mine plant site shall not exceed the volume of infiltration, drainage and mine drainage waters which is in excess of the make up water required for operation of the beneficiation process. The concentration of pollutants in process wastewater discharged from an open-cut mine plant site shall not exceed:

Effluent Characteristics	Effluent Limitations Instantaneous Maximum
Settleable Solids	0.2 ml/l

(b) The volume of process wastewater which may be discharged from a dredge plant site shall not exceed the volume of infiltration, drainage and mine drainage waters which is in excess of the make up water required for operation of the beneficiation process. The concentration of pollutants in process wastewater discharged from a dredge plant site shall not exceed:

Effluent Characteristics	Effluent Limitations Instantaneous Maximum
Settleable Solids	0.2 ml/l

New Source Performance Standards (NSPS)

Any new source subject to this subpart must achieve the following NSPS representing the degree of effluent reduction attainable by the application of the best available demonstrated technology:

(a) The volume of process wastewater which may be discharged from an open-cut mine plant site shall not exceed the volume of infiltration, drainage, and mine drainage waters which is in excess of the makeup water required for operation of the beneficiation process. The concentration of pollutants in process wastewater discharged from an open-cut mine plant site shall not exceed:

Effluent Characteristics	Effluent Limitations Instantaneous Maximum
Settleable Solids	0.2 ml/l

(b) The volume of process wastewater which may be discharged from a dredge plant site shall not exceed the volume of infiltration, drainage, and mine drainage waters which is in excess of the makeup water required for operation of the beneficiation process. The concentration of pollutants in process wastewater discharged from a dredge plant site shall not exceed:

Effluent Characteristics	Effluent Limitations Instantaneous Maximum
Settleable Solids	0.2 ml/l

(c) Notwithstanding any other provision of this chapter, the Regional Administrator or Director of a State agency with authority to administer the NPDES program shall in designating new source gold placer mines take into account and base the decision on whether one or more of the following factors has occurred after promulgation of these regulations.

1. The mine will operate in a permit area which is not covered by a currently valid NPDES Permit
2. The mine significantly alters the nature or quantity of pollutants discharged.
3. The mine discharges into a stream into which it has not discharged under its currently valid NPDES permit.
4. The mine will operate in an area that has not been mined during the term of the currently valid NPDES permit.
5. Such other factors as the Regional Administrator or State Director deems relevant.

Best Management Practices (BMP)

The following best management practices are specific requirements which shall be included in each NPDES permit for all mining operations regulated under this subpart to the greatest extent applicable in each such mining operation.

(a) Surface water diversion: The flow of surface waters into the plant site shall be interrupted and these waters diverted around and away from incursion into the plant site.

(b) Berm construction: Berms, including any pond walls, dikes, low dams, and similar water retention structures shall be constructed in a manner such that they are reasonably expected to reject the passage of water.

(c) Pollutant materials storage: Measures shall be taken to assure that pollutant materials removed from the process water and wastewater streams will be retained in storage areas and not discharged or released to the waters of the United States.

(d) New water control: The amount of new water allowed to enter the plant site for use in ore processing shall be limited to the minimum amount required as makeup water for processing operations.

(e) Maintenance of water control and solids retention devices: All water control devices such as diversion structures and berms and all solids retention structures such as berms, dikes, pond structures, and dams shall be maintained to continue their effectiveness and to protect from unexpected and catastrophic failure.

STORM EXEMPTION

The following specialized provision applies only to Subpart M:

If, as a result of precipitation (rainfall or snowmelt), a source subject to this subpart (gold placer mine subcategory) has an overflow or discharge of effluent which does not meet the limitations or standards of this subpart, the source may qualify for an exemption from such limitations and standards with respect to such discharge if the following conditions are met:

(i) The treatment system is designed, constructed, and maintained to contain the maximum volume of untreated process water which would be discharged from the beneficiation process into the treatment system during a 4-hour operating period without an increase in volume from precipitation or infiltration, plus the maximum volume of water runoff resulting from a 5-year, 6-hour precipitation event. In computing the maximum volume of water which would result from a 5-year, 6-hour precipitation event, the operator must include the volume which should result from the plant site contributing runoff to the individual treatment facility.

(ii) The operator takes all reasonable steps to maintain treatment of the wastewater and minimize the amount of overflow.

(iii) The source is in compliance with the BMP in 140.148 and related provisions of its NPDES permit.

(iv) The operator complies with the notification requirements of Section 122.41 (m) and (n) of this Title. The storm exemption is designed to provide an affirmative defense to an enforcement action. Therefore, the operator has the burden of demonstrating to the appropriate authority that the above conditions have been met.

SECTION III

INTRODUCTION

PURPOSE

The 1982 ore mining regulations were divided into eleven subcategories, one of which was designated for gold ores. At that time, gold placer mines were included as a subcategory under gold ores. However, because of insufficient data, EPA did not promulgate regulations for gold placer mines when the 1982 regulations were promulgated. Further consideration led to the establishment of a separate subcategory for gold placer mines (no longer a part of gold ores). The purpose of this document is to present the technical information used to develop regulations for this newly created subcategory.

EPA has conducted various studies to determine the presence and concentrations of toxic (or "priority") pollutants in the waste water discharged from the gold placer mining segment. This development document presents the technical data base compiled by EPA with regard to these pollutants, as well as conventional and nonconventional pollutants, and evaluates their treatability for regulation under the provisions of the Clean Water Act.

This document also outlines the technology options considered and the rationale for the option selected at each technology level. These technology levels are the basis for the limitations and standards of the final regulations. No pretreatment standards are proposed, because there are no known indirect dischargers in this subcategory, nor are there likely to be, because most operations are rural and far from any publicly owned treatment works (POTW).

LEGAL AUTHORITY

These regulations are established under authority of Sections 301, 304, 306, 307, and 501 of the Clean Water Act (the Federal Water Pollution Control Act Amendments of 1972, 33 USC 1251 et seq., as amended by the Clean Water Act of 1977, P.L. 95-217, and the Water Quality Act of 1987, P.L. 100-4 (the "Act")).

The Federal Water Pollution Control Act Amendments of 1972 established a comprehensive program to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters," Section 101(a). By July 1, 1977, existing industrial dischargers were required to achieve "effluent limitations requiring the application of the best practicable control technology currently available" (BPT), Section 301(b)(1)(A). By July 1, 1983, these dischargers were required to achieve "effluent limitations requiring the application of the best available technology economically achievable . . . which will result in reasonable further progress toward the national goal of eliminating the discharge of all pollutants" (BAT), Section 301(b)(2)(A). New industrial direct dischargers were required to comply with Section 306 new source performance standards (NSPS), based on best available demonstrated technology. The requirements for direct dischargers were to be incorporated into National Pollutant Discharge Elimination System (NPDES) permits issued under Section 402 of the Act. Although Section 402(a)(1) of the 1972 Act authorized the setting of requirements for direct dischargers on a case-by-case basis, Congress intended that, for the most part, control requirements would be based on regulations promulgated by the Administrator of EPA. Section 304(b) of the Act required the Administrator to promulgate regulations providing guidelines for effluent limitations setting forth the degree of effluent reduction attainable through the application of BPT and BAT. Moreover, Sections 304(c) and 306 of the Act required promulgation of regulations for designated industry categories, Section 307(a) of the Act required the Administrator to promulgate effluent standards applicable to all dischargers of toxic pollutants. Finally, Section 301(a) of the Act authorized the Administrator to prescribe any additional regulations "necessary to carry out his functions" under the Act.

EPA was unable to promulgate many of these regulations by the dates contained in the Act. In 1976, EPA was sued by several environmental groups, and in settlement of this lawsuit, EPA and the plaintiffs executed a settlement agreement that was approved by the Court. This agreement required EPA to develop a program and adhere to a schedule for promulgating for 21 major industries BAT effluent limitations guidelines and new source performance standards covering 65 priority pollutants and classes of pollutants. See Settlement Agreement in Natural Resources Defense Council, Inc. v. Train, 8 ERC 2120 (D.D.C. 1976), modified, 12 ERC 1833 (D.D.C. 1979), modified by Orders of October 26, 1982, August 2, 1983, January 6, 1984, July 5, 1984, and January 7, 1985.

On December 27, 1977, the President signed into law the Clean Water Act of 1977 (P.L. 95-217). Although this act made several important changes in the federal water pollution control program, its most significant feature was its incorporation of several basic elements of the NRDC Settlement Agreement program for toxic pollution control. Sections 301(b)(2)(A) and 301(b)(2)(C) of the Act required the achievement, by July 1, 1984, of effluent limitations requiring application of BAT for toxic pollutants, including the 65 priority pollutants and classes of pollutants that Congress declared toxic under Section 307(a) of the Act. Likewise, EPA's programs for new source performance standards are now aimed principally at toxic pollutant controls. Moreover, to strengthen the toxics control program, Section 304(e) of the Act authorizes the Administrator to prescribe best management practices (BMP) to control the release of toxic and hazardous pollutants from plant site runoff, spillage or leaks, sludge or waste, and drainage from raw material storage associated with, or ancillary to, the manufacturing or treatment process.

Promulgation of the Ore Mining and Dressing Point Source Category regulation on December 3, 1982 (47 FR 54598) satisfied the requirements of the Settlement Agreement for the ore mining and dressing category. The regulation for gold placer mines is not issued pursuant to the agreement.

The proposed regulation for gold placer mines, 50 FR 47982 and subsequent notices of information, provide effluent limitations guidelines for BPT and BAT and establish NSPS on the basis of the authority granted in Sections 301, 304, 306, 307, and 501 of the Clean Water Act. As explained earlier, pretreatment standards (PSES and PSNS) were not proposed for the gold placer mine subcategory of the ore mining and dressing point source category, since no known indirect dischargers exist nor are any known to be in the planning stage. In general, ore mines and mills, particularly gold placer mines in Alaska and several other states, are located in rural areas, far from any POTW.

GENERAL CRITERIA FOR EFFLUENT LIMITATIONS

BPT Effluent Limitations

The factors considered in defining BPT include the total cost of applying such technology in relation to the effluent reductions derived from such application, the age of equipment and facilities involved, the process employed, non-water quality environmental impacts (including energy requirements), and other factors the Administrator considers appropriate [Section 304(b)(1)(B)]. In general, the BPT technology level represents the average of the best existing performances of plants of various ages, sizes, processes, or other common characteristics. Where existing performance is uniformly inadequate, BPT may be transferred from a different subcategory or category. BPT focuses on end-of-pipe treatment rather than process changes or internal controls, except where the latter are common practice. The cost-benefit inquiry for BPT is a limited balancing, committed to EPA's discretion, which does not require the Agency to quantify benefits in monetary terms. See, e.g., American Iron and Steel Institute v EPA, 526 F.2d 1027 (3rd Cir. 1975). In balancing costs in relation to effluent reduction benefits, EPA considers the volume and nature of discharges expected after application of BPT, the general environmental effects of the pollutants, and the cost and economic impacts of the required pollution control level. The Act does not require or permit consideration of water quality problems attributable to particular point sources or industries, or water quality improvements in particular water bodies. Therefore, EPA has not considered these factors. See Weyerhaeuser Co. v. Costle, 590 F.2d 1011 (D.C. Cir. 1978).

BAT Effluent Limitations

The factors considered in assessing BAT include the age of equipment and facilities involved, the process employed, process changes, and non-water quality environmental impacts, including energy requirements [Section 304(b)(2)(B)]. At a minimum, the BAT technology level represents the best economically achievable performance of plants of various ages, sizes, processes, or other shared characteristics. BAT may include process changes or internal controls, even when these technologies are not common industry practice. The statutory assessment of BAT "considers" costs, but does not require a balancing of costs against effluent reduction benefits (see Weyerhaeuser v. Costle, supra). In developing the proposed BAT regulations, however, EPA has given substantial weight to the reasonableness of costs. The Agency has considered the volume and nature of discharges, the volume and nature of discharges expected after application of BAT, the general environmental effects of the pollutants, and the costs and economic impacts of the required pollution control levels.

Despite this expanded consideration of costs, the primary determinant of BAT is effluent reduction capability. As a result of the Clean Water Act of 1977, 33 USC 1251, et seq., the achievement of BAT has become the principal national means of controlling water pollution due to toxic pollutants.

BCT Effluent Limitations

The 1977 Amendments added Section 301(b)(2)(E) to the Act establishing best conventional pollutant control technology (BCT) for discharges of conventional pollutants from existing industrial point sources. Conventional pollutants are those specified in Section 304(a)(4) [biological oxygen demanding pollutants (BOD5), total suspended solids (TSS), fecal coliform, and pH], and any additional pollutants defined by the Administrator as "conventional" (to date, the Agency has added oil and grease, 44 FR 44501, July 30, 1979).

BCT is not an additional limitation but replaces BAT for the control of conventional pollutants. In addition to other factors specified in Section 304(b)(4)(B), the Act requires that BCT limitations be assessed in light of a two-part "cost-reasonableness" test. American Paper Institute v. EPA, 660 F.2d (4th Cir. 1981). The first test compares the cost for private industry to reduce its conventional pollutants with the costs to publicly owned treatment works for similar levels of reduction from their discharge of these pollutants. The second test examines the cost-effectiveness of additional industrial treatment beyond BPT. EPA must find that limitations are "reasonable" under both tests before establishing them as BCT. In no case may BCT be less stringent than BPT.

New Source Performance Standards

The basis for NSPS under Section 306 of the Act is best available demonstrated technology (BDT). New operations have the opportunity to design and utilize the best and most efficient processes and wastewater treatment technologies. Congress therefore directed EPA to consider the best demonstrated process changes, in-plant controls, and end-of-pipe treatment technologies that reduce pollution to the maximum extent feasible.

Pretreatment Standards for Existing Sources

Section 307(b) of the Act requires EPA to promulgate pretreatment standards for existing sources (PSES).

There are no ore mines, including gold placer operations, that currently discharge to a POTW. By the nature of their locations, it is unlikely that any indirect dischargers exist. Therefore, no PSES are being promulgated at this time.

Pretreatment Standards for New Sources

Section 307(c) of the Act requires EPA to promulgate pretreatment standards for new sources (PSNS) at the same time that it promulgates NSPS. New indirect dischargers, like new direct dischargers, have the opportunity to incorporate the BDT, including process changes, in-plant controls, and end-of-pipe treatment technologies, and to use plant site selection to ensure adequate treatment system installation. Due to the location of placer gold deposits, future operations are expected to be located in rural areas far from any POTW. Therefore, no PSNS are being promulgated at this time.

PRIOR EPA REGULATION

Effluent limitations guidelines and standards are not directly enforceable against dischargers. Instead, they are incorporated into a National Pollutant Discharge Elimination System (NPDES) permit, which is required by Section 402(a)(1) of the Clean Water Act for the discharge of pollutants from a point source into the waters of the United States. If EPA has not established industry-wide effluent limitations guidelines and standards to cover a particular type of discharge, Section 402(a)(1) of the Act expressly authorizes the issuance of permits upon "such conditions as the Administrator determines are necessary to carry out the provisions of this Act." In other words, this section authorizes a determination of the appropriate effluent limitations (e.g., BPT, BCT, BAT), on a case-by-case basis, based on the Agency's "best professional judgment" (BPJ).

The establishment of effluent limitations in NPDES permits on a case-by-case basis is a two-step process. First, EPA must identify the appropriate technology basis. The second step in the permitting process is the setting of precise effluent limitations which can be met by application of that technology at that site. The Clean Water Act does not require dischargers to install the technology which is the basis of the limitations; dischargers may meet the effluent limitations in any way they choose.

Regulation of the Ore Mining and Dressing Category

On November 6, 1975, EPA published interim final regulations establishing BPT requirements for existing sources in the ore mining and dressing category (see 40 FR 41722). These regulations became effective upon publication. However, concurrent with their publication, EPA solicited public comments with a view to possible revisions. On the same date, EPA also published proposed BAT and NSPS (see 40 FR 51738) for the ore mining and dressing point source category, which included gold placer mines.

On May 24, 1976, as a result of the public comments received, EPA suspended certain portions of the interim final BPT regulations, including the portion which applied to gold placer mining, and solicited additional comments (see 41 FR 21191). EPA promulgated revised, final BPT regulations for the ore mining and dressing category on July 11, 1978 (see 43 FR 29711, 40 CFR Part 440). On February 8, 1979, EPA published a clarification of the BPT regulations as they apply to storm runoff (see 44 FR 7953). On March 1, 1979, the Agency amended the final regulations by deleting the requirements for cyanide applicable to froth flotation mills in the base and precious metals subcategory (see 44 FR 11546).

On December 10, 1979, the U.S. Court of Appeals for the Tenth Circuit upheld the BPT regulations, rejecting challenges brought by five industrial petitioners, Kennecott Copper Corp., v. EPA, 612 F.2d 1232 (10th Cir. 1979). The Agency withdrew the proposed BAT, NSPS, and pretreatment standards on March 19, 1981 (see 46 FR 17567).

On June 14, 1982, EPA again proposed BAT, BCT, and NSPS for the ore mining point source category. On December 3, 1982, final BAT and NSPS limitations for the ore mining point source category were promulgated without limitations for gold placer mining.

Regulation of Gold Placer Mines

The 1976-1977 Permits

In 1976 and 1977, EPA issued 170 permits to Alaska placer miners. Because there were no promulgated effluent limitations and standards for gold placer mines at that time, these permits were based on BPJ. In addition, these permits included limitations designed to satisfy Alaska's water quality standards.

Each of the permits had identical effluent limitations, monitoring requirements, and reporting requirements. The permits required treatment of process wastes so that the maximum daily concentration of settleable solids was 0.2 milliliters per liter (ml/l). In addition, the permits required monthly monitoring for this pollutant or, instead of monitoring to establish compliance with the settleable solids limitation, each permittee was given the option of installing a settling pond with the capacity to hold 24 hours' water use. The technology basis for the settleable solids limitation was settling ponds. In addition, the permittee could not cause an increase in turbidity of 25 JTU (Jackson Turbidity Units) over natural background turbidity in the receiving stream at a point measured 500 feet downstream from the final discharge point. EPA added the turbidity limitation at the request of the State of Alaska, which included the turbidity requirement in its certification of these permits under Section 401 of the Clean Water Act to ensure compliance with its state water quality standards.

In June 1976, Gilbert Zemansky requested an adjudication of the 1976 NPDES permits as an interested party. Subsequently, the Trustees for Alaska (Trustees) and the Alaska Miners Association (Miners), as well as others, were admitted as additional parties to the proceeding. The Trustees and Zemansky argued that the permit terms were not stringent enough and that EPA should have selected recirculation as the model BPT technology and required zero discharge of any pollutants, while the Miners argued that the terms were too stringent and not achievable. After the initial adjudicatory hearing, the Regional Administrator for Region X issued his Initial Decision on October 25, 1978, upholding the terms of the permits.

The Trustees, Zemansky, and the Miners each petitioned the Administrator of EPA to review the initial decision. On March 10, 1980, the EPA Administrator issued his decision on review. The Administrator held that the Regional Administrator's findings regarding settling pond technology "conclusively establish that any less stringent control technology does not satisfy the requirements of BPT" (Decision of the Administrator (Ad. Dec.) at 15). The Administrator also found that "the Regional Administrator was in doubt about the facts respecting the extra costs of recycling. . . ." Therefore, the Administrator remanded the proceedings to the Regional Administrator "for the limited purpose of reopening the record to receive additional evidence on the extra cost of recycling in relationship to the effluent reduction benefits to be achieved from recycling" (Ad. Dec. at 22). The Administrator directed the Regional Administrator to determine whether recycling constitutes BPT based on the additional evidence received.

After the Administrator rendered his decision, the Trustees requested the Administrator to: (1) determine the effluent limitations necessary to meet state water quality standards; (2) determine appropriate effluent monitoring requirements in the event the Regional Administrator did not determine that zero discharge was required; and (3) direct the Regional Administrator on remand to determine effluent limitations for total suspended solids or turbidity, for arsenic, and for mercury based on BPT in the event he did not determine that zero discharge is required. On July 10, 1980, the Administrator issued a Partial Modification of his decision, directing the Presiding Officer "to allow additional evidence to be received if he determines on the basis of the record that such additional evidence is needed to make the requested determinations" (Partial Modification of Remand at 3).

The hearing on remand was held in March and June 1981, and the Presiding Officer issued his Initial Decision on Remand (Rem. Dec.) on March 17, 1982. After reviewing the costs and effluent reduction benefits associated with both settling ponds and recirculation, the Presiding Officer held that "the preponderance of the evidence in this case indicates that zero discharge is not 'practicable' for gold placer miners in Alaska" (Rem. Dec. at 17). He also ordered EPA to modify the permits to include monitoring requirements for settleable solids and turbidity, and to require monitoring for arsenic and mercury, for at least one season, "to determine whether or not [they] constitute a problem with placer mining" (Rem. Dec. at 19-20).

On September 20, 1983, the Administrator denied review of the Initial Decision on Remand. Both the Trustees for Alaska and Zemansky, as well as the Alaska Miners Association, petitioned the Ninth Circuit Court of Appeals for review (Case No. 83-7764 and Case No. 83-7961). The Ninth Circuit consolidated the cases and issued its decision in Trustees for Alaska v. EPA and Alaska Miners Association v. EPA on December 10, 1984 (749 F.2d 549).

In this court proceeding, the Miners raised various legal issues, including certain constitutional challenges, each of which was dismissed by the Court. Specifically, the Court held that: (1) the Clean Water Act's permit requirements applied to placer mining, i.e., when discharge water is released from a sluice box it is a point source; (2) EPA's failure to establish effluent limitations guidelines and standards for the placer mining industry could only be challenged in district court; and (3) the Miners' challenge to the assignment of the burden of proof in the administrative hearings was not timely--it should have been raised when the permit regulations establishing that standard were promulgated.

The Court also dismissed the Miners' constitutional claims as too speculative or premature. The Miners had claimed, e.g., that the permit conditions constituted a taking of their vested property rights in violation of the Fifth Amendment; the permits' self-monitoring, reporting, and record keeping provisions infringed their constitutional privilege against self-incrimination; and the permits' inspection provisions infringed their rights under the Fourth Amendment to be free from unreasonable searches.

The Court dismissed most other challenges to the permits as moot since the permits expired before this case reached the Ninth Circuit, and EPA had issued two sets of subsequent permits (in 1983 and 1984) based on newer, more complete records by the time the Court heard this case. The Court specifically held that EPA's choice of settling ponds as "best practicable control technology" (BPT) was moot because a different standard, "best available technology" (BAT), now applies.

However, the Court held that the form of the limitations included in the permits to ensure achievement of state water quality standards was not moot since both the permits at issue and the subsequent permits incorporated state water quality standards directly into the permits. After reviewing the definition of "effluent limitation," the legislative history of the 1972 amendments to the Clean Water Act, and relevant court cases, the Court held that EPA should not have incorporated the state water quality standard for turbidity, which was a receiving water standard, directly into the permits. Instead, the Court held that the permits must include end-of-pipe effluent limitations necessary to achieve the water quality standards. The Court also held that EPA should have given the Trustees the "opportunity to present in a public hearing their case for proposed effluent limitations or monitoring requirements for arsenic and mercury."

The 1983 Permits

During the proceedings on the 1976-1977 permits, EPA issued additional permits to Alaskan placer miners. In 1983, EPA issued 269 new permits. The 1983 permits were issued for the 1983 mining season and differed from the 1976 permits in several respects. For example, the 1983 permits contained a daily maximum discharge limit of 1.0 ml/l and a monthly average discharge limit of 0.2 ml/l on settleable solids. The 1983 permits also included a limit on arsenic based on the Alaska state water quality standards.

The Trustees for Alaska and Gilbert Zemansky requested an evidentiary hearing on the 1983 permits which the EPA Region X Regional Administrator granted. On February 16, 1984, the proceedings were dismissed for several reasons, including expiration of the 1983 permits and the Agency's intent to issue new permits that would take effect in the next mining season (i.e., the summer of 1984). No one appealed the decision within the Agency or petitioned for judicial review of the decision.

The 1984 Permits

In 1984, EPA issued BAT permits to 445 placer miners (the first set was issued on June 8, 1984; additional permits were issued on June 14, 1984). The technology basis for the BAT permits, like the BPT permits, was settling ponds. Based on additional data developed since the BPJ permits were issued, the instantaneous maximum settleable solids discharge limit was 1.5 ml/l and the monthly average limit was 0.7 ml/l. Monitoring was required twice per day, each day of sluicing. The permits incorporated Alaska's state water quality standards for turbidity and arsenic and required visual monitoring for turbidity.

The 1985, and 1987 Permits

On January 31, 1985, in response to the Ninth Circuit opinion, which held that permits must include end-of-pipe effluent limitations necessary to achieve state water quality standards (see above), EPA proposed to modify the 1984 permits to include effluent limitations for turbidity (5 NTUs above background) and arsenic (0.05 mg/l). On February 12, 1985, EPA proposed permits for 93 additional mines. These permits proposed the same limitations as the 1984 permits except that they included the effluent limitations for turbidity and arsenic, just mentioned, rather than simply citing the state water quality standards. The Alaska Department of Environmental Conservation certified the permits with the stipulation that the settleable solids effluent limitation not exceed 0.2 ml/l. This superceded EPA's proposed limit of 0.7/1.5 ml/l described above. On May 10, 1985, EPA issued both the modified permits to miners holding permits in 1984 and the new permits to the 1985 applicants. A total of 539 permits were issued, and approximately 20 evidentiary hearing requests were received by the Agency. Included in these requests were challenges to all the permits which were filed by the Trustees for Alaska and the miner's Advocacy Council. On January 30, 1987, a decision was issued which granted a hearing on some issues while denying on others. The partial denials were appealed to the Administrator by both the Trustees for Alaska and the Miner's Advocacy Council and the Administrator subsequently denied the petitions for review. The partial hearings were postponed pending appeal. Permits issued for 1987 were essentially the same as the 1985 permits. Evidentiary hearing requests were again received for the 415 permits issued in 1987, and the Regional Administrator issued a decision denying in part and granting in part the requests. Petitions for review of the partial denied are pending before the Administrator. Several miners have requested that the hearings on the 1985 and 1987 permits be consolidated. Commencement of the hearings on both permits awaits a ruling by the Administrator on the petitions for review of the partial denial of a hearing on the 1987 permits.

The 1985 Proposal

On November 20, 1985, EPA proposed BPT, BAT, BCT, and NSPS for Gold Placer Mining. The Agency proposed three subcategories for the industry:

1. Large dredges, with a production rate greater than 4,000 cu yds per day, which operate in a self-contained pond.

2. All mines using all mining methods with production rates greater than 20 cu yds per day and less than 500 cu yds per day of "bank run" ore.

3. All mines, all mining methods (except group 2, large dredges) with a production rate greater than 500 cu yds per day of "bank run" ore.

Small mines processing less than 20 cu yds per day were proposed to be not regulated by these regulations. BPT proposed for regulated subcategories except dredges with capacities of more than 4,000 cu yds per day was based on simple settling with limitations on settleable solids of 0.2 ml/l and total suspended solids (TSS) of 2,000 mg/l. No discharge of process water was proposed for dredges that process more than 4,000 cu yds per day. BAT proposed for mines processing 20 to 500 cu yds per day was also 0.2 ml/l of settleable solids, with no discharge of process water for the two larger subcategories. BCT was proposed at 2,000 mg/l TSS for mines processing between 20 and 500 cu yds per day of ore, with no discharge from the two larger categories. NSPS was proposed equivalent to BAT and BCT for each subcategory.

Notices of New Information

In response to comments received on the proposed regulation, the Agency collected additional economic and technical information on gold placer mining. The Agency published two notices of availability of new information in the Federal Register and requested public comment on each of them.

The first Notice of New Information was published in the Federal Register on February 14, 1986 (51 FR 5563). The additional information identified in the Notice included technical and economic data that had been collected and a method detection limit study for settleable solids in placer mining effluent. The Agency extended the comment period on the proposal to provide for public comment on this information. The second Notice of New Information was published in the Federal Register on March 24, 1987 (52 FR 9414). In addition to the additional data collected, the Agency announced changes in its economic methodology and identified possible alternate regulatory options under consideration. A new comment period was provided to allow public comment on this information.

GENERAL APPROACH AND METHODOLOGY

From 1973 through 1976, the EPA Effluent Guidelines Division obtained data on Alaskan gold placer operations as part of its general study of the ore mining and dressing point source category. Because the category itself was so large and diverse, the Agency determined after promulgating interim final BPT limitations that the data base for gold placer mines, in general, and gold placer mines in Alaska, Colorado, Montana, California, Idaho, Washington, Oregon, and Nevada, in particular, was inadequate to form the basis of national effluent limitations guidelines and standards. From 1977 through the present, the Agency has undertaken several sampling surveys and data collection efforts aimed at resolving various issues. A discussion of the major study tasks and their results is presented in Section V of this report.

INDUSTRY PROFILE

Historical Perspective

Prior to the Alaska purchase in 1867, the existence of gold in placer form in Alaska was known to the Russians, the English of the Hudson Bay Company, and members of the Western Union Telegraph exploration party, but little exploitation of these deposits took place. Gold placer mining in Alaska was started primarily by California gold rush prospectors moving up the coast. Significant events which stimulated this activity were gold discoveries in the Juneau vicinity (1880), Rampart (1882), Forty-mile district (1886), and Birch Creek (Circle) district (1893). The Klondike gold rush of 1897-1898 in Canada also stimulated Alaskan prospecting. Additional deposits were discovered in Nome (1898), Fairbanks (1902), and the Tolovana (Livengood) district (1914). High-grade deposits were mined out rapidly, but the introduction of large-scale permafrost thawing, hydraulic stripping, and mechanized excavation methods increased the productivity of placer mining and allowed working of lower-grade deposits. Mechanical dredges were introduced in Nome in 1905 and large electric-powered dredges were employed in Nome and Fairbanks in the 1920s.

In 1940, Alaska was the leading gold-producing state with production of 750,000 troy ounces, mostly from placer mines. (One troy ounce is equal to 31.1 grams, 1.097 ounces avoirdupois.)

Placer mining activity was substantially reduced during World War II, and operations after the war remained at a low level because of rising operating costs and a government-fixed gold price of $35 per troy ounce. Dredging was reduced to only a few operations in the 1960s. Relaxation of federal restrictions on prices and private ownership of gold in the 1970s and an increase in the market price stimulated gold mining activity in the later 1970s; several hundred placer mines came into operation. In 1982, gold production was more than 160,000 troy ounces from placer mining alone (total Alaskan gold production for 1982 from lode and placer mines was in excess of 175,000 troy ounces).

Almost all of the gold produced in the United States outside of Alaska was produced in the following 17 states: Alabama, Arizona, California, Colorado, Georgia, Idaho, Montana, Nevada, New Mexico, North Carolina, Oregon, South Carolina, South Dakota, Utah, Virginia, Washington, and Wyoming. Gold mining in the United States began in North Carolina, with Georgia joining in production in 1829, and Alabama in 1830. Production began in other states as prospectors moved west. The most important gold discovery, because of its influence on western development, was at Sutter's Mill in California in 1848. Later discoveries were made in most other Western states and territories.

Early mining was largely by placer methods with miners working stream deposits by various hydraulic techniques. The gold was recovered by gravity separation or by amalgamation with mercury. During the period 1792 through 1964, 88 percent of the production came from gold ores (51 percent - lode; 37 percent - placers) and 12 percent as a by-product from other metal mines. The total U.S. gold production as of 1980 was 319 million ounces with lode gold mining supplying about 50 percent, placer mining 35 percent, and base metal mining (by-product) accounting for 15 percent. Lode mining is defined as "hard rock" mining using either open pit or underground methods of mining minerals that are in place as originally deposited in the earth's crust or that have been reconsolidated into a composite mass with waste rock. The sought after mineral is not in a "free" or loose state.

Description of the Industry

Nature of Deposits

Placer mining is the process involved in the extraction of gold or other metals and minerals from primarily alluvial deposits which may be from recent ("young" placers) or ancient deposits ("old " "ancient," or "fossil" placers). Current placer mining activity generally takes place in young placers originating as waterborne or glacially-deposited sediments. For many years, gold has been the most important product obtained, although considerable platinum, silver, tin (as cassiterite, SnO_2), phosphate, monazite, rutile, ilmenite, zircon, diamond and other heavy, weather-resistant metals or minerals have been produced from these deposits at various locations in the world. Since gold has a high specific gravity (19.3), it settles out of water rapidly and is found associated with other heavy minerals in the deposits.

Most placer deposits consist of unconsolidated or semiconsolidated sand and gravel that actually contain very small amounts of native gold and other heavy minerals. Most are stream deposits and occur along present stream valleys or on benches or terraces of pre-existing streams. Placer gold deposits are also occasionally found as beach or offshore deposits as at Nome, Alaska.

Residual placers are defined as deposits found spread over a local gold bearing lode deposit as a residual of the decay or erosion of that deposit and are found at a number of localities such as Flat, Happy, and Chicken Creeks in the Iditarod District of Alaska, but have not been an important source of gold. Creek bench deposits are found in virtually all the districts. Modern creek placers occupy the present creek channels and usually contain gravels from a few feet to 10 feet or more thick. The ancient placers are those in benches or terraces along present streams. The deeply buried channels or "deep gravels" are deposits of ancient streams which are now buried by alluvium. The best examples of these deposits are in the interior of Alaska, particularly in the Fairbanks, Hot Springs, Tolovana, and the Yukon-Tanana region. The gravels are ordinarily 10 to 40 feet thick but are buried under black humus (sometimes called muck), fine gray sand, silt, and clay which may be 10 to 30 feet or more thick.

Bench placers have the characteristics of modern creek placers but are higher than the present bed of the stream. Present streams have cut into the deposits forming surface terraces that resemble benches. High-bench deposits result from the action of streams of a former drainage system with no direct relation to existing drainage channels. These high gravels are sometimes called "bar" deposits. Some of the best examples are in the Rampart, Hot Springs, and Ruby Districts. Some of the high bench deposits near Nome between Dexter and Anvil Creeks have been very productive.

Beach placers are resorted deposits that have been formed by wave action which erodes adjacent alluvial deposits and concentrates their gold along the beach. Examples of these deposits are at Lituya Bay, Yakataga and Kodiak Island. The most important beach placers are at and near Nome. At Nome, there are both submerged and elevated beach placers formed at various times particularly over the last million years when the sea level fluctuated. In most cases, the beach lines, usually gravels, covered with muck and overburden, have been very productive. Their thickness ranges from 30 to 100 feet.

Other types of placers include river bar, gravel plain, those associated with bedding planes and crevices of the bedrock, and some placers in which the bedrock has formed or is overlain by a sticky clay or "gumbo" in which the gold may be distributed.

The presence of beds of clay or "hardpan" in placer deposits may influence the distribution of the gold. The clay beds form impervious layers (false bedrock) on which concentration of gold takes place and prevents the gold from working below them.

Location

Gold placer mining in the United States is located almost entirely in Alaska and the seven Western states of California, Colorado, Idaho, Montana, Nevada, Oregon, and Washington. Data received on the 1986 mining season indicate 457 operating commercial mines, with 265 (58 percent) operating in the lower 48 states and 192 (42 percent) in Alaska. Small recreational and assessment mining activities bring the total number of operations considerably higher, possibly in excess of 1,000; however, there is no known reliable information on the smaller operations. Information obtained by the Agency indicates considerable change in the industry since 1982; while the industry in the Lower 48 has grown by 34 percent, the number of mines in Alaska has dropped over 36 percent. Activity in Alaska and the major producing states in the Lower 48 has been reviewed by the Agency and included in the data base for this regulation.

Alaska

Figure III-1 (p. 60) shows locations of major gold producing camps in Alaska. Table III-1 (p. 45) lists cumulative production information for these camps since their discovery. Historically, the size of the mining activity has fluctuated with the price of gold and other factors. Figure III-2 (p. 61) illustrates the dramatic fluctuation of activity in Alaska over the past century.

Recently, factors other than the price of gold have been controlling the size of gold placer mine activity in Alaska. Despite an average 23 percent increase in the price of gold from 1985 to 1986, gold placer mining activity in the state of Alaska has dropped off sharply. While the number of permits issued has declined only slightly (446 in 1984, 437 in 1987), the number of active placer mines as reported by the Alaska Division of Geological and Geophysical Surveys shows a more substantial decline:

Year	No. of Mines
1982	304
1985	266
1986	195

A study done by Louis Berger and Associates, identified the areas around Fairbanks (the Eastern Interior region) as the most dependent upon placer mining. Alaska's Division of Geological and Geophysical Surveys reported a 49 percent decline in employment for placer mining in this area during 1986. Table III-2 (p. 46) shows the changes in number of operators, employees, and production by region for 1985 and 1986. The reasons cited for the decline of placer activity in Alaska are uncertainty about state water quality regulations and two lawsuits related to mining on Federal lands in Alaska.

Lower 48

Gold placer mining in the lower 48 states fluctuates from year to year, primarily based on the price of gold. The exact number of mines in each state varies considerably. Information collected on Idaho, Montana, Colorado, California, Nevada, Oregon, and Washington is summarized below:

Idaho. Based upon a review of applications for dredging and gold placer mine permits in Idaho and other information in the Idaho Department of Land files, there are approximately 29 active gold placer mines and 42 inactive mines in the state. Twenty-seven of the 29 active operations are located in ten counties with the majority of these located in two counties. The volume of ore sluiced per day ranges from approximately 36 cu yds to 4,800 cu yds, with the sizes and types of operations being basically similar to those in Alaska and Montana.

Montana. There are 50 gold placer mines (employing mechanical, open-cut methods) in Montana which have discharge permits or are otherwise known to exist. It is likely that there may be another 60 mines that do not have discharge permits (some may not discharge wastewater). The mines are located in the western portion of the state. There are no known hydraulic mining operations or mechanical dredges operating in Montana. However, the Montana Department of Health and Environmental Sciences has issued water discharge permits to approximately 97 suction dredges, which generally are quite small (2- to 4-inch diameter). The mining methods, classification methods, wastewater treatment technologies, and size of the operations all appear similar to those encountered in Alaska.

Colorado. A review of the Colorado Water Pollution Control Division's files indicated that only four gold placer mines in the state had permits to discharge wastewater. Other sources indicate that there may be as many as 19 more gold placer mines in the state. This apparent discrepancy may be explained by several possibilities including: (a) no discharge of wastewater; (b) inactive status; (c) improper classification as a gold placer mine; and (d) discharge without a permit. The gold placer mines for which permits have been issued are relatively small (less than 150 cu yds per day), seasonal, open-cut mines employing settling ponds for treatment of wastewater.

California. According to the U.S. Bureau of Mines, one large dredging operation was expected to recover 20,000 to 25,000 troy ounces of gold annually. There are likely to be other operations, but no data on these operations are available. It has been estimated that there may be as many as 25 operating gold placer mines in California, but all are thought to be zero discharge operations.

Nevada. According to Reference 6, 157 troy ounces of gold were obtained from gold placer deposits in Nevada. However, little is known about any active gold placer mine operations. It has been estimated that there are six commercial gold placer mines in Nevada.

Oregon. Several small gold placer mines (small suction dredges) were reported as operating along gold-bearing drainages in southwestern Oregon. Production is unknown. It is thought that there may be 25 to 50 operations in Oregon.

Washington. It has been estimated that there are 30 gold placer mines in Washington, but little is known about them. No state discharge standards are in effect.

Production

Most gold placer deposits contain a few cents to several dollars worth of gold per cu yd (1 cu yd weighs about 1.5 tons); a rich placer deposit would contain only a few grams of gold per ton of gravel. The largest placer deposits have yielded several million ounces of gold, but most have been much smaller. The Bureau of Mines has estimated that gold placer deposits contributed as much as 3 percent of the U.S. total annual production in 1982. Taking the State of Alaska's 1982 estimates of gold placer production and comparing them to the Bureau of Mines 1982 total gold production indicates that Alaska gold placer deposits contributed approximately 10 percent of total U.S. gold production, while 1986 data indicates Alaska production was approximately 4 percent of total U.S. gold production.

Figure III-2 (p. 61) is a plot of historical gold production and value in Alaska for the period 1880-1986. Based upon recent estimates performed by the State of Alaska's Division of Geological and Geophysical Surveys, gold placer production in Alaska was 160,000 troy ounces in 1986, a decline of 16 percent from the previous year.

Gold Prices

Gold prices during the last 20 years have been subject to wide variation as illustrated in Table III-3 (p. 47). Gold placer mining should be viewed against the backdrop of fluctuating prices, since the factor of rising prices can stimulate prospecting, influence the number of active operations, cause increases in production, and allow the mining of lower grade ores, while decreasing prices have the opposite effect.

Summary of Mining and Processing Methods

The mining and processing methods in use today in Alaska and the other gold placer mining states are similar in many respects to those in use elsewhere in the ore mining and dressing category. Three important differences exist in this category: (a) the nature of the deposits requires that a great deal of material must be excavated or moved and then processed to remove an accessory or trace constituent (gold) and, because gravity separation methods are used, a great deal of water per unit of production is needed; (b) the climate and location of many operations dictate harsh operating conditions and constant maintenance; (c) some permanently frozen overburden and ore deposits must be thawed in order to be exploited which, in turn, produces excess water to be treated prior to release.

The actual mining season varies with location and availability of water but generally ranges between 40 and 137 days per year, with the average operation probably in the 100-115 operating day range for the entire United States; Alaska would be lower. This range is most typical for operations in the industry as a whole, but there are a few operations in the conterminous states which operate with longer seasons (270 days).

Before 1930, open cut gold placer mines operated with steam-powered shovels, scrapers, draglines, cableway excavators, and reciprocating and pulseometer pumps. The development of the lightweight diesel engine, which resulted in the advent of diesel-powered bulldozers, draglines, and pumps brought about a revolution in open cut placer mining methods in Alaska, as well as other states.

The introduction in the mid-1930s of efficient modern excavating equipment and portable centrifugal pump units made it possible to work many deposits that could not be mined earlier by the more cumbersome machines. Improvements in gravel washing and recovery systems were developed simultaneously.

Readily movable steel sluiceboxes with hoppers and grizzlies, mounted on steel trestles with skids, replaced awkward and less desirable wooden structures. The steel sluiceplate, often called the slick plate, was one of the most influential improvements; it was responsible for the development of simple and flexible mining techniques. The use of portable diesel-driven centrifugal pumps allowed the recycle of wastewater to supplement limited water supplies. Utilization of draglines, bulldozers and loaders in combination facilitates the removal of both frozen and thawed overburden as well as the handling of gravel and bedrock during sluicing. Improved designs of processing equipment, using revolving trommels and stacker conveyors mounted on crawler-type tracks, were developed into successful washing and recovery plants at several properties.

The choice of excavation equipment, the beneficiation system, and arrangement of the plant is based essentially upon the size and physical characteristics of the deposits as well as on the water supply, the ultimate choice depending on the funds available for initial capital investment and the personal preference of the operator.

Mining Methods

Dredging Systems. Dredging systems are classified as hydraulic or mechanical, depending on the method of digging, and both are capable of high production. A floating dredge consists of a supporting hull with a mining control system, excavating and lifting mechanism, beneficiation circuits, and waste-disposal systems. These are all designed to work as a unit to dig, classify, beneficiate ores, and dispose of waste.

a. Hydraulic Dredging Systems. Whether the lifting force is suction, suction with hydrojet assistance, or entirely hydrojet, hydraulic dredging systems have been used much less frequently than mechanical systems in large commercial gold placer mining. Suction dredges have become quite popular with the small or recreational gold placer miner.

However, in digging operations where mineral recovery is not the objective, the hydraulic or suction dredge has greater capacity per dollar of invested capital than any mechanical system because the hydraulic system both excavates and transports. The hydraulic dredge is superior when the dredged material must be moved some distance to the point of processing.

Hydraulic digging is best suited to relatively small-size loose material. It has the advantage over mechanical systems in such ground when the material must be transported from the dredge by either pipeline or barge. In easy digging, excavation by hydraulic systems has reached depths of about 225 feet, but excavation for mineral recovery to date has been much less, only about one-third of that depth.

Even with efficiently designed units and powerful pumps, the size of the gold that can be captured by hydraulic dredging is limited. The ability of a hydraulic system to pick up material in large part depends upon intake and transport velocities that must be increased relative to specific gravity and size of particles. If the gold occurs as nuggets, especially large nuggets, the velocity required for capturing the gold can cause excessive abrasion in the entire system. In addition, higher velocities require more horsepower. When the flake size of the gold is very fine, higher velocities make gold recovery in the sluice box very difficult. Undercurrent systems solve this problem.

The digging power of hydraulic systems has been greatly increased with underwater cutting heads. One disadvantage of a cutterhead is that it must be designed with either right- or left-hand cutting rotation, which results in less efficient digging when the dredge is swung in one direction, especially in tough formations. As digging becomes more difficult and the cutterhead is swung across the face in the direction so that its blades are cutting from the old face to the new, the cutterhead tries to climb onto and ride the scarp. This produces considerable impact stress through the power-delivery system and reduces the capacity of the cutter.

The principal uses of large hydraulic dredges have been for non-mining jobs such as in digging, deepening, reshaping, and maintaining harbors, rivers, reservoirs, and canals; in building dams and levees; and in landfill and reclamation projects. Hydraulic systems in mining have been used to produce sand and gravel, mine marine shell deposits for cement and aggregate, reclaim mill tailings for additional mineral recovery, and to mine deposits containing diamonds, tin, titanium minerals, and monazite.

(b) Mechanical Dredging Systems. Digging systems on continuous mechanical dredges can be a bucket-ladder, rotary-cutter, or bucket-wheel excavator, each with advantages peculiar to specific situations. The bucket-ladder or bucket-line dredge has been the traditional gold placer mining tool, and is still the most flexible method where dredging conditions vary. Gold placer dredges, rated according to bucket size, have ranged from 1 1/2 to 20 cubic feet, although the larger equipment has been used in non-mineral harbor work.

Excavation equipment consists of a chain of buckets, traveling continuously around a truss or plate-girder ladder, that scoop up a load as they are forced against the mining face while pivoting around the lower tumbler and then dump as they pivot around the upper tumbler. The ladder is raised or lowered as required by a large hoisting winch through a system of cables and sheaves. Before the development of the deep digging dredges, the maximum angle of ladder when in its lowest digging position was usually 45° below the horizontal. During the last few years in Malaysia, 18-cubic-foot dredges digging from 130 to 158 feet below water level have often been operating at angles of 55° and sometimes more. At its upper position, the ladder inclines about 15° below the horizontal. Figure III-3 (p. 62) is a side view of the 18-cubic-foot Yuba Manufacturing Division, Yuba Industries, Inc., No. 110 dredge that was designed to dig 85 feet below water level.

Compared with any hydraulic system, the bucket-line dredge is more efficient in capturing values that lie on bedrock or in scooping up the material which sloughs or falls from the underwater face. It is more efficient when digging in hard formations, because its heavy ladder can be made to rest on the buckets providing them with more ripping force. Bucket size and speed can be varied with formation changes in the deposit according to the volume of material that can be processed through the gold-saving plant. Most bucket-line dredges used in placer mining have compact gravity-system processing plants mounted on the same hull as the excavating equipment. The waste stacking unit, also mounted on the same hull, combines with other dredge functions to make the dredge a complete and efficient mining unit. The advantages of an integral waste distributing system trailing behind the excavator become readily apparent when considering that up to 10,000 cubic yards of oversize waste must be disposed of each day on a large dredge. To assure a high percentage of running time, dredge components must be designed for long life and relatively easy and quick replacement of parts. Dredging experience has shown that most parts need to be larger and heavier than theoretical engineering designs indicate, and the simpler their design, the lower their replacement and installation costs.

The advantages of the bucket-line dredge as compared to the hydraulic dredge are as follows. The bucket-line dredge:

- Lifts only payload material, whereas a hydraulic system expends considerable energy lifting water
- Loses fewer fines which contain most of the fine or small fraction gold
- Digs more compact material
- Cleans bedrock more efficiently
- Allows more positive control of the mining pattern
- Has a simpler waste disposal system compared to a hydraulic system with an onshore treatment plant
- Requires less horsepower

The disadvantages of mechanical systems compared to hydraulic systems include: (1) they require more initial capital investment per unit of capacity; and (2) they require a secondary pumping system if the excavated materials must be transferred to a beneficiation plant which is distant from the dredge.

Open Cut Methods. Many perennially frozen and buried gold placer deposits in Alaska cannot be mined profitably without modern earthmoving equipment. In general, this equipment is used to mine deposits where the size, depth, and characteristics of the deposit and the topography and condition of the underlying bedrock prohibit dredging. Bulldozers, draglines, loaders and scrapers are used to mine some deposits by open-cut methods. As indicated earlier, the choice of excavation equipment, recovery system and the mining method is based on the size, degree of consolidation, the physical characteristics of the deposits, and the water supply.

a. Bulldozers. Whether used exclusively or in combination with other earthmoving equipment, bulldozers are employed in all phases of open-cut gold placer mining. They are used for stripping muck and barren gravel overburden, pushing pay dirt to sluiceboxes, stacking tailings, and constructing ditches, ponds, and roads. Rippers attached to bulldozers may be used to excavate bedrock where gold has penetrated fractures and joints or frozen ground. According to a Canadian study, bulldozers are utilized at about 80 percent of Yukon Territory placer mines.

The tractor sizes range from 100 to 460 horsepower. Straight blades normally are preferred due to their versatility. Scrapers have limited utility but may be used in special circumstances.

b. Draglines. Although draglines are less mobile than bulldozers, they can move materials at a lower cost per unit. Because of their high initial cost when new, most of these units are used and rebuilt. Draglines are used essentially for the same purposes as bulldozers, plus a dragline can move material from underwater conditions. The 1 1/2 cu yd bucket capacity is preferred although the 3/4-, 1-, and 2 cu yd sizes are not uncommon.

Draglines are not used extensively in Alaska or in Canada's Yukon gold placer industry. Experienced operators are very difficult to find. Draglines have been used effectively for cleaning settling ponds, feeding hoppers for trommels, and stacking tailings.

c. Loaders. Front-end loaders are the second most common equipment type and are used extensively at gold placer mines (III-21). Although they are usually mounted on rubber tired wheels, they also can be track-mounted. Front-end loaders have the following advantages:

- The economic load and carry distance may be as far as 700 feet.
- Classification equipment such as grizzlies can be more easily utilized than with bulldozers.
- Wheel loaders have a greater flexibility in moving

material (e.g., out of pits, around tailings piles).

- Skilled operators are readily available or can be easily trained.

Hydraulic Methods. Hydraulic mining, also known as hydraulicking, utilizes water under pressure which is forced through nozzles to break up and transport the gold placer ore to the recovery unit (usually a sluice box). The adjustable nozzles are also known as monitors or giants. They are also used to break up or wash away overburden. If done in stages, frozen muck can be thawed effectively. A pump, or occasionally, gravity is used to produce the required pressure. Pure hydraulic mining is not currently being used in this industry.

Monitors or giants can swing in a full circle and through a wide vertical angle. Modern design utilizes the resultant forces to counterbalance the units for ease of operation.

Hydraulic mining (sometimes called hydraulicking) was used as an effective method of mining in water rich geographic areas. However, with the advent of modern earthmoving equipment and restrictions on the availability and pollution of water, the use of hydraulic mining has declined. Today there are no known wastewater discharges from hydraulic gold placer mines in the U.S. It appears quite unlikely that hydraulic mining will be revived as a common mining method because of the efficiency and low cost of mechanical earthmoving.

There appear to be no situations in which the mechanical earthmoving systems cannot be used effectively to remove ore from the mine. Hence, in any field application where hydraulic mining methods were being considered, the owner would need to evaluate the economic benefits of the hydraulic mining against the now standard mechanical mining approach.

Because all mines can use the methods costed by the Agency, this rule applies to all mine activities, including hydraulicing.

Other Associated Activities. There are many activities which occur at mine sites which are either directly or indirectly related to operation of a gold placer mine. The remaining portions of this subsection address these activities.

a. Prospecting and Evaluation. Sampling methods include various types of drilling (mainly churn and core drilling) and excavating (trenches, pits, and shafts). Other than possible erosion of disturbed soils, sampling methods generally involve only minor effects on water quality. However, processing of samples can in some circumstances produce significant quantities of a sediment-laden effluent.

Processing methods and the resultant amount of sediment produced depend on the size of sample processed. Small samples, from a few pounds up to a few tons, can be processed by hand with a rocker and a pan. A steady flow of water 4 to 5 gallons per minute is sufficient to operate a small (1 x 4 foot) rocker. With reuse, net consumption of water may be as low as 50 to 100 gallons per cubic yard. Figure III-4 illustrates a basic design for a prospector's rocker.

Bulk samples of up to several cubic yards can be excavated by hand or with a tractor-mounted backhoe. These samples are processed in a small sampling sluice 6 inches to 24 inches in width and 6 to 20 feet in length. When working by hand, two people can process and evaluate one to three cubic yards per day. When working with a backhoe and excavating relatively closely spaced test pits, about 100 cubic yards per day can be processed. Water requirements vary from a minimum of 50 gallons per minute for a 6-inch sluice to several hundred gallons per minute for a 24-inch sluice.

b. Stripping Vegetation. Mining areas are stripped for the following purposes:

- To remove the insulating layer to allow thawing of permafrost
- To remove organic material which would interfere with processing
- To expose the overburden and minable ore

Mechanical stripping of vegetation can expose erodible soils and, therefore, can significantly degrade water quality. Where stripped soils are on a slope, gully erosion can result. Hydraulic removal of vegetation is usually a part of hydraulic thawing and stripping overburden and can significantly degrade water quality.

c. Thawing Permafrost. There are basically four methods of thawing frozen ground:

1. Mechanical removal of the insulating layer of surface vegetation and overburden, and solar thawing
2. Hydraulic removal (using monitors) of the surface vegetation and combined cold surface water and solar thawing
3. Hot or cold water thawing of the frozen ground by driving or jetting closely spaced well points and injecting water into the frozen ground that surrounds the well point (steam has also been used in this manner)
4. Diverting surface water over or against frozen ground (ground sluicing)

d. Stripping Overburden. In many districts, gold placer gravels are overlain by silty, organic-rich deposits of barren, frozen organic laden material which must be removed prior to mining. Geologically, the material is thought to be primarily colluvium (material transported by unconcentrated surface runoff) but may also contain loess (wind-blown deposits). Some areas are particularly noted for high organic and high ice contents. Other types of overburden are barren alluvial gravels, broken slide rock, or glacial deposits. There are two primary methods of stripping used--mechanical and hydraulic. Each will be discussed below.

Mechanical stripping refers to the use of excavating equipment for removal of overburden. Miners who mechanically strip overburden generally utilize the same equipment for mining. Few have specialized stripping equipment, e.g., shovels, scrapers, draglines, bucket wheel excavators. Mechanical stripping can be constrained by permafrost, severe space limitations for overburden dumps, difficult workability of weak thawed silts, and thick overburden deposits.

If the hydraulicking is done in stages, frozen muck can be thawed effectively and stripped. Pumps and occasionally gravity are used to produce the required water pressure. The major constraint to the application of hydraulicking, other than environmental considerations, is probably lack of an adequate water supply. Construction of storage reservoirs and lengthy ditches and diversions are frequently necessary. Although the water quality effects stem primarily from the hydraulicking itself, unstable diversions, ditches, and reservoir dikes washed out by floods also contribute to the sediment load. Some recirculation of thaw water is being done in Alaska.

Processing Methods

There probably is no such thing as a single "typical" mine due to the wide variation in processing equipment used, overburden characteristics and methods of removal, type of deposit, size range of the gold recovered, topography, etc. Therefore, the actual equipment and mining methods used will probably be some combination of mining methods and processing technology discussed here.

A large percentage of the present gold placer mining operations use some type of sluice box to perform the primary processing function, beneficiation; but a few jig plants are used.

Many operations make use of feed classification. Some of the most prominent equipment is discussed under various headings below.

Classification. Classification (screening) involves the physical separation of large rocks and boulders from smaller materials such as gravel, sand, and silt or clay. The object of classification is to prevent the processing of larger-sized material which is unlikely to contain gold values. Gold placer miners who were interviewed as part of a previous study reported that this practice improves the efficiency of gold recovery. The reason was attributed to the fact that a lower flow rate of water may be required compared to the high flow rate necessary to wash large rocks through the sluice. The low flow rate enhances the settling and entrapment of smaller-sized gold particles in the sluice. Use of increased rates of flow when classification is not practiced is thought to cause some of the finer gold particles to be washed through the sluice and be lost. Operating conditions also are enhanced by preventing the entry of large rocks and boulders which must be removed manually when lodged in the box.

a. Grizzlies. A grizzly is a large screen of a fixed opening size which serves to reject oversize material and prevent it from entering the sluice. This oversize material is then discarded. Typically, a grizzly would be inclined to facilitate removal of the rejected material. Grizzlies operated wet usually produce the best results. Figure III-5 (p. 64) is a schematic of a grizzly.

The advantage of a grizzly is that it prevents processing of coarse material which is unlikely to contain gold, and it allows a shallower depth of flow over the sluice riffles which enhances recovery of fine gold. This can result in a water use reduction.

b. Trommels. A trommel is a wet-washed, revolving screen which offers the following advantages:

- It washes the gravel clean and helps in disintegrating gold-bearing clayey material by impact with oversize material and strong jets of water
- It screens and distributes slimes, sand, and fine gravel (usually less than 1/2 inch) to the processing section and discards the oversize material

Taggert reported that plants equipped for removal of oversize material with subsequent treatment in sluices are capable of processing 60 to 67 percent more ore per unit area of a sluice. Figure III-6 illustrates a trammel.

c. Fixed Punchplate Screen-High Pressure Wash (Ross Box). The Ross Box is essentially a punchplate with hole sizes generally 1/2 to 3/4 inch in diameter. A dump box receives the gold placer ore, while a header with several nozzles delivers wash water into the dump box in a direction opposite to the flow of the ore.

This turbulent washing action washes undersize material through the punchplate where it is diverted to outside undercurrents fitted with riffle sections. These side channel sluices handle the material smaller than 3/4 inch. Oversize material is washed down the center channel which is fitted with riffles to collect coarser gold. Water flow is controlled to each of the sluice areas.

d. Vibrating Screens. A vibrating screen is a screen which uses vibration to improve the rate at which classification occurs. Generally, 1/2 to 3/4 inch screens are used with the oversize material rejected to a chute or tails stacker conveyor belt (Figure III-7, p. 66). These screens usually are loaded by a front-end loader, dragline, or a backhoe, but in some cases they are loaded via conveyer belts. In some configurations, several size screens are stacked and different size classifications are sluiced independently. Wet screening normally is used to break up clay and loosely bound particles.

Sluices. A sluice is a long, sloped trough into which water is directed to effect separation of gold from ore (Figure III-8, p. 67). The ore slurry flows down the sluice and the gold, due to its relatively high density, is trapped in riffles along the sluice. Other heavy minerals present in the ore are also trapped in these riffles. These other minerals are generically called "black sands" and are separated from the gold during final clean-up, i.e., in small sluices, vibrating tables, gold wheels or amalgamation.

Sluice boxes are usually constructed of steel. Typically, a sluice is 6 to 12 meters (20 to 40 feet) long, and 60 to 120 cm (24 to 48 inches) wide. Longer sluices are used where the ore is not broken up prior to sluicing. Shorter and narrower sluices are used in prospecting and during clean-up operations. Water depths in sluices may vary from 3.8 cm to 15.2 cm (1.5 inches to 6 inches). The slope of the sluice boxes ranges from 8.3 cm to 16.6 cm vertical per meter horizontal (1 to 2 inches per foot). The grade of sluice boxes can be varied depending upon the ore. In general, the recovery of fine gold requires shallower and wider sluices. The majority of the gold is recovered in the first several feet of riffles. The following discussion describes various types of riffles used in sluices. Figure III-9 illustrates some of the riffles described.

a. Hungarian Riffles. The Hungarian riffle design is widely used in placer mining. Hungarian riffles are essentially angle irons mounted transversely in the sluice box. The riffles are spaced 3.8 to 7.6 cm (1.5 to 3 inches) apart. The size and spacing of the riffles are designed to maximize gold capture and to minimize packing of the riffles with non-gold bearing particles. These riffles are sometimes custom-modified with notches and holes to improve gold recovery. A coarse, fibrous matting such as a carpet (e.g., AstroTurf) or coconut husks may be placed under the riffles to capture and retain the gold for further processing. Sections of riffles can be removed to withdraw the carpet.

b. Expanded Metal. Expanded metal of various sizes may be used as the riffle in sluices and is gaining widespread acceptance in the industry. A number of tests have shown the direction of placement of the expanded metal does not affect gold recovery. Expanded metal appears to perform very well in recovery of small particle sized gold.

c. Horizontal Pole Riffles. Wooden poles placed perpendicular to the flow have been used to create riffles at placer mines. This type of riffle has been used in small-scale, remotely located operations because the riffle can be made with locally available materials. Wooden poles are not as durable as their steel counterparts, and their use has largely been discontinued.

d. Longitudinal Pole Riffles. Wooden poles, usually spruce, are placed parallel to the direction of flow through the sluice. The spacing between these pole riffles varies from 3.8 cm to 7.6 cm (1.5 inches to 3 inches). Similar to horizontal pole riffles, longitudinal pole riffles are not believed to be in widespread use.

e. Other Riffle Types. Wooden blocks, rocks, rubber and plastic strips, railroad rails, heavy wire screen, and cocoa mats have been used at various times as riffles in gold placer mining. These riffle designs are not in common use today.

Clean-Up Methods. Many accessory heavy minerals found in the gold placer ore are also concentrated by the methods discussed in this section. Therefore, it is essential that the concentrate collected from the sluice is separated into gold values and the unwanted accessory heavy minerals. The following discussion presents methods in use today.

a. Jigs. In general, the concentrate is fed as a slurry to a chamber in which agitation is provided by a pulsating plunger or other such mechanism. The feed separates into layers by density within the jig with the lighter gangue being drawn off at the top with the water overflow, and the denser mineral (in this case gold) drawn off on a screen on the bottom. Several jigs may be used in series to achieve acceptable recovery and high concentrate grade. In addition to clean-up of concentrate from sluices, large jigs are also used as the primary beneficiation process to recover gold from ore in lieu of sluices. Large dredges often use a number of jigs in series to recover gold from sized or screened ore, and several open cut mines are using jigs in the primary recovery or beneficiation of sized ore.

b. Tables. Shaking tables of a wide variety of designs have found widespread use as an effective means of achieving gravity separation of finer ore particles 0.08 mm (0.003 inch) in diameter (Figure III-10, p. 69). Fundamentally, they are tables over which flow ore particles suspended in water. A series of ridges or riffles perpendicular to the water flow trap heavy particles while lighter ones are suspended and flow over the obstacles with the water stream. The heavy particles move along the ridges to the edge of the table and are collected as concentrates (heads) while the light material which follows the water flow is generally a waste stream (tails). Between these streams may be some material (middlings) which has been partially diverted by the riffles. These are often collected separately and returned to the table feed. Reprocessing of heads or middlings, or both, and multiple-stage tabling are common.

c. Spirals. Spiral separators, i.e., Reichert and Humphrey concentrators, provide an efficient means of gravity separation for large volumes of material between 0.1 mm and 2 mm (0.004 to 0.08 in) in diameter. Spirals have been widely applied, particularly in the processing of heavy sands for titanium minerals. Spirals consist of a helical conduit about a vertical axis. The ore, or in this case concentrate, is fed with water to the conduit at the top and flows down the spiral under gravity. The heavy minerals concentrate along the inner edge of the spiral from which they may be withdrawn through a series of ports. Wash-water may also be added through ports along the inner edge to improve the separation efficiency. In large plants, several to hundreds of spirals may be run in parallel, although in gold placer mining operations, a small number is usually sufficient. Several open cut mines have been reported as using spirals in the primary recovery of gold from gold placer deposits.

d. Gold Wheels. A gold wheel is a gravity separation device used during cleanup to separate the gold from the "black sand." The wheel may vary between 30 cm to 112 cm (12 inches to 44 inches) in diameter and may rotate at a rate up to 42 rpm. The rotational speed on most units can be controlled by the operator. Inside the wheel, there are 0.64 cm (1/4 inch) to 1.27 cm (1/2 inch) channels arranged in a helix in the plane of the table. The wheel is tilted with only small angles being capable of separating materials of relatively different specific gravities. Conversely, steeper angles separate materials with little difference in specific gravity. Water is sprayed onto the wheel from several ports at a rate of 10 gpm or less. This water can be recirculated if needed. Gold concentrate is placed along the perimeter of the wheel, and the gold works its way to the center where it is withdrawn. The lighter material flows over the perimeter lip of the wheel and is captured and reworked to recover any remaining gold. Surfactants (e.g., liquid soap) are sometimes added to the water to aid in recovery of the gold by reducing surface tension of the water.

e. Small Sluices. Small sluices are simply scaled-down versions of the sluices described above. The advantage of using a small sluice is that only small amounts of concentrate are processed at a rate conducive to maximize gold separation from other heavy minerals in the concentrate. Several passes or several small sluices may be used in series to ensure that no gold is lost. Only small amounts of water are required because the size range of the concentrate is relatively restricted.

f. Magnetic Methods. A large proportion of the heavy mineral concentrate from which the gold is extracted may contain minerals (primarily magnetite) which exhibit magnetic properties. The basic process involves the transport of the concentrate through a region of high magnetic field gradient. In large-scale applications of this method, an electromagnet may be used, but at small operations, a hand magnet is often employed. This method is often applied along with other methods to effect the best separation of the gold from other heavy minerals in the concentrate.

g. Chemical Methods. There are two chemical methods in use in the gold industry today which may be used in association with gold placer mining: amalgamation and cyanidation. Amalgamation was used on a wider scale in the past but is not commonly used today except for cleanup of a concentrate. Cyanidation is not known to be used for extraction of gold from a concentrate but could be used to rework tailings from gold placer operations by heap leaching. Wastewater from such heap leach operations is regulated under 40 CFR Part 440.100 (Subpart J).

Amalgamation. Amalgamation is the process by which mercury is alloyed, generally to gold or silver, to produce an amalgam. The amalgam is placed in a small retort to recover the mercury for reuse and to reclaim the gold.

Cyanidation. This process is not widely used in Alaska for primary extraction of placer gold but is being used extensively in the lower 48 states to recover gold from low grade ores by heap or vat leaching. It has been economically applied in the recovery of gold from tailings left by hard rock gold mills and from low grade deposits. The cyanidation process involves the extraction of gold or silver from fine-grained or crushed ores, tailings, low grade mine rock, etc., by the use of dilute potassium or sodium cyanide in strong alkaline solutions. After dissolution of the gold, the gold is absorbed onto activated carbon or precipitated with metallic zinc usually in dust form. The gold may be recovered by filtering with the filtrate being returned to the leaching solution. Some interest and use of this process is currently occurring in Alaska.

Small-Scale Methods. The methods described in this sub-section are primarily utilized by recreational or assessment operations. The various small-scale methods are similar to regular methods in that they employ principles based upon gravity separation. Small-scale methods are responsible for only a very small percentage of all gold placer mine production. A few representative methods are described below.

a. Gold Pan and Batea. Panning currently is mostly used for prospecting and recovering valuable material from concentrates. The pan is a circular metal dish that varies in diameter from 6 to 18 inches with 16-inch pans being quite common. The pans often are 2 to 3 inches deep and have 30- to 40-degree sloping sides. The pan with the mineral-bearing gravel or sand is immersed in water, shaken to cause the heavy material to settle toward the bottom of the pan, and then the light material is washed away by swirling and overflowing water. This is repeated until only the heavy concentrates remain. In some countries, a conical-shaped wood pan, called a batea, is used. This unit has a 12- to 30-inch diameter with a 150-degree apex angle. It is often used to recover valuable metals from river channels and bars.

b. Long Tom. A long tom is essentially a small sluice box with various combinations of riffles, matting, expanded metal screens, and occasionally, in the old days, amalgamating plates. A long tom usually has a greater capacity than a rocker box and does not require the labor of rocking. It consists of a short receiving launder, an open washing box six to twelve feet long with the lower end a perforated plate or screen set at an angle, and a short sluice with riffles. The component boxes are usually set on slopes ranging from 1:12 to 1.5:12. A long tom is illustrated in Figure III-11 (p. 70).

c. Rocker Box. Rocker boxes are used to sample placer deposits or to mine high-grade areas when installation of larger equipment is not justified. The box is constructed of wood and is essentially a short, sloped box chute over which the pay dirt and water flow as the box is rocked back and forth. A screen is mounted at the head of the box to reject oversize material. It may be fitted with riffles and usually has a canvas or carpeted bottom.

d. Dip Box. The dip box is useful where water is scarce and where an ordinary sluice cannot be used because of the terrain. It is portable and has about the same capacity as the rocker box. The box is about 2 to 4 meters (6 to 12 feet) long, and 0.3 meter (12 inches) wide with 0.15-meter (6-in) sides. The bottom of the box is covered with burlap, canvas, or thin carpet to catch the gold. Over this is laid a 0.3 by 1.0 meter (1 by 3 ft) strip of heavy wire screen of about 0.6 mm (1/4-in) mesh. Material is dumped or shoveled into the upper end and washed by pouring water over it from a dipper, bucket, hose, or pipe until it passes through the box. Large rocks are removed by hand and riffles may be added to the lower section of the box to improve recovery

e. Suction Dredge. Small suction dredges are being used successfully for prospecting or for recreational or small (part-time) ventures. The pump sizes most commonly found in use vary from one to four inches. The pump is usually floated immediately above the area being worked. There are two basic assemblies that are commonly used: (1) the gold-saving device is in a box next to the suction pipe and carried under water, and (2) the other system uses two hoses in the nozzle--one transporting water to the head and the other transporting material to the surface of a gold-saving device, i.e., usually a small sluice box with tails being deposited back into the stream.

Industry Practice

Until recently, little detailed information was available concerning gold placer mining operations in Alaska and other states. However, during the last few years, EPA has embarked upon efforts described elsewhere in this document to identify specific operations and obtain information concerning gold placer mining practices, water use, wastewater treatment technologies employed, flow, etc. This information has been obtained by site and sampling visits, review of Tri-agency report forms from Alaska, visits to various state pollution control agencies, from the gold placer miners, and from other sources.

Some characteristics of the operations emerge from examination of the information gathered which serve to place gold placer mining in perspective. Most operations are located in remote areas far from supplies and the amenities of civilization or a developed infrastructure. Electric power is usually generated on-site by the operators, with fuel delivered periodically to the site over land routes or by air. Many operations are family-owned and operated, and over 95 percent probably employ seven or fewer persons. Most of the operations are seasonal, generally averaging between 100 to 115 operating days per year. The size of the operations ranges from processing less than 20 cu yds per day to as much as 12,000 cu yds per day. Although gold is very valuable, the amount contained in the gold placer ore is very low with even the richest deposits containing only a few grams of gold per cubic yard; the gold gives a value of a few cents to over eight dollars per cubic yard of ore and more depending upon the current international price for gold.

Wastewater treatment technology employed in the gold placer mine subcategory generally ranges from treatment with settling ponds and discharge to partial recycle or recirculation of the total process water flow. The majority of gold placer mines provide simple settling, and a few employ tailings filtration for solids removal. No advanced treatment technology methods are known to be employed in Alaskan operations today, although some operators have tried or continue to try flocculant addition. Recycle or recirculation of process water is practiced at many mines in Alaska, primarily to conserve water. The percentage of process water recycled at a single mine may vary from 0 to 100 percent during a single season, subject to changes in precipitation and mining location. Data obtained by the Agency through the Alaska Department of Environmental Conservation shows that nearly 30 percent of the miners indicated, at permit application time, an intention to recycle 100 percent of their process water. An additional 30 percent intended to recycle some portion of their process water. No field confirmation of the information contained in the permit applications was conducted.

The remainder of this section consists of Tables III-4, III-5, III-6, III-7, and III-8 (pp. 51-56), which are profiles of the Alaska, California, Colorado, Idaho, and Montana gold placer mines surveyed and for which some data were available. Table III-9 (p. 59) contains profiles of Alaskan gold placer mines visited in 1986 by EPA collecting data and conducting treatability testing. The objective of Tables III-4 to III-9 is to provide information and data gathered at gold placer mining operations in this subcategory. Discussion of an operation or presentation of data and information does not imply that the gold placer mining operation is exemplary, typical, or represents good wastewater treatment. This list does not include all existing gold placer mines, particularly with respect to the hundreds of recreational or assessment operations which are believed to exist. Rather, the tables that follow present a summary of data and information that EPA has obtained which serve to illustrate the range of operations in the United States today. Although limited production has been reported from other states, the Agency has no precise data on the number of gold placer mines or production in other states.

Table III-1. Mineral Activity in Alaska by Mining Camp as of 1982

Map No.	Camp[b]	Gold Production (tr. oz.)	Discovery Date
1.	Nome	4,348,000	1898
2.	Solomon	251,000	1899
3.	Bluff	90,200	1899
4.	Council	588,000	1897
5.	Koyuk	52,000	1899
6.	Fairhaven (Candle)	179,000	1901
7.	Fairhaven (Inmachuk)	277,000	1900
8.	Kougarok	150,400	1900
9.	Port Clarence	28,000	1898
10.	Noatak	39,000	1898
11.	Kobuk (Squirrel River)	7,000	1909
12.	Kobuk (Shungnak)	15,000	1898
13.	Koyukuk (Hughes)	211,000	1910
14.	Koyukuk (Nolan)	290,000	1893
15.	Chandalar	35,708	1905
16.	Marshall (Anvik)	120,000	1913
17.	Goodnews Bay	29,700	1900
18.	Kuskokwim (Aniak)	230,600	1901
19.	Kuskokwim (Georgetown)	14,500	1909
20.	Kuskokwim (McKinley)	173,500	1910
21.	Iditarod	1,364,404	1908
22.	Innoko	400,000	1906
23.	Tolstoi	87,200	
24.	Iliamna (Lake Clark)	1,500	1902
25.	Skwentna (included in Yentna production)		
26.	Yentna (Cache Creek)	115,200	1905
27.	Kantishna	65,000	1903
28.	Ruby	420,000	1907
29.	Gold Hill	1,200	1907
30.	Hot Springs	450,000	1898
31.	Rampart	105,000	1882
32.	Tolovana	387,000	1914
33.	Fairbanks	7,940,000	1902
34.	Chena (included in Fairbanks production)		
35.	Bonnifield	50,000	1903
36.	Richardson	103,000	1905
37.	Circle	800,000	1983
38.	Woodchopper-Coal Creek (included in Circle production)		
39.	Seventymile (included in Fortymile production)		
40.	Eagle	45,000	1895
41.	Fortymile	417,000	1886
42.	Valdez Creek	44,000	1904
43.	Delta	2,500	
44.	Chistochina-Chisna	177,000	1898
45.	Nabesna	93,500	1899
46.	Chisana	50,000	1910
47.	Nizina	143,500	1901
48.	Nelchina	2,900	1912
49.	Girdwood	125,000	1895
50.	Hope (included in Girdwood) production)		
51.	Kodiak	4,800	1895
52.	Yakataga	15,709	1898
53.	Yakutat	2,500	1867
54.	Lituya Bay	1,200	1867
55.	Porcupine	61,000	1898
56.	Juneau(Gold Belt)	7,107,000	1880
57.	Ketchikan-Hyder	62,000	1898
58.	Sumdum	15,000	1869
59.	Glacier Bay	11,000	
60.	Chichagof	770,000	1871
61.	Willow Creek	652,052	1897
62.	Prince William Sd.	137,900	1894
63.	Unga Island	107,900	1891

(a)-Compiled from U.S. Geological Survey publications, U.S. Bureau of Mines records, Alaska Division of Geological and Geophysical Survey records and publications, Mineral Industry Research Laboratory research projects, and other sources.

(b)-Camp names are those that appear in official recording-district records. Many are also known by other names, some of which are shown in parentheses.

Source: Ref. 31

Table III-2. Reported Refined Gold Production, Number of Operators, and Industry Employment in Alaska By Region and Mining District, 1985-86.

Region and mining district	Mechanized units[a]	1985 Production (troy oz)	Number of employees	Mechanized units[a]	1986 Production (troy oz)	Number of employees
Northern	18	14,400	70	4	4,500	15
Chandalar						
Shungnak						
Koyukuk-Nolan						
Western	40	40,000	340	42	53,000	363
Nome						
Kougarok						
Koyukuk-Hughes						
Port Clarence						
Fairhaven						
Ruby						
Solomon						
Koyuk						
Council						
Eastern Interior	135	66,000	740	83	45,350	375
Circle						
Livengood-Tolovana						
Fairbanks						
Fortymile						
Manley-Eureka						
Richardson						
Bonnifield						
Kantishna						
Rampart						
Southcentral	38	52,500	263	30	39,000	268
Cache Creek						
Nizina						
Chistochina						
Valdez Creek						
Kenai Peninsula						
Nelchina						
Southwestern	32	17,000	125	33	18,000	128
Innoko-Tolstoi						
Iditarod-George River						
Moore Creek						
Nyac						
Crooked Creek						
Lake Clark-Mulchatna						
Southeastern and Alaska Peninsula	3	100	7	3	150	6
TOTAL	266	190,000	1,545	195	160,000	1,155

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[a] Mechanized-placer and small lode operations are included; small 'recreational-assessment' projects such as panning, long-tom sluicing, suction-dredging, and pick-and-shovel prospecting are not included. We estimate that 95 operations employed 275 people in 1985 and 80 operations employed 230 people in 1986.

Table III-3. Variations in Yearly Gold Prices

Year	Tr.Oz.
1935 - 1967	$ 35.00
1968	39.26
1969	41.51
1970	36.39
1971	41.25
1972	58.60
1973	97.81
1974	159.74
1975	169.49
1976	125.32
1977	148.31
1978	193.55
1979	307.50
1980	612.56
1981	459.94
1982	375.91
1983	424.00
1984	360.66
1985	317.66
1986	377.00
1987p	446.41

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p Preliminary

Source: U.S. Bureau of Mines, U.S. Geological Survey, and U.S. Treasury Department

Table III-4. Profile of Alaskan Gold Placer Operations

MINE CODE	LOCATION (DISTRICT)	OPER. DAYS PER YEAR	CLASSIFICATION METHOD USED	VOLUME SLUICED (CU. YD/DAY)	MINING METHOD	WASTEWATER TREATMENT TECHNOLOGIES USED	RECYCLE (%)	DAILY DISCHARGE VOLUME (GPM)
4109	50	100	Screens	1,350	Open Cut	Settling Ponds (2)	0	3,000
4110	50	60	Trommel and hyd. prewash	750	Open Cut and Hyd.	Settling Ponds (5)	75	1,000
4126	31	245	Trommel	6,800	Mech. Drdg.	Settling Ponds (5)	100	0
4127	31	245	Trommel	Unk.	Mech. Drdg.	Settling Ponds (2)	>0	3,140
4132	5	Unk.	None	90	Open Cut	Settling Ponds (2)	0	1,350
4133	5	180	Unk.	1,000	Open Cut	Settling Ponds (2)	0	675
4134	5	210	None	2,000	Open Cut	Settling Ponds (3)	0	23,000
4138	4	80	Vibrating Screens	90	Open Cut	Settling Ponds(10)	30	1,050
4169	50	189	None	900	Open Cut	Settling Ponds (5)	98	224
4170	50	132	Grizzly	1,000	Open Cut	Settling Pond (1)	0	2,400
4171	50	112	Trommel	1,000	Open Cut	Settling Pond (1)	0	1,800
4172	47	122	Trommel	2,750	Open Cut	Settling Ponds (3)	~ 17	6,000
4173	47	138	None	3,500	Open Cut	Settling Ponds (3)	>0	3,500
4174	47	122	Grizzly	2,500	Open Cut	Settling Ponds (2)	50	1,260
4175	47	102	None	1,000	Open Cut	None	0	8,000
4176	47	120	Grizzly	1,250	Open Cut	Settling Pond (1)	0	3,500
4178	47	90	Grizzly	1,500	Open Cut	Settling Ponds (3)	0	2,500
4180	47	131	Vibrating Screens	1,900	Open Cut	Settling Pond (1)	0	2,500

Table III-4. Profile of Alaskan Gold Placer Operations (Continued)

MINE CODE	LOCATION (DISTRICT)	OPER. DAYS PER YEAR	CLASSIFICATION METHOD USED	VOLUME SLUICED (CU. YD/DAY)	MINING METHOD	WASTEWATER TREATMENT TECHNOLOGIES USED	RECYCLE (%)	DAILY DISCHARGE VOLUME (GPM)
4183	47	Unk.	Unk.	Unk.	Open Cut	None	>0	1,400
4185	47	107	Trommel	800	Open Cut	Settling Ponds (2)	<50	3,200
4189	50	122	Trommel	950	Open Cut	Settling Ponds (4)	0	1,500
4190	51	104	None	2,500	Open Cut	Settling Ponds (2)	50	1,800
4193	51	80	Derocker	900	Open Cut	Settling Pond (1)	50	700
4197	59	102	Screens	200	Open Cut	Settling Pond (1)	75	450
4211	14	152	Trommel	4,000	Drdg.	Settling Pond with Tailings Filtration	>0	3,600
4213	50	120	None	250	Open Cut	Settling Ponds (2)	97	60
4216	12	132	Vibrating Screen	300	Open Cut	Settling Ponds (3)	0	800
4217	12	154	Vibrating Screen	350	Open Cut	Settling Ponds (3)	0	2,000
4219	53	162	None	1,000	Open Cut	Settling Ponds (4)	93	450
4222	31	150	Trommel	700	Mech. Drdg.	Settling Pond (1)	45	1,800
4223	47	120	Grizzly	1,000	Open Cut & Suct. Drdg.	Settling Pond (1)	0	2,500
4224	51	65	None	300	Open Cut	Settling Ponds (2)	0	2,000
4225	47	120	None	900	Open Cut	Settling Ponds (4)	50	3,000
4226	50	162	Jig	1,500	Open Cut	Settling Ponds (2)	50	2,200
4227	51	183	None	Unk.	Hyd. & Open Cut	Settling Pond (1)	0	4,000

Table III-4. Profile of Alaskan Gold Placer Operations (Continued)

MINE CODE	LOCATION (DISTRICT)(1)	OPER. DAYS PER YEAR	CLASSIFICATION METHOD USED(2)	VOLUME SLUICED (CU. YD/DAY)	MINING METHOD	WASTEWATER TREATMENT TECHNOLOGIES USED	RECYCLE (%)	DAILY DISCHARGE VOLUME (GPM)
4229	47	135	Unk.	1,400	Open Cut	Settling Ponds (5)	0	5,800
4230	58	120	Unk.	300	Open Cut	Settling Pond (1)	0	6,700
4231	50	168	Trommel	500	Open Cut	Settling Pond (1)	90	800
4232	47	108	FPS *	1,020	Open Cut	Settling Ponds (2)	50	2,000
4233	5	162	Grizzly	99	Open Cut	Settling Ponds (3)	0	417
4234	58	90	Grizzly	500	Hyd. (Booming)	None	0	1,500
4235	47	107	None	1,000	Open Cut	Settling Pond (1)	0	3,000
4236	58	213	Trommel	2,000	Open Cut	Settling Pond (1)	0	580
4239	14	Unk.	None	Unk.	Open Cut	Settling Ponds (2)	>0	450
4240	47	122	Vibrating Screen & Grizzly	500	Open Cut	None	0	2,000
4241	47	117	Grizzly	850	Open Cut	Settling Pond (1)	0	2,300
4242	47	89	None	800	Open Cut	Settling Ponds (4)	0	3,500
4243	51	107	Unk.	26	Hyd. and Open Cut	Settling Ponds (2)	0	1,500
4244	51	122	None	615	Open Cut	Settling Ponds (2)	0	3,000
4245	51	88	Unk.	400	Open Cut	Settling Ponds (2)	0	2,500
4247	5	150	FPS	500	Open Cut	Settling Pond (1)	0	2,000

* FPS = Fixed punch-plate screen.

Table III-5. Profile of California Gold Placer Mines

MINE CODE	COUNTY	OPER. DAYS PER YEAR	CLASS. METHOD	VOLUME PROCESSED (CU. YD/DAY)	MINING METHOD	WASTEWATER TREATMENT TECHNOLOGY USED	RECYCLE (%)	DAILY DISCHARGE VOLUME (gpm)
4260	Yuba	364	Trommel Jigs	12,360	Mech. Dredge	Seepage Ponds	Partial	0

Table III-6. Profile of Colorado Gold Placer Mines

MINE CODE	COUNTY	OPER. DAYS PER YEAR	CLASS. METHOD	VOLUME PROCESSED (CU. YD/DAY)	MINING METHOD	WASTEWATER TREATMENT TECHNOLOGY USED	RECYCLE (%)	DAILY DISCHARGE VOLUME (gpm)
4267*	San Juan	60	Screens	<135	Open Cut	Settling Pond (1)	0	300
4268***	Arapahoe	Seasonal	Screens	Unk.	Open Cut	Settling Ponds (2)**	>0	35
4269	Gilpin	150	Trommel	100-150	Open Cut	Settling Ponds (3)	>0	120
4270	Montrose	Unk.	Unk.	150	Open Cut	Settling Ponds (2)	Unk.	13

* Requested inactivation of his discharge permit

** One pond for each of the discharge points

***Sand and gravel also recovered at this mine

Table III-7. Profile of Idaho Gold Placer Mines

MINE CODE	COUNTY	OPER. DAYS PER YEAR	CLASS. METHOD	VOLUME PROCESSED (CU. YD/DAY)	MINING METHOD	WASTEWATER TREATMENT TECHNOLOGY USED	RECYCLE (%)	DAILY DISCHARGE VOLUME (gpm)
4271	Idaho	Seasonal	Trommel	320	Open Cut	Settling Ponds (3) (possible use of flocculants)	100	0
4272	Idaho	Seasonal	Screen, Trommel	100	Open Cut	Settling Ponds (2)	100	0
4273	Idaho	Seasonal	Trommel	100	Open Cut	Settling Ponds (2)	approx. 100	approx. 0
4274	Shoshone	Seasonal	Screens	100	Open Cut	Settling Ponds (2)	0	approx. 670
4275	Idaho	Seasonal	Unk.	100	Unk.	Settling Ponds (3)	Unk.	Unk.
4276	Custer	Seasonal	Grizzly, Screens	320-400	Open Cut	Settling Ponds (3)	Partial	Unk.
4277	Idaho	Seasonal	Grizzly, Vibrating Screens, Crusher	320	Open Cut	Settling Ponds (3)	100	0
4278	Owyhee	Unk.	Grizzly, Trommel Jigs & Table	Unk.	Open Cut	Settling Ponds (4)	Unk.	Unk.
4279	Idaho	Seasonal	Trommel	800-1000	Floating Wash Plant	Settling Ponds (2)	100	0
4280	Ada	Unk.	Unk.	Unk.	Open Cut	Unk.	Unk.	Unk.
4281	Idaho	Unk.	Unk.	approx. 1600	Open Cut	Settling Ponds (?)	0	Unk.
4282	Boise	Seasonal	Trommel	Unk.	Open Cut	Settling Ponds (?)	0	Unk.
4283	Boise	Seasonal	Unk.	Unk.	Open Cut	Settling Ponds (?)	0	Unk.

Table III-7. Profile of Idaho Gold Placer Mines (Continued)

MINE CODE	COUNTY	OPER. DAYS PER YEAR	CLASS. METHOD	VOLUME PROCESSED (CU. YD/DAY)	MINING METHOD	WASTEWATER TREATMENT TECHNOLOGY USED	RECYCLE (%)	DAILY DISCHARGE VOLUME (gpm)
4284	Bonneville	Seasonal	Trommel	approx. 125	Open Cut	Settling Ponds (3)	100	0
4285	Unk.	Year Round	Magnetic Separators, Amalgamation	4,800	Open Cut	Settling Pond (3) (lined with bentonite)	approx. 100	Slight
4286	Power	Year Round	Vibrating Screen	280	Open Cut	Settling Ponds (2)	100	0
4287	Idaho	Seasonal	Unk.	120-160	Open Cut	Settling Ponds (3)	100	0
4288	Boise	Seasonal	Grizzly, Trommel	500	Open Cut	Settling Ponds (2)	100	0
4289	Idaho	Seasonal	Trommel	320	Open Cut	Settling Ponds (4) Flocculants maybe used	100	0
4290	Idaho	Seasonal	Trommel, Jigs	800	Open Cut	Settling Ponds (?) with use of settling agents (flocculants?)	0	approx. 900
4291	Idaho	Year Round	Trommel, Vibrating Screens	500	Open Cut	Settling Ponds (2)	0	2,500
4292	Idaho	240	Screens	160	Open Cut	Settling Ponds (2)	Partial	20
4293	Unk.	Seasonal	Trommel	125	Open Cut	Settling Ponds (2)	Partial	Unk.
4294	Idaho	Unk.	None	800	Open Cut	Settling Ponds (?)	0	Unk.
4295	Clearwater	Unk.	Unk.	800	Dredge	Settling Pond (1)	Partial	Unk.

Table III-7. Profile of Idaho Gold Placer Mines (Continued)

MINE CODE	COUNTY	OPER. DAYS PER YEAR	CLASS. METHOD	VOLUME PROCESSED (CU. YD/DAY)	MINING METHOD	WASTEWATER TREATMENT TECHNOLOGY USED	RECYCLE (%)	DAILY DISCHARGE VOLUME (gpm)
4296	Boise	approx. 180	Grizzly, Trommel, Screens, Magnetic Separator, Jigs & Table	1,600	Open Cut	Settling Ponds (4)	approx. 100	approx. 0
4297	Idaho	Unk.	Trommel, Screens, Jigs, Bowls	1,600	Open Cut and Suction Dredge	Settling Ponds (3) with discharge to tailings	unk.	approx. 0
4298	Elmore	Unk.	Grizzly, Trommel	36	Open Cut	Settling Ponds (3)	Partial	Unk.
4299	Idaho	Unk.	Unk.	800	Suction Dredge	Settling Pond (1)	Partial	0

Table III-8. Profile of Montana Gold Placer Mines

MINE CODE	COUNTY	OPER. DAYS PER YEAR	CLASS. METHOD	VOLUME PROCESSED (CU. YD/DAY)	MINING METHOD	WASTEWATER TREATMENT TECHNOLOGY USED	RECYCLE (%)	DAILY DISCHARGE VOLUME (gpm)
4261	Lewis & Clark	270	Grizzly, Trommel	320-500	Open Cut	Settling Ponds (3)	100	0
4264	Broadwater	200	Grizzly, Trommel	200	Open Cut	Settling Ponds (2)	100	0
4262	Missoula	270	Trommel	300-400	Open Cut	Settling Ponds (4)	100	0
4263	Broadwater	100	Trommel	300	Open Cut	Settling Ponds (4)	Partial	Unk.
4341	Broadwater	+90	Trommel	100	Open Cut	None	0	Unk.
4300	Meagher	Unk.	Unk.	Unk.	Open Cut	Settling Pond (1)	Unk.	0
4301	Ravalli	Unk.	Unk.	100	Open Cut	Settling Pond (1)	0	800
4302	Missoula	Unk.	None	15	Open Cut	Settling Pond (1)	0	190
4303	Powell	Unk.	Unk.	25	Open Cut	Settling Pond (1)	0	150
4304	Powell	Unk.	Trommel	Unk.	Open Cut	Settling Pond (1)	0	Unk.
4305	Powell	Unk.	Unk.	40 to 60	Open Cut	Settling Ponds (?)	Unk.	250
4306	Broadwater	Unk.	Unk.	2	Open Cut	Settling Pond (1)	0	0
4307	Powell	Unk.	Unk.	40 to 60	Open Cut	Settling Pond (1)	0	380
4308	Meagher	Unk.	Trommel	50 to 100	Open Cut	Settling Pond (1)	0	160
4309	Meagher	Unk.	Unk.	100	Open Cut	Settling Pond (1)	Partial	0
4310	Meagher	Unk.	Unk.	40 to 50	Open Cut	Settling Pond (1)	0	0
4311	Powell	Unk.	Unk.	Unk.	Open Cut	Settling Pond (1)	0	250

Table III-8. Profile of Montana Gold Placer Mines (Continued)

MINE CODE	COUNTY	OPER. DAYS PER YEAR	CLASS. METHOD	VOLUME PROCESSED (CU. YD/DAY)	MINING METHOD	WASTEWATER TREATMENT TECHNOLOGY USED	RECYCLE (%)	DAILY DISCHARGE VOLUME (gpm)
4312	Mineral	Unk.	Unk.	2 to 3	Open Cut	Settling Pond (1)	0	0
4313	Lewis and Clark	Unk.	Trommel	37	Open Cut	Settling Pond (1)	Partial	0
4314	Lewis and Clark	Unk.	Unk.	50	Open Cut	Settling Pond (1)	0	25
4315	Lewis and Clark	Unk.	Unk.	24	Open Cut	Settling Pond (1)	approx. 100	approx. 0
4316	Powell	Unk.	Vibrating Screens	50	Open Cut	Settling Ponds (3)	0	250
4317	Meagher	Unk.	Trommel	400	Open Cut	Settling Ponds (3)	0	400
4318	Meagher	Unk.	Trommel	160	Open Cut	Settling Ponds (4)	0	400
4319	Granite	Unk.	Trommel	150	Open Cut	Settling Pond (1)	0	300
4320	Madison	Unk.	Unk.	100	Open Cut	Settling Ponds (4)	Partial	< 900
4321	Jefferson	Unk.	Trommel	500	Open Cut	Settling Ponds (5)	0	< 100
4322	Lincoln	Unk.	Unk.	200	Open Cut	Settling Pond (1)	Partial	400
4323	Powell	Unk.	Shaker Screens	60	Open Cut	Settling Ponds (2)	0	150
4324	Beaverhead	Unk.	Trommel	700	Open Cut	Settling Pond (1)	0	Unk.
4325	Silver Bow	Unk.	Wash Plant	300	Open Cut	Settling Pond (1)	0	600 to 700
4326	Madison	Unk.	Unk.	250	Open Cut	Settling Ponds (2)	> 0	1,500

Table III-8. Profile of Montana Gold Placer Mines (Continued)

MINE CODE	COUNTY	OPER. DAYS PER YEAR	CLASS. METHOD	VOLUME PROCESSED (CU. YD/DAY)	MINING METHOD	WASTEWATER TREATMENT TECHNOLOGY USED	RECYCLE (%)	DAILY DISCHARGE VOLUME (gpm)
4327	Meagher	Unk.	Trommel Grizzly Screens	325	Open Cut	Settling Pond (1)	0	100
4328	Lewis and Clark	Unk.	Unk.	300	Open Cut	Settling Ponds (3)	>0	700
4329	Beaverhead	Unk.	Trommel	300	Open Cut	Settling Ponds (3)	0	300
4330	Powell	Unk.	Trommel	25	Open Cut	Settling Ponds (?)	>0	3,000
4331	Lewis and Clark	Unk.	Trommel	Unk.	Open Cut	Settling Ponds (2)	0	600
4332	Powell	Unk.	Trommel	200	Open Cut	Settling Ponds (2)	>0	approx. 0
4333	Powell	Unk.	Grizzly Trommel Jigs	600	Open Cut	Settling Ponds (3)	100	0
4334	Meagher	Unk.	Trommel	50	Open Cut	Settling Pond (1)	0	500
4335	Silver Bow	Unk.	Trommel	>100	Open Cut	Settling Ponds (2)	if water needed	150
4336	Meagher	Unk.	Unk.	50 to 100	Open Cut	Settling Pond (1)	Unk.	320
4337	Mineral	Unk.	Unk.	50	Open Cut	Settling Ponds (4)	approx. 100	approx. 0
4338	Powell	Unk.	Unk.	300	Open Cut	Settling Ponds (3)	approx. 100	approx. 0
4339	Madison	Unk.	Unk.	250	Open Cut	Settling Pond (1)	approx. 100	approx. 0
4340	Jefferson	Unk.	Unk.	20	Open Cut	Settling Pond (1)	approx. 100	approx. 0

Table III-9. Profile of Alaskan Placer Gold Operations - 1986

Mine Code	Location (District)	Oper. Days Per Year	Classification Method Used	Volume Sluiced (Cu yd/Day)	Mining Method	Wastewater Treatment Technologies Used	Reycle (%)	Discharge Volume (GPM)
4922	Nome	275	Unk.	5500	Mech. dredge	Settling ponds (2)	65	1460
4998	Valdez Creek	240	Grizzly	2250	Open cut	Settling ponds (5)	0	4100
4999	Innoko	160	None	450	Open cut	Settling ponds (2)	0	7200
5000	Innoko	90	None	200	Open cut	Settling pond	0	1220
5001	Ruby	140	None	Unk.	Open cut	Settling pond	0	5830
5002	Ruby	180	None	75	Open cut	Settling pond	99.5	20
5003	Nome	120	Vibrating screens	950	Open cut	Settling ponds (2)	100	0
5004	Nome	80	Vibrating screens and grizzly	3000	Open cut	Settling ponds (2)	Unk.	Unk.

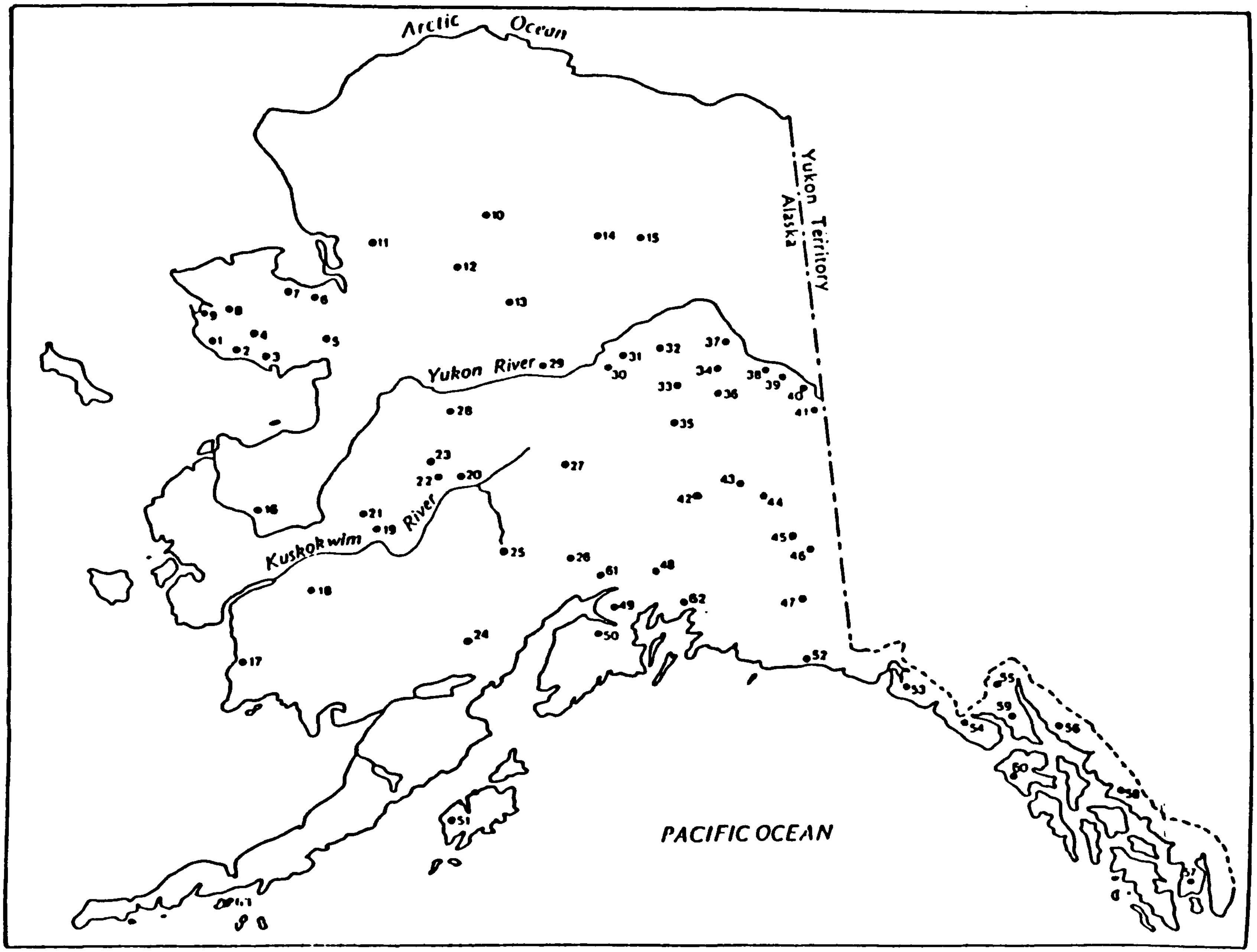
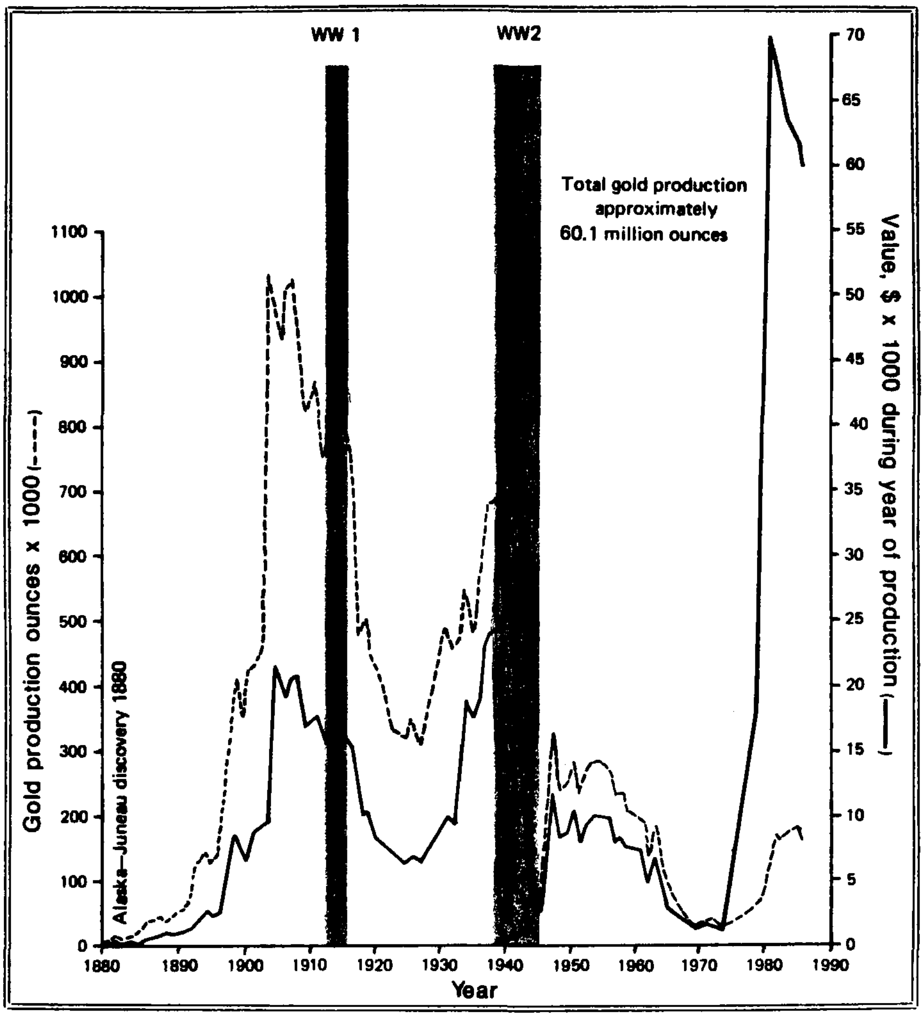


Figure III-1. Principal Gold Placer-Producing Camps in Alaska



Source: Ref. 4

Figure III-2. Gold Production in Alaska, 1880-1986

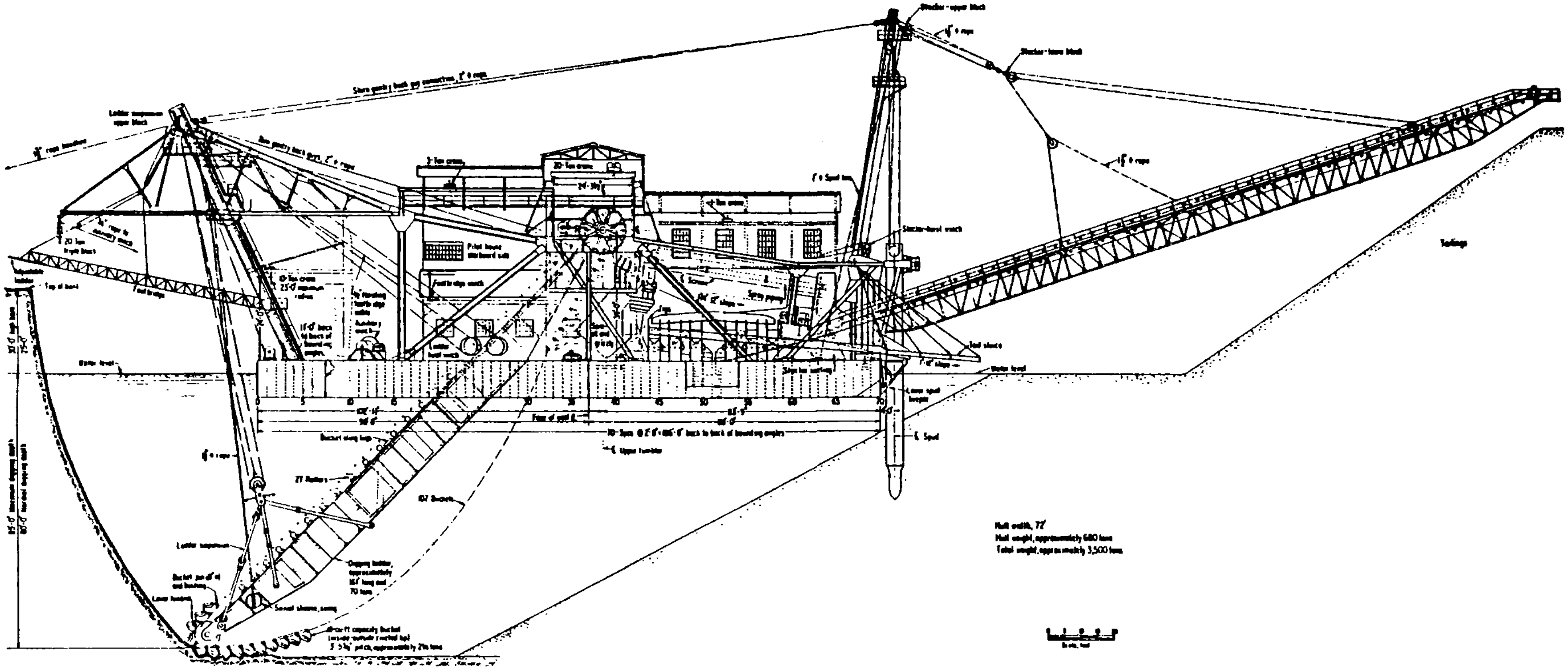
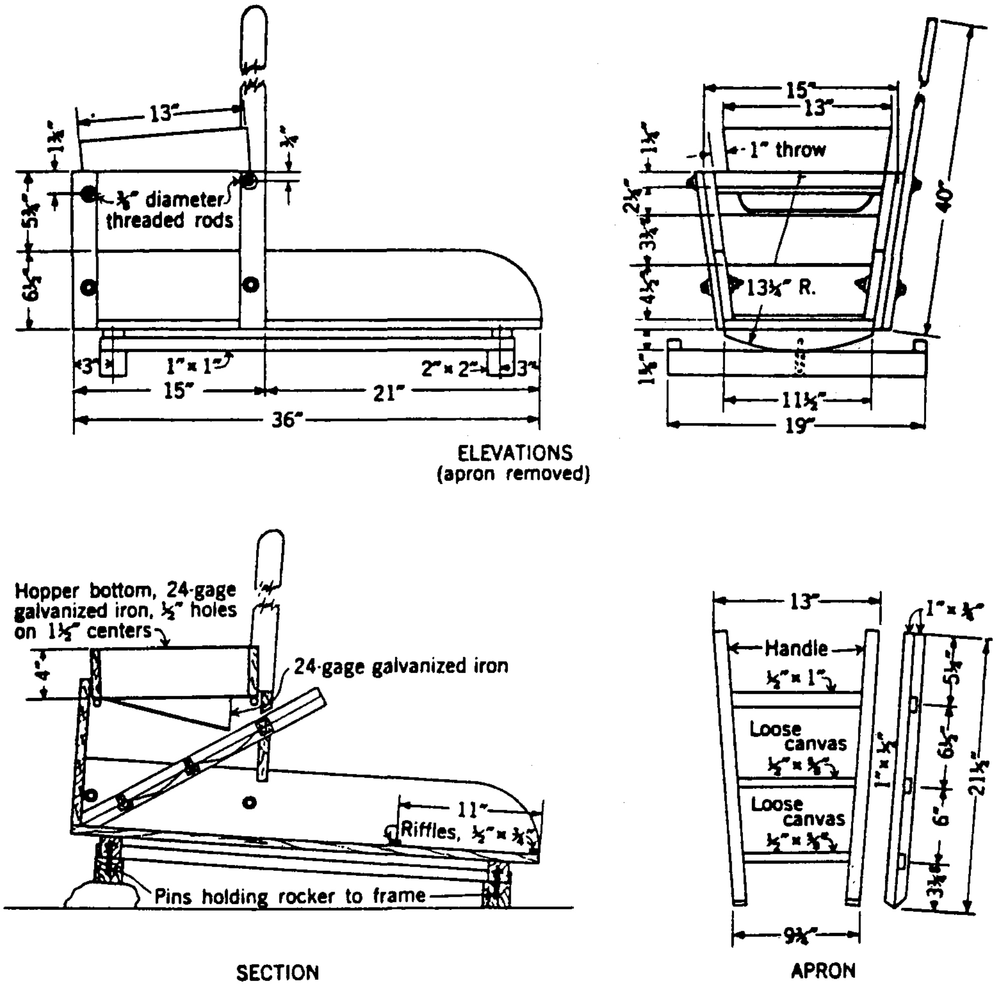


Figure III-3. Side View of 18-Cubic-Foot Yuba Manufacturing Division. 110 Dredge Designed to Dig 85 Feet Below Water.



Source: Ref. 55

Figure III-4. Basic Design for a Prospector's Rocker.

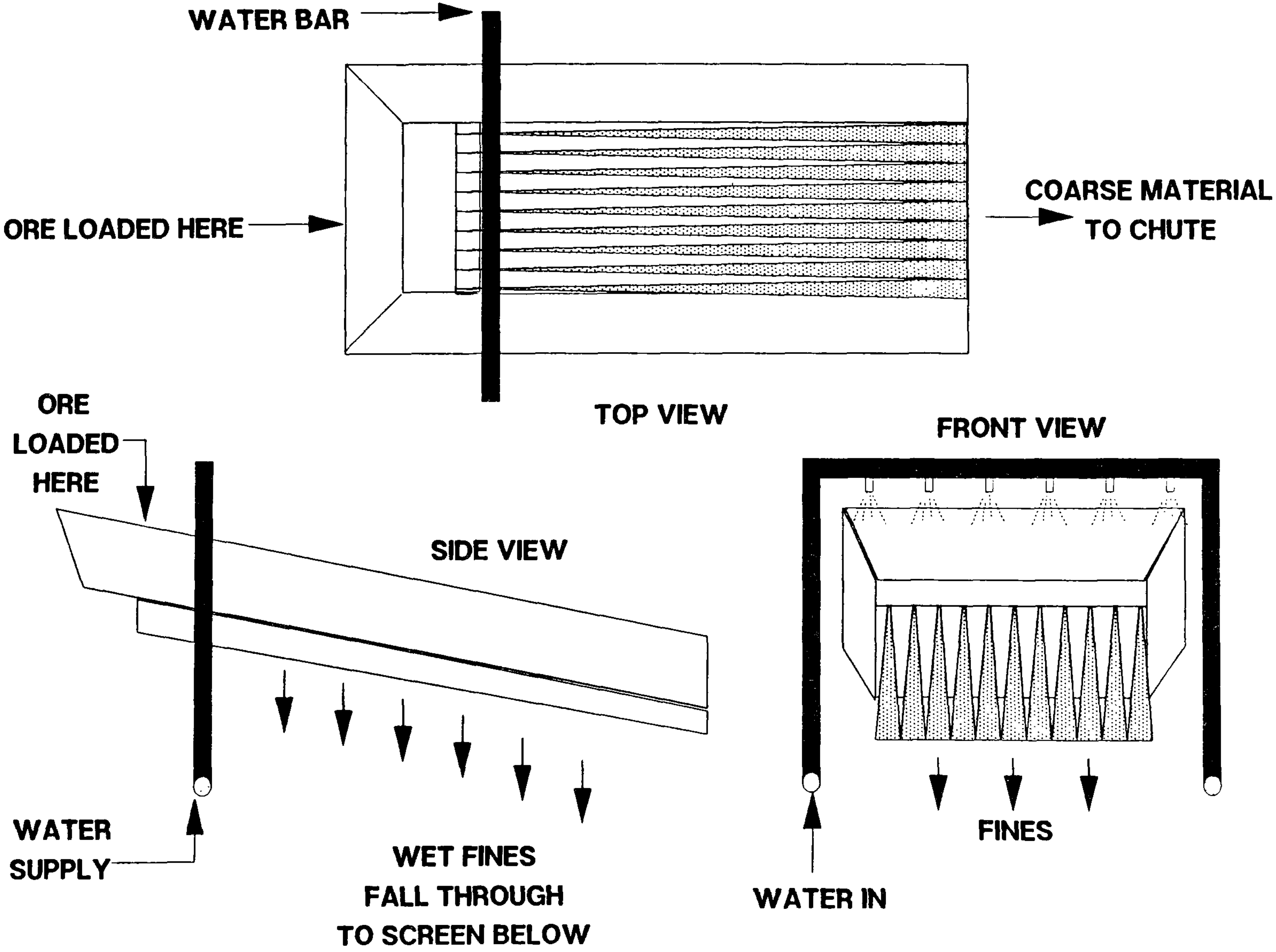


Figure III-5. Schematic of a Grizzly.

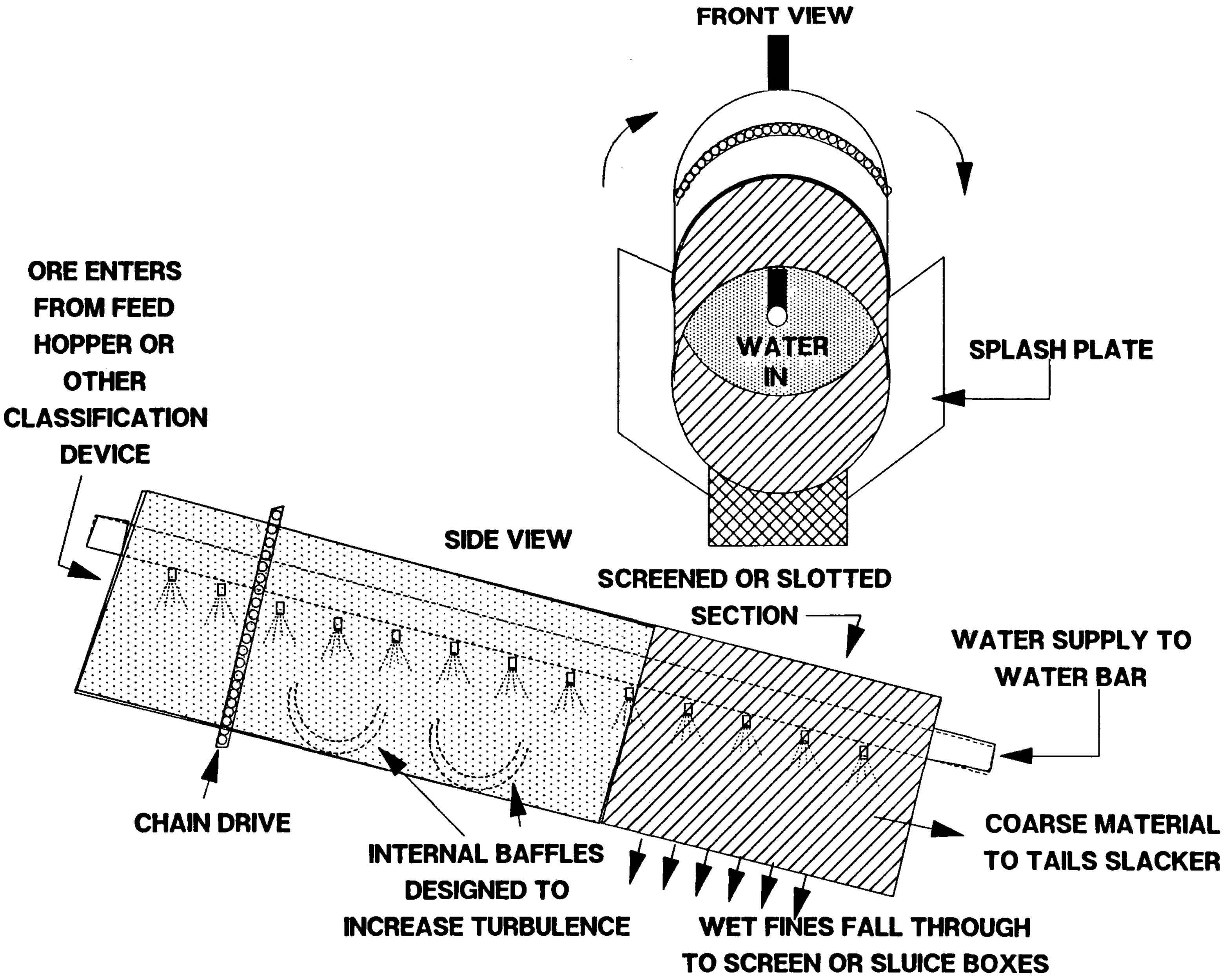


Figure III-6. Schematic of a Trommel.

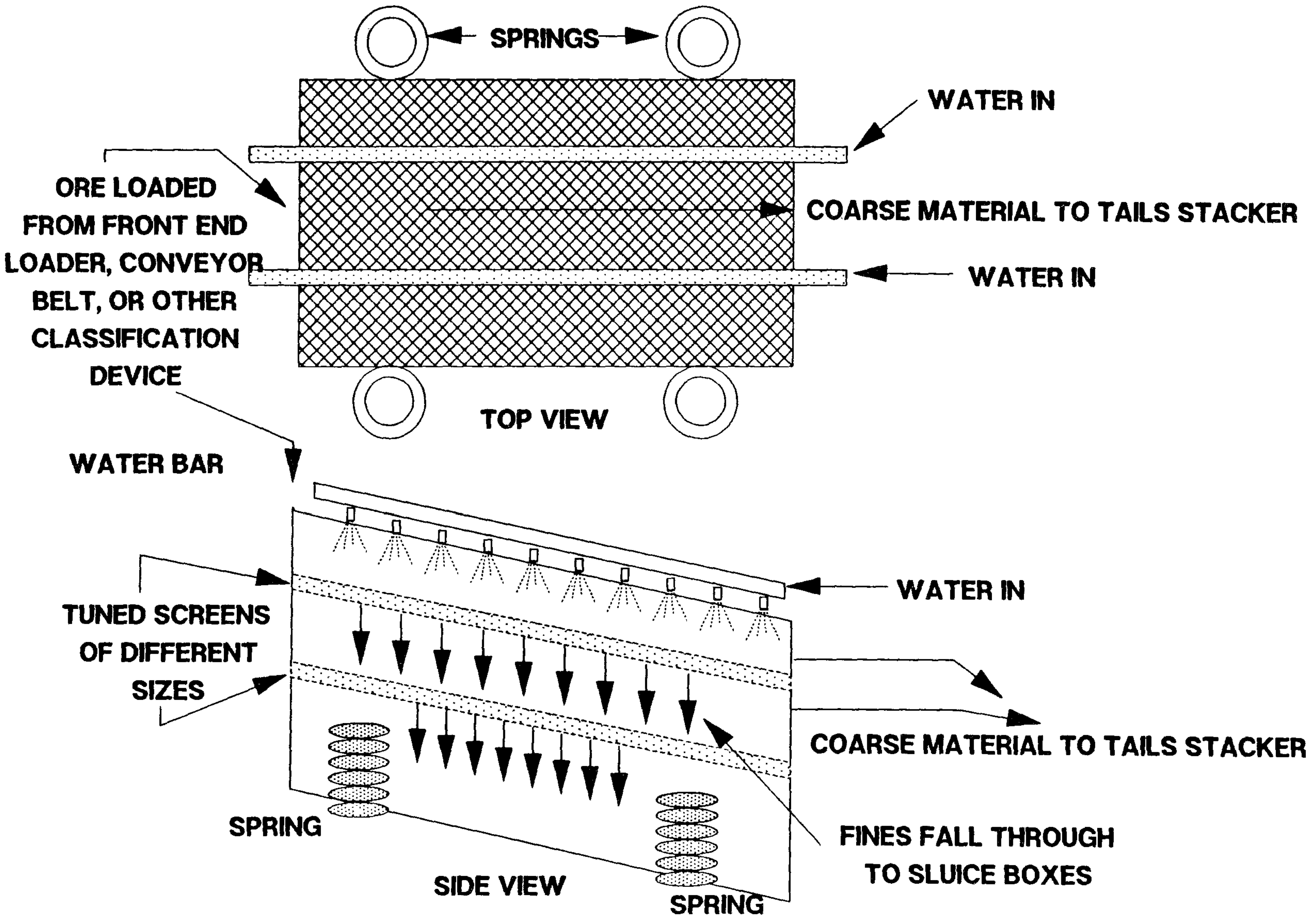


Figure III-7. Schematic of a Vibrating Screen (Double Screen Deck).

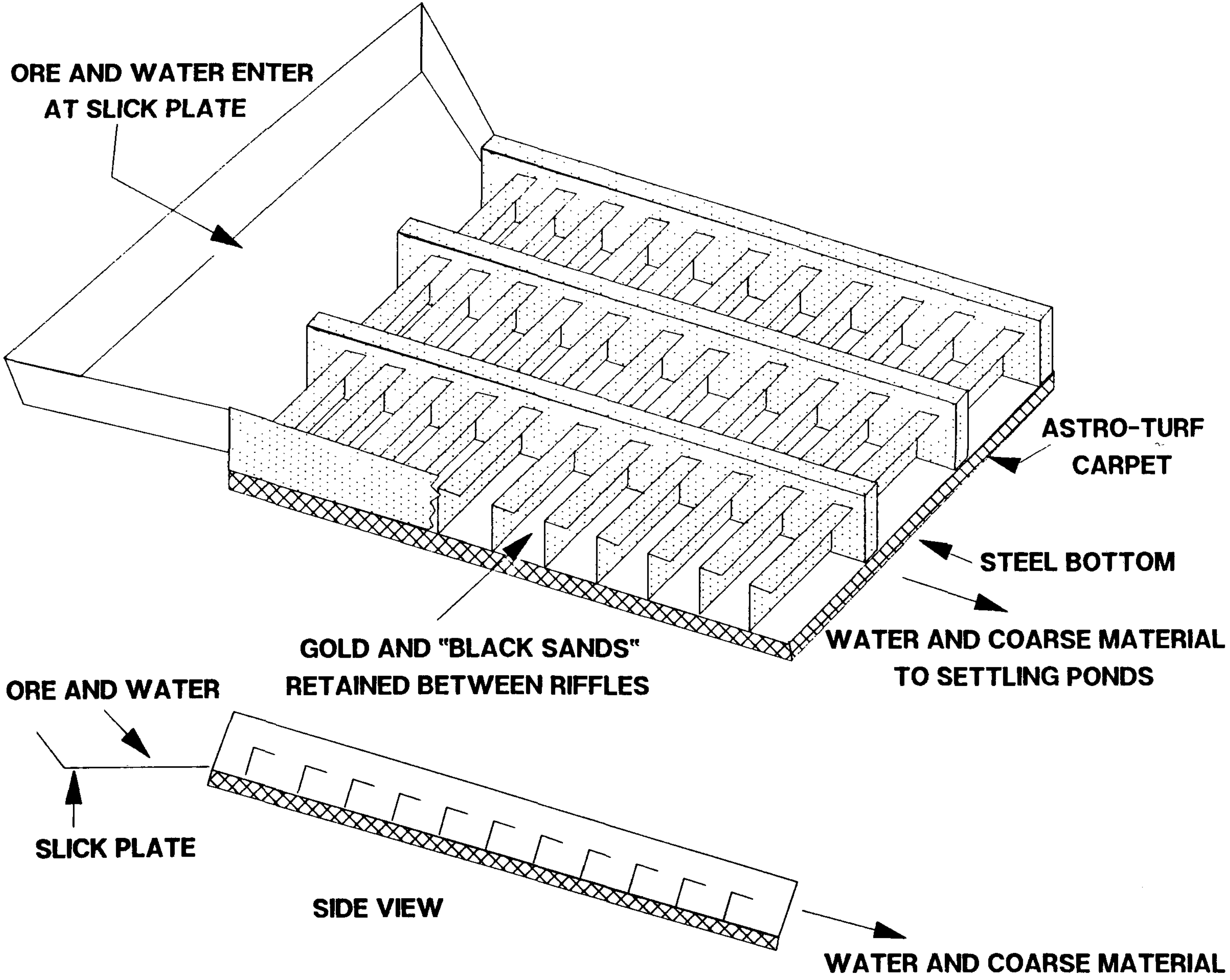
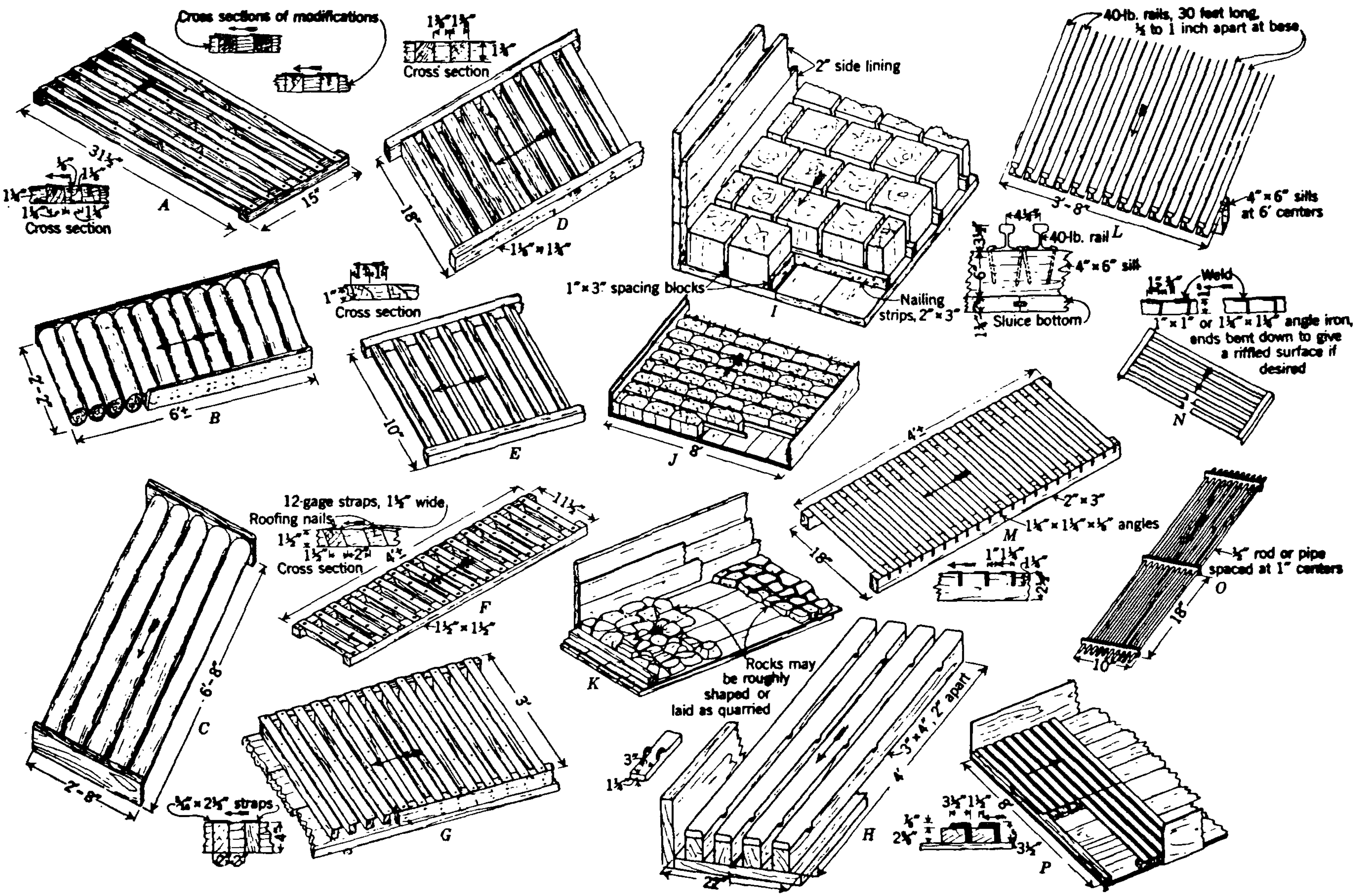


Figure III-8. Schematic of a Sluice Box (With Hungarian Riffles).



Types of riffles: *A*. Transverse wooden, steel-capped riffles used on dredges. *B*. Transverse pole riffles. *C*. Longitudinal pole riffles. *D*. Transverse wooden riffles, square section. *E*. Transverse wooden riffles, beveled section. *F*. Transverse wooden riffle, steel-capped, inclined section. *G*. Transverse wooden riffles, steel clad, with overhang. *H*. Longitudinal wooden riffles capped with cast-iron plates. *I*. Wooden-block riffles for large sluices. *J*. Wooden-block riffles for undercurrents. *K*. Stone riffles. *L*. Longitudinal rail riffles on wooden sills. *M*. Transverse angle-iron riffles. *N*. Transverse angle-iron riffles with top tilted upward. *O*. Longitudinal riffles made of iron pipe. *P*. Transverse cast-iron riffles used in undercurrents.

Source: Ref. 7

Figure III-9

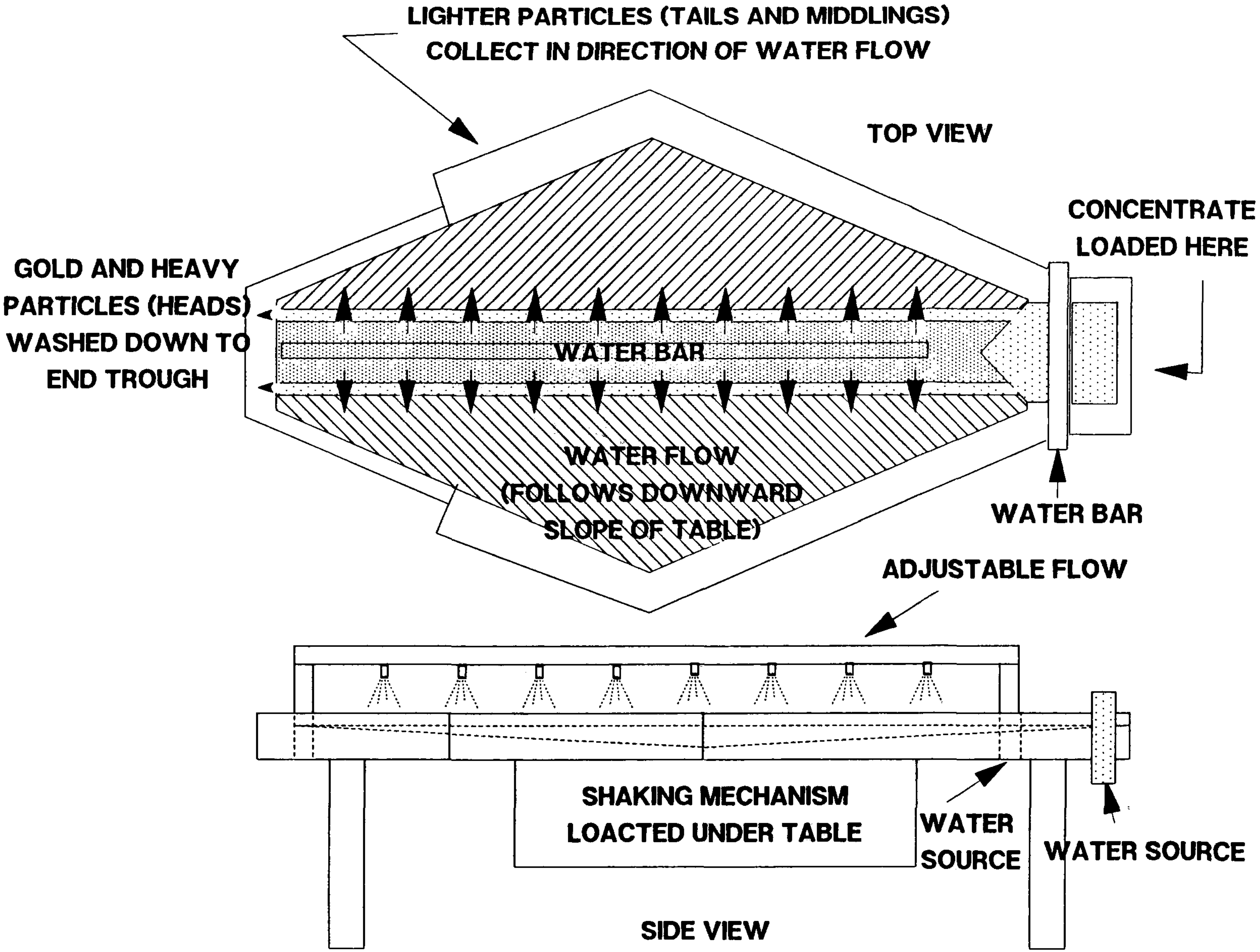


Figure III-10. Schematic of a Shaking Table.

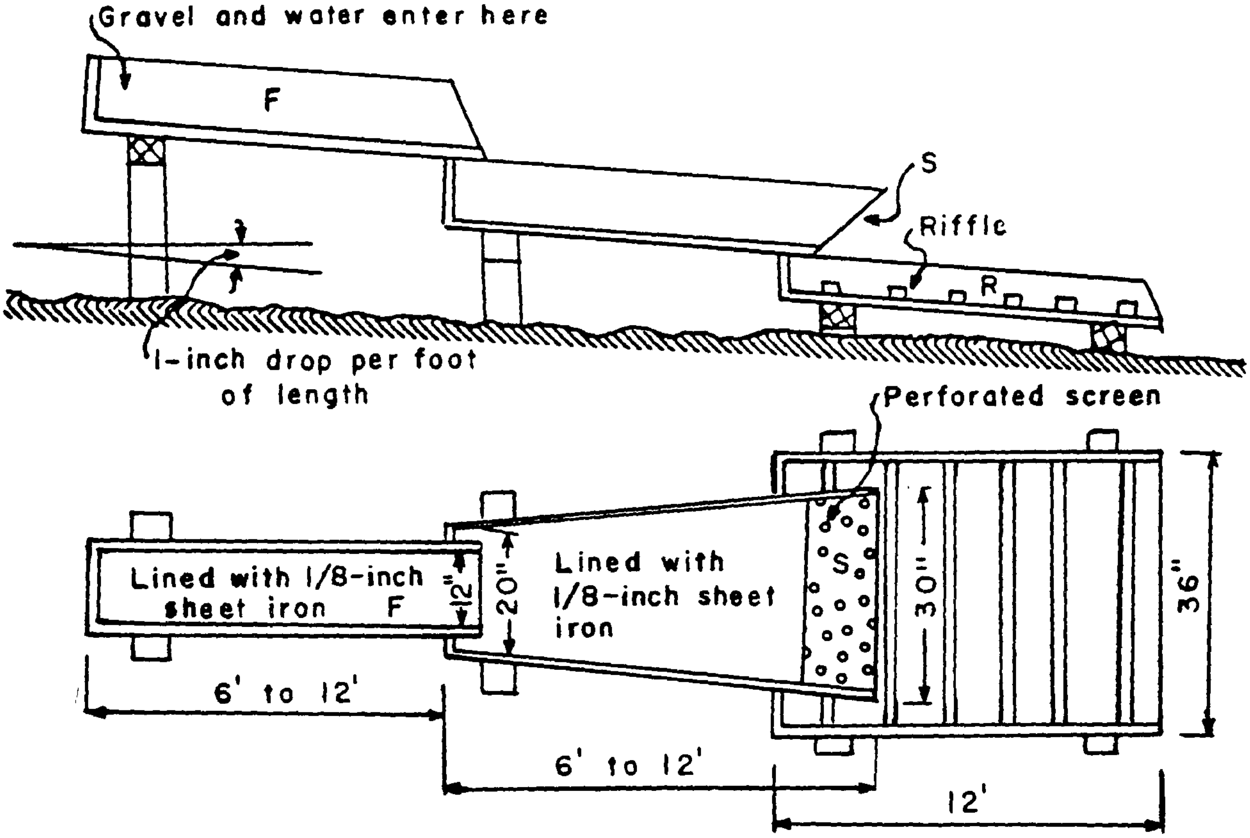


Figure III-11. A Long Tom

SECTION IV

INDUSTRY SUBCATEGORIZATION

During development of effluent limitations and new source standards of performance for the ore mining and dressing category, consideration was given to whether uniform and equitable regulation could be applied to the industry as a whole or whether different limitations and standards ought to be established for various subcategories of the category. Ore mining and dressing was subdivided into ten subcategories, based primarily on ore type, with one additional subpart used for category-wide definitions. These subcategories were further subdivided into discharges from mines (mine drainage) and discharges from mill or beneficiation processes. Initially, gold placer mines were included in Subpart J along with other gold mining. However, EPA decided not to regulate gold placer mines at that time because available information on gold placer mines was inadequate. Placer deposits and extraction techniques are significantly different from those covered under Subpart J.

TECHNICAL CONSIDERATIONS FOR INFLUENCING SUBCATEGORIZATION

In developing regulations for gold placer mines, EPA considered whether further subcategorization was necessary. Placer operations are conducted as land surface activities similar to many other industries covered under the ore mining and dressing regulation. The resultant water pollution problems associated with these activities are affected by a variety of factors such as size of operation, climate, and topography.

During the promulgation of the regulation for ore mining and dressing, an exhaustive list of possible subcategorization schemes was developed. Drawing on the experience gained from this, the following specific factors were used by the Agency to review the technical aspects of gold placer mining.

1. Size of mine

2. Age of facility

3. Number of employees

4. Processes employed

    - Mining methods
    - Ore processing methods (including classification)
    - Reagent use

5. Water use or water balance

6. Treatability of pollutants (including mineralogy of the

ore and overburden)

7. Wastewater characteristics

8. Treatment and control technologies

9. Treatment costs

10. Non-water quality environmental impacts

    - Solid waste generation
    - Energy requirements

11. Unique plant and site characteristics

    - Topography and geographic location
    - Climate and rainfall

A detailed discussion of each of these factors is presented below.

Size of Mine (Capacity to Process Ore)

An industry profile demonstrates a convenient and rational means to divide the industry on the basis of size (capacity to mine, or through-put, calculated as cubic yards per day or year of ore processed). Size is an appropriate criterion for subcategorization because many of the differences between mines are directly related to size. Principal among these are the mining and ore processing methods employed, mass of pollutants discharged in the wastewater, and economic viability of the mine. One conceptual division is based on whether a facility is "non-commercial" or "commercial" (i.e., small capacity versus large capacity). The non-commercial operations (recreational, hobby, and assessment types of operations) tend to be very small, while the commercial operations vary in size from fairly small to very large. Table IV-1 (p. 81) shows a partial profile of small, non-commercial mines versus larger, commercial mining ventures. The non-commercial mines or operators may number over 1,000 and be the largest number of mines both in Alaska and in the conterminous 48 states. However, EPA has been unable to obtain substantial data on these extremely small operations.

For purposes of this regulation, we have defined extremely small mines as those which process less than 1,500 cubic yards of ore per year. Because they process a low total volume of ore, they generally discharge a very low volume of process water. Such small mines characteristically have little mechanized equipment and are usually intermittent in operation. They include weekend panners, small suction dredges, small sluices, and rocker box operations.

The extremely small designation also applies to small-scale assessment mines. Assessment mines include those operations that could develop a commercial or larger type of operation but, for one of several reasons, are doing only a limited amount of work adequate to maintain legal control of their property. This group also covers prospecting, testing, and development work.

This regulation does not cover gold placer mines that mine or process less than 1,500 cubic yards of ore per year. These unregulated mines are usually non commercial operations, such as recreational, hobby assessment mines, for which there is little available data on which to base limitations. Even though these mines are not covered by this regulation, they are not exempt from the CWA requirement that they must obtain an NPDES permit for any wastewater discharge. Regulated gold placer mines vary in size from 1,500 cu yds per year, to many thousands of cu yds per day processed by the largest dredges. The proposed regulation segmented the industry into two subcategories based on the volume of ore processed. This distinction was made on the basis of economic modeling at the time of proposal which indicated marginal profitability for mines processing less than 500 cu yds per day of ore. Improvements in economic modeling indicate that this distinction no longer is appropriate.

Modeling for the final regulation separated dredges from open cut mines. For the purpose of economic analysis, open cut mines were divided into four size groupings. Using these sizes, the impact of the potential regulations on the mines was analyzed and no substantial size oriented difference in the impact was found. Technically, while the open cut mines use a variety of standard earth-moving equipment to move overburden and recover ore, they are essentially similar even though there is a size difference. The ore is moved and processed in an essentially similar manner even though different equipment may be employed. The technology for water control and pollution control appears to be equally applicable to all open cut mines irrespective of size. The Agency has, therefore, concluded that subcategorization of open cut mines by size is not appropriate.

Bucket-line dredges all use the same mechanisms for removal of the ore and are essentially similar in the ore processing and tailings disposal processes. The only substantial variant among dredges is the size of the machine. The technologies for control of wastewater pollutants appear to be equally applicable to all sizes of dredges. Economic analysis for dredges indicates that there is no significant adverse impact on either the large or small size dredge analyzed.

Very late in the regulatory development process, the Agency became aware of several very small dredges which were not specifically examined in the technical or economic analysis. The technical information available on these dredges indicates that their individual annual production is less than 50,000 cu yds per year. Since no economic model was constructed for this size unit, there is no specific evaluation of the impact on them. Because data on which to regulate these very small dredges has not been collected and analyzed, they are not being regulated under this rule. EPA, therefore, will make a small-size cutoff for bucket-line dredges at 50,000 cu yds per year. The few existing dredges (three or four) of this size will be regulated by the use of BPJ permits.

Age of Facility

Many placer mines have been operated in the same general location in excess of 50 years (usually under different management). A number of these deposits have been reworked several times to recover gold which was missed or by-passed by previous operators for one of several reasons (i.e., gold price differentials that make lower grades more attractive, inefficiencies in the operation, oversight by the operator, or extension of the deposit in depth or area). Mining equipment and processing equipment (sluices) are repaired or replaced as needed. The same operating techniques and wastewater treatment systems applicable to this subcategory may be employed at old or new mines or at new locations within an existing operation without consideration of the age of the facility. Therefore age of the operation is not a basis for subcategorization.

Number of Employees

The amount and quality of process wastewater generated is directly related to the size (through-put capacity), the mining and recovery processes employed, the amount of water available, the degree of recycle employed, the effectiveness of wastewater treatment employed, plus the site-specific factors related to each individual mine (i.e., treatability, mineralogy, location, topography, geology, overburden and pay dirt characteristics, etc.). There may be a loose correlation between the number of employees and the size of a mine, but the modified economic analysis used for development of the final regulation showed no basis for subcategorization based on number of employees.

Processes Employed

Mining Methods

There are two general mining methods being employed in the industry today--mechanical and hydraulic. The choice of mining method is determined by the general geology, grade of ore (assay), size, configuration and depth of the deposit, type and thickness of overburden, geographic details of the site, and availability of water. The mechanical approach to mining utilizes considerably less water than the hydraulic method. With the advent and adaptation of the small, high powered diesel engines to tractors, loaders, shovels, draglines, backhoes, and vehicles, the miner is able to move mechanically larger volumes of material (ore and waste) economically, thus significantly expanding the use of mechanical mining. The 150- to 460-horsepower diesel tractors have the capability to rip, strip, move, and stockpile a considerable amount of material. The units can feed 1,500 to 4,000 cubic yards of ore daily. The mines employ a surface, open-cut method.

Another mining method in current use that is classified as mechanical mining is the use of mechanical buckets in dredging operations. The ore is cut, mined, and moved mechanically in buckets attached to a continuous chain. The dredge has a self contained method to process the ore and to dispose of the waste material. These obvious physical differences provide a basis for subcategorization.

The hydraulic system of mining uses varying amounts of water. Small suction dredges often use less than 100 GPM and large hydraulic water cannons can use over 10,000 GPM. The small suction dredges are often used non-commercially by hobbyists. A number of larger suction dredge operations have existed in the past and possibly could operate in the future. The hydraulic water cannon mining technique virtually has been replaced by mechanical means. The hydraulic system, if used to clear or move overburden, utilizes a large amount of water and generates a large amount of pollutants in the wastewater. The hydraulic system can also be used to thaw overburden but is very water use-intensive. Smaller hydraulic cannons are used to load ore into the sluices, for mixing purposes and for the movement of wastes. Regardless of the mining method employed, the processing of ore generally employs similar gravity and physical separation methods to produce a concentrate.

Ore Processing Methods (Including Classification)

Gold placer mining currently utilizes several gravity and physical separation methods to process ore and recover the free gold. The scope of this rule is limited to this particular type of ore processing. Currently, all areas of the country utilize straight sluicing, sluices with punch plates and undercurrents, sluices with varying degrees of classification, jigs, spirals, cyclones, and tables to separate the gold in the ore. Although physical classification of the ore by particle size is considered a part of ore processing, it was also examined as a potential basis for subcategorization. The various methods of classification all have the same goal--to reduce the volume of ore for further processing. By separating a portion of the ore by particle size into a direct waste component (gangue or tailings), classification reduces the total amount of water needed to process the ore. This reduces the volume of wastewater to the treatment system (see "Placer Mining Wastewater Treatment Technology Project, Phase 3 Final Report - Draft," January 1985 by Shannon & Williams, Inc.). The total tonnage of particulate matter in the wastewater effluent is reduced by the amount classified out of the ore. Based on the wide variations in type and degree of classification utilized, plus the fact there is no fundamental difference in the type of pollutants produced with or without classification, classification is not considered to be appropriate as a means of subcategorization.

Reagent Use

Current operations for which the Agency has information do not use reagents to recover free gold in gold placer mining. Mercury coated copper recovery plates located in the flow stream at the end of the sluices have been employed in the past but have lost their appeal in the current operating schemes and regulatory requirements. None was observed during the last several years of site visits by the Agency. In addition, this subcategory (gold placer mines) is limited in scope to include only gravity separation (recovery) methods. Thus the use of reagents would be covered under the existing regulation for the ore mining and dressing point source category at 40 CFR Part 440, Subpart J.

Water Use or Water Balance

The rate of water use or water balance is affected by many different factors, not the least of which is the personal preference of each individual miner. Water use can be affected by the mining method employed, the beneficiation process used, the degree of ore classification used prior to gold recovery, the type of deposit, the type and amount of overburden, water availability, gold particle size and shape, climate, rainfall, and geographic location. All of these factors can vary widely and, considered in combination, make water use extremely site specific. As a result of this lack of uniformity, the Agency is not subcategorizing gold placer mines by water use or water balance.

Treatability (Mineralogy of the Ore and Overburden)

Gold placer mining generates wastewater that is relatively consistent in the types of pollutant ("muddy water" subject to variation in composition from different sources), while the quantity of pollutants found in the wastewater varies considerably. The amount of pollutants depends on several factors in addition to the size of operation. The mineralogy of the waste rock and soil involved, amount of classification used, and the degree of recycle or treatment employed bear directly upon the quantity of pollutants produced and discharged to the environment.

The mineralogy of an ore deposit often determines the recovery (beneficiation) process to be used. Consideration must be given to both the valuable portion (free gold in this case) and the waste (gangue) portion of the gold placer ore. Placer deposits are usually either alluvial or glacial in origin. The alluvial deposits generally concentrate the heavier portions of the ore, while glacial action tends to scatter all segments of the deposit on a random basis. Both types produce a wide range of particle shapes and sizes, and particle composition varies by the original source of the material. All of these factors may affect the treatability of the effluent. Settling rates for the particles vary by size, shape, and composition (specific gravity). In addition, if the particle is colloidal, the electromagnetic forces involved tend to keep these particles in suspension for a longer period of time. The nature and composition of soils at placer deposits may vary widely within small distances because of the mechanism of placer formation. This wide range of particle size and composition and erratic distribution possible in these ores make it impossible to use mineralogy as a basis for subcategorization.

Wastewater Characteristics

As stated previously, the characteristics of the wastewater created by gold placer mining vary as the mineralogy varies from one ore deposit to the next. The extreme diversity in wastewater characteristics make them unsuitable factors for subcategorization. Detailed discussions of wastewater characteristics, the pollutants of concern, and Agency samples at gold placer mines are included in Section V of this document.

Treatment and Control Technologies

Currently, the end-of-pipe wastewater treatment and control technology commonly used at gold placer mines is settling pond(s) (either single or multiple in series) either with or without recycle. There are a number of variations in site-specific layouts. The applicable technologies for all types of configurations of gold placer mines are similar. Therefore, treatment and control technologies do not provide a basis for subcategorization.

Treatment Costs

To estimate the costs of treatment, economic models were developed that characterize the industry-wide range of operating conditions of mines and dredges. These models were described earlier in this section under "Size of Mine" and are discussed in greater detail in Section VIII of this document. Because many differences among mines are related to size, treatment costs were not used as primary criteria for subcategorization but were considered after the size criterion was applied to the industry.

Non-water Quality Environmental Impacts

Solid Waste Generation

Physical and chemical characteristics of solid wastes generated by treatment of gold placer mining wastewater are determined by the ore and overburden characteristics. Those are beyond the control of the operator and are site specific. The miner recovers a fraction of a percent of the ore mined (less than a fraction of an ounce per ton mined). The majority of the solids removed in the beneficiation process simply fall out at the discharge end of the sluice before wastewater treatment. The characteristics of the solid wastes generated by wastewater treatment are unrelated to differences in currently employed mining and process technology with the exception of recirculation in both mechanical and dredge operations (i.e., zero discharge). Current wastewater process technology is virtually identical in this segment (settling ponds) for all types of mining operations. Therefore, this factor is not a basis for subcategorization.

Energy Requirements

Energy requirements in this segment vary widely. The main use of energy in wastewater control and treatment is for pumping water when recycle or recirculation is required. However, this energy requirement would be only a slight increase over the energy presently required to supply process water at mines pumping wash water to the beneficiation process. Energy for pond construction and maintenance is only a small fraction of the energy required for mining and processing. It is very difficult to reliably identify energy requirements specifically related to wastewater treatment. Therefore energy requirement is not selected as a basis for subcategorization.

Unique Plant and Site Characteristics

Topography and Geographic Location

There are approximately 195 gold placer mines in Alaska and 265 mines in the 48 conterminous states, with the vast majority located in seven western states (California, Colorado, Idaho, Montana, Nevada, Oregon, and Washington). The majority of site-specific information the Agency has is representative of mines in Alaska.

Topography differs among mining areas and from site to site within areas (i.e., seashore marine gravels to broad, gently sloping valleys to rugged, narrow, steeply sloping valleys). These differences can affect the operation, particularly in regard to waste disposal and settling pond location and size. Rainfall accumulation and runoff from steep slopes can cause problems as well. Narrow valleys with steep slopes place constraints upon the location of ponds in terms of area available, construction costs, and the costs associated with pumping against a greater head for recirculation. Topography has an impact on construction and cost of operation. However, based on the current data available to the Agency, topography does not significantly affect wastewater characteristics or treatability, and thus is not a basis for subcategorization.

Information regarding mines which would be unable to build adequate settling ponds due to topography and lack of space was requested in the notice of proposed rulemaking. Several commenters responded that they did not have adequate space but did not provide specific information regarding the extent of available space or other information on which the claim of lack of available space could be evaluated. The lack of space for settling ponds was not documented and there is basis for EPA to develop limitations addressing this alledged circumstance. Therefore topography has not been selected as a basis for subcategorization.

Figures IV-1 and IV-2 (pp. 82 and 83) are plots of production versus percentage of mines in each production interval for Alaska (separately on Figure IV-1) and California, Colorado, Idaho, and Montana (shown as a group on Figure IV-2). These data show the same general distribution by size for the two areas. There are several minor differences between these two general areas of location; harsher climatic conditions, shorter length of operating season, the availability of water, and higher costs to operate prevail in Alaska.

EPA has concluded that the many similarities in the mines of Alaska and the conterminous 48 states are compelling; none of the above-mentioned differences is of such significance as to warrant subcategorization on this geographical basis.

Regardless of the geographic location, the various gold placer mines have similar problems regarding wastes (both liquid and solids). Logistics, operation, and communications problems are exacerbated in the more remote areas but these do not affect the quantity or quality of the effluent wastewater from a given operation. There is a wide range of site-specific conditions present throughout but, as also discussed under size or capacity to process ore, the similarities in mines regardless of geographic location is significant. Geographic site specific factors in Alaska cause production costs to be higher than in the lower 48; these higher costs have been taken into account in the compliance costing and economic impact analysis. Because wastewater characteristics in Alaska and the lower 48 are similar, location is not being used as a basis for subcategorization.

Climate and Rainfall

There is a wide diversity of climatic and rainfall conditions in the locations where gold placer mines are operated. Gold placer mine operators cannot choose a location with more favorable climate or rainfall conditions but must accommodate whatever is present at the discovery site. Some mines in Alaska are located in regions close to the coast and, as a result, have milder climate and more abundant rainfall which, in turn, allows for a longer mining season with fewer problems related to the availability of process water. Other mines are located in interior areas, including mountainous terrain, with resultant colder, harsher climates and possibly reduced rainfall for part of the operating season. These areas have shorter mining seasons and may have to contend with permafrost and a shortage of water. Some of these areas are fed by glacial meltwater, which compensates for the lack of adequate rainfall.

Climate and rainfall may have a direct bearing on the length of mining season, occurrence of permafrost, availability of process water (possibly necessitating recycle), and, to some degree, on the types of mining and recovery processes used. The increased costs associated with these conditions have been taken into account, but these factors do not control the size of mining operation, the quality or quantity of wastewater (except as it affects the degree of recycle employed), or the treatment technology used. Therefore, these factors are not a basis for subcategorization.

ECONOMIC CONSIDERATIONS

EPA's economic assessment is presented in the report "Economic Impact Analysis of Effluent Limitations and Standards for the Placer Gold Mining Industry." This report estimates the investment and compliance costs for the placer gold mines covered by this regulation. Compliance costs are based on engineering estimates of capital requirements and construction expenses as set forth in Section VIII of this document. The report also estimates the economic effect of compliance costs in terms of mine closures, employment losses, profitability impacts, and regulatory costs as a percentage of sales and as a percentage of operating costs. Modifications to the economic analysis since the time of proposal show no basis for subcategorization of small mines.

SUBCATEGORIZATION FOR GOLD PLACER MINES

As the revised economic model no longer indicates a need for subcategorization due to impacts on small mines, the overall subcategorization scheme is identical to the subcategorization based on technical considerations. This final rule contains two regulated segments; the rule applies to all open-cut mines processing more than 1,500 cu yds per year of ore and to all bucket-line dredges processing more than 50,000 cu yds per year of ore. The rule does not apply to open-cut mines processing less than 1,500 cu yds per year of ore, to bucket-line dredges processing less than 50,000 cu yds per year of ore, or to dredges operating in open waters (i.e., marine and coastal waters or large rivers).

Table IV-1. Partial Profile of Extremely Small (< 20 cubic yards/day) Gold Placer Mines.[1]

Mine Name/Owner	State	Oper. Days per Year	Class. Method	Volume Processed (cu.Yd/Day)	Mining Method	Wastewater Treatment Technology Used	Recyle (%)	Daily Discharge Volume (gpm)
1-EW	MT	Unk.	None	15	Open-Cut	Settling Pond (1)	0	180
2-PJ	MT	Unk.	Unk.	2	Open-Cut	Settling Pond (1)	0	Unk.
3-ES	MT	Unk.	None	2-3	Open-Cut	Settling Pond (1) and seepage	0	250
4-JD	MT	Unk.	Unk.	20	Open-Cut	Settling Pond (1)	approx. 100	approx. 0
5-HM	MT	Unk.	None	2	Suction Dredge	Settling Pond (1)	0	10
6-GH	MT	Unk.	None	10	Open-Cut	Settling Ponds	0	200
7-AH	MT	Unk.	Wash Plant	15-20	Open-Cut	Settling Pond (1)	0	100 (part time)
8-CN	MT	Unk.	None	0.5	Hand Shovel	None	0	80
9-EC	MT	Unk.	None	Unk.	Suction Dredge	None	0	175
10-JD	MT	Unk.	Unk.	20	Open-Cut	Settling Pond (1)	100	0
11-JA	MT	Unk.	Unk.	3	Suction Dredge	Settling Pond (1)	>0	170
12-AC	AK	150	Unk.	2-4	Suction Dredge	None	0	Unk.

[1] Frontier TEchnical Associates, Inc. Report of 1984 Field Survey, David Harty.

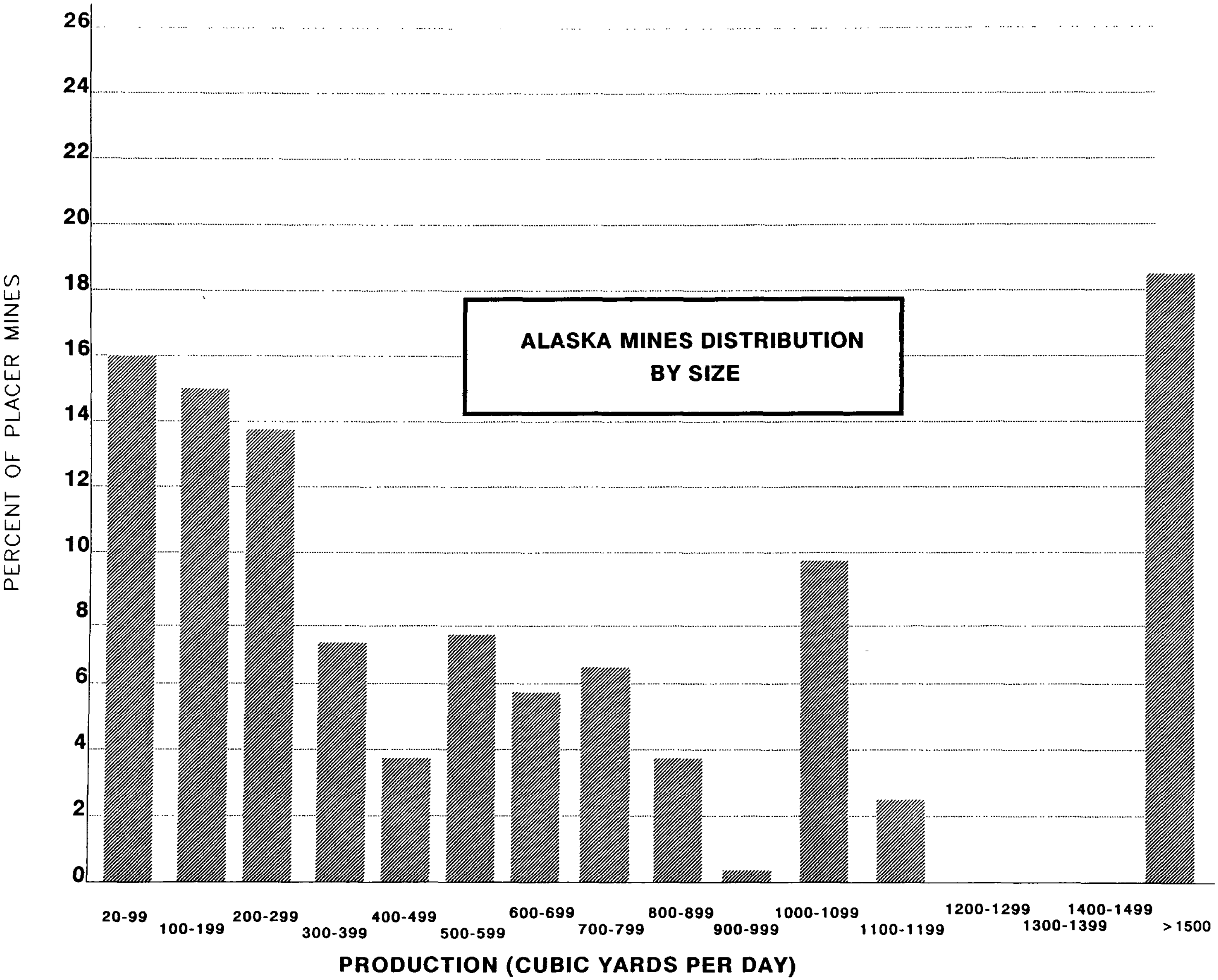


Figure IV-1. Distribution of Alaska Gold Placer Mines by Size
Source: Computer Summary of Tri-Agency Forms - 1983

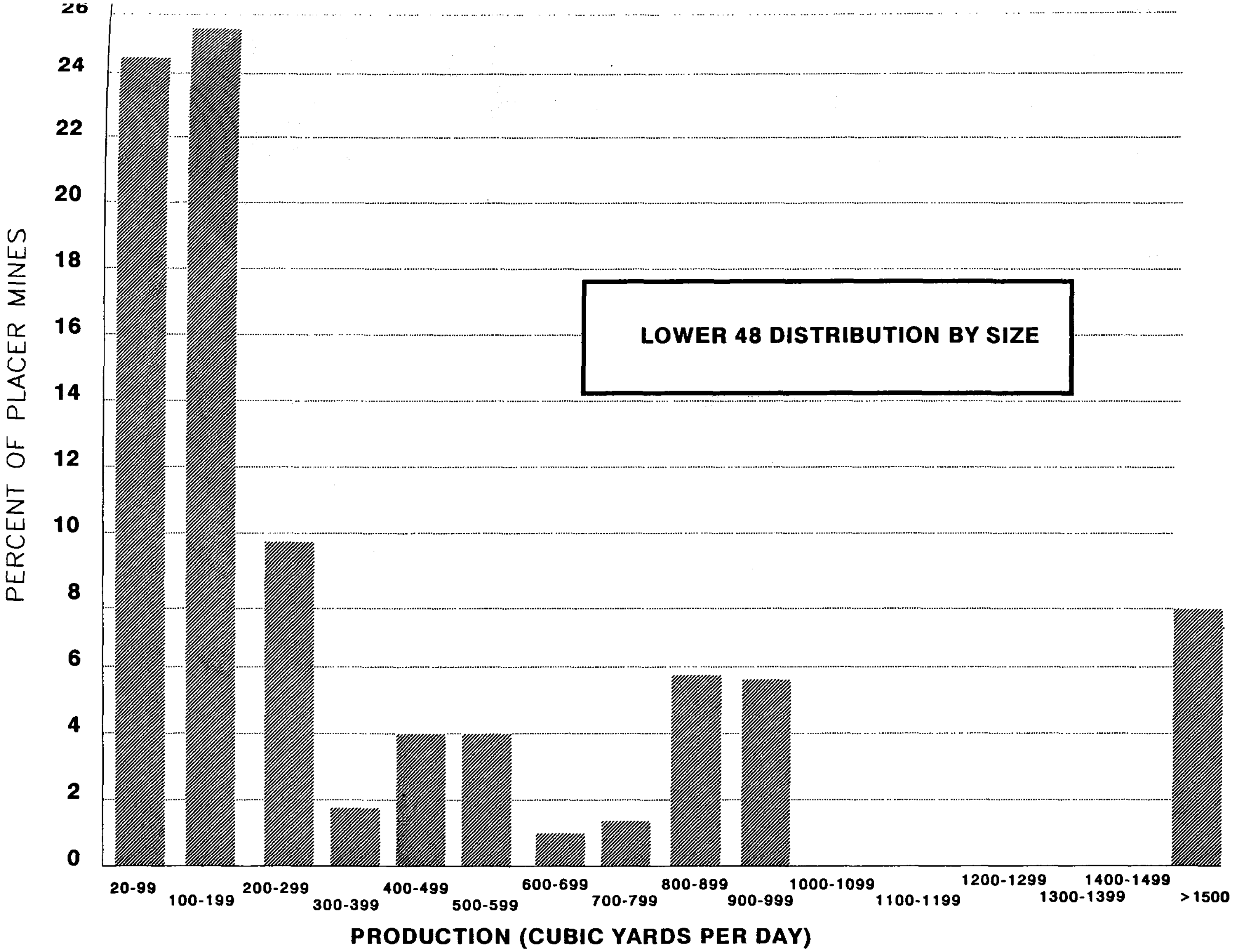


Figure IV-2. Distribution of Gold Placer Mines in the Lower 48 States by Size
Source: Permit Files from Montana, Idaho, Colorado, and California

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SECTION V

WATER USE AND WASTEWATER CHARACTERIZATION

The wastewater characterization program for placer gold mining was undertaken primarily to provide a data base for development of effluent limitations and standards for gold placer mining. The data acquired has also been used to support EPA Regions VIII, IX, and X in developing NPDES permit conditions and identifying pollutants of concern. Pollutants of particular concern were suspended and settleable solids, turbidity, and toxic metals.

This section identifies the sites sampled and parameters analyzed by studies during 1982 through 1986. It also describes sample collection, preservation, and transportation techniques and identifies the analytical methods used. Finally, it describes the pollutants and their concentrations found in both the raw wastewater and treated effluents. All data obtained during these studies are included in the administrative record of this rulemaking.

DATA COLLECTION

EPA determined during the rulemaking effort that produced the 1982 Ore Mining and Dressing regulation that economic and financial information about Alaskan gold placer mines was inadequate to develop and promulgate effluent guidelines. The information available was incomplete and anecdotal, as it had been developed primarily in the course of public hearings and other meetings.

The Agency, with the cooperation of the gold placer miners, conducted an information-gathering effort during the 1983, 1984, 1985, and 1986 mining seasons. EPA already was conducting an examination of effluent and receiving water quality characteristics which was expanded to incorporate an economic and financial component.

Although EPA has historical data from gold placer mines from as early as 1976, and many subsequent years, the Agency primarily relied upon the studies performed in 1984, 1985, and 1986 since this data on treatment performance was more current and more fully documented than earlier studies. The majority of the economic data also were obtained in 1984, 1985, and 1986. Table V-1 (p. 104) lists those studies most influential in developing the gold placer mining effluent limitations. A tabulation of all applicable studies of the gold placer mines is shown in Table V-2 (p. 105). The reference numbers assigned to the studies listed in Table V-2 are used throughout this section to identify each study. Within the text of this section, studies by EPA and EPA contractors are not differentiated because the contractors were performing under the immediate technical direction of an EPA project officer. Table V-2 and Section XV, however, indicate which contractor was involved.

The majority of the information collected was from Alaska because the impact of the regulation is expected to be greatest there. Existing state regulations in the lower 48 will minimize impact in most of these states. However, data on facilities in the lower 48 states were collected from state contacts and site visits. These data were also used in development of the regulation. All site visits included the collection of data on existing treatment. Studies performed in Alaska provided data on pilot-scale treatment technology, the effects of recycle and recirculation, costs of operations and treatment, and the economic viability of mines.

EPA Region X - 1982 Study

EPA Region X conducted sampling visits at 51 sites during 1982.

EPA Region X - 1983 Study

For the 1983 sampling effort conducted by EPA Region X, a size-structured random sample was drawn from 409 Tri-agency gold placer mining permit applications on file at EPA Region X. A primary sampling group of 34 mines was supplemented by a similarly structured secondary group of 31 mines to provide an adequate sample in the event of nonresponse, failure to locate, intermittent or ceased operations, or other obstacles to information-gathering and sampling.

The 34-mine sampling proved impossible to achieve. Distance, accessibility, intermittent nature of the operations, equipment breakdowns, and location uncertainties combined to reduce the sample size. Both time and budget constraints made it necessary to treat the primary and secondary sample components as a single sample of 65 mines, and to attempt to contact each potential respondent at least once rather than to make repeated visits to the primary sample group in order to verify the operational status of each. Site visits were actually conducted at 60 gold placer mines.

EPA Region X - 1984 Study

During the 1984 mining season, site visits were conducted by EPA Region X personnel to seven mines.

EPA 1984 - Treatability Study

EPA gathered data during the 1984 mining season at gold placer mines in Alaska. Studies included treatability tests of effluents with and without polyelectrolyte settling aids, flow determination, sampling and profiling the mine's equipment costs, physical layout, and wastewater treatment system. Mine sites were screened using available data from 1983 and through discussions with EPA, Region X, Alaska DEC, individual miners and miners' associations. Twenty mines were selected for further screening and on-site visits. These 20 mines were selected to be representative of mines found over the State of Alaska considering: geographical location, type of mining, size, depth and type of overburden, topography, and treatment employed (including high rate recirculation).

These 20 mine sites were visited in June 1984 by EPA and a mineral consultant; an engineering work-up and fact sheet was completed at each mine. The mines represented the seven mining districts with the largest population of mines; mines had capacities of 50 cu yds per day to over 3,000 cu yds per day; water use varied from once-through to over 90 percent recycle; overburden varied from none to over 60 feet; and mines located in broad flood plains and narrow valleys were represented. The data collected were reviewed by EPA, and 10 mines were selected as representative of the site factors considered. These 10 mines were than sampled and on-site treatability studies were performed.

During the month of July and August 1984, a field crew visited each of the 10 mines selected and conducted on-site treatability testing as well as sampling and analyses for settleable solids and turbidity. Samples were prepared for laboratory analyses of TSS, arsenic, and mercury and flow measurements were made at each of the 10 mines selected. The crew were on site 2 to 4 days at each mine.

At each mine, the treatability tests were performed in three parts. First, jar tests were used to select the appropriate polyelectrolytes and to determine dosage at each site. Second, settling column tests, with and without polyelectrolytes, were conducted over a period of two hours. Finally, a long-term (up to 24 hours) unaided settling test was conducted. The results indicated an optimal dosage of polyelectrolyte of about 2.0 mg/l. The conclusions of this study are discussed under the treated wastewater characteristics of this section.

The existing wastewater treatment system was evaluated by sampling the influent water, effluent from the sluice, effluent from the ponds or discharge to the receiving water, and other points to evaluate water quality, i.e., recycled water and run off. Using dye, flow patterns were observed to determine detention time or identify short-circuiting in the ponds. Flow meters, weirs, and free pipe discharges were used to determine the flow from the sluice and discharge from the ponds. The sizes of the ponds were measured using a range finder and the depths were determined using a "sinker" at various locations in the ponds.

EPA Treatability Studies - 1983

The treatability studies evaluated both unaided and polymer-aided settling. Unaided and unaided settling column tests were conducted at each of the eleven mines visited.

EPA Settleable Solids Method Detection Limit Study

During July of 1985 EPA personnel performed a field study, the major purpose of which was to establish the Method Detection Limit (MDL) of Settleable Solids in wastewaters discharging from gold placer mining operations. This study also included the gathering of background data and sampling of the mines visited.

The data gathering and Method Detection Limit testing were performed at ten gold placer mine sites in Alaska. These sites which represent several Alaskan geographical locations were selected by U.S. EPA personnel. Where possible background data was obtained by completing fact sheets and several points of the existing mine water system were sampled and analyzed for temperature, pH, settleable solids, turbidity and total suspended solids.

The sampling, analysis, and testing to establish the MDL for settleable solids in wastewaters discharging gold placer mining operations were performed in accordance with the following procedure:

- "Guidelines Establishing Test Procedures for Analysis of Pollutants under the Clean Water Act" 40 CFR part 136 (49 FR No. 209 Friday October 26, 1985)
- "Definition and Procedure for the determination of the Method Detection Limit" Appendix A, Revision 1.11, prepared by EPA's office of Research and Development, Environmental Monitoring and Support Laboratory (EMSL), Cincinnati, Ohio.

The sampling and testing was coordinated with EMSL and samples of the water used for the testing were sent to EMSL for duplicate testing.

The computed field testing and the EMSL study results for settleable solids MDL in wastewaters discharging from Gold Placer Mining Operations were 0.16 ml/l and 0.19 ml/l respectively. Based on these the results of both the field and laboratory studies it was determined that values of settleable solids in wastewater discharging from gold placer mining operations can be read with a reasonable degree of accuracy to below 0.2 ml/l using the volumetric method outlined in Standard Methods and 304(h) of the Agency's "Methods for Analyses of Water and Wastewater".

EPA 1986 - Treatability Study

EPA gathered data during the 1986 mining season at gold placer mine sites in Alaskan mining areas which had not been previously visited by EPA. The study included sampling, flow determinations, and treatability testing of the processing plant effluent, profiling the mine's equipment costs and the preparing of a physical layout of the wastewater treatment system at each mine.

During the last half of June and the first half of July 1986, EPA conducted on-site treatability testing and sampling at each of eight mine sites. On-site analyses were performed for pH, temperature, turbidity, and settleable solids. Liquid and solid samples were prepared for laboratory analyses of TSS, IFB metals, and acid soluble metals. Sludge samples from settling ponds (usually first pond) were analyzed for percent solids, IFB metals, and a trace elements analysis (ICP).

Existing treatment systems were evaluated by sampling the influent water, effluent from the processing plant, recycled water, if it existed, and effluent from the final pond. When possible, flow measurements were made using weirs, free pipe discharges and or timing of transit time of an object over a known distance. Where possible, sludge samples were taken in the first active pond and sketches of the system prepared. Utilizing the pond sizes and measured depths, pond volumes were determined.

At each mine treatability tests were performed in two phases. First, jar tests were used to select the appropriate chemical dosage. Treatability tests were then performed which consisted of simple settling tests and two chemically assisted settling tests. The tests were run over a 2- or 6-hour period. Conclusions and results of this study are presented in the treated wastewater characteristics of this section.

Of the eight mine sites sampled during the field testing program, six sites were processing ore using sluice boxes, one site was a dredge operation, one site was hydraulically stripping overburden and was not sluicing ore at the time of sampling, and one of the six sluice box sites was intermittently sluicing ore.

1986 Placer Mining Full-Scale Field Investigations of Chemical Treatment

This investigation was the first attempted by the Agency on a scale similar to an actual discharge from a gold placer mine operating under a partial recycle system. The testing simulated a treatment system using polyelectrolyte on a continuous basis treating wastewaters discharging from a gold placer mine. These tests had two major purposes: first, to try to confirm the data collected in previous field studies using bench scale tests and second, to generate data which would define possible scale-up problems when using chemicals to treat effluents from gold placer mining operations.

Two sites in Alaska were selected for the testing program. Only one polyelectrolyte was available at the site for testing. At both locations, samples were taken of the untreated wastewater and the settling pond effluent. These samples were analyzed for settleable solids and turbidity at both sites and total suspended solids at one site. The data developed during the testing provides additional information to support the testing previously done by the Agency on a bench scale in Alaska. The report also indicates that the processes were operated with limited success at each site. Limitations associated with these tests included:

1. Achieving proper mixing
2. Maintaining dosage levels
3. Reducing operator time required

<u>"Development and Demonstration of Treatment Technology for The Placer Mining Industry" (1985)</u>

This study was sponsored by the Canadian Government through Environmental Protection Services. The final report indicated that the project had the following specific objectives:

1. To develop a coagulation - flocculation methodology suitable for removal of the colloidal solids associated with aqueous discharges from placer mining operations.

2. To develop and optimize the low energy hydraulic mixing systems required for efficient coagulant mixing and particulate flocculation.

3. To design and install a full-scale effluent treatment system at a selected placer mining operation in the Yukon.

4. To demonstrate at full-scale the ability of the technology to treat adequately the process discharges from placer mining operations.

5. To develop realistic cost estimates of the treatment technology and to evaluate the impact of its implementation on the placer mining industry in the Yukon.

The study was conducted during the 1984 mining season using the results of previous studies a short list of candidate polymers was prepared. This list was reduced using jar tests. The jar tests were also utilized to design the mixing and settling structure.

The demonstration testing was performed at two sites using a dry polymer feed system and weir box system for mixing flocculation. When the mixing and flocculation systems are properly installed and operated the polymer produces a good settling solid.

Some of the conclusions from the study are as follows:

1. Coagulation of placer mining wastewater with anionic polymers was effective in reducing the discharges of suspended particulate matter.

2. Polymer dosage requirements were related to the suspended solids content of the process water treated

and the treatment objective.

Effluent Quality (TSS mg/l)	Polymer Dosage (kg/kkg TSS)
1000	0.071
500	0.129
250	0.261
100	0.865

3. Primary settling pond design and maintenance is a critical factor in achieving effective treatment at low polymer dosages.

4. The full-scale polymeric coagulation system performance was similar to the performance predicted at laboratory-scale by jar testing.

5. The cost for application of polymer aided settling is most sensitive to the chemical requirements.

1984 Wastewater Treatment Technology Project

The Alaska Department of Environmental Conservation (ADEC) funded a study to address the potential loss of gold recovery during recirculation. This study was divided into two parts--a pilot-scale study and a field study.

1986 Fine Gold Recovery Study

The primary purpose of this study was to determine the effect of varying levels of total suspended solids in the sluice feed water on riffle packing and gold recovery in a pilot-scale sluice box. A secondary purpose of this study was to determine the interrelationships between gold recovery and viscosity.

Canadian Department of Indian and Northern Affairs Treatability Study

The treatability studies performed for the Canadian Department of Indian and Northern Affairs were similar to the EPA treatability studies. Unaided and polymer-aided settling column tests and coagulation jar tests using organic polymers were performed at several mines. Unaided settling column tests were performed at four placer gold mines and polymer-aided settling column tests were performed at two mines. All mines were located in the Yukon Territory of Canada.

Settling column tests were performed on simulated sluice effluents. Soil samples from the mine were mixed with a known volume of water to produce the simulated wastewater. A six-inch-diameter, six-foot-long plexiglas column with sampling ports at 1, 3, and 5 feet from the bottom was used. Settling column tests were performed to determine settling rates and settling pond effluent quality. These settling column tests were conducted for a period of 18 to 19 hours. Turbidity values at the end of unaided settling tests ranged from 80 NTU to 2,200 NTU.

Two organic polymers were used in performing standard jar tests on simulated placer mine wastewaters. Non-ionic and anionic polymers were also used in the 1984 EPA treatability study. In this study, the anionic polymer produced the best results at each of the mines tested. Relatively low dosages of this anionic polymer removed a high percentage of the turbidity and suspended solids from the wastewater. Polymer dosages between 3 and 20 mg/l were effective. Jar tests at an additional mine proved ineffective in that 20 mg/l of an anionic polymer was required to produce a supernatant TSS of 500 mg/l.

Lime, alum, and ferric chloride were independently tested on this wastewater at dosages of 100 mg/l. Using these inorganic coagulants, TSS concentrations between 100 and 200 mg/l were achieved.

Based on the jar tests, two polymer-aided settling column tests were conducted. The duration of these tests were relatively short as most of the turbidity and suspended solids were removed from the wastewater during the first few minutes of the test. Polymer dosages selected for use in the column tests were 3 mg/l and 10 mg/l. At these dosages, final TSS concentrations of 30.5 mg/l and 10.5 mg/l, respectively, were achieved.

In summary, this Canadian treatability study of Yukon gold placer mine wastewaters supports the basic conclusions of several of the EPA treatability studies. First, unaided or natural settling of gold placer mining wastewater over relatively long periods of time does not produce a high quality effluent. Second, several organic polymers have been identified which can produce relatively low turbidity and suspended solids concentrations in placer gold mining wastewater at dosages of approximately 10 mg/l.

Lower 48 Study

EPA visited six mines in the lower 48 states (five in Montana, and one in California) to obtain operational, economic, and water quality information relative to the operation of mines outside of Alaska.

Water Quality Study - 1976

This study was one of the first studies conducted which attempted to evaluate water quality from mining operations. Many of the mines visited did not have settling ponds installed, and therefore little information on the effectiveness of settling ponds was obtained.

NEIC Study - 1977

The EPA National Enforcement Investigations Center (NEIC) sampled eight mines with ponds. The results indicate a wide range of settleable solids levels achieved ranging from <0.1 to 15 ml/l. Mercury was not detected in the effluent from any of the settling ponds. The ponds are characterized as not being designed or built to obtain effluent goals, but to provide a temporary holding pond or sump for process water for the beneficiation process, i.e., sluice.

Wastewater Treatment Study - 1979

In 1978, EPA sampled the effluent from eleven operating Alaskan gold placer operations. Five mines achieved settleable solids readings of less than 0.1 ml/l. The total suspended solids (TSS) concentrations ranged from 76 to 5,700 mg/l in the effluent. No turbidity readings were obtained. Arsenic concentrations in the final effluent ranged from <0.002 mg/l to 1.2 mg/l. It was noted that the highest settleable solids and TSS readings occurred with the highest arsenic and mercury data which suggested a concentration of TSS with arsenic and mercury.

Pond retention time and volume were not measured, but the visual assessment indicated inadequately sized ponds are included in this data.

Settling Pond Demonstration Project - 1982

This study included an evaluation of a demonstration pond and settling column tests. Seven mines employing settling pond treatment technology were visited and sampled. Ponds sampled do not necessarily represent adequate sized ponds. Therefore, the results do not indicate the best effluent quality that can be achieved. Settleable solids concentrations ranged from <0.1 to 19.5 ml/l. At one mine, an increase in settleable solids, turbidity, and TSS increased during the year indicating that the pond was filling up. Turbidity readings in the pond effluent during this study ranged from 160 to 6,900 NTU and averaged 2,676 NTU.

Another of the major objectives of this study was to evaluate the sedimentation rates of particles from placer mine sluice discharges. Settling column tests were conducted on the wastewater from 15 individual mines. Wastewater was obtained from sluice box effluents. Turbidity values were taken 1.5 feet and 5.5 feet below the initial height of the settling column. This study concluded that reductions in turbidity to the Alaska standard of 25 NTU above natural conditions could probably not be obtained in a practical manner by sedimentation alone." Extrapolation of the data indicated that approximately 60 days of sedimentation would be necessary to achieve the 25 NTU standard under the laboratory conditions of the test. Based on the settling column tests, the study concluded that it would not be practical to design a demonstration settling pond to achieve state turbidity standards.

A 22-day settling column test was conducted at one mine. After

528 hours of quiescent settling, the TSS and turbidity values were 120 mg/l and 390 NTU, respectively. Even after 22 days, a considerable amount of dilution water from the creek would be needed to meet the State of Alaska water quality standard for turbidity.

At 15 mines, six-day settling column tests were conducted. The average TSS concentration from the 15 mines after six days of quiescent settling was 931.3 mg/l. The average turbidity reading obtained at the end of the same period was 1,543.7 NTU.

SAMPLING AND ANALYSIS

Pollutants

Detailed data on conventional, nonconventional, and toxic pollutant concentrations in raw and treated process wastewater streams were collected in a comprehensive sampling and analysis program. Information available from the 1982 ore mining regulations indicated that toxic organic pollutants would not be expected to be significant in placer mining wastewaters because the ore consists of natural earth materials. Reagents are not used in processes covered by these guidelines.

Mine Sites Sampled

Samples were obtained at each mine visited in 1983, 1985, and 1986 (except mines not operating). In 1984 EPA visited 20 mines but only 10 were sampled. A list of facilities visited (by mine code) is presented in Table V-3 (p. 106). The parameters that were analyzed during the program are shown in Table V-4 (p. 109). Analysis was performed according to the EPA Chemical Analysis methods as listed in Table V-5 (p. 110).

The use of a pre-selected random sample as an information-gathering procedure by Region X in the 1983 study was based largely on the needs of the economic component of the study. The Agency had sampled effluent and receiving waters during the 1982 mining season, employing the simple selection strategy of taking samples at any mine whose sluice was in operation at the time it was visited. It was reasoned that information developed only from mines with operational sluices might bias the economic study toward the more efficient and better situated operations.

Stratification of the sample was based on the requirements of the water sampling portion of the study. This was intended to obtain information from mines of various sizes and with a broad range of sluice water treatment or controls (e.g., sedimentation, recycle). The final composition of the sample was a compromise that reflected the competing requirements of economic and effluent control data gathering. Table V-6 (p. 110) presents a summary comparison of the size distribution of permitted mines in Alaska and the mines sampled.

Sample Collection, Preservation and Transportation

Collection, preservation, and transportation of samples were accomplished in accordance with procedures outlined in "Methods for Chemical Analysis of Water and Wastes," EPA Report No. EPA/4-79-020, March 1979, USEPA Environmental Monitoring and Support Laboratory, Cincinnati, OH, Appendix III of "Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants" (published by the EPA Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, March 1977, revised April 1977), "Sampling Screening Procedure for the Measurement of Priority Pollutants" (published by the EPA Effluent Guidelines Division, Washington, D.C., October 1976) or other EPA-approved procedures.

Samples were obtained from some or all of the following locations:

- Intake water
- Influent to beneficiation process
- Influent to treatment
- Effluent from treatment
- 500 feet downstream of discharge into receiving stream

All samples obtained were grab samples. In general, the following types of samples were collected at each site:

1. Total suspended solids--sample filtered in the field using preweighed glass fiber filters; filter weighed subsequently in the laboratory;

2. Total metals--sample collected for determination of total arsenic and mercury; preserved in the field with 1:1 HN03 to a pH less than 2;

3. Total recoverable metals--samples collected for determination of total recoverable arsenic; preserved in the field with five ml/1 concentrated nitric acid;

4. Dissolved metals--sample filtered through a 0.45 micron filter; preserved with 1:1 HNO3 to a pH less than 2;

5. Acid Soluble Metals--Samples collected for determination of acid soluble metals were acidified with (1:1) nitric to a pH of 1.75± 0.1 and allowed to digest for approximately 16 hours - filtered using 0.45 um membrane filter before shipping to laboratory.

6. Settleable solids--determined immediately in the field using an Imhoff cone;

7. Turbidity--sample analyzed in the field using a field nephelometer (dilutions often necessary);

8. pH and Temperature--analyzed in the field using a calibrated pH meter and a thermometer.

Sample numbers, locations, dates, times, etc. were noted and a sketch of the site and sample locations was prepared. Field measurements of pH, temperature, turbidity, and settleable solids were recorded.

All sample containers were labeled to indicate sample number, sample site, sampling point, individual collecting the sample, type of sample (influent, effluent, etc.), sampling dates and times, preservative used (if any), etc.

All samples being sent for outside analysis were packed in waterproof plastic foam-insulated chests which were used as shipping containers. Sample shipments were made by air freight to the laboratories as soon as possible.

WATER USE

Classification

Mines which employ classification (sizing or screening) of ore prior to sluicing typically use less water than mines which do not classify. Estimated water use rates for mines that use classification and for mines using no classification are shown in Table V-7 (p. 111) for various levels of production. Average water usage at mines employing classification methods (grizzlies, screens, and trammels) is approximately 5.6 cubic meters of water per cubic meter of ore (1,467 gal per cu yd). At mines using no classification, the average water usage is 9.0 cubic meters of water per cubic meter of ore (2,365 gal per cu yd).

Water Recycle and Recirculation Practices at Alaska Placer Gold Mines

Recycle practices at various production levels were investigated. It was determined for 1984 that some degree of recycle is practiced at all mine sizes; however, approximately one-half (50.7 percent) do not recycle any process wastewater. This compares with the projected 60 percent that thought they might use some recycle as stated on their Tri-agency permit applications for 1985, 1986 and 1987.

Table V-8 (p. 112) lists the number of mines recycling wastewater, grouped by production level and the amount of recycle employed. Table V-9 (p. 113) lists the quantity of mines practicing recycle by percentage. This information was obtained from a computerized Summary of Tri-agency Forms compiled from mines which submitted completed Tri-agency forms in 1984. These forms are submitted by the miner prior to the mining season and are an estimate of what the miner plans to do, not necessarily what will actually be done. Table V-10 (p. 114) summarizes the Alaskan gold placer industry by production level from information submitted on Tri-agency forms.

The larger mines are small in number but sluice approximately one-third of the total volume of material. Based on production levels above, 21.3 percent of the industry during 1984 is achieving 90-100 percent recycle of the process wastewater.

Geographic Distribution of Mines Which Recycle

The geographic distribution of mines practicing some degree of recycle was examined to determine if location played any significant role in determination of recirculation practices. Table V-11 (p. 114) summarizes the approximate percentage of mines in each mining district and the corresponding percentage of partial and total wastewater recycling operations for the 1984 season only. Based upon the analysis presented above, recycling or recirculating of wastewater at gold placer mines in Alaska is practiced in all major Alaskan mining districts. Many facilities which recirculate do so because of limited water availability.

RAW WASTEWATER CHARACTERIZATION

The sampling programs previously described provided the data EPA used to determine the presence and concentration of pollutants in placer mining wastewater. In determining the characteristics of raw gold placer mining wastewater, EPA relied primarily on the 1983, 1984, and 1986 data.

Below is a discussion, according to pollutant parameter, of the existence and concentrations of pollutants found in raw gold placer mine wastewater.

TSS

The parameters used to measure solids include total suspended solids (TSS) and settleable solids (SS).

Total suspended solids (TSS) data in raw placer wastewater that was used for development of limitations is listed in Table V-12 (p. 115). TSS data on raw effluent is a measure of all solids including those solids that would be measured as settleable solids. The subcategory average was rounded to 20,000 mg/l TSS. This average was used in all computations for this regulation, including calculations of sludge volume accumulating in ponds and metals removal estimates.

For each mine where more than one solids analysis was conducted on the raw wastewater, the average of all individual analyses was used as the value for that mine in computing the industry average. Three mines, nos. 4922, 4998 and 5002, were not used to compute the average. Mine 4922 was a dredging operation using thaw field water in the dredge pond having TSS levels not representative of the subcategory. Mine 5002 was conducting hydraulicing operations for overburden removal and was not sluicing at the time of sampling. Mine 4998 was operating intermittently during the sampling period.

Metals

The metals present in raw placer effluent are a naturally occurring component of the soil. These metals were shown by the data collected to be almost entirely in the solid form. The preservation technique for total metals analysis mentioned earlier in this section involves acid addition to the sample, which solubilizes metals. Acid digestion further solubilizes these metals. Individual mine and average values of total metal for the 27 metals tested in 1986 in raw placer gold wastewater are listed in Table V-15 (p. 118). Table 16 (p. 119) shows the effluent levels measured for 41 trace identity.

The data presented on raw wastewater and wastewater after chemically aided settling shows that most metals are removed to near or below the detection limit. This is further confirmation of the physical state of metals in gold placer mine wastewaters.

Other Measured Parameters

The water used in placer gold operations does not vary appreciably in pH from source, through processing, to discharge. The pH of waters measured was close to neutral at all sampling locations. The temperature is also unaffected to any noticeable extent. Turbidity is increased considerably due to solids content; the turbidity of raw placer wastewater is such that dilution is necessary to allow measurement with this light scattering technique.

CHARACTERISTICS OF TREATED WASTEWATER

In determining the characteristics of treated gold placer mine wastewater, EPA relied on data from the 1983, 1984, and 1986 studies. EPA found that earlier data collection efforts did not always document the operating conditions of the treatment options at the mine sites. The data used take into account the maintenance, construction, and operation of treatment systems and are considered representative of actual current operating practices.

Below is a discussion, according to pollutant parameters, of the existence and concentrations of pollutants found in treated gold placer mine wastewater.

Toxic Organic Compounds

In 1984, samples of treated final effluent from ten mines were analyzed for the presence of toxic organics. Table V-13 (p. 116) lists the ten mines by code and shows that only two of the toxic organics (methylene chloride and bis(2-ethylhexylphthalate) were detected in the final effluents.

Metal Pollutants

Table V-14 (p. 117) presents the results of analysis for the 13 toxic metals in samples taken from the final discharge of ten Alaskan placer mines during 1984. During the 1986 Alaskan placer mining season, the final discharge from eight mines were sampled. Analyses were performed for 27 metals and 41 elements. Data collected during the summer of 1986 were analyzed for use in determining the effectiveness of metals concentration reduction achieved by simple settling and by chemically aided settling. The data were obtained in sampling efforts conducted at eight different mines to obtain information on the settling characteristics of certain pollutants in the wastewater. Data from three of the mines were not used in the analysis for the reasons stated previously. The operations of the mines from which data were used are considered to be typical of gold placer mining operations.

Influent and effluent concentration measurements were taken for settleable solids, total suspended solids (TSS), and metals from both simple settling tests and chemically aided settling tests. A summary of the data collected and some analysis of these data are presented in Figures V-1 through V-3 (pages 126-128).

The final regulation is based on three hours of quiescent settling which provides removal for the majority of contaminants. A pond sized for 4 hours of detention time should provide equivalent removal; the additional hour of detention time in the pond is included to allow for non-ideal settling conditions due to turbulence and end effects in flow patterns into and out of the pond.

The metals data available for gold placer mining operations consist of initial (raw waste) concentrations and concentrations after 6 hours of settling. An estimation technique was developed to estimate the metals concentration levels after 3 hours of tube settling (which approximates 4 hours of pond detention time). Since metals constitute a certain proportion of TSS, it is a reasonable assumption that metals settle out of the wastewater in a manner similar to TSS. Metals concentrations in the effluent after 3 hours of settling were estimated based on the corresponding TSS settling characteristics. The TSS concentration data were fitted to a non-linear model containing an exponential time-rate decay function. Settleable contaminants would be expected to settle according to such a relationship. Analysis of variance (ANOVA) procedures were performed to test the assumption that the TSS data can be characterized by this non-linear model. The ANOVA results indicate a good fit of the TSS data to the non-linear model shown below. The methodology for the estimation procedure is outlined below:

1. Fit the TSS data, mine by mine, to a non-linear equation of the form:

$$\text{TSS concentration} = \hat{\alpha}\, e^{-\hat{\Gamma} t} + \hat{\beta}$$

where t = settling time (hours)

and $\hat{\alpha}$, $\hat{\beta}$ and $\hat{\Gamma}$ are constant parameters estimated from the data

2. Using the "shape" parameter from the TSS curve, $\hat{\Gamma}$, solve for $\hat{\beta}$ and $\hat{\alpha}$ for each metal using the metals concentrations observed at t=0 (initial) and t=6 (final, after six hours). This procedure assumes that the curve describing the metals settling process has the same general shape as the curve describing the TSS settling process.

3. Using these estimated parameters calculate the estimated metal concentration, on a mine by mine basis, after three hours of settling by the equation:

   $\text{metal}_i \text{ concentration} = \hat{\alpha}_i e^{-\hat{\Gamma}t} + \hat{\beta}_i$

   where t = time (hours) = 3 hours

   and $\hat{\alpha}_i$ and $\hat{\beta}_i$ are estimated constant parameters for metal_i

   and $\hat{\Gamma}$ is the "shape" parameter based on TSS data.

At four of the five mines used in the study, two settling tests were performed at each of the four to determine the effectiveness of chemically aided settling. In the additional tests, TSS concentrations were not measured up to the full 6 hours. For these four mines, the parameters were estimated using the data pairs (TSS concentration and settling time) from both samples together. Metals concentrations were also measured in the additional samples. All the metals samples were analyzed for the initial concentrations and again after the full 6 hours of settling time. The parameters for the metals were estimated using the average initial and 6-hour concentrations where two samples were taken.

Averages were then taken for TSS across all mines for each of the time intervals. These averages were then fit to the equation in the same manner as the individual mines data. Estimates derived for the parameters were then used to calculate the theoretical concentrations at the specified time intervals.

Over the 3 years of gold placer mining data, the average influent TSS concentration is approximately 20,000 mg/l. This 20,000 mg/l average influent TSS concentration was used in the environmental assessment and economic impact modeling studies. For the 1986 settling test data, the average influent TSS measurements were lower - 14,436 mg/l for the simple settling. The average initial TSS concentration for the calculated 3-hour simple settling was adjusted to 20,000 mg/l to compensate for the lower influent TSS concentration levels in the samples. This was done in order to have a more adequate estimate of the overall effect of simple settling on gold placer mine discharges. Correspondingly, the metals concentrations were adjusted proportionally to reflect the higher initial TSS concentration. The adjustment to the initial metals concentrations is given as follows:

$$\text{adjusted metals conc.} = \frac{\underline{20{,}000}\ \underline{\text{mg/l}}\ \underline{\text{TSS}}}{\text{actual TSS}} \times \text{actual metals conc.}$$

The estimated TSS concentrations at each time interval based on an influent TSS concentration of 20,000 mg/l are displayed in Tables V-17 and V-18 (pp. 120) as "CALCULATED BASED ON 20,000 mg/l TSS". Metals concentrations after 3 hours' settling but adjusted to an initial TSS concentration of 20,000 mg/l are shown in Table V-16 (p. 119) as the 3-hour settled column. Additional data collected during the 1986 study but not in Table V16 are shown in Table V23.

Solids

The results of data collected from the effluent of gold placer mines (using existing treatment) during 1983-1986 are presented in Table V-19 (p. 121).

Settling tests were conducted at several sites in Alaska during 1983, 1984 and 1986. Eight-inch-diameter settling tubes were filled with raw wastewater and allowed to settle, simulating the activity of a treatment pond. Under these quiescent settling conditions, the largest portion of suspended and settleable solids removal occurred during the first 2 to 3 hours of settling.

In the 1984 Treatability Study, 24-hour simple settling tests were performed on ten mines. The wastewater was sampled at 1 1/2 to 1 ft below the surface at 0, 1, 2, 3, 6 and 24 hours. As for the 2-hour settling test, the solids in the supernatant would be consistently less than indicated here because the water was sampled well below the surface of the testing device. A tabulation of TSS and SS concentrations for these time periods for the ten mines is presented in Table V-20 (p. 122). The results show a decrease in all parameters throughout the 24-hour period; however, the 24-hour settling test results indicate that the improvement from 3 hours to 24 hours is minimal.

In addition, the 1984 study of in place treatment revealed that properly designed, operated, and maintained settling ponds will remove very high percentages of pollutants associated with the solids encountered in the wastewater from placer mines. An evaluation of these ten existing treatment facilities tested in 1984 indicated that four of the mines should be deleted from the data base: two of the mines selected had not maintained the ponds and the ponds were filled with sludge causing short circuiting and severely reduced detention, one mine had no point source discharge because of recirculation and one mine had a unique and unusual distribution of colloidal clays in the ore. Eliminating the data from these four mines and averaging the analysis from the remaining six mines resulted in the averages listed in Table V-21 (p. 123).

Settling tests over 3 hours in duration were conducted at 17 mines during 1984 and 1986. The settleable solids content of the wastewater from these mines after 3 hours of quiescent settling is shown in Table V-22 (p. 124). The 1986 data collected for TSS in settling tests is presented in Table V-17 (p. 120). Additional settling beyond 3 hours, while ensuring removal of any residual settleable solids, does not greatly alter the removal of suspended solids from the wastewater. Based on the data obtained in pilot settling tests, engineering requirements and experience for design and construction of actual field installations, an additional hour of settling time (i.e., 3-hour settling test vs. 4-hour field design) would be required to compensate for flow velocity changes in the pond.

The average TSS level in raw gold placer gold mine wastewater was determined to be 20,000 mg/l. To evaluate the effectiveness of simple settling and chemical aided treatment technologies, the TSS concentration data from Table V-13 (p. 116) were fitted to a nonlinear model containing an exponential time rate decay function. The nonlinear model was used to predict the concentrations of solids that would be present in average gold placer mine wastewater following 3 hours of simple settling. These results are presented in Table V-16 (p. 119). Three hours of simple settling on wastewater containing 20,000 mg/l TSS is predicted to result in an effluent containing 1670 mg/l TSS.

Coagulation and Flocculation

Settling tests performed in Alaska during the 1983 mining season demonstrated that polyelectrolytes had a potential as a method to treat gold placer mining wastewater and the 1984 and 1986 Alaskan field tests confirmed the chemical viability of treating gold placer mining wastewaters with polyelectrolyte. The 1984 Treatability Study testing program was designed to determine the quality of water discharging from ponds at various detention times and determine the optimum dosage of polyelectrolyte required for optimum treatment.

A combination of polymers in many instances proved more effective in reducing the contaminant levels than application of a single polymer. These tests are not all inclusive but offer a comparison between simple settling and flocculent-assisted settling.

The 1986 testing program was utilized to extend the data base into Alaskan gold placer mining areas where testing was not performed previously. Table V-16 (p. 119) presents a summary of the 1986 results after 6 hours of chemically aided settling.

The conclusions of the 1986 Treatability Study showed that, in general, a dosage of about 3.5 mg/l of polyelectrolyte was optimum. At times a combination of polymers was more effective in reducing the contaminant levels. While these tests are empirical, they do offer a comparison between simple settling and chemically assisted settling.

At the site operating by hydraulically stripping overburden the polymers available at the site for testing did not perform satisfactorily. This site also has very poor simple settling characteristics. The results of these tests confirm the conclusions made during the 1983 and 1984 studies that considerable reduction in solids can be achieved by chemically aided settling and that metals are in suspension and would be removed incidentally with the removal of suspended solids. It further supports EPA's belief that simple settling facilities designed, constructed, and operated as outlined in this section can consistently attain less than 0.2 ml/l settleable solids.

Table V-1. Principal Studies Relied Upon in the Development of Effluent Limitations for Gold Placer Mining

Study Title (Code Name)	Purpose and Number of Sites Visited	Year
1984 Treatability Study (1984-A)	(20) Engineering site visits to obtain obtain economic and operational data, wastewater sampling, and treatability studies	1984
Method Detection Limit Study (1985-A)	(10) Sample visits to determine settleable solids detection limits	1985
1983, 1984, 1986 Treatability Studies	(24) Test simple and flocculent-aided settling	1983, 1984, 1986
Fine Gold Recovery Study (1984-B)	Pilot-scale study to determine fine gold recovery	1984
1984 Wastewater Treatability Project (1984-E)	(2) Coagulation-flocculation treatability study	1984
Fine Gold Recovery Study (1986-C)	Pilot-scale study to determine fine gold recovery	1986
1986 Treatability Study Study (1986-A)	(5) Process and effluent water sampling and chemically aided treatability studies	1986

Table V-2. Gold Placer Mine Studies - 1976-1986

Study Code	Study Title, Author, and Date	Reference
1986-A	EPA/KRE Treatability Study, 1986	1
1986-B	EPA/CENTEC Full-scale Flocculant Study, 1986	2
1985-A	EPA/KRE Method Detection Limit Study, 1985	3
1985-B	Canadian Dept. of Environment - 1985 Placer Study	4
1986-C	EPA/L.A. Peterson and Associates Fine Gold Recovery, September 1986	5
1984-A	EPA/KRE Treatability Study - 1984	6
1984-B	EPA/Peterson Pilot Scale Sluice Study - 1984	7
1984-C	EPA Region X - 1984 Study	8
1984-D	EPA/FTA Study - 1984 (Lower 48)	9
1984-E	Shannon and Wilson - 1984 Wastewater Treatment Technology Project	10
1983-A	EPA/FTA and KRE - 1983 Treatability Studies	11
1976	Dames and Moore - 1976 Study	12
1979-A	Calspan Corp. - 1979 Study	13
1977	EPA/NEIC - 1977 Study	14
1979-B	ADEC - 1977, 1978, 1979 Reports	15
1982-A	R&M Consultants - 1982 Treatability Study, Site Visits, and Pond Design Manual (for ADEC)	16
1982-B	EPA Region X - 1982 Study	17
1983-B	EPA Region X - 1983 Study	18
1981-A	Canadian Dept. of Environment - 1981 Yukon Study	19
1983-C	Canadian Dept. of Environment - 1983 Yukon Study	20

NOTE: See Section XV for full designation of contractors and other Contributors to this document.

Table V-3. Facilities Visited in the Sampling Effort (Continued)

	Study Code (See Table V-2)								
Mine Code	1983-B	1982-B	1983-A[1]	1983-A[2]	1984-D	1984-A	1984-C	1985-A	1986-A
4235	X								
4236	X								
4237	X	X							
4239	X								
4240	X								
4241	X								
4242	X								
4243	X	X							
4244	X	X				X			
4245	X						X		
4247	X		X			X			
4248						X	X	X	X
4249						X	X	X	
4250						X	X		
4251						X			
4252						X			
4253							X		
4254							X	X	
4255							X		
4260					X				
4262					X				
4975								X	
4978								X	
4988								X	
4998									X
4999									X
5000									X
5001									X
5002									X
5003									X
5004									X

Table V-3. Facilities Visited in the Sampling Effort (Continued)

Mine Code	Study Code (See Table V-2)							
	1983-B	1982-B	1983-A[1]	1983-A[2]	1984-D	1984-A	1984-C	1985-A	1986-A
4194		X							
4195		X							
4196		X							
4197	X	X							
4198		X							
4199		X							
4200		X							
4201		X							
4202		X							
4203		X							
4204		X							
4205		X							
4206		X							
4207		X							
4208		X							
4209		X							
4210		X							
4211	X	X							
4212		X							
4213	X							X	
4216	X		X						
4217	X	X	X						
4219	X								
4222	X								
4223	X	X							
4224	X								
4225	X								
4226	X								
4227	X							X	
4229	X								
4230	X								
4231	X								
4232	X								
4233	X								
4234	X								

Table V-3. Facilities Visited in the Sampling Effort

Mine Code	Study Code (See Table V-2)								
	1983-B	1982-B	1983-A[1]	1983-A[2]	1984-D	1984-A	1984-C	1985-A	1986-A
4107		X							
4109	X	X		X					
4110	X			X					
4126	X								
4127	X								X
4132	X								
4133	X								
4134	X		X						
4138			X						
4167		X							
4168		X							
4169	X	X				X		X	
4170	X	X							
4171	X	X							
4172		X		X					
4173	X	X		X		X			
4174	X	X							
4175	X	X							
4176	X	X							
4177		X							
4178	X								
4179		X							
4180	X	X				X			
4181		X							
4182		X							
4184		X							
4185	X	X		X					
4186		X							
4187		X							
4188		X							
4189	X	X		X					
4190	X	X						X	
4191		X							
4192		X							
4193	X	X							

Table V-4. Sample Parameters Analyzed

Parameter	1983-B	1983-A^{1}	1983-A^{2}	1984-A	1984-C	1985-A	1986-A
pH	x	x	x	x	--	x	x
TSS	x	x	x	x	--	x	x
Set. Solids	x	x	x	x	x	x	x
Turbidity	x	x	x	x	--	x	x
Total As	x	x	x	x	--	--	x
Diss. As	x	x	x	--	--	--	--
Acid Sol. Hg	--	--	--	--	--	--	x
Tot. Rec. As	x	x	x	--	--	--	--
Tot. Hg	**	x	x	x	--	--	x
Diss. Hg	**	x	--	--	--	--	--
Acid Sol.As	--	--	--	--	--	--	x
Spec. Gravity	x	--	--	--	--	--	--
Prior.Organ.	--	--	--	x	--	--	--
Temperature	x	x	x	x	--	x	x
IFB Metals	--	--	--	--	--	--	x
Trace Elements Analysis	--	--	--	--	--	--	x

Table V-5. EPA Chemical Analysis Methods

Parameter	EPA Method
pH	150.1
TSS	160.2
Sett. Solids	160.5
Temperature	170.1
Turbidity	180.1
Acid Soluable Metals	200.1
Trace Elements Analysis	200
Priority Organics	1618, 1624 1625
Mercury	245
Arsenic	206
Antimony	204
Selenium	270
Silver	272
Thallium	279
Other Metals	200

Table V-6. Size Distribution of Permitted Mines in Alaska

Size*	Permitted Mines	Sampled Mines**
100-750 cu.yd./day	87%	48%
750-3500 cu.yd./day	20%	44%
>3500 cu.yd./day	3%	7%
Mean Capacity (yd^3/day)	756	1170
Mean Employment (persons)	4.3	6.0

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*Sluicing capacity used for this study:

**Applies to EPA 1983 Region X sampling only

Table V-7. Evaluation of Water Usage Sluicing Operation - Alaskan Gold Placer Mines (1984-1986)

	Average	
	gpm	gal/cu yd
All Mines	2630	1864
All mines with classification	2132	1467
All mines without classification	3260	2365
Mines with production >1,500 to <70,000 cu yd/yr all mines	2223	2319
Mines with production >1,500 to <70,000 cu yd/yr with classification	1806	1962
Mines with production >1,500 to <70,000 cu yd/yr without classification	2219	2631
Mines with production 70,000 to <230,000 cu yd/yr all mines	3207	1442
Mines with production 70,000 to <230,000 cu yd/yr with classification	2272	993
Mines with production 70,000 to <230,000 cu yd/yr without classification	4890	2250
Mines with production 230,000 and greater cu yd/yr all mines	3500	1487
Mines with production 230,000 and greater cu yd/yr with classification	3800	1280
Mines with production 230,000 and greater cu yd/yr without classification	3350	1590

Source: Ref. 27

Table V-8. Recycle of Wastewater at Alaskan Gold Placer Mines

	Volume of Ore Sluiced Per day (cu yds/day)					
	<1000		1000 to 2500		>2500	
Recycle Percent	No. of Mines	Percent of Mines	No. of Mines	Percent of Mines	No. of Mines	Percent of Mines
0	95	42.6	14	6.3	4	1.8
1-24	4	1.8	1	0.4	0	0
25-49	6	2.7	5	2.2	2	0.9
50-74	23	10.3	5	0	3	1.4
75-89	8	3.6	0	0.4	0	0
90-99	8	3.6	1	0.7	0	0
100	38	17.0	3	1.4	3	1.4
Total	182	81.6	29	12.9	12	5.5

Source: Ref. 15

Table V-9. Recycle of Wastewater at Alaskan Gold Placer Mines Expressed by Production - 1984

Recycle Percent	Volume of Ore Sluiced Per day (yd3/day)					
	<1000		1000 to 2500		>2500	
	No. of yd3/day	Percent of Mines	No. of yd3/day	Percent of Mines	No. of yd3/day	Percent of Mines
0	24,070	14.4	23,800	14.3	13,600	8.1
1-24	690	0.4	1,500	0.9	0	0
25-49	2,510	1.5	9,000	5.4	11,000	6.6
50-74	11,040	6.6	9,700	5.8	21,050	12.6
75-89	3,240	2.0	0	0	0	0
90-99	4,620	2.8	1,200	0.7	0	0
100	11,245	6.8	4,700	2.8	13,800	8.3
Total	57,415	34.5	49,900	129.9	59,450	35.6

Source: Ref. 15

Table V-10. Summary of Alaskan Gold Placer Industry by Production (from Tri-agency Data)

	<1000 (gpm)	1000 to 2500 (gpm)	>2500 (gpm)
Mines	81.6%	13.0%	5.4%
Production	34.5%	29.9%	35.6%

Table V-11. Amount of Mines Per Mining District Recycling in Alaska (1984)

Mining District	Percentage of Mines Recycling	Percentage of Mining Operations
Circle	15.4	17.5
Fairbanks	26.4	24.2
Forty Mile	7.3	7.2
Hot Springs	1.8	1.3
Iditarod	0.0	0.9
Innok	0.9	0.0
Koyukuk	6.4	6.3
Kuskikwin	3.6	2.3
Seward	2.7	4.6
Seward Peninsula	6.4	4.0
Other Districts	29.1	30.9

Source: Ref. 15

Table V-12. Summary of Process Discharge Raw Effluent TSS Concentrations (mg/l)
(Data, 1983 - 1986)

Mine Number	Number of Analyses	Total	Average	Standard Deviation
4900	15	234520	15635	3837
4901	3	33400	11133	613
4903	4	17215	4304	4285
4904	5	186240	37248	5777
4906	7	108876	15554	7692
4907	1	10460	10460	0
4909	1	6920	6920	0
4919	7	124647	17807	10743
4920	8	185978	23247	18365
4921	4	32780	8195	2115
4922	5	220520	44104	10667
4923	4	14562	3641	3891
4928	4	51628	12907	2296
4931	3	8520	2840	0
4933	1	48910	48910	0
4941	9	196383	21820	14425
4943	4	43932	10983	139
4944	4	23652	5913	1319
4963	7	53810	7687	1868
4975	1	5780	5780	0
4978	1	30470	30470	0
4980	12	399056	33255	21649
4985	5	101986	20397	8982
4987	6	279841	46640	13560
4988	1	74440	74440	0
4995	7	426633	60948	17693
4998	5	94313	18863	16162
4999	5	26992	5398	4243
5000	5	25278	5056	3151
5001	4	19082	4771	1768
5002	3	367630	122543	55376
5003	5	110985	22197	14170
5004	5	104555	20911	14489

	N	SUM	E(AVG)	SD(AVG)	E(VAR)
TOTAL	161	3669994	23666	24696	7857
w/o 4922	156	3449474	23027	24809	7769
w/o 5002	158	3302364	20576	17717	6372
w/o 4922 & 5002	153	3081844	19817	17481	6233

Table V-13. Priority Organics Detected in the 1984 EPA Study

Mines Sampled (Listed by Code)	Pollutant Detected	Concentration (mg/l)
4249	Methylene Chloride	0.022
4173	Methylene Chloride	0.023
4247	Methylene chloride Bis(2-ethylhexyl)phthalate	0.017 0.068
4169	None	
4248	None	
4180	None	
4244	None	
4250	None	
4251	None	
4252	None	

Table V-14. Priority Metals Sampling Results from Gold Placer Mines
Final Effluents - 1984 Sampling

Mine Code	TSS	Ag	As	Be	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn	Sb	Tl
		Concentration (mg/l)												
4180	773	<0.02	0.275	<0.01	0.01	0.09	0.15	<0.0005	0.16	0.075	<0.005	0.12	0.005	<0.002
4180	773	<0.02	0.412	<0.01	0.02	0.13	0.30	0.0007	0.24	0.155	<0.005	0.26	0.002	<0.002
4173	3,515	<0.02	0.066	<0.01	<0.01	0.09	0.08	<0.0005	<0.10	0.028	<0.005	0.08	<0.002	<0.002
4173	3,515	<0.02	0.072	<0.01	<0.01	0.08	0.09	0.0006	0.12	0.032	<0.005	0.09	<0.002	<0.002
4250	425	<0.02	0.168	<0.01	<0.01	<0.05	0.04	<0.0005	<0.1	0.006	<0.005	<0.02	0.015	<0.002
4250	425	<0.02	0.167	<0.01	<0.01	0.09	0.09	<0.0005	<0.1	0.006	<0.005	0.07	0.015	<0.002
4251	1,431	<0.02	0.004	<0.01	<0.01	0.08	0.10	<0.0005	<0.10	0.007	<0.005	0.08	0.011	<0.002
4251	1,431	<0.02	0.064	<0.01	<0.01	0.09	0.11	<0.0005	<0.10	0.056	<0.005	0.15	0.034	<0.002
4247	619	<0.02	0.075	<0.01	0.05	0.35	0.49	0.0009	0.38	0.150	<0.005	0.89	0.002	<0.002
4247	619	<0.02	0.032	<0.01	0.02	0.10	0.27	0.0008	0.11	0.080	<0.005	0.33	0.002	<0.002
4252	-	<0.02	0.009	<0.01	<0.01	<0.05	0.05	<0.0005	<0.1	0.016	<0.005	0.03	<0.002	<0.002
4252	-	<0.02	0.004	<0.01	<0.01	<0.05	0.05	0.0050	<0.1	0.018	<0.005	0.04	<0.002	<0.002
4169	3,360	<0.02	0.220	0.02	0.08	0.56	0.52	0.0005	1.06	0.230	<0.005	0.90	<0.002	0.004
4169	3,360	<0.02	0.220	0.02	0.08	0.48	0.45	0.0006	0.40	0.195	<0.005	0.78	<0.002	0.004
4244	1,175	<0.02	0.085	<0.01	0.03	0.23	0.14	<0.0005	<0.10	0.27	<0.005	0.29	<0.002	<0.002
4248	178	<0.02	0.110	<0.01	0.01	0.22	0.14	0.0011	0.38	0.019	<0.005	0.26	<0.002	<0.002
4248	178	<0.02	0.120	<0.01	<0.01	0.25	0.14	0.0009	0.36	0.021	<0.005	0.28	<0.002	<0.002
4249	117	<0.02	0.078	<0.01	<0.01	0.06	0.05	<0.0005	0.12	0.011	<0.005	0.02	<0.002	<0.002
4249	117	<0.02	0.077	<0.01	<0.01	0.06	0.06	<0.0005	<0.10	0.013	<0.005	0.03	<0.002	<0.002
Avgs*	1,158	0.01	0.119	0.007	0.019	0.160	0.175	0.0008	0.20	0.073	0.0025	0.25	0.005	0.001

*Averages for numbers listed as "less than" (<) are calculated using 1/2 their value. (For example <.01 = .005 for averaging purposes.)

TABLE V-15

SETTLING AND CHEMICAL ANALYSIS DATA FOR FIVE MINES - 1986
(mg/l)

	RAW WASTE DATA Mine No.						SIMPLE SETTLING			CHEM AID
Property	4999	5000	5001	5003	5004	Average	6 Hour Average	Initial Calc'td	3 Hour Calc'td	6 Hour Average
Al	166.000	50.900	50.200	84.800	526.870	175.580	26.870	316.536	33.193	0.581
Sb	0.304	0.050	0.207	0.332	0.991	0.377	0.078	0.679	0.089	0.050
As	0.247	0.026	0.057	0.037	0.275	0.128	0.082	0.231	0.085	0.010
Ba	5.040	0.808	1.010	4.000	4.660	3.104	0.550	5.595	0.663	0.050
Be	0.008	0.0025	0.0025	0.0025	0.033	0.0097	0.0025	0.017	0.0029	0.025
B	0.560	0.050	0.121	0.050	0.080	0.316	0.217	0.570	0.224	0.050
Cd	0.109	0.037	0.060	0.080	0.266	0.110	0.022	0.199	0.025	0.005
Ca	89.000	23.200	58.300	1560.00	1730.00	692.100	40.000	1247.719	56.752	33.850
Cr	0.293	0.114	0.088	0.131	0.584	0.242	0.061	0.436	0.069	0.025
Co	0.269	0.078	0.130	0.321	1.840	0.528	0.043	0.951	0.063	0.025
Cu	1.210	0.147	0.520	0.329	1.330	0.707	0.176	1.275	0.198	0.013
Fe	366.000	106.000	180.000	140.000	683.000	295.000	126.494	531.826	133.955	0.909
Pb	0.327	0.100	0.100	0.100	2.110	0.547	0.123	0.987	0.145	0.100
Mg	6.000	31.000	32.800	108.000	258.000	87.160	19.510	157.132	21.913	6.113
Mn	12.800	5.190	3.740	28.700	88.700	27.826	1.441	50.165	2.414	0.199
Hg	0.0036	0.0007	0.0004	0.0012	0.0090	0.003	0.0008	0.0054	0.0009	0.0004
Mo	0.050	0.050	0.050	0.050	0.256	0.091	0.050	0.164	0.052	0.050
Ni	0.267	0.143	0.167	0.664	3.540	0.952	0.057	1.717	0.081	0.020
Se	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.009	0.005	0.005
Ag	0.0018	0.0005	0.0005	0.0028	0.0116	0.003	0.0009	0.006	0.001	0.005
Na	5.640	3.240	4.240	17.000	7.820	7.588	6.332	13.680	6.413	6.685
Tl	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.009	0.005	0.005
Sn	0.050	0.050	0.050	0.148	0.356	0.131	0.050	0.236	0.053	0.050
Ti	4.980	0.423	0.447	0.100	0.281	1.252	1.004	2.257	1.027	0.041
V	0.681	0.127	0.258	0.056	0.100	0.244	0.127	0.441	0.132	0.025
Y	0.165	0.025	0.070	0.289	1.100	0.330	0.032	0.595	0.044	0.025
Zn	1.080	0.352	0.565	0.519	2.820	1.067	0.164	1.924	0.201	0.014
TSS	10700	3590	4870	15100	37928	14436	914	20000	1670	9

NOTES: Raw waste data is directly from simple settling tests. Average data is linear average of values recorded in tests. Initial and three hour calculated data is calculated as described in the text of this Section and has been normalized to 20,000 mg/l TSS in the raw waste.

Table V-16

METALS SAMPLING RESULTS FROM PLACER GOLD MINES FINAL EFFLUENT
1986 ALASKAN PLACER MINING STUDY

TRACE ELEMENTS ANALYSIS

MINE NUMBER	Au	Bi	Ce	Dy	Er	Eu	Ga	Gd	Ge	Hf	Ho	I	In	Ir	La	Li	Lu	Nb	Nd	Os	P	Pd	Pr	Pt	Re	Rh	Ru	S	Sc	Si	Sm	Sr	Ta	Tb	Te	Th	Tm	U	W	Yb	Zr
4922	ND	ND	DET	ND	ND	ND	ND	ND	<500	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<200	DET	ND	ND	ND	ND	ND	<500	DET	ND	DET	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4998	ND	DET	ND	<100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	DET	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4999	ND	ND	DET	ND	<100	ND	ND	ND	ND	ND	ND	<1000	ND	ND	ND	ND	ND	ND	ND	<200	DET	ND	ND	ND	ND	ND	<500	DET	ND	DET	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
5000	ND	ND	DET	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	DET	ND	DET	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
5001	ND	ND	DET	ND	<100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	DET	ND	DET	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
5002	ND	ND	DET	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	DET	ND	DET	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
5004	ND	ND	DET	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	DET	ND	DET	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

NOTES

All Values in ug/l
ND - Not Detected
DET - Element Metal possible present but of a value not definable
T - Total Metals
A - Acid Soluable Metals

Table V-17. TSS Concentration Levels After Simple Settling

Mine Number	Test Number	Total Suspended Solids (mg/l) Time (hrs) 0	1	2	3	4	5	6
4999	5	10700	5400	4500	4210	3690	3420	2920
5000	9	3590	1670	1260	1050	868	848	828
5001	13	4870	1905	1176	1084	936	852	757
5003	22	15100	150	63	59	32	34	28
5004	26	37920	14230	102	92	88	53	39
Average		14436	4671	1420	1299	1123	1041	914
Calculated Based on 20,000 mg/l TSS		20000	4472	1868	1167	1008	962	950

Table V-18. TSS Concentration Levels After Chemically Aided Settling

Mine Number	Test Number	Totally Suspended Solids (mg/l) Time (hrs) 0	0.5	1	2	3	4	5	6
4999	6	3840	40	27	27	26	23	23	24
4999	7	869	36	23	23				
5000	10	3060	41	24	22	21	18	11	8
5001	14	5930	30	26	17	12	12		
5003	23	43100	113	22	20	8	9	8	2
5004	28	12000	62	20	14	10	5	6	3
Average		15840	49	23.8	20	18.4	18	12	9.3

Table V-19 Alaska Sampling Data Gold Placer Mine Discharges, 1983-1986

Mine No.	TSS (Average) (mg/l)
4903	12
4941	3480
4943	16
4928	1251
4921	953
4904	6505
4923	28
4931	175
4901	650
4920	2800
4944	1304
4987	315
4906	3288
4941	3137
4919	819
4995	173
4985	1111
4920	8440
4963	678
4900	4025
4904	124
4907	3850
4980	896
4989	100
4909	266
4988	252
4922	1433
4998	600
4999	2213
5000	22
5001	193
5002	71
5003	50
5004	4

Table V-20. 1984 24-hour Simple Settling Test: Solids Concentrations at Various Detention Times

Settling Time-Hours		Settleable Solids ml/l	Suspended Solids mg/l	Turbidity NTU
0	Range	3.2 to 125	5,580 to 51,413	2,016 to 34,560
	Average	47.3	27,000	20,000
1	Range	0.2 to 6	400 to 11,825	603 to 21,600
	Average	1.75	6,600	10,000
2	Range	0 to 1.0	183 to 12,320	281 to 32,000
	Average	0.47	5,200	11,300
3	Range	0 to 0.4	116 to 12,700	128 to 30,240
	Average	0.16	4,900	9,950
6	Range	0 to 0.1	29 to 12,000	38 to 35,280
	Average	0.05	3,900	9,650
24	Range	0 to <0.1	19 to 9,120	27 to 25,200
	Average	<0.1	2,800	7,700

Table V-21. EPA Treatability Study - 1984

Values for 6 Mines

	Water Supply			Sluice Discharge			Final Effluent		
	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
Settleable Solids (ml/l)	0	0.28	<0.2	5.9	148.8	48.2	0	<0.2	<0.2
TSS (mg/l)	26.5	743	303	8,699	66,639	28,589	173	4,025	1,550
Turbidity (ntu)	4.7	805.5	330	6,975	43,440	22,258	129	11,610	2,968
Arsenic (mg/l)	0.0080	0.2220	0.0915	0.3065	2.4	0.8058	0.0045	0.3760	0.2290
Mercury (mg/l)	<0.0005	0.0017	0.0006	<0.0005	0.0030	0.0012	<0.0005	<0.0015	0.0006

Note: For all raw data listed at less than the detection limit a 1/2 value of the detection limit was used for the averages including values for zero and trace.

Table V-22. Total Suspended and Settleable Solids Tests 1984 and 1986 (3 hours of Quiescent Settling)

Mine No.	TSS (mg/l)	SS (ml/l)
	1984	
4900	10,110	0.2
4906	4,270	0.3
4919	4,791	0.4
4920	8,520	<0.2
4941	7,441	0.4
4963	1,715	0.1
4985	131	TR
4987	3,970	<0.1
4995	--	TR
4904	--	
4980	116	-
	1986	
4922	15,380	0.51
4998	2,040	0.2
4999	4,207	TR
5000	1,050	TR
5001	1,084	TR
5002	41,700	1.0[2]
5003	59	TR
5004	92	TR

TR = Trace

[1] Sample was taken from dredge pond

[2] At the time of sampling, mine was hydraulicking overburden, not sluicing ore

Table V-23. EPA Treatability Study - 1986

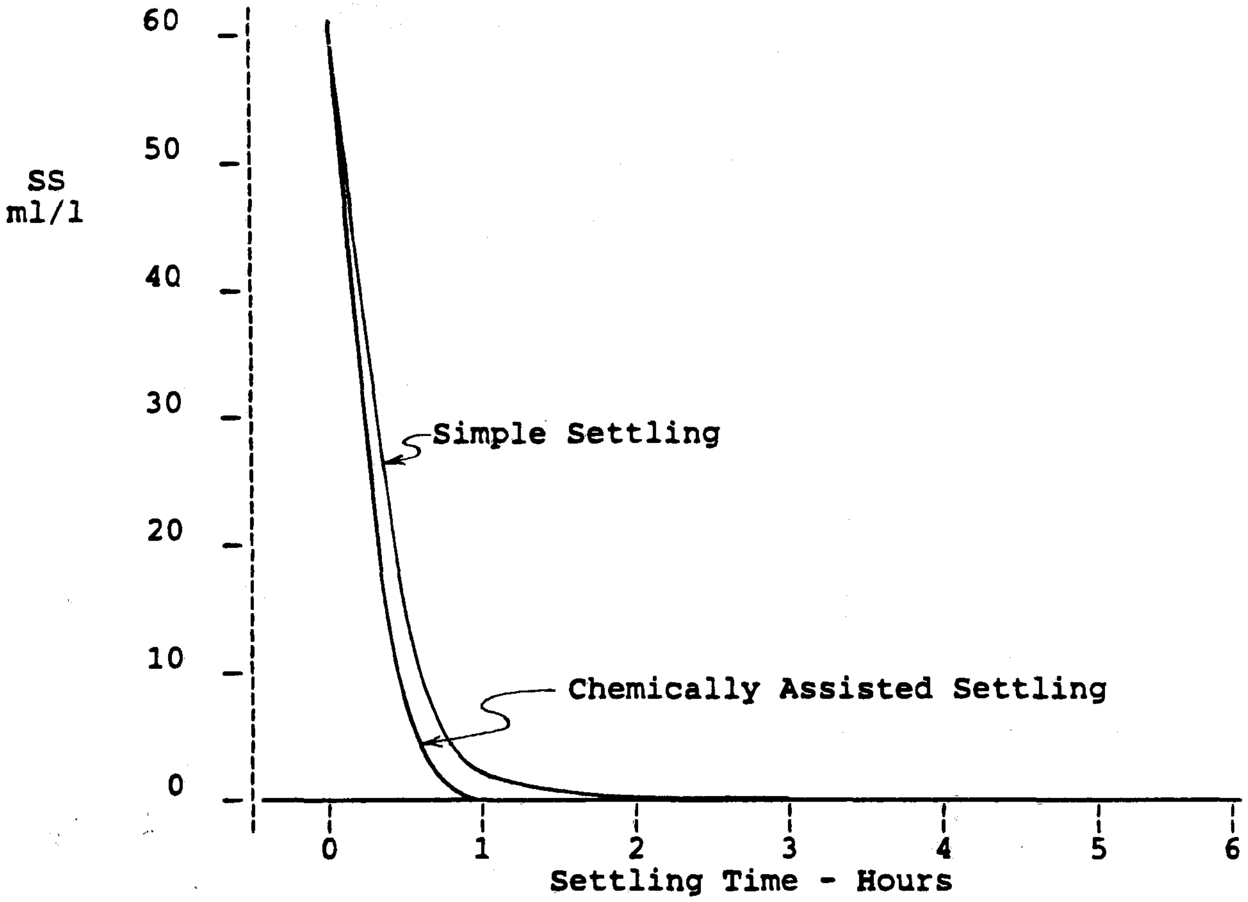
Average (6 mines using sluice boxes)

	Water Supply	Processor Recirc. Water	Process Effluent	Final Pond Effluent
Settleable Solids (ml/l)	Trace	<0.1	58	<0.1
T.S.S. (mg/l)	28	35	9790	610
Turbidity (NTU)	43	50	10,630	1290
Total Arsenic (mg/l)	<20	27	76	42
Acid Soluble Arsenic (mg/l)	<20	<20	24	24
Total Mercury (mg/l)	<0.2	<0.2	1.1	0.9
Acid Soluble Mercury (mg/l)	<0.2	<0.2	<0.2	<0.2

Figure V-1

GOLD PLACER MINING

Settleable Solids



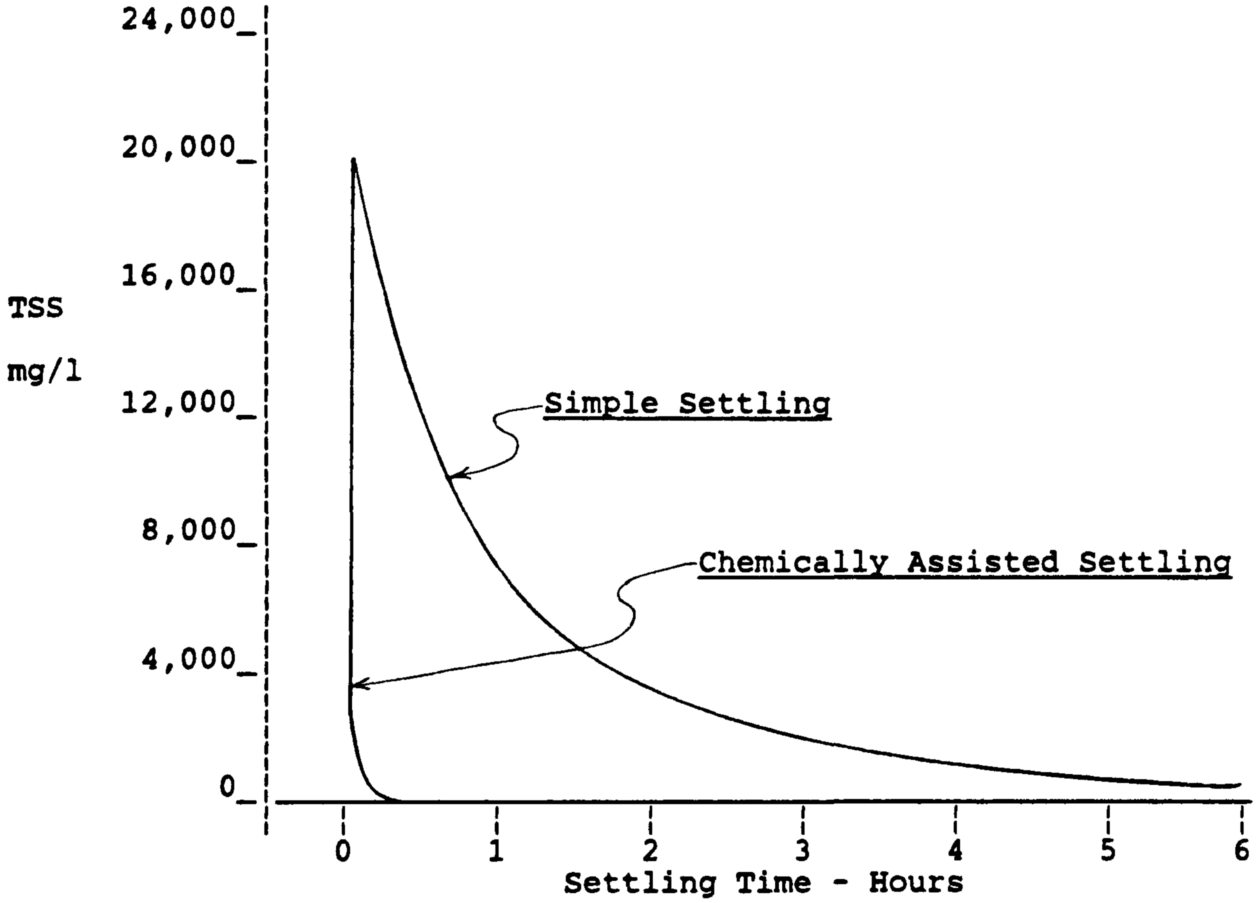
Average of 1984 and 1986 Data

Settling Time (Hours)	SS - (ml/l) Simple Settling	SS - (ml/l) Chemically Asstd. Settling
0	60.6	60.6
1.0	2.2	Trace
2.0	0.5	0
3.0	0.15	0
4.0	0.10	0
5.0	Trace	0
6.0	Trace	0

Figure V-2

GOLD PLACER MINING

Total Suspended Solids



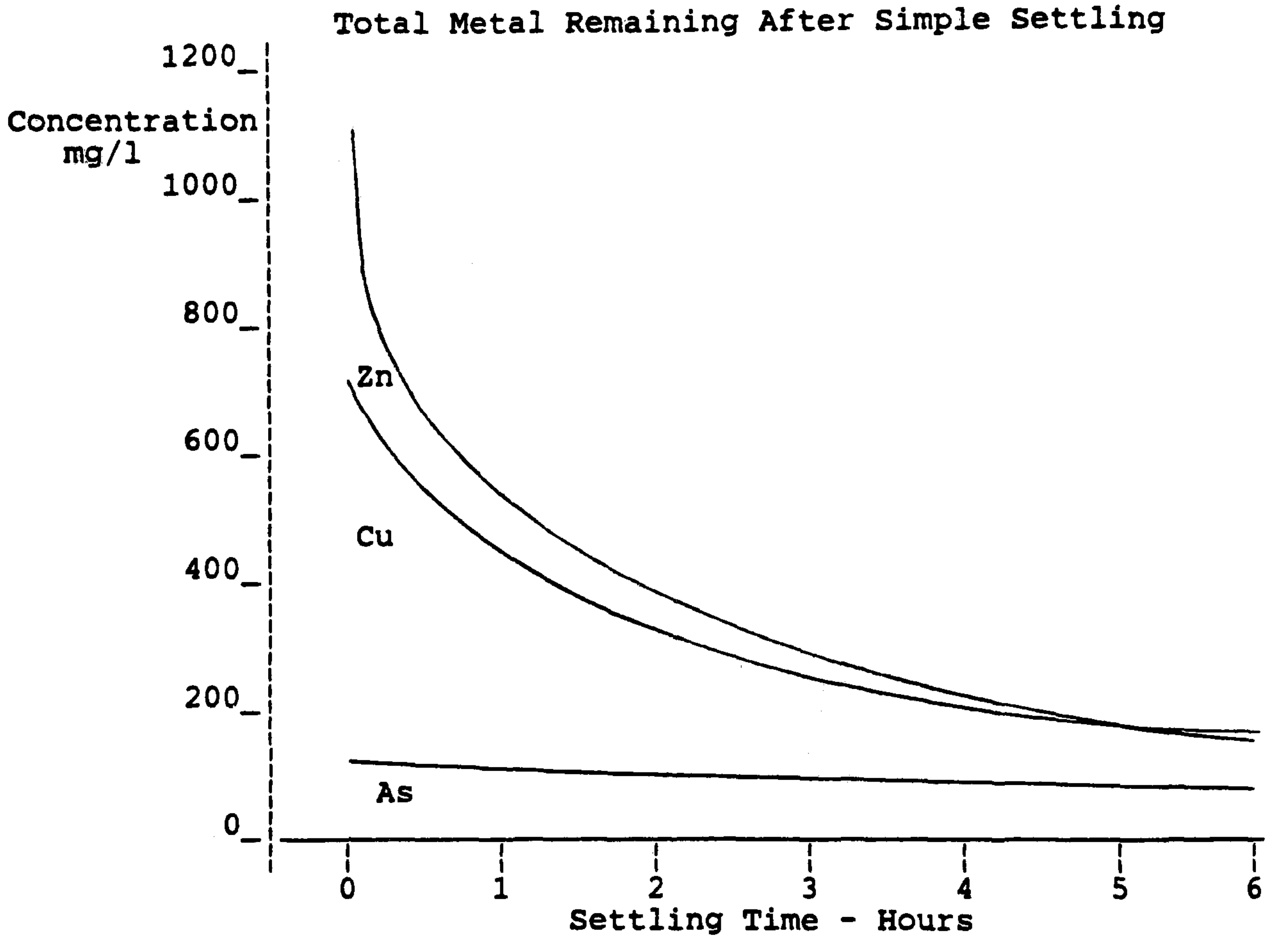
1986 DATA

Settling Time (Hours)	TSS - (mg/l) Simple Settling	TSS - (mg/l) Chemically Asstd. Settling
0	20,000	20,000
0.25	- - -	96
0.50	- - -	21
1.0	7,512	21
2.0	3,176	21
3.0	1,670	21
4.0	1,147	21
5.0	966	21
6.0	903	21

Figure V-3

GOLD PLACER MINING

Typical Toxic Metal Removal



1986 DATA

Settling Time (Hours)	(ug/l)		
	Arsenic	Copper	Zinc
0	128	707	1067
3.0	94	247	293
6.0	82	176	164

SECTION VI

SELECTION OF POLLUTANT PARAMETERS

The Agency has studied placer mining wastewaters as well as other ore mining and dressing wastewaters to determine the presence or absence of toxic, conventional, and nonconventional pollutants. According to the requirements of the Clean Water Act of 1977 (CWA), 129 toxic pollutants are to be studied in the formulation of these limitations and standards (see Section 307 (a)(1), Table 1 of the Act).

EPA conducted sampling and analysis at facilities which represented a wide range of locations, operating conditions, processes, water use rates, topography, production rates, and treatment technologies (settling ponds--single or multiple; recycle and recirculation). The quantities and treatability of pollutants in these treated wastewaters form the basis for selection of pollutant parameter for regulation.

The Administrator is required by the CWA to consider the regulation of all toxic pollutants and categories of pollutants listed under Section 307 but is not specifically required to regulate any of them.

The criteria used for exclusion of pollutants from regulation in this subcategory are summarized below:

1. The pollutant is not detectable in effluents within the subcategory by approved analytical methods representing state-of-the-art capabilities.

2. The pollutant is detected in only a small number of sources within the category and is uniquely related to only those sources.

3. The pollutant is present in only trace amounts and is neither causing nor likely to cause toxic effects.

4. The pollutant is present in amounts too small to be effectively reduced by technologies applicable to this subcategory.

5. The pollutant is effectively controlled by the technologies upon which are based other effluent limitations and standards.

SELECTED POLLUTANT PARAMETER

EPA has selected settleable solids (SS) as the only directly regulated parameter for effluent discharge from gold placer mines. The recirculation of process water and the removal of settleable solids in any waters discharged from the mines will adequately control all pollutants found in effluents from this subcategory. These pollutants include metals which are removed with the solids and turbidity which is reduced when solids are reduced. Settleable solids has been selected as the regulated parameter to best control solids because the most stringent demonstrated technology for this subcategory, simple settling, provides reliable removal of SS. The removal of TSS and incidental removal of metals and turbidity by this technology is highly variable and does not produce a consistent enough database on which to base an effluent limitations and standards.

TOXIC POLLUTANTS

Organic Pollutants

The toxic organic compounds generally are not naturally associated with metal ores. On the basis of the study of the entire ore mining and dressing category in the United States, EPA excluded 114 of the toxic organic pollutants during the 1982 BAT rulemaking for the category. No information has been developed during the course of these studies or provided to EPA by the public which indicates that any of the organic priority pollutants are present in amounts that are treatable. In addition, organic reagents are not used in this subcategory because it relies on gravity separation methods to extract gold from the ore. Therefore, organic pollutants were not expected to be present in the wastewater from gold placer mining operations. Screening analysis was performed to confirm this assumption.

In 1984, samples for the toxic organics were collected and analyzed. Treated final effluent samples from ten mines were analyzed for the presence of toxic organics (see Table V-15, p. 118). Two of the toxic organics (methylene chloride and bis(ethylhexyl)phthalate) were detected in the final effluent of placer mining operations.

In the sampling for the toxic organics, 117 toxic organics were not detected and therefore were excluded from further consideration based on Criterion 1 above. The particular organics detected are not known to exist in natural ore formations and their presence is questioned. Additionally, these organics occur in organics analysis laboratories (methylene chloride) and in some sampling equipment. This leads to the belief that they may be artifacts of the laboratory and sampling procedures rather than pollutants existing in the subcategory. Moreover, the two toxic organics detected also could have been excluded based on Criteria 3 and 4.

The gold placer mining subcategory does not use reagents or chemicals for the processing of gold from ore. All processing relies on physical or gravity separation, so any contaminants or pollutants present generally would originate from the ore. Oil and grease could be present, in some instances, from hydraulic fluids or fuels; however, in most cases good housekeeping practices will control this parameter. Therefore, based on data available for the ore mining category as a whole and knowledge of the processes and ores used in gold placer mining, the Agency will not further consider the regulation of toxic organic pollutants for this subcategory.

Metal Pollutants

Data on the presence of metals in treated effluent are shown in Table V-15 (p. 118). The toxic metals are excluded from regulation based on Criteria 3, 4 and 5, 6, and 7. However, because of the frequent occurrence of arsenic and the cumulative effects of mercury, these two metals are discussed further below.

Arsenic

Arsenic is a normal constituent of most soils, with concentrations ranging up to 500 mg/kg. It occurs mostly in the form of arsenites of metals or as arsenopyrite (FeS2.FeAs2). Arsenic is known to be present in many complex metal ores--particularly, the sulfide ores of cobalt, nickel and other ferroalloy ores, antimony, lead, gold and silver. It may also be solubilized in mining and milling by oxidation of the ore and appear in the effluent stream.

The chemistry of arsenic in water is complex and the form present in solution is dependent upon such environmental conditions as pH, organic content, suspended solids, and sediment. The relative toxicities of the various forms of arsenic apparently vary from species to species. For inorganic arsenic(III), acute values for 16 freshwater animal species ranged from 812 ug/l for a cladoceran to 97,000 ug/l for a midge, but the three acute-chronic ratios only ranged from 4.660 to 4.862. The five acute values for inorganic arsenic(V) covered about the same range, but the single acute-chronic ratio was 28.71. The six acute values for MSMA ranged from 3,243 to 1,403,000 ug/l. The freshwater residue data indicated that arsenic is not bioconcentrated to a high degree but lower forms of aquatic life may accumulate higher arsenic residues than fish. The low bioconcentration factor and short half-life of arsenic in fish tissue suggest that residues should not be a problem to predators of aquatic life.

The available data indicate that freshwater plants differ a great deal as to their sensitivity to arsenic(III) and arsenic(V). In comparable tests, the algae Selenastrum capricornutum was 45 times more sensitive to arsenic(V) than to arsenic(III), although other data present conflicting information on the sensitivity of this alga to arsenic(V). Many plant values for inorganic arsenic(III) were in the same range as the available chronic values for freshwater animals; several plant values for arsenic(V) were lower than the one available chronic value.

The other toxicological data revealed a wide range of toxicity based on tests with a variety of freshwater species and endpoints. Tests with early life stages appeared to be the most sensitive indicators of arsenic toxicity. For example, an effect concentration of 40 ug/l was obtained in a test on inorganic arsenic(III) with embryos and larvae of a toad.

The procedures described in "Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses" indicate that, except possibly where a locally important species is very sensitive, freshwater aquatic organisms and their uses should not be affected unacceptably if the 4-day average concentration of arsenic(III) does not exceed 190 ug/l more than once every 3 years on the average and if the 1-hour average concentration does not exceed 360 ug/l more than once every 3 years on the average.

The procedures described in the Guidelines indicate that, except possibly where a locally important species is very sensitive, saltwater aquatic organisms and their uses should not be affected unacceptably if the 4-day average concentration of arsenic(III) does not exceed 36 ug/l more than once every 3 years on the average and if the 1-hour average concentration does not exceed 69 ug/l more than once every 3 years on the average. This criterion might be too high wherever Skeletonema cosrarum or Thalassiosira aestivalis are ecologically important.

Mercury

Mercury's cumulative nature makes it extremely dangerous to aquatic organisms since these organisms have the ability to absorb significant quantities of mercury directly from the water as well as through the food chain. Methyl mercury is the major toxic form; however, the ability of certain microbes to synthesize methyl mercury from the inorganic forms renders all mercury in waterways potentially dangerous.

The best available data concerning long-term exposure of fish to mercury(II) indicate that concentrations above 0.23 mg/l caused statistically significant effects on the fathead minnow and caused the concentration of total mercury in the whole body to exceed 1.0 mg/kg. Although it is not known what percent of the mercury in the fish was methylmercury, it is also not known whether uptake from food would increase the concentration in the fish in natural situations. Species such as rainbow trout, coho salmon, and, especially, the bluegill, might suffer chronic effects and accumulate high residues of mercury about the same as the fathead minnow.

With regard to long-term exposure to methylmercury, McKim et al (1976) found that brook trout can exceed the FDA action level without suffering statistically significant adverse effects on survival, growth, or reproduction.

The procedures described in "Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses" indicate that, except possibly where a locally important species is very sensitive, freshwater aquatic organisms and their uses should not be affected unacceptably if the 4-day average concentration of mercury does not exceed 1.2 x 10-5 mg/l more than once every 3 years on the average and if the 1-hour average concentration does not exceed 2.4 x 10-3 mg/l more than once every 3 years on the average. If the 4-day average concentration exceeds 9.12 x 10-5 mg/l more than once in a 3-year period, the edible portion of consumed species should be analyzed to determine whether the concentration of methylmercury exceeds the FDA action level.

One of the reasons that limits for arsenic and mercury are not being established is that limiting the discharge of solids (the principal pollutant in the wastewater from placer mines) controls other pollutants which are also found in the solid form. Arsenic, mercury, and other metals found in discharges from placer mines are substantially reduced by the incidental removal associated with the control and removal of settleable solids. By controlling settleable solids at the BPT and BAT levels discussed in Sections IX and X, any arsenic and mercury in the discharge would be reduced to levels that are below the level at which they can be effectively treated by other technologies available for this subcategory. Furthermore, as shown in Table V-15 (p. 118), metals concentrations for current discharges are frequently below the analytical detection limit.

The Agency finds that it may not always be feasible to directly limit each toxic that is present in a waste stream. Surrogate or indicator relationships provide an alternative or direct limitation of toxic pollutants according to Criterion 5. Section V discusses the data analysis which has been performed to determine the presence of total arsenic and mercury in gold placer mining treated effluent. Based upon the relationships developed, these metals have been shown to be associated with the solids portion (either settleable or suspended) of the wastewater stream rather than the dissolved portion. Furthermore, the data available indicate that after removal of the solids the levels of toxic metals are too low to further reduce by the application of any other treatment technology being considered. The data available on the removal of metals from gold placer mining wastewaters indicate clearly that the level of metals in the wastewaters is reduced as the amount of settleable and suspended solids in the wastewater is reduced. The available data do not provide the basis for the mathematical correlation required to provide a surrogate relationship; however, the correlation is adequate to support the use of settleable solids as an indicator for toxic metals removals.

CONVENTIONAL AND NONCONVENTIONAL POLLUTANTS

pH

High or low pH values in process waters can result in solubilization of certain ore components and can adversely affect receiving water pH. Acid conditions can result in the oxidation of sulfide minerals in certain ores. No pH problems have been encountered in placer mining discharges. The water used in placer gold operations does not vary appreciably in pH from source, through processing, to discharge. The pH of waters measured was close to neutral at all sampling locations.

Solids

Fish and other aquatic life requirements concerning suspended solids can be divided into those whose effect occurs in the water column and those whose effect occurs following sedimentation to the bottom of the water body. Noted effects are similar for both fresh and marine waters.

The effects of suspended solids on fish have been reviewed by the European Inland Fisheries Advisory Commission (1965). This review identified four means by which suspended solids adversely affect fish and fish food populations:

1. By acting directly on the fish swimming in water where solids are suspended, and either killing them or reducing their growth rate, resistance to disease, etc.
2. By preventing the successful development of fish eggs and larvae
3. By modifying natural movements and migrations of fish
4. By reducing the abundance of food available to the fish

Settleable materials which blanket the bottom of water bodies damage the invertebrate populations, block gravel spawning beds, and, if organic, remove dissolved oxygen from overlying waters. In a study downstream from the discharge of a rock quarry where inert suspended solids were increased to 80 mg/l, the density of macroinvertebrates decreased by 60 percent while in areas of sediment accumulation benthic invertebrate populations also decreased by 60 percent regardless of the suspended solid concentrations. Similar effects have been reported downstream from an area which was intensively logged. Major increases in stream suspended solids (25 mg/l suspended solids upstream vs. 390 mg/l downstream) caused smothering of bottom invertebrates, reducing organism density to only 7.3 per square foot versus 25.5 per square foot. Solids in suspension that will settle in one hour under quiescent conditions because of gravity are settleable solids.

When settleable solids block gravel spawning beds which contain eggs, high mortalities result, although there is evidence that some species of salmonids will not spawn in such areas.

It has been postulated that silt attached to the eggs prevents sufficient exchange of oxygen and carbon dioxide between the egg and the overlying water. The important variables are particle size, stream velocity, and degree of turbulence.

Deposition of organic materials to the bottom sediments can cause imbalances in stream biota by increasing bottom animal density, principally worm populations, and diversity is reduced as pollution-sensitive forms disappear. Algae likewise flourish in such nutrient-rich areas, although forms may become less desirable.

Plankton and inorganic suspended materials reduce light penetration into the water body, reducing the depth of the photic zone. This reduces primary production and decreases fish food. The NAS committee recommended that the depth of light penetration not be reduced by more than 10 percent. Additionally, the near surface waters are heated because of the greater heat absorbency of the particulate material which tends to stabilize the water column and prevent vertical mixing. Such mixing reductions decrease the dispersion of dissolved oxygen and nutrients to lower portions of the water body.

The presence of solids in placer gold mining discharges has been documented in the sampling programs described in Section V. The results of sampling conducted by EPA between 1983 and 1986 are presented in Table V-20 (p. 122).

Asbestos

The 1982 final effluent limitations and standards for ore mining and dressing excluded the toxic pollutant asbestos from direct regulation because effluent limitations on solids (TSS) effectively controlled the discharge of asbestos (chrysotile). Asbestos was found in all raw waste discharges and all effluent from all ore mines and mills where an analysis was made for asbestos (88 samples representing 23 facilities). EPA found a high degree of correlation between solids and chrysotile asbestos in the raw wastewater and treated wastewater and concluded that settling technology was so successful at removing solids, a specific limitation on asbestos was not appropriate in light of the correlation with solids and the expense of monitoring specifically for asbestos.

Turbidity

Turbidity is the property of a material to scatter light as the light passes through a water columm in which the material is suspended. The treatments considered for this subcategory do not directly control turbidity but control settleable solids or suspended solids. While removing these solids from water will tend to reduce the level of turbidity, there is no good correlation between SS or TSS and turbidity. Since turbidity is a water quality parameter it is highly site specific and the control and regulatory levels necessary to meet the water quality requirements must be equally site specific. For these reasons, turbidity is not further considered for regulation.

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SECTION VII

CONTROL AND TREATMENT TECHNOLOGY

This section discusses the techniques for pollution abatement available to gold placer mining. General categories of techniques are: in-process controls, end-of-pipe treatment, and best management practices. The current or potential use of each technology in gold placer mining and the pollutant reduction effectiveness of each are discussed.

Selection of the optimal control and treatment technology for wastewater generated by this subcategory has been influenced by several factors:

1. There are some differences in wastewater composition and treatability caused by ore mineralogy, ore particle size and distribution, and processing techniques.

2. Geographic location, topography, and climatic conditions often influence the amount of water to be handled, treatment and control strategies, and costs.

3. A mine operator must frequently rebuild the treatment facilities because of the progressively moving nature of these operations.

END-OF-PIPE TREATMENT TECHNOLOGIES

This subsection presents a discussion of technologies which may be employed for the treatment of wastewater discharged from gold placer mining operations. Most mines are in remote locations, so that the type of equipment and the availability of outside construction services must be considered. For a given site, the terrain is most important to define design, construction and maintenance requirements for treatment facilities. The following factors were also considered in reviewing the available and appropriate treatment and control facilities for gold placer mines:

1. Engineering considerations for construction of treatment facilities in most mining locations, including settling pond size, number of ponds, drainage diversion and water use reduction

2. The length of the gold placer mining season which ranges from about 2 to 4 months in Alaska and from 5 to 10 months in the lower 48

3. Design considerations due to climate, especially rainfall and temperature

4. Construction equipment available to, and practices employed by, the mining crew to install treatment or control facilities

The ore mining category currently uses some form of sedimentation technology which usually involves settling basins, clarifiers, or ponds. Large concrete settling basins and clarifiers normally found at typical "hard rock" ore mines generally are not found because they are not adaptable to conditions related to frequent moves, seasonal operation, and the remote location of gold placer mines. Other technologies impractical for gold placer mining include granular media filtration, adsorption, chemical treatment, and ion exchange.

IN-PROCESS CONTROL TECHNOLOGY

Process changes are available to existing mines that will improve the quality or reduce the quantity of wastewater discharged from mines. Use of in-process changes will reduce end-of-pipe treatment costs and improve treatment effectiveness.

Classification

Mines which employ classification (sizing or screening) of the ore prior to sluicing typically use less water than mines which do not classify. Several different classification devices are commonly employed at gold placer mines--such as grizzlies, trommels and screens (fixed and vibrating). Each of these devices removes oversized material prior to sluicing. Removal of oversized material reduces water usage because less material is sluiced and a lower water velocity is required to move the smaller rocks down the sluices. Descriptions of grizzlies, trommels and screens are found in Section III. Estimated water use rates for each of the classification devices and for mines using no classification are shown in Table V-8 (p. 112). Average water use at mines employing classification methods (grizzlies, screens and trommels) is approximately 5.57 cu m water per cu m are (1467 gal per cu yd of ore processed). At mines using no classification, the average water use is 8.97 cubic meters of water per cubic meter of ore (2365 gal per cu yd). Classification is common practice in the industry. A significant number of mines, especially those mines in water short areas, consider it good mining practice to reduce water usage by classifying. In Section III, Tables III-4 to III-8 (pp. 48-56) indicate that over 50 percent of the mines use some form of classification.

High Pressure - Low Volume Spray Nozzles

One of the factors that affects the amount of water required at gold placer mines is the cohesiveness of the ore particles. Mines washing ores which contain a significant percentage of clay particles generally use greater volumes of water to break up the ore during beneficiation than mines processing ores with larger particle sizes and less clay. Screening in conjunction with the use of high pressure, low volume spray nozzles prior to sluicing can assist in breaking up the agglomerated ore, freeing the gold particles. This type of operation will use less water per unit of ore processed than if large volume low pressure nozzles were employed.

Sluice Design

The amount of water required for sluicing is a function of slope, width, water depth, riffle type, riffle spacing, ore particle size, composition and size distribution of the ore as discussed above. However, sluice design and the efficiency of a given sluice in recovering gold is most often the result of trial and error by the miner to obtain the best recovery of gold from a particular ore. Numerous mining text books and journals have published design parameters for sluice boxes plus describing "normal" operation requirements. A 1986 study performed upon ore from a mine in Yukon, Canada is a clear presentation of the many variables involved in the proper design and operation of a sluice box.

Control

Water use can also be reduced by stopping the influent flow to the beneficiation process during extended periods when ore is not being loaded into the process. This will decrease the total flow into the settling ponds and increase the settling time. Continued water flow in the absence of ore is sometimes called "running clear" and is to be avoided.

Simple Settling

Simple settling is the process by which wastewater is given a period of time to sit undisturbed in a pond or vessel. This quiescent settling time allows gravity to act on the settleable solids in the wastewater.

The use of ponds for both primary and secondary settling is very common in gold placer mining. The wastewater entering these ponds from the mining and ore processing operations contain a high solids loading. Primary settling ponds are often used to remove the heavy particles and then secondary settling ponds are used to remove the finer particles.

Design Construction and Operation of Settling Ponds

To achieve the desired results or effluent from a settling pond(s), the pond must be properly designed, installed, and maintained. It was apparent from the visits to many mine sites that the ponds were of insufficient size to treat the wastewater. The ponds may have had sufficient volume to adequately treat the mines' flow when constructed, but gradually, the solids settling from the wastewater reduced the volume of the ponds, reducing their effectiveness. Also, the ponds at some mines visited were "short-circuiting" (i.e., wastewater flowed straight through the pond without much, if any settling) due to improper placement of the influent and effluent points.

A properly designed pond should have the influent in the middle of one end and the effluent at the middle of the other end or as far from the influent as is possible. Ideal ponds have the length two to three times the width and adjustable weirs at the influent and effluent points. These weirs are utilized to determine and direct the flow into and out of the ponds and to control water height in the ponds.

The disposal of sludge deposited in the ponds can be handled by two methods: (1) Sludge can be removed from the ponds periodically, using mechanical means such as dredges, slurry pumps, front end loaders, backhoes or drag lines, and disposed in the area used for tailings disposal; or (2) sludge can be left in the pond until the pond fills and is closed by proper reclamation. Both approaches require the pond volumes to be increased above that required for detention of the wastewater being treated so that the volume of sludge does not intrude on the volume required for proper wastewater detention and treatment. The increased volume of the ponds will depend upon the method of sludge disposal being utilized, and the amount of solids present in the wastewater that will settle. The ponds will be smaller in volume if the sludge is removed periodically.

Therefore, in sizing the settling pond for a mine site, the following must be determined:

1. Volume of wastewater to be treated (process water, excess water, and storm runoff)

2. Amount of sludge to be stored in the pond

3. Method of sludge handling

4. Drainage from a 6-hour 5-year storm event

Using these data, ponds of proper size to treat the wastewater generated can be designed and installed. A typical pond plan and cross section is presented on Figures VII-1 and VII-2 (pp. 154-155).

1. Determination of Wastewater Volume To Be Treated

The volume of wastewater to be treated in placer mining operations is determined from the actual amount of water used in the beneficiation process (sluicing) (process water), the excess water consisting of surface water and infiltration which enters the pond, and the storm water runoff from the mine site (the beneficiation area and the mine area) for a 5 year, 6 hour storm intensity which the pond should be designed to handle.

The size of the ponds and cost of construction discussed in Section VIII are based on the volume of water to be treated. At most mine sites the major flow to be treated is the process water used for the beneficiation process, i.e., sluicing. Minimizing process water use by high pressure, low volume nozzles for pre-wash, and ore classification will result in smaller ponds and lower costs for treatment of process water.

2. Determination of Sludge Volume To Be Handled

The volume of sludge is computed by determining the amount of suspended solids present in the wastewater entering the pond and the amount of suspended solids present in the wastewater discharging the pond after the required settling time. Using the difference between the influent and effluent suspended solids and the volume of wastewater being treated, and knowing the solids content of the sludge, the volume of sludge to be handled can be computed. Using this data and the methods of sludge handling, the volume of the pond required for sludge storage can be determined.

3. Method of Sludge Handling

Each mine is site specific in the design manner in which sludge will be handled throughout the mining season. Some mines plan to clean out the ponds on a regular basis to maintain the desired wastewater detention time, while others will plan to build new ponds as needed to maintain permit requirements throughout the mining season. Proper sludge disposal is critical for the desired performance of the pond.

4. Storm Water Exemption

The storm exemption allows the discharge of untreated or inadequately treated wastewater when the treatment ponds are designed to contain (and treat) the rainfall runoff from the mine site caused by a 5-year, 6-hour storm. Failure to design adequate retention volume into the ponds denies the mines eligibility for the storm water exemption

Pond Design Example

For example, an operation (small model mine) sluices 35,000 cu yds per year (70 cu yds per hour - 8 hr/day, 50 min/hr, 75 days/yr) and produces 1,350 gpm process wastewater plus 20 percent excess water or 1620 gpm (43,300 cu ft per 4 hours) water to the treatment pond. Sludge deposited from this water into each of 4 ponds constructed during the season (or ponds cleaned) (20,000 mg/l solids in process wastewater, 57 percent solids in the sludge) would require 53,000 cu ft of pond volume. The minimum pond volume-assuming 4 ponds constructed per year - is 96,300 cu ft. To be eligible for the storm exemption an additional volume would be required. Assuming that the mine area is 175 ft x 720 ft and the 5 year 6-hour storm event is 1.5 in.

of rain, the added volume is 15,750 cu ft. A pond approximately 70 x 108' filled to a height of 10 ft would be required to contain the volumes of water, sludge and excess stormwater. This size pond would be predicted to achieve a settleable solids level of less than 0.2 ml/l as determined from treatability tests of simple settling. Attention to detail will be required to address such factors as: surface area of the pond, rate of flow through the pond, eliminating short circuiting of flow across the pond, and entrance and exit effects of the wastewater. A number of handbooks are available to assist the mine operator in the design, construction, and maintenance of ponds, including "Placer Mining Settling Pond Design Handbook," January 1983, State of Alaska Department of Environmental Conservation and "Placer Mining Demonstration Grant Project Design Handbook," March 1987, ADEC and ADNR. The use of the concepts depicted in such handbooks will greatly aid and facilitate the mine operator in designing wastewater treatment ponds.

Coagulation and Flocculation

The majority of the suspended solids present in placer mine effluent after simple settling are very fine (presumably colloidal) in size and do not readily settle without the aid of chemicals. Chemicals can be introduced to the wastewater which will coagulate small particles into particles large enough to settle by gravity or be removed by other physical methods. The major chemicals used for coagulation are called polymers (or polyelectrolytes). Polymers operate by forming a physical bridge between particles, thereby causing them to agglomerate forming a floc. The floc, an agglomeration of small particles, is generally settleable. When the polymer alone does not form particles that will settle due to lack of particle weight, coagulant aids such as lime or ferric sulfate are used to add the required weight.

Coagulant aids are normally added ahead of the settling facility. The coagulant must be added and mixed with the wastewater by a turbulent action such as an in-line mixer to ensure complete mixing and dispersion of the coagulant into the wastewater. After complete mixing, the treated wastewater must pass through a flocculation stage which allows the particles to come in contact with each other so that the agglomeration can occur to form a floc.

A complete demonstration of the technical and economic feasibility of a flocculant system for gold placer mines has yet to be made. The Agency and others including several miners have made a number of studies but as yet an adequate data base to support this technology has not been developed.

Natural Filtration

Removal of solids by filtration is achieved by passing the wastewater through a medium where the pore sizes are smaller than the particles being removed, thereby trapping the particles. At many placer mines, filtration is performed naturally as the wastewater is discharged through the tailings from the mining operations. Those particles larger than the pore size in the tailings are trapped and removed. Tailings filtration may be beneficial in that the fines are recombined with the coarse tailings. No specific data are available to determine the removal efficiencies or the effluent quality from existing treatment at gold placer mines because the discharge is not generally discrete, but is most often diffuse in the form of seepage.

Recirculation of Process Waters

Recirculation is the continued reuse of water internally within a process. Water in gold placer mines is used as the transport medium for mined solids and is used to move these solids from the slick plate feed to a screen or trommel, through a sluice or other separation device, and on into a solids retention device or pond. After the water has released its solids burden, it may be withdrawn from the pond and returned to the slick plate to repeat the process. As applied to gold placer mining, recirculation is the continued reuse of the same water as the transport medium for solids (ore) to or through the classification process, the beneficiation process, and into the solids removal process. Figure VII-3 (p. 156) illustrates schematically the recirculation of process water at a gold placer mine. Under this definition, any water used to remove ore from the mine; transport, classify, beneficiate, or treat that ore; and remove any solids from these processes would be returned for reuse to the system. A major reduction of the pollution load on the receiving waters can be achieved through recirculation of process water. This also conserves water and is in practice at some gold placer mines.

Approximately 60 percent of the mines have indicated that they plan to recycle all or a portion of their process water. Those that recycle or recirculate process water at a gold placer mine require the installation of a pump at the pond and piping to the head of the mining operation. The size of the pumps and piping would be based on the required process flow.

Recirculation of process water at gold placer mines has several advantages and disadvantages as summarized below:

Advantages

1. Allows mining especially in water short areas and minimizes water use elsewhere.
2. Reduces mass of pollutant to the receiving stream.
3. May require smaller or fewer settling ponds to meet effluent limitations.

Disadvantages

1. Higher pumping costs because of additional energy requirements.

2. Higher piping costs because more pipe may be required.

A concern of the industry was that fine gold recovery decreases when recirculated water containing suspended solids is reused in the sluice. However, only limited scientific data were available to address this issue. Therefore, the Alaska Department of Environmental Conservation (ADEC) funded a study (VII-3) to address the potential loss of gold recovery during recirculation. This study was divided into two parts, a pilot-scale study and a field study. EPA expanded on this study and funded a supplemental study (in 1984) on the effects of recirculation on gold recovery. The EPA study (VII-4) used essentially the same set-up as the ADEC study. In both of these studies, a 15-centimeter-wide (6-in), 2.4-meter-long (8-ft) sluice with a feed hopper and slick plate were used (see Figures VII-4 and VII-5, pp. 157-158). The slope of the sluice during both studies was set at 1.75:12.

In the EPA study, ore from an operating mine in the Fairbanks District was used. The ore was screened and only material finer than 20 mm (0.75 in) was used in the pilot-scale tests. A new batch of ore with an unknown quantity of gold was used during each run. The material was resluiced after each run to determine the gold loss. The gold used in the study was -30 to +60 mesh. A known quantity of gold was added to the ore prior to each run in order to have a statistically significant amount of gold in the sluice box. The size distribution of gold added during each test run is shown in Table VII-1 (p. 147). The major results of this study are summarized on Tables VII-2 and VII-3 (pp. 148-149). Gold loss at all suspended solids levels due to recirculation is minimal.

After reviewing the results of the previously discussed studies EPA decided to perform an additional study during the 1986 mining season (VII-15). The primary purpose of this additional study was to determine the effect of varying levels of total suspended solids in the sluice feed water on riffle packing and gold recovery in a pilot scale sluice box. A secondary purpose to the new study was to determine the interrelationships between gold recovery and viscosity. This study utilized a system consisting of the 15-centimeter-wide by 2.5-meter-long (6 in by 8 ft) sluice box used in the previous studies, a 10-hp centrifugal water pump, and a recirculation tank. The sluice box was preceded by a vibrating screen mounted over a feed hopper with a hydraulic lift feeding the sluice and followed by a secondary receiving system consisting of a wedge wire screen, slurry pump, hydrocyclone, reichert spiral and Gemini shaking table. The total pilot plant system is presented schematically in Figure VII-6 (p. 159).

Ore from an operating mine in the Fairbanks District was used for this study. This dirt was dry screened though a 20 mm (0.75 in) wire screen and only that passing the screen was utilized in the testing. Each test run was made using a separate portion of the screened ore. To insure that a statistically significant quantity of gold was present in the sluice box fine gold was added to the ore during each test run. The size distribution of gold added to each test run is shown in Table VII-4 (p. 150). The major results of this study are summarized in Tables VII-5, VII-6, and VII-7 (pp. 151-153). Based on the results of this test program, it appears that both run duration and influent water suspended concentration influence the rate of riffle packing and gold migration. Gold starts to migrate after the riffles become packed, see Table VII-7. This confirms the best professional practice in gold placer mining to clean up when the riffles become packed.

Treatment Effectiveness

This section compares the raw and treated effluent characteristics. Data for this comparison were collected from treatability tests and from an examination of operating mines. Table V-18 (p. 120) indicates the average treatment effectiveness after 6 hours of simple quiescent settling, after 6 hours of chemically aided settling, and calculated treatment effectiveness after 3 hours of simple settling based on 20,000 mg/l initial TSS for various pollutants.

The long-term, daily, and monthly achievable levels are determined statistically using the effluent data obtained in 1984 at existing facilities sampled by EPA headquarters and EPA Region X sampling teams, and data from treatability studies conducted by EPA. As previously discussed in Section V, some of the effluent data from existing facilities does not represent good treatment which can be obtained by properly designed, constructed, and operated settling ponds. Also, by referring to the data, i.e., total suspended solids analysis for the same day, large differences in reported values are observed which, if considered as individual values, cause a large standard deviation from the mean and push up the long term average. The effect of using data from under sized or poorly constructed and operated treatment facilities is two fold: (1) it increases the simple average or mean and (2) the peak values, e.g., outliers, increase the statistically determined attainable long term average limitations.

During reconnaissance sampling in 1983 through 1986 EPA measured the SS in the effluent from sampled mines. This data is summarized in Tables V-19 and V-22 (pp. 121 and 124) and shows that about 60 percent of the existing mines were meeting the SS limit of 0.2 ml/l. Footnotes on Table V-22 indicate the logical reasons for failure of some mines to achieve the 0.2 ml/l level when such reasons were known.

During the 1983, 1984 and 1986 mining seasons EPA made treatability tests at mines in Alaska. The data for the 1983 season is not reproduced here because the tests were only two hour settling tests and are not relevant to the present regulation. The 1984 and 1986 data are displayed in Table V-22 (p. 124). These settling tests show that six of the eight mines sampled in 1986 were achieving the SS MDL of 0.2 ml/l after three hours of quiescent simple settling: one mine that did not achieve the MDL was hydraulicing overburden and not sluicing at the time of sampling and the other mine, a dredge, achieved the MDL after four hours of quiescent settling.

The 1984 data show that seven of the ten mines sampled achieved the MDL of 0.2 ml/l with three hours of quiescent settling: the reasons for failure to achieve the MDL in three hours are noted on the data table. All of the mines samples achieved the MDL within six hours.

From this data we conclude that the treatment effectiveness of simple quiescent settling is applicable to the requirement that mines achieve the MDL of 0.2 ml/l before discharging wastewater.

DEMONSTRATION STATUS

EPA personnel have observed six mines and one dredge in Alaska in 1986 and 1987 operating in a recirculation mode. Additionally one dredge in the lower 48 has been observed to operate in that mode. This data is considered to be the primary basis for considering recirculation of process water to be a demonstrated technology. In addition, EPA has information from a contractor (See Reference No. xx) that in 1984, over 20 percent of the production by the subcategory was processed with wash water that was 90 to 100 percent recycled. Data obtained by the Agency for the 1985, 1986, and 1987 mining seasons indicate that 30 percent of the subcategory in Alaska was planning to be able to operate on total recycle of process water, with another 30 percent of the gold placer mines performing partial recycle. Many states in the Lower 48 have existing regulations requiring recirculation of total flow. Recycle or recirculation is employed in most mining districts for which the Agency has information (generally because of existing regulations or a shortage of water), indicating that pumping and powering of the pumps is a viable process change even in remote locations.

Table VII-1. Size Distribution of Gold Added to Each Run

Run No.	-30 + 50 Mesh	-50 + 60 Mesh	Total
1	9.9612	2.5279	12.4891
2	10.0079	2.6490	12.6569
3	10.2561	2.4956	12.7517
4	10.3743	2.5238	12.8981
5	9.8473	2.6621	12.5094
6	10.2897	2.5169	12.8066
Total	60.7365	15.3753	76.1118

Note: Amounts of gold are presented in grams.

Source: Ref. 33

Table VII-2. Pilot Test Water Quality Data (Sluice Influent)

SLUICE INFLUENT

	Run					
Parameter	1	2	3	4	5	6
TSS	217	39,100	58,800	90,100	194,000	187,000
Turbidity	95	24,000	30,000	46,000	134,000	108,000
Settleable Solids	-0.1	180	270	400	680	650
Specific Gravity	0.998	1.022	1.034	1.052	1.122	1.118
Viscosity @ 20 C	1.0	1.8	2.0	3.0	4.2	4.1
Visc. @ Run Temp.	2.0	3.2	2.9	4.9	7.7	6.2
Run Duration	34	39	37	38	38	14
Water Duty	0.22	0.19	0.21	0.20	0.20	0.56

SLUICE EFFLUENT

	1	2	3	4	5	6
TSS	10,000	48,000	65,100	98,300	199,000	204,000
Turbidity	2,200	24,000	33,000	39,000	128,000	100,000
Settleable Solids	25	200	290	420	680	660
Specific Gravity	1.004	1.029	1.039	1.060	1.122	1.133
Viscosity @ 20 C	1.5	1.7	2.2	2.8	4.4	4.9
Visc. @ Run Temp.	3.0	3.1	3.1	4.6	8.1	7.3

Units:	TSS	mg/l
	Turbidity	NTU
	Settleable Solids	ml/l
	Specific Gravity	gm/cc at 20 C
	Viscosity	cp(centipoise) - gm mass/cm sec
	Run Duration	min
	Water Duty	yd3/1000 gal (cubic yards of pay dirt sluiced using 1000 gallons of water)

Note: "-0.1" denotes less than 0.1

Source: Ref. 33

Table VII-3. Percent Gold Recovery

TOTAL GOLD

	Riffle				
Run	1	2	3	4	Gold Loss*
1	99.63	0.32	-0.01	0.01	0.04
2	99.59	0.38	0.02	0.01	-0.01
3	99.54	0.39	-0.01	-0.01	0.05
4	99.40	0.52	0.04	0.03	0.02
5	99.08	0.71	0.04	0.03	0.13
6	97.84	1.83	0.08	0.08	0.18

-50 + 80 MESH GOLD

Riffle

Run	1	2	3	4	Gold Loss*
1	99.00	0.81	0.02	0.05	0.12
2	98.97	0.94	0.05	0.02	0.03
3	98.96	0.86	0.03	0.04	0.11
4	98.41	1.41	0.06	0.08	0.04
5	97.96	1.79	0.10	0.04	0.11
6	95.42	4.03	0.25	0.09	0.21

Note: "-0.01" denotes less than 0.01 percent.

*Recovered after sluicing by suction dredge

Source: Ref. 33

Table VII-4. Size Distribution of Gold Added to Each Test Run (EPA Funded Second Study, 1986)

Run No.	-50 + 70 Mesh	-70 + 100 Mesh	Total
1	16.9192	16.2044	33.1236
2	19.0723	18.7591	37.8314
3	4.7762	3.0793	7.8555
4	18.4704	19.0145	37.4849
5	18.9047	19.0682	37.9729

Note: Amounts of gold are presented in grams.

Source: Ref. 32

Table VII-5. Pilot Test Water Quality Data For Composite Samples

	Run				
Parameter	1	2	3	4	5
	SLUICE INFLUENT				
Suspended Solids	249,000	285,000	421,000	62,300	348
Turbidity	59,000	74,000	76,000	19,000	17
Settleable Solids	280	400	420	120	<0.1
Specific Gravity	1.155	1.178	1.282	1.040	1.000
Visc. @ Run Temp.	2.8	3.5	4.1	1.8	1.0
Run Duration	315	315	60	315	315
Screened Water Duty	0.5	0.5	0.5	0.5	0.5
Bank Yard W.D.	0.6	0.6	0.6	0.6	0.6
	SLUICE EFFLUENT				
Suspended Solids	292,000	313,000	469,000	95,400	29,700
Turbidity	67,000	80,000	88,000	21,000	4,000
Settleable Solids	350	440	440	130	36
Specific Gravity	1.182	1.200	1.296	1.062	1.020
Visc. @ Run Temp.	3.2	3.5	6.1	2.0	1.5

Units:	Suspended Solids	mg/l
	Turbidity	NTU
	Settleable Solids	ml/l
	Specific Gravity	gm/cc at 20 C
	Viscosity	cp(centipoise) - gm mass/cm sec
	Run Duration	minutes
	Water Duty	yd3/1000 gal (cubic yards of pay dirt sluiced using 1000 gallons of water)

Table VII-6. Gold Recovery Data

	Riffle Section			Genemi Table		
	1	2	3	A	B	C
Run 1						
+50	0.8816	0.1596	0.0074	0.0230	0.0054	---
-50+70	10.2954	4.0721	0.1871	0.0398	0.0174	---
-70+100	9.3542	5.4994	0.6804	0.0375	0.0354	---
-100	0.6031	0.4949	0.1147	0.0084	0.0051	---
Total	21.1325	10.2260	0.9896	0.1087	0.0633	---
Run 2						
+50	0.3340	0.1062	0.0034	0.0068	0.0083	---
-50+70	12.9604	4.2468	0.1957	0.0401	0.0748	---
-70+100	11.3537	6.2027	0.6885	0.0655	0.1593	---
-100	0.6011	0.3781	0.0817	0.0134	0.0273	---
Total	25.2492	10.9338	0.9693	0.1258	0.2697	---
Run 3						
+50	0.2337	0.0429	0.0021	0.0002	0.0014	0.0011
-50+70	2.9018	0.4666	0.0263	0.0004	0.0015	0.0041
-70+100	2.6023	0.9973	0.1298	0.0004	0.0015	0.0062
-100	0.1407	0.0917	0.0204	0.0000	0.0001	0.0023
Total	5.8785	1.5985	0.1786	0.0010	0.0045	0.0137
Run 4						
+50	0.8800	0.2340	0.0025	0.0035	0.0000	---
-50+70	14.0653	2.9334	0.0111	0.0051	0.0004	---
-70+100	11.2215	4.9325	0.0453	0.0069	0.0003	---
-100	0.5912	0.3753	0.0066	0.0004	0.0001	---
Total	26.7580	8.4752	0.0655	0.0159	0.0008	---
Run 5						
+50	1.2494	0.0188	0.0019	0.0022	0.0004	---
-50+70	15.7981	0.9817	0.0071	0.0051	0.0033	---
-70+100	15.9866	2.3041	0.0222	0.0054	0.0025	---
-100	0.9314	0.1968	0.0035	0.0005	0.0004	---
Total	33.9655	3.5014	0.0347	0.0132	0.0066	---

Notes: (1) Gold weights are in grams.

(2) Gemeni table designations A, B and C are: for Runs 1, 2, 4 and 5, A is the first 4 hours, 15 minutes of operation and B is the last 25 minutes of operation.

For Run 3, A is the first 30 minutes of operation, B is for 31 to 45 minutes, and C is for 46 to 60 minutes.

Table VII-7. Percent Gold Recovery

	Riffle Section			Genemi Table		
	1	2	3	A	B	C
Run 1						
+50	2.71	0.49	0.02	0.07	0.02	---
-50+70	31.66	12.52	0.58	0.12	0.05	---
-70+100	28.76	16.91	2.09	0.12	0.11	---
-100	1.85	1.52	0.35	0.03	0.02	---
Total	64.98	32.44	3.04	0.34	0.20	---
Run 2						
+50	0.89	0.28	0.01	0.02	0.02	---
-50+70	34.52	11.31	0.52	0.11	0.20	---
-70+100	30.24	16.52	1.83	0.17	0.42	---
-100	1.60	1.01	0.22	0.04	0.07	---
Total	67.25	29.12	2.58	0.32	0.72	---
Run 3						
+50	3.05	0.56	0.03	0.00	0.02	0.01
-50+70	37.81	6.08	0.34	<0.01	0.02	0.05
-70+100	33.91	12.99	1.69	<0.01	0.02	0.08
-100	1.83	1.19	0.27	0.00	<0.01	0.03
Total	76.60	21.82	2.33	0.01	0.06	0.17
Run 4						
+50	2.49	0.66	0.01	0.01	0.00	---
-50+70	39.83	8.31	0.03	0.01	<0.01	---
-70+100	31.78	13.97	0.13	0.02	<0.01	---
-100	1.67	1.06	0.02	<0.01	<0.01	---
Total	75.77	24.00	0.19	0.05	<0.01	---
Run 5						
+50	3.33	0.02	<0.01	<0.01	<0.01	---
-50+70	42.10	2.62	0.02	0.01	<0.01	---
-70+100	42.61	6.14	0.06	0.01	<0.01	---
-100	2.48	0.52	<0.01	<0.01	<0.01	---
Total	90.52	9.33	0.09	0.04	0.02	---

Notes: Gemeni table designations A, B and C are: for Runs 1, 2, 4 and 5, A is the first 4 hours, 15 minutes of operation and B is the last 25 minutes of operation.

For Run 3, A is the first 30 minutes of operation, B is for 31 to 45 minutes, and C is for 46 to 60 minutes.

FIGURE VII-1 PLACER MINING WASTEWATER TREATMENT

TYPICAL SETTLING POND PLAN

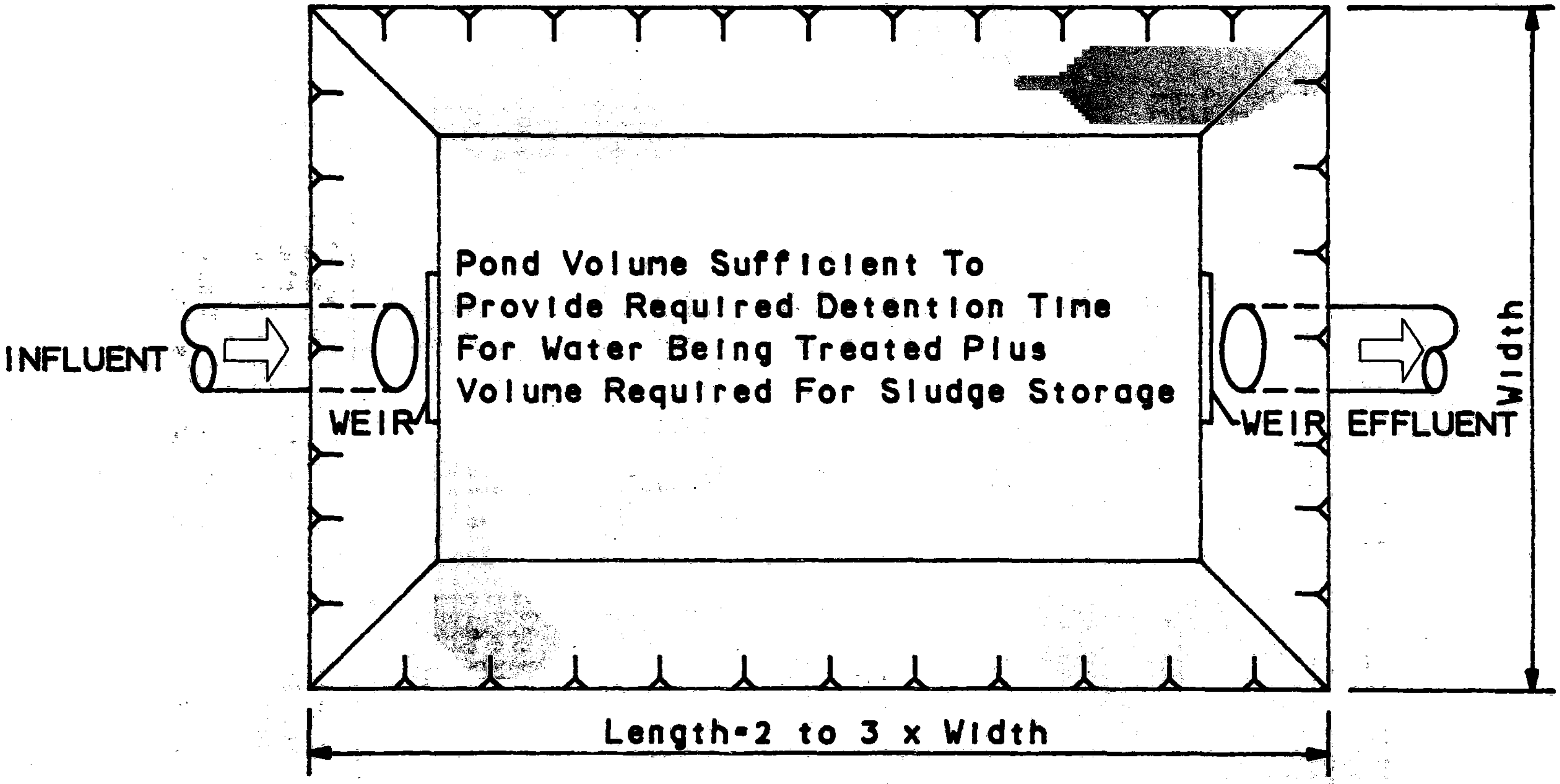
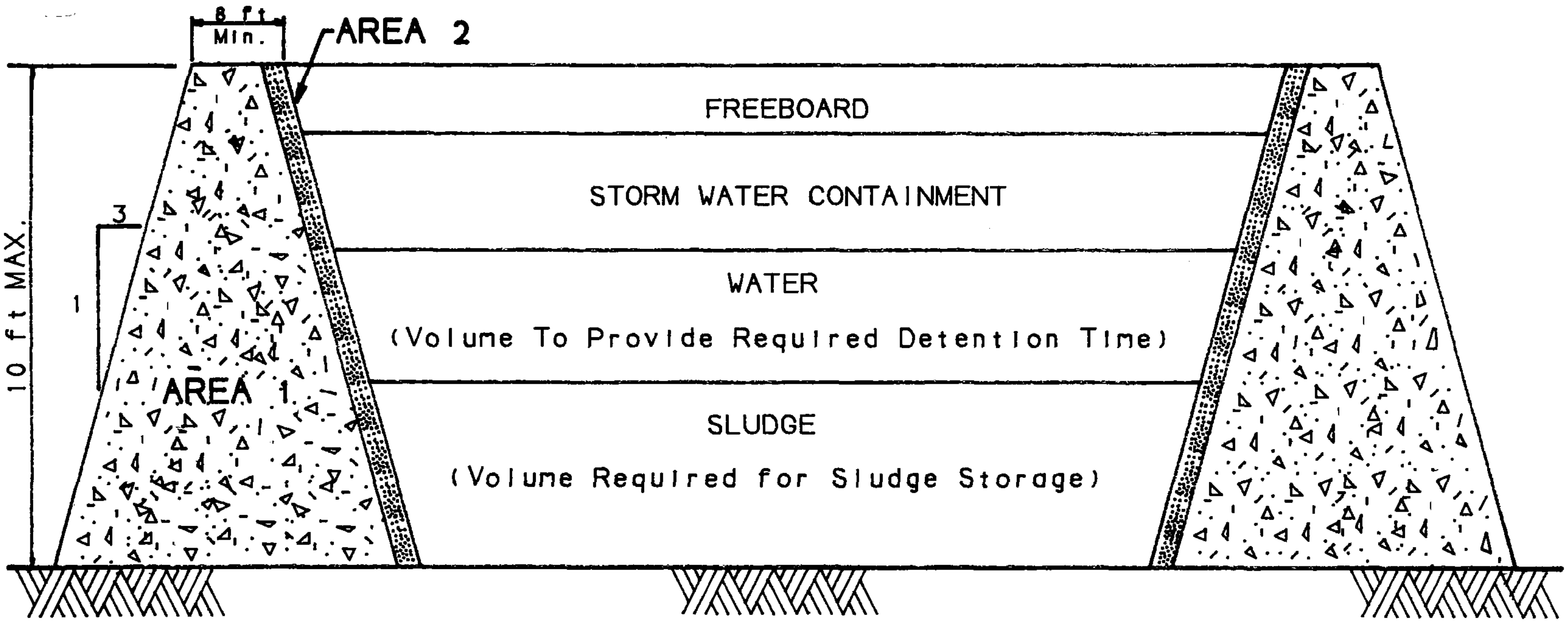


FIGURE VII-2 PLACER MINING WASTEWATER TREATMENT

SETTLING POND - TYPICAL SECTION



NOTES:

AREA 1: Core of berm (mixed coarse and fine tailings)

AREA 2: Fines (Silt.clay or other fine material) if fines not available. appropriate material should be used as replacement.

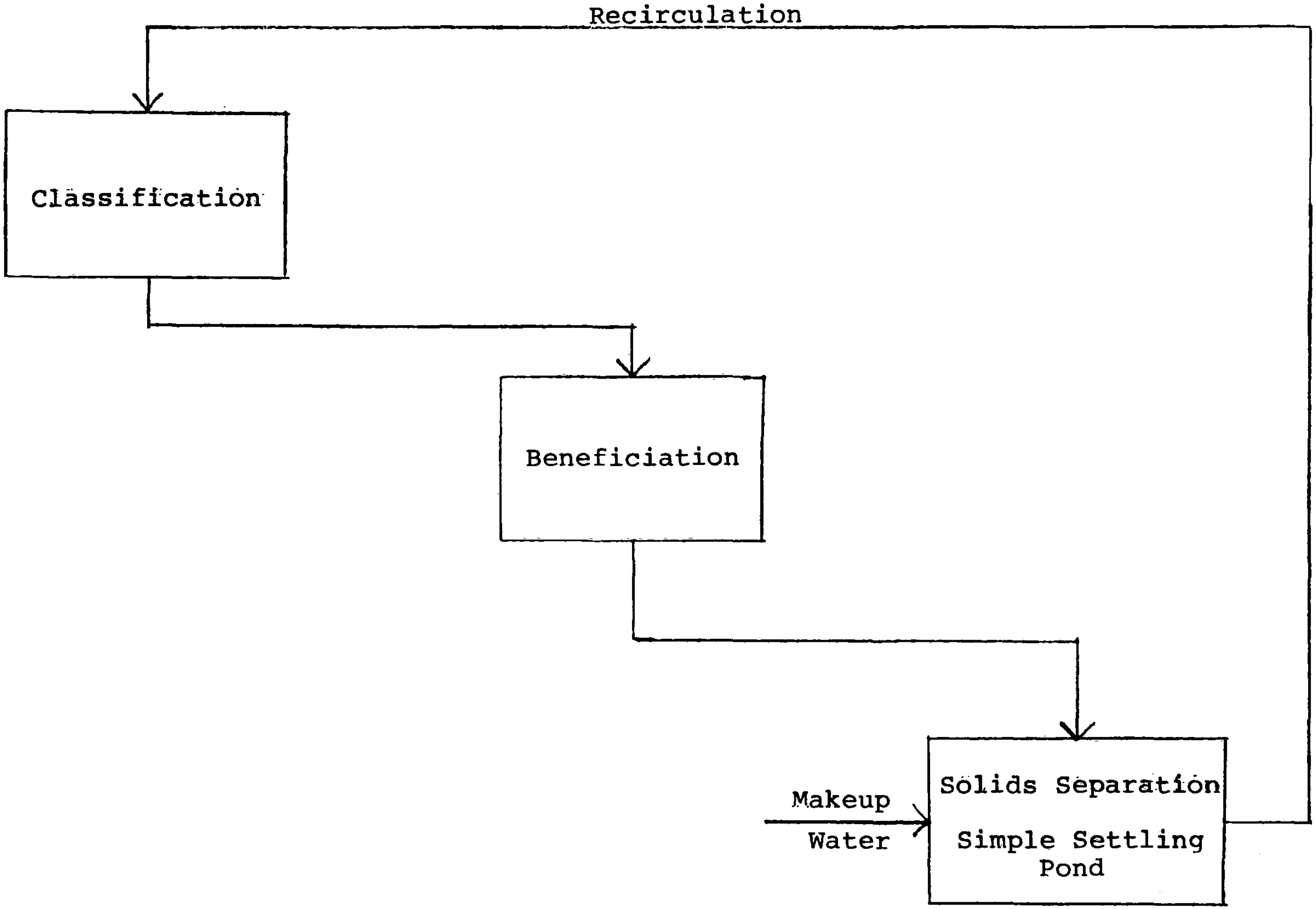


Figure VII-3. Schematic of Recirculation at a Gold Placer Mine

Figure VII-4

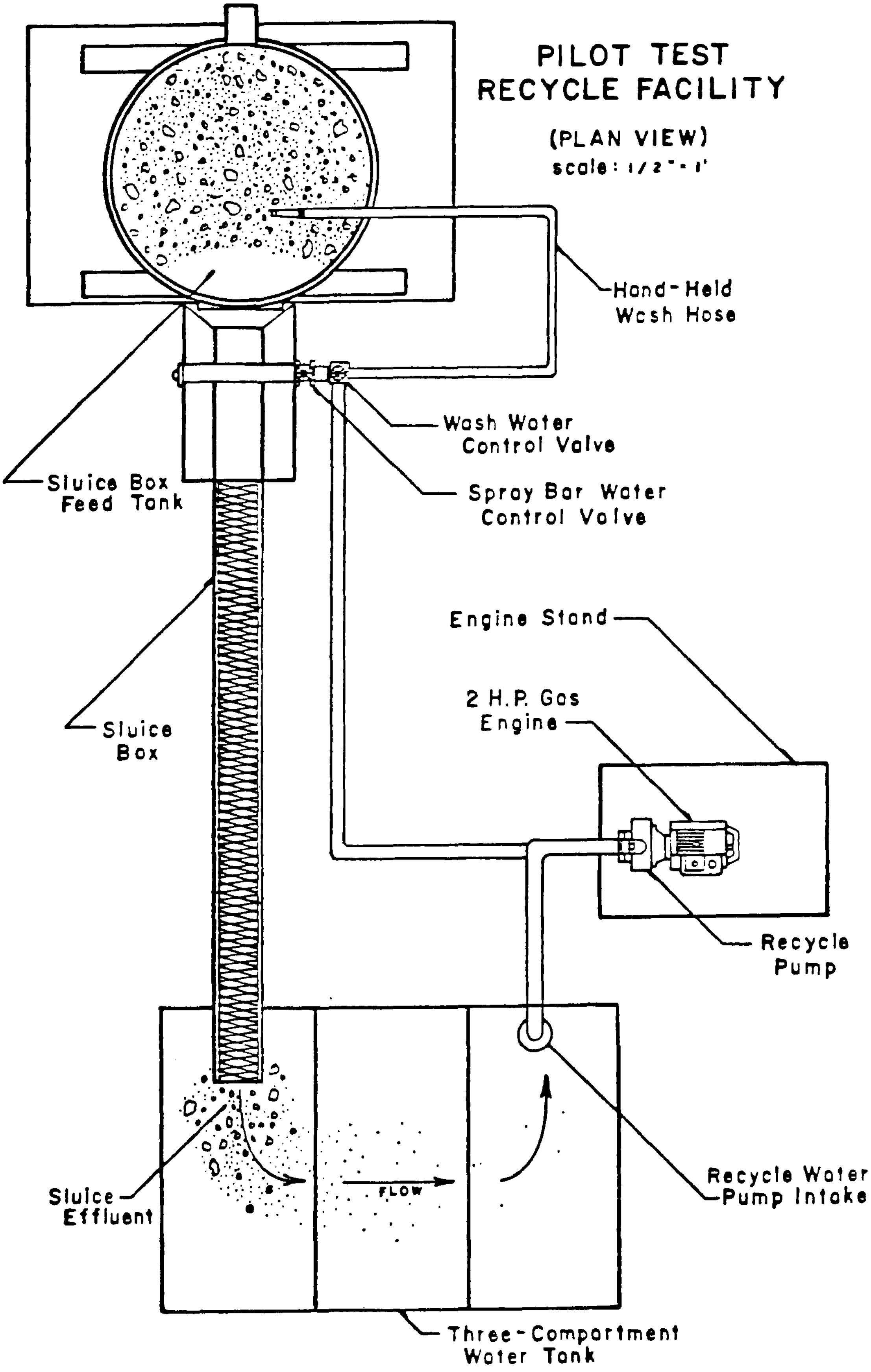

PILOT TEST
RECYCLE FACILITY
(PLAN VIEW)
scale: 1/2" = 1'
Hand-Held Wash Hose
Wash Water Control Valve
Spray Bar Water Control Valve
Sluice Box Feed Tank
Engine Stand
2 H.P. Gas Engine
Sluice Box
Recycle Pump
FLOW
Sluice Effluent
Recycle Water Pump Intake
Three-Compartment Water Tank

Figure VII-5

PILOT TEST RECYCLE FACILITY

(SIDE VIEW)

scale: 1/2" = 1'

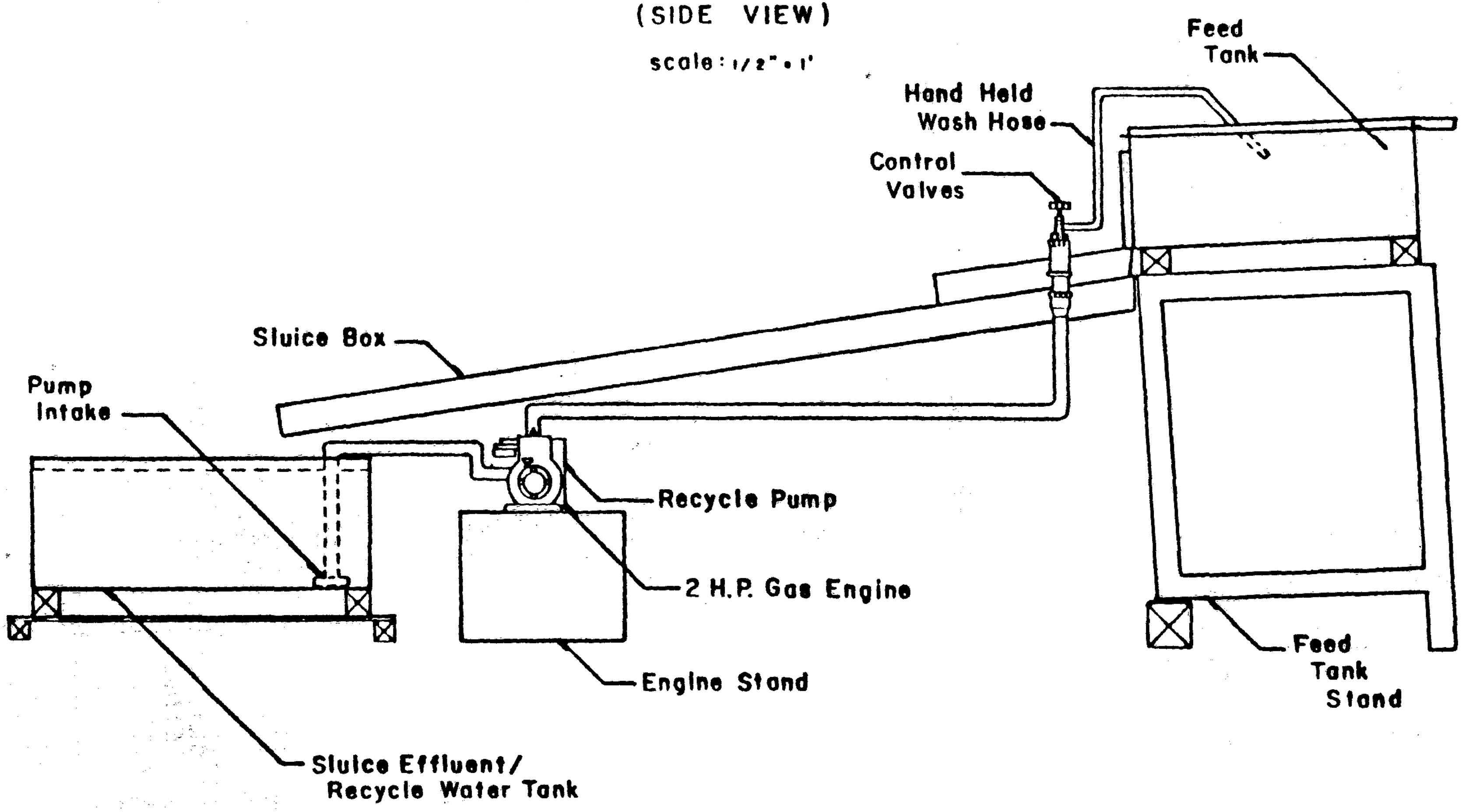
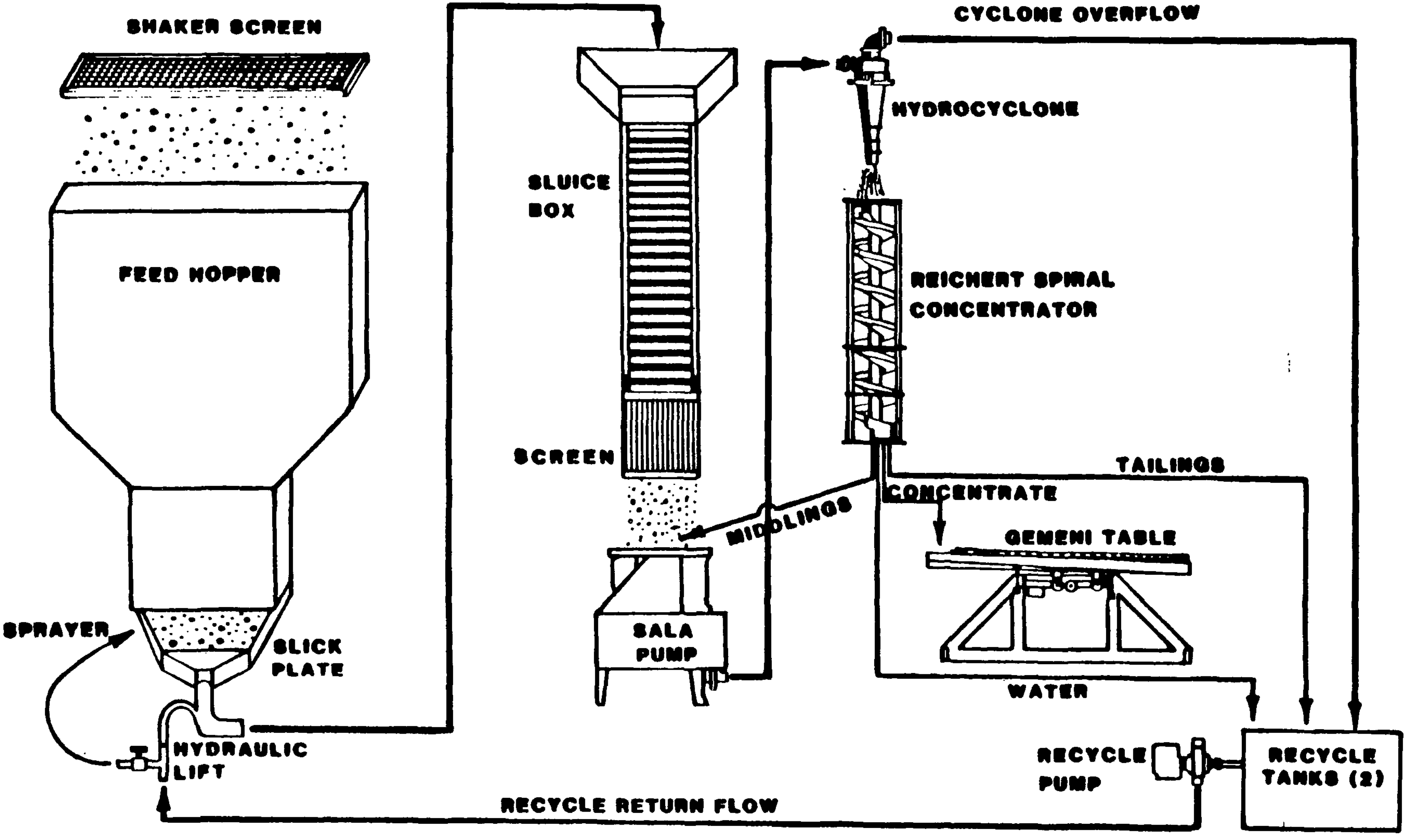


Figure VII-6



RECYCLE FLOW SCHEMATIC

Note: Not drawn to scale.

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SECTION VIII

COST, ENERGY AND OTHER NON-WATER QUALITY ISSUES

DEVELOPMENT OF COST DATA BASE

Costs of different treatment options for various sizes and types of gold placer mines are presented here. These costs are presented in detail in Reference VIII-1.

Estimate Assumptions

Generalized capital and annual costs for wastewater treatment processes at gold placer mining facilities are based on gallons per minute of process water flow. All costs are expressed in 1986 dollars (Engineering News Record, Construction Cost Index (CCI) = 4332: third quarter of 1986).

The cost estimates were based on assumptions regarding system loading and hydraulics, treatment process design criteria, material, equipment, personnel and energy costs. These assumptions are documented in detail in this section. The estimates prepared have an accuracy of plus or minus 30 percent.

The wastewater treatment unit processes studied are as follows:

A - Simple settling (primary settling)
B - Recirculation
C - Chemically aided settling

These unit processes were then used in the following treatment options:

OPTION	DESCRIPTION
A - OPEN CUTS - 1 Pond	Simple settling of total flow (process and excess water) in a pond having 4-hour detention time. Pond built once per mining season. Discharge of total flow.
A - DREDGES	Pumping of total flow (process and excess water) from the dredge pond to a simple settling pond having a 4-hour detention time. Pond built once per mining season. Discharge of any or all flows.
A - OPEN CUTS - 3 or 4 Ponds	Simple settling of total flow (process and excess water) in a pond having 4-hour detention time. Pond built three or four times per mining season depending on mine model. Discharge of total flow.

B - OPEN CUTS - 1 Pond	Simple settling of total flow (process and excess water) in a pond having 4-hour detention time followed by recirculation of process water. Pond built once per mining season. Discharge of excess flow.
B - DREDGES	Recirculation of the process water within the dredge pond recirculation system and pump the excess water to a simple settling pond having a 4-hour detention time. Pond built once per mining season. Discharge of excess flow.
B - OPEN CUT - 3 or 4 Ponds	Simple settling of total flow (process and excess water) in a pond having 4-hour detention time followed by recirculation of process water. Pond built three or four times per mining season depending on mine model. Discharge of excess flow.
C - OPEN CUT	Chemical treatment of total flow (process and excess water) discharging Open Cut Options 1 or 2. Chemical addition (polyelectrolyte) followed by secondary settling having 3-hour detention time. Pond built once per mining season. Discharge of total flow.
C - DREDGES	Pumping of total flow (process and excess water to a settling pond having 3-hour detention time. Chemical (polyelectrolyte) added ahead of pond. Pond built once per mining season. Discharge of any or all flows.

The above options are shown schematically in Figures VIII-1 through VIII-3 (pp. 183-185).

CAPITAL COST

Capital Cost of Facilities

Figures VIII-4 through VIII-6 (pp. 186-188) present schematic representations of generic gold placer mine treatment systems for all open cut mining treatment options. Schematic representations of generic gold placer mine treatment systems for all dredge mining treatment options are presented on Figures VIII-7 through VIII-9 (pp. 189-191). These diagrams show the distances assumed between the various facilities. These distances were used to determine the material required for the systems and the subsequent costs.

Settling Ponds

Construction costs for settling ponds were based upon assumptions (specifically documented later in this section) regarding the detention time and geometry of the ponds. Costs for earthmoving were based on a cost per cubic yard of material moved. The cost of earthmoving was determined by contacting the largest retailer of earth-moving equipment and a leasing agency in Alaska. Using this data the earthmoving capacity and costs of both new and old equipment are as follows:

MINE MODEL	EQUIPMENT	OPERATING CAPACITY		LEASE COST*	
		NEW	OLD	NEW	OLD
Very Small Open Cut	D6D Dozer	150yd3/hr	120yd3/hr	$80.87/hr	$ 64.72/hr
	930 Loader	125yd3/hr	100yd3/hr	$71.19/hr	$ 49.65/hr
Small Open Cut	D7G Dozer	300yd3/hr	240yd3/hr	$91.86/hr	$ 71.16/hr
	966C Loader	250yd3/hr	200yd3/hr	$79.27/hr	$ 64.15/hr
Medium Open Cut	D8K Dozer	450yd3/hr	360yd3/hr	$124.75/hr	$ 89.53/hr
	988B Loader	420yd3/hr	340yd3/hr	$141.80/hr	$102.54/hr
Large Open Cut	D9L Dozer	640yd3/hr	520yd3/hr	$201.16/hr	$134.47/hr
	988B Loader	420yd3/hr	340yd3/hr	$141.80/hr	$102.54/hr
Small Dredge	D8K Dozer	450yd3/hr	360dy3/hr	$124.75/hr	$ 89.53/hr
	966C Loader	250yd3/hr	200yd3/hr	$ 79.27/hr	$ 64.15/hr
Large Dredge	D8K Dozer	450yd3/hr	360yd3/hr	$124.75/hr	$ 89.53/hr
	966C Loader	250yd3/hr	200yd3/hr	$ 79.27/hr	$ 64.15/hr

*Includes equipment, insurance, fuel, operator and nominal maintenance. Fuel cost used was $1.75 gallon (these estimates also reflect maneuvering time).

The estimated costs and hours to construct the settling ponds were determined using both new and old machines.

Sludge Handling

All sludge which enters settling ponds is handled in the pond system. This is accomplished by constructing the ponds with sufficient capacity, in addition to that required for wastewater settling, to contain the estimated volume of sludge produced per year. A solids concentration in the sludge (settled solids) of 57 percent was used to calculate the pond volumes needed. Costing for the earthmoving required for the sludge volume is based on the cost of equipment presented under settling ponds. The estimated costs and hours for sludge handling were determined using both new and old machines.

Piping

Capital costs for piping, using aluminum pipe, were obtained from various suppliers and from References 1 and 2. The costs include the cost of the pipe, delivery to the site, and installation.

Piping was sized based on normal velocities and pressure drop used in engineering design. A minimum design velocity of 2-1/2 feet per second was used.

Pumps

Capital costs for horizontal centrifugal pumps with diesel engine drives, were obtained from vendor quotations and from References 1 and 2. Installation and delivery costs were added. The costs include piping and valves at the pump location.

Polyelectrolyte Feed Systems

The capital costs for the polyelectrolyte feed systems were obtained from vendor telephone quotations and installation and delivery costs were added.

The polyelectrolyte feed system consists of a mixing and storage tank, mixer, solution metering pump and small generator. The polyelectrolyte feed solution would be prepared daily and delivered to the wastewater by the metering pump set at the proper dosage rate. The wastewater and polyelectrolyte solution will be blended using a static mixer. This feed system is shown schematically on Figure VIII-10 (p. 192).

Capital Cost of Land

Land costs were not included in the estimates since the facilities would be constructed on land which is part of the mining claims. Therefore, no additional costs would be incurred for the land needed for the treatment facilities.

Delivery and Installation Costs

All equipment costs were increased by appropriate percentages to account for delivery and installation at remote regions in Alaska.

ANNUAL COST

Annual Equipment Depreciation Costs

Initial capital costs were depreciated on the basis of a 14 percent annual interest rate with assumed life expectancy of 7 years for general, civil, structural, mechanical, and electrical equipment. However, since the settling ponds will be constructed yearly, their cost is written off every year.

$$CRF = \frac{(r)\,(1+r)^{n}}{(1+r)^{n} - 1}$$

where CRF = capital recovery factor
r = annual interest rate
n = useful life in years

Therefore, CRF = 0.23319

Annual cost of depreciation was computed as:

$$Ca = B\ (CRF)$$

where Ca = annual depreciation cost, and
B = initial capital cost

Annual Cost of Operation and Maintenance

Maintenance

Annual maintenance costs were assumed to be 3 percent of the total mechanical and electrical equipment capital costs (unless otherwise noted) which excludes the annual costs of the ponds.

Reagents

A polyelectrolyte cost of $2.25/lb, delivered, was used to estimate the annual chemical costs.

A dosage of 8 mg/l (0.066 pounds per 1,000 gallons) was assumed in calculating the annual cost for polyelectrolyte. This assumption is based on the tests performed during the 1983, 1984, and 1986 treatability studies.

Annual Cost of Energy

The energy cost required for wastewater treatment is the cost of fuel to drive the required engines. Fuel cost at $1.75 per gallon, including delivery, was used.

Facilities were assumed to operate 8 hours per day and 60 days per year for very small open cut mines, 8 hours per day and 75 days per year for small open cut mines, 10 hours per day and 83 days per year for medium open cut mines, 20 hours per day and 85 days per year for large open cut mines, 24 hours per day and 100 days per year for small dredges, and 24 hours per day and 148 days per year for large dredges.

TREATMENT PROCESS COSTS

Simple Settling

Capital Costs

The required sizes of simple settling ponds was determined by hydraulic loading and design data obtained during field settling tests. Simple settling ponds were sized for each option based on the appropriate detention times. All pond volumes include the required volume to treat the process flow plus an additional 20 percent for excess water. This volume was increased by 20 percent for freeboard and the volume for sludge storage was added to arrive at the total pond volume required. It was assumed that new ponds would be built when the detention time dropped below the design figure due to sediment buildup. A sludge sediment solids concentration of 57 percent was used for design purposes.

The wastewater was assumed to flow to and from the pond by gravity. In all options having more than one simple settling pond, it was assumed that three or four such ponds would be constructed each mining season at different locations and that the spent ponds would not be refilled.

The cost of pond construction for all options is based on the construction cost of the pond walls. The cost presented is for the construction of one longitudinal wall and one transverse wall, which is the dam on the down stream end. This approach was used since normal mining operations would stack tailings in such a manner to basically form the longitudinal walls required for the pond.

Secondary Settling

Capital Costs

The required sizes of secondary settling ponds were determined by hydraulic loadings. Secondary settling ponds were sized for the required detention times, previously indicated based on either total flow of process and excess flow or excess flow alone. All pond volumes have provisions for freeboard and sediment storage.

The wastewater was assumed to flow to and from the ponds by gravity. One secondary pond would be constructed during the mining season. The same method described under simple settling was utilized when determining the cost of the secondary ponds.

Annual Costs

Since the ponds will only be constructed for one mining season, the annual cost was assumed to be the total construction cost for each pond.

Piping

Capital Costs

If recirculation is practiced, piping will be required from the recirculation pumps to the processing plant. This length of pipe is dependent on the conditions at each site (site specific). Figures VIII-4 and VIII-5 (pp. 186-187) show typical layouts of placer mine treatment systems with assumed distances. The length of pipe from one end of the settling pond to the other will depend upon the flow rate which dictates the pond size and configuration.

Prices for aluminum piping were obtained from manufacturers and costs for transportation to the site and installation was added. The pipe costs per thousand feet of pipe for various diameters are as follows:

Size (dia.)	$/1000 ft.
6"	4,075
8"	6,375
10"	7,830
12"	9,260
14"	10,850

Pipes were sized based on normal values of pressure drop and velocity.

Annual Costs

Annual costs for piping systems were assumed to include the following: (1) depreciation calculated at 14 percent annual interest over 7 years for equipment (CRF = 0.23319), and (2) annual maintenance at 3 percent of capital equipment costs.

Chemical Addition

Capital Costs

The capital costs were estimated for the polyelectrolyte feed system as presented schematically on Figure VIII-10 (p. 192). This feed system would feed the polyelectrolyte solution directly into the wastewater flow utilizing a static mixer to mix the wastewater and the polyelectrolyte.

Annual Costs

Depreciation of capital cost for the polyelectrolyte systems assumed a 14 percent annual interest rate with life expectancies of 7 years for equipment (CRF = 0.23319). Additional costs were estimated as follows: annual maintenance was assumed to be 3 percent of capital equipment cost: chemicals were costed at $2.25 per pound for polymer. The cost of polyelectrolyte per 100 hours operation versus flow rate is plotted on Figure VIII-11 (p. 193). This figure indicates the cost for several chemical dosages.

Pumps

Capital Costs

The recirculation pumps were assumed to be horizontal, centrifugal types complete with diesel engines. The pumps are normally supplied as a package which includes the pump engine, and fuel tank and are either skid or wheel mounted.

Pumping equipment costs were based on vendor quotations. Local piping, valves, and fittings were costed based on standard pump piping configurations and the costing methodology in Reference 1.

Pumping equipment selection was based on hydraulic flow requirements assuming a total dynamic head of 150 TDH# in feet.

Total capital costs estimates include pumps, diesel engine drivers, piping valves, fittings, installation, and shipping.

Annual Costs

Annual cost for water pump systems were assumed to include the following: (1) depreciation calculated at 14 percent annual interest over 7 year for equipment (CRF = 0.23319). (2) annual maintenance at 3 percent of capital equipment costs, and (3) fuel computed at $1.75 per gallon, and (4) the cost of labor required for the operation and installation.

Construction Time

Due to the relatively short operating period per year available at many sites, the time required to construct and operate the wastewater treatment facilities can reduce the total available time for mining. Therefore, estimates were also prepared on the time required to construct, install and operate the various facilities. This includes pond construction, equipment installation and chemical solution preparation, If ponds or equipment installation was required more than once per year the additional time was included in the estimate.

MODEL MINES

Development of Models

To estimate the costs of treatment, economic models were developed that characterize the industry-wide range of operating conditions of mines and dredges. Six baseline models were developed to reflect small to large processing capacities, including four model open cut mines and two model dredges. The operating conditions assumed for each model are described below.

Very Small Open Cut

The very small open cut mine model is baseline mine processing 18,000 cubic yards of pay gravel annually, operating 8 hours per day and 60 days per year. The baseline model has a process water flow of 875 gpm based on a water application rate of 1,167 gallons per cubic yard.

Small Open Cut

The small open cut mine model is a baseline mine processing 35,000 cubic yards of pay gravel annually, operating 8 hours per day and 75 days per year. The baseline model has a process water flow of 1,350 gpm based on a water application rate of 1,157 gallons per cubic yard.

Medium Open Cut

The medium open cut mine model is a baseline mine processing 150,000 cubic yards of pay gravel annually, operating 10 hours per day and 83 days per year. The baseline model has a process water flow of 2,250 gpm based on a water application rate of 623 gallons per cubic yard.

Large Open Cut

The large open cut mine model is a baseline mine processing 340,000 cubic yards of pay gravel annually, operating 20 hours per day and 85 days per year. The baseline model has a process water flow rate of 2,500 gpm based on a water application rate of 625 gallons per cubic yard.

Small Dredge

The small dredge mine model is a baseline dredge which processes 216,000 cubic yards annually, operating 24 hours per day and 100 days per year. The baseline model has a process water flow rate of 1,660 gpm based on a water application rate of 1,000 gallons per cubic yard.

Large Dredge

The large dredge mine model is a baseline dredge which processes an average of approximately 810,000 cubic yards annually, operating 24 hours per day and 148 days per year. The baseline model has a process water flow rate of 3,800 gpm based on a water application rate of 1,000 gallons per cubic yard.

Excess Water

All mines will be required to handle and treat water in excess of that used for processing. This excess water is due to drainage, ground water infiltration, natural thawing and other miscellaneous waters entering the active mining area. The actual volume of water will vary and must be determined on a site specific basis.

The cost of treating this excess water, which can be determined from the appropriate curve will have little impact on total cost if the mine is treating the total wastewater discharging from the active mining area. To determine a cost for the treatment of the excess water an excess water volume of 20 percent of the process flow was assumed.

ESTIMATED COSTS FOR THE TREATMENT

The estimated costs for each option previously discussed are presented in tabular and graphic form on the following tables and figures. Estimates of total fixed annual cost, total annual pond costs, total annual operating cost, total annual cost and total annual hours required are presented on the summary tables for each mine model category for each appropriate treatment option. A plot of the estimated total annual cost versus flow is presented in Figures VIII-12 through VIII-37 (pp. 194-219).

The estimated total fixed annual cost is the depreciation cost for mechanical equipment such as pumps, piping, chemical feed systems, etc., using estimated costs of the equipment delivered to site. The depreciation cost is based on a 14 percent annual interest rate with assumed life expectancy of 7 years (0.23319 factor).

The estimated items total annual operating cost include some or all of the following depending on the treatment option used:

- o Equipment installation cost based on estimated installation hours, any miscellaneous supplies to install and any equipment required in the installation.
- o Equipment maintenance cost based on 3 percent of mechanical and electrical equipment capital cost (purchase price).
- o Energy cost for equipment based on the fuel requirements per hour for equipment such as pumps, number of hours operating per day and number of days operating per year.
- o Service cost based on the estimated hours per season to service equipment such as recirculation pumps.
- o Operator costs based on the estimated hours per season to prepare the chemical solution required in the treatment of the wastewater.
- o Cost of chemicals based on dosage determined during field testing, flow to be treated in gpm, number of operating hours per day and number of operating days per year.

Tables VIII-1 through VIII-6 (pp. 173-183) are summary tables for each mine model presenting the summary cost for each applicable option and treatment combination.

NON-WATER QUALITY ASPECTS OF POLLUTION CONTROL

The elimination or reduction of one form of pollution may cause other environmental problems. Therefore, Sections 304(b) and 306 of the Act require EPA to consider the non-water quality environmental impacts (including energy requirements) of certain regulations. In compliance with these provisions, EPA has considered the effect of this regulation on air pollution, solid waste generation, water scarcity, and energy consumption. While it is difficult to balance pollution problems against each other and against energy utilization, EPA is promulgating regulations which best serve often competing national goals.

The following non-water quality environmental impacts (including energy requirements) are associated with the final regulation. The impacts identified below are justified by the benefits associated with compliance with the limitations and standards.

A. Air Pollution - Imposition of BPT may cause a minor increase in the emissions of dust from the movement of earth to build settling ponds recommended for the gold placer mining subcategory. These emissions are not expected to create a substantial air pollution problem. BAT and NSPS will not result in any increase in air pollution above BPT. The Agency does not consider this to be a significant impact.

B. Solid Waste - EPA estimates that the promulgated BPT limitation for gold placer mines nationwide will generate 1,838,000 kkg (2,021,300 tons) per year of solid wastes (sludge) (wet basis - 1986 production levels) as a result of wastewater treatment; BAT will generate 1,977,000 kkg (2,174,800 tons) per year solid waste from raw waste. These sludges will be comprised of soil solids containing very small concentrations of toxic metals, including arsenic, antimony, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc. Because these sludges are characteristic of the soils indigenous to the particular mine and contain no additives, it is the Agency's view that solid wastes generated as a result of these guidelines will not be considered as hazardous under RCRA. Furthermore, an analysis was made of the toxic metals data collected for raw and treated wastewaters at five mines in 1986. This analysis showed that even if all of the toxic metals taken out of the water in the sludge were extracted by the RCRA EP test, the sludge would not be classified as a hazardous (toxic) waste under RCRA.

C. Energy Requirements - EPA estimates that the achievement of BPT effluent limitations will result in the consumption of approximately 155,800 gallons of additional diesel fuel per year. The BAT technology should increase the energy requirements above BPT by 485,200 gallons per year. NSPS will not add any additional energy requirements. To achieve the BAT effluent limitations, a typical direct discharger will increase total energy consumption by 14.2 percent of the energy consumed for production purposes. This increase in energy consumption is not considered to be of national significance.

D. Consumptive Water Loss - Treatment and control technologies that require extensive recirculation and reuse of water often result in the substantial consumption of water because the water is used as a cooling mechanism. Because the gold recovery processes do not generate heat or require cooling of water, loss through evaporation is negligible. the Agency concludes that the consumptive water loss is negligible and that the pollution reduction benefits of recirculation outweigh the impact on consumptive water loss.

TABLE NO. VIII-1
PLACER MINING WASTEWATER OPTIONS
1987 COSTING STUDY
VERY SMALL OPEN CUT
SUMMARY

PROCESS FLOW IN GPM	MODEL 875	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
I) OPTION A - SIMPLE (PLAIN) SETTLING - NEW EARTHMOVING EQUIPMENT - ONE POND											
TOTAL FIXED ANNUAL COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL POND COST:	2630	2790	3830	4730	5410	6100	6640	7230	7690	8220	8630
TOTAL ANNUAL OPERATING COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL COST:	2630	2790	3830	4730	5410	6100	6640	7230	7690	8220	8630
TOTAL ANNUAL HOURS REQUIRED:	33	35	48	58	66	73	80	86	92	97	102
II) OPTION A - SIMPLE (PLAIN) SETTLING - OLD EARTHMOVING EQUIPMENT - ONE POND											
TOTAL FIXED ANNUAL COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL POND COST:	2630	2790	3840	4740	5410	6100	6640	7230	7690	8220	8630
TOTAL ANNUAL OPERATING COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL COST:	2630	2790	3840	4740	5410	6100	6640	7230	7690	8220	8630
TOTAL ANNUAL HOURS REQUIRED:	40	43	59	71	82	91	99	107	114	121	127
III) OPTION A - SIMPLE (PLAIN) SETTLING - NEW EARTHMOVING EQUIPMENT - THREE PONDS											
TOTAL FIXED ANNUAL COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL POND COST:	5670	6010	8150	10090	11470	12990	14090	15410	16350	17540	18380
TOTAL ANNUAL OPERATING COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL COST:	5670	6010	8150	10090	11470	12990	14090	15410	16350	17540	18380
TOTAL ANNUAL HOURS REQUIRED:	72	75	102	123	141	156	169	180	192	204	213
IV) OPTION A - SIMPLE (PLAIN) SETTLING - OLD EARTHMOVING EQUIPMENT - THREE PONDS											
TOTAL FIXED ANNUAL COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL POND COST:	5670	6010	8150	10090	11470	12990	14090	15410	16350	17540	18380
TOTAL ANNUAL OPERATING COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL COST:	5670	6010	8150	10090	11470	12990	14090	15410	16350	17540	18380
TOTAL ANNUAL HOURS REQUIRED:	87	93	126	150	171	192	207	222	237	252	264
V) OPTION B - RECIRCULATION - NEW EARTHMOVING EQUIPMENT - ONE POND											
TOTAL FIXED ANNUAL COST:	3430	3440	4960	6220	9630	11930	19150	19240	19620	21000	22560
TOTAL ANNUAL POND COST:	2630	2790	3830	4730	5410	6100	6640	7230	7690	8220	8630
TOTAL ANNUAL OPERATING COST:	4880	7410	10110	11090	11450	12540	19160	19180	19230	32820	33830
TOTAL ANNUAL COST:	10940	13640	18900	22040	26490	30560	44950	45650	46540	62030	65020
TOTAL ANNUAL HOURS REQUIRED:	46	48	63	73	82	90	97	104	111	116	121
VI) OPTION B - RECIRCULATION - OLD EARTHMOVING EQUIPMENT - ONE POND											
TOTAL FIXED ANNUAL COST:	3430	3440	4960	6220	9630	11930	19150	19240	19620	21000	22560
TOTAL ANNUAL POND COST:	2630	2790	3840	4740	5410	6100	6640	7230	7690	8220	8630
TOTAL ANNUAL OPERATING COST:	4860	7390	10080	11070	11430	12520	19140	19160	19210	32800	33810
TOTAL ANNUAL COST:	10920	13620	18880	22020	26470	30540	44930	45630	46520	62010	65000
TOTAL ANNUAL HOURS REQUIRED:	53	56	74	86	98	108	116	125	133	140	146

TABLE VIII-1 (CONT.)
VERY SMALL OPEN CUT

SUMMARY

PROCESS FLOW IN GPM	MODEL 875	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
VII) OPTION B - RECIRCULATION - NEW EARTHMOVING EQUIPMENT - THREE PONDS											
TOTAL FIXED ANNUAL COST:	3360	3370	4800	5980	9360	11620	18750	18800	19160	20420	21960
TOTAL ANNUAL POND COST:	5670	6000	8150	10090	11470	12990	14100	15410	16350	17540	18380
TOTAL ANNUAL OPERATING COST:	5010	5860	11090	12080	12460	13550	20180	20200	20260	33850	34860
TOTAL ANNUAL COST:	14040	15230	24030	28150	33280	38160	53020	54420	55760	71800	75190
TOTAL ANNUAL HOURS REQUIRED:	127	130	160	182	202	218	231	244	257	270	280
VIII) OPTION B - RECIRCULATION - OLD EARTHMOVING EQUIPMENT - THREE PONDS											
TOTAL FIXED ANNUAL COST:	3360	3370	4800	5980	9360	11620	18750	18800	19160	20420	21960
TOTAL ANNUAL POND COST:	5670	6090	8150	10090	11470	12990	14100	15410	16350	17540	18380
TOTAL ANNUAL OPERATING COST:	4950	5800	11030	12020	12390	13490	20110	20140	20200	33780	34790
TOTAL ANNUAL COST:	13980	15170	23970	28080	33220	38100	52960	54350	55710	71740	75130
TOTAL ANNUAL HOURS REQUIRED:	142	148	184	209	232	254	270	286	302	318	331
IX) OPTION C - CHEMICAL TREATMENT OF TOTAL FLOW - NEW EARTHMOVING EQUIPMENT											
TOTAL FIXED ANNUAL COST:	1140	1140	1300	1300	1470	1470	1630	1630	1790	1790	1960
TOTAL ANNUAL POND COST:	990	1040	1360	1700	1900	2180	2350	2600	2740	2970	3090
TOTAL ANNUAL OPERATING COST:	6430	7140	12850	18530	24230	29920	35620	41310	47010	52700	58400
TOTAL ANNUAL COST:	8560	9320	15510	21530	27600	33570	39600	45540	51540	57460	63450
TOTAL ANNUAL HOURS REQUIRED:	60	63	92	120	148	176	203	230	257	283	310
X) OPTION C - CHEMICAL TREATMENT OF TOTAL FLOW - OLD EARTHMOVING EQUIPMENT											
TOTAL FIXED ANNUAL COST:	1140	1140	1300	1300	1470	1470	1630	1630	1790	1790	1960
TOTAL ANNUAL POND COST:	990	1040	1360	1700	1900	2180	2350	2600	2740	2970	3090
TOTAL ANNUAL OPERATING COST:	6430	7140	12850	18530	24230	29920	35620	41310	47010	52700	58400
TOTAL ANNUAL COST:	8560	9320	15510	21530	27600	33570	39600	45540	51540	57460	63450
TOTAL ANNUAL HOURS REQUIRED:	62	66	96	124	153	181	209	236	263	290	317

TABLE NO. VIII-2
PLACER MINING WASTEWATER OPTIONS
1987 COSTING STUDY
SMALL OPEN CUT
SUMMARY

		MODEL									
PROCESS FLOW IN GPM	1000	1350	2000	3000	4000	5000	6000	7000	8000	9000	10000
I) OPTION A - SIMPLE (PLAIN) SETTLING - NEW EARTHMOVING EQUIPMENT - ONE POND											
TOTAL FIXED ANNUAL COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL POND COST:	1840	2090	2480	3070	3490	3960	4290	4690	4980	5350	5600
TOTAL ANNUAL OPERATING COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL COST:	1840	2090	2480	3070	3490	3960	4290	4690	4980	5350	5600
TOTAL ANNUAL HOURS REQUIRED:	21	24	28	33	38	42	45	49	52	55	58
II) OPTION A - SIMPLE (PLAIN) SETTLING - OLD EARTHMOVING EQUIPMENT - ONE POND											
TOTAL FIXED ANNUAL COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL POND COST:	1790	2030	2410	2990	3390	3850	4170	4560	4840	5200	5400
TOTAL ANNUAL OPERATING COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL COST:	1790	2030	2410	2990	3390	3850	4170	4560	4840	5200	5400
TOTAL ANNUAL HOURS REQUIRED:	25	29	34	41	46	51	56	60	64	67	71
III) OPTION A - SIMPLE (PLAIN) SETTLING - NEW EARTHMOVING EQUIPMENT - FOUR PONDS											
TOTAL FIXED ANNUAL COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL POND COST:	4970	5600	6560	8190	9220	10530	11350	12510	13210	14270	14900
TOTAL ANNUAL OPERATING COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL COST:	4970	5600	6560	8190	9220	10530	11350	12510	13210	14270	14900
TOTAL ANNUAL HOURS REQUIRED:	56	64	76	88	100	108	120	128	136	140	148
IV) OPTION A - SIMPLE (PLAIN) SETTLING - OLD EARTHMOVING EQUIPMENT - FOUR PONDS											
TOTAL FIXED ANNUAL COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL POND COST:	4850	5450	6390	7980	8980	10260	11050	12180	12870	13910	14510
TOTAL ANNUAL OPERATING COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL COST:	4850	5450	6390	7980	8980	10260	11050	12180	12870	13910	14510
TOTAL ANNUAL HOURS REQUIRED:	68	76	92	108	120	132	144	156	164	172	180
V) OPTION B - RECIRCULATION - NEW EARTHMOVING EQUIPMENT - ONE POND											
TOTAL FIXED ANNUAL COST:	3460	4910	5000	6280	97000	12000	19250	19350	19740	21140	22720
TOTAL ANNUAL POND COST:	1840	2090	2480	3070	3490	3960	4290	4690	4980	5350	5600
TOTAL ANNUAL OPERATING COST:	6620	9930	13100	14300	14670	15960	24060	24080	24130	41090	42310
TOTAL ANNUAL COST:	11910	16930	20580	23650	27860	31920	47600	48130	48850	67570	70620
TOTAL ANNUAL HOURS REQUIRED:	68	72	76	82	88	93	97	101	105	108	112
VI) OPTION B - RECIRCULATION - OLD EARTHMOVING EQUIPMENT - ONE POND											
TOTAL FIXED ANNUAL COST:	3460	4910	5000	6280	9700	12000	19250	19350	19740	21140	22720
TOTAL ANNUAL POND COST:	1790	2030	2410	2990	3390	3850	4170	4560	4840	5200	5440
TOTAL ANNUAL OPERATING COST:	6610	9920	13090	14290	14650	15950	24050	24070	24120	41070	42290
TOTAL ANNUAL COST:	11850	16850	20490	23550	27740	31800	47460	47980	48690	67410	70450
TOTAL ANNUAL HOURS REQUIRED:	72	77	82	90	96	102	108	112	117	120	125

TABLE VIII-2 (CONT.)
SMALL OPEN CUT
SUMMARY

PROCESS FLOW IN GPM	1000	MODEL 1350	2000	3000	4000	5000	6000	7000	8000	9000	10000
VII) OPTION B - RECIRCULATION - NEW EARTHMOVING EQUIPMENT - FOUR PONDS											
TOTAL FIXED ANNUAL COST:	3370	4740	4800	5970	9350	11610	18740	18790	19140	20400	21940
TOTAL ANNUAL POND COST:	4970	5600	6560	8190	9220	10530	11350	12510	13210	14270	14900
TOTAL ANNUAL OPERATING COST:	7330	10640	13830	15050	15430	16740	24840	24880	24940	41890	43120
TOTAL ANNUAL COST:	15670	20980	25190	29210	34000	38880	54930	56180	57290	76570	79950
TOTAL ANNUAL HOURS REQUIRED:	127	136	150	164	178	188	201	211	220	225	235
VIII) OPTION B - RECIRCULATION - OLD EARTHMOVING EQUIPMENT - FOUR PONDS											
TOTAL FIXED ANNUAL COST:	3370	4740	4800	5970	9350	11610	18740	18790	19140	20400	21940
TOTAL ANNUAL POND COST:	4850	5450	6390	7980	8980	10260	11050	12180	12870	13910	14510
TOTAL ANNUAL OPERATING COST:	7270	10580	13770	14990	15370	16680	24780	24820	24880	41830	43060
TOTAL ANNUAL COST:	15480	20780	24960	28940	33690	38540	54570	55790	56890	76140	79510
TOTAL ANNUAL HOURS REQUIRED:	139	148	166	184	198	212	225	239	248	257	267
IX) OPTION C - CHEMICAL TREATMENT OF TOTAL FLOW - NEW EARTHMOVING EQUIPMENT											
TOTAL FIXED ANNUAL COST:	1140	1140	1300	1300	1470	1470	1630	1630	1790	1790	1960
TOTAL ANNUAL POND COST:	740	810	920	1170	1290	1500	1590	1783	1870	2050	2120
TOTAL ANNUAL OPERATING COST:	8850	11340	15970	23080	30210	37310	44440	51550	58670	65780	72900
TOTAL ANNUAL COST:	10720	13290	18200	25550	32960	40280	47660	54960	62330	69610	76970
TOTAL ANNUAL HOURS REQUIRED:	69	81	103	136	168	201	233	266	298	330	363
X) OPTION C - CHEMICAL TREATMENT OF TOTAL FLOW - OLD EARTHMOVING EQUIPMENT											
TOTAL FIXED ANNUAL COST:	1140	1140	1300	1300	1470	1470	1630	1630	1790	1790	1960
TOTAL ANNUAL POND COST:	720	790	900	1140	1260	1470	1560	1750	1830	2000	2070
TOTAL ANNUAL OPERATING COST:	8850	11340	15970	23080	30210	37310	44440	51550	58670	65780	72900
TOTAL ANNUAL COST:	10710	13270	18180	25530	32940	40240	47630	54920	62290	69570	76930
TOTAL ANNUAL HOURS REQUIRED:	70	82	105	138	170	204	236	269	302	334	367

TABLE NO. VIII-3
PLACER MINING WASTEWATER OPTIONS
1987 COSTING STUDY
MEDIUM OPEN CUT
SUMMARY

			MODEL								
PROCESS FLOW IN GPM	1000	2000	2250	3000	4000	5000	6000	7000	8000	9000	10000
I) OPTION A - SIMPLE (PLAIN) SETTLING - NEW EARTHMOVING EQUIPMENT - ONE POND											
TOTAL FIXED ANNUAL COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL POND COST:	1890	2550	2690	3160	3590	4070	4410	4830	5120	5500	5760
TOTAL ANNUAL OPERATING COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL COST:	1890	2550	2690	3160	3590	4070	4410	4830	5120	5500	5760
TOTAL ANNUAL HOURS REQUIRED:	17	22	23	26	30	33	36	38	40	43	45
II) OPTION A - SIMPLE (PLAIN) SETTLING - OLD EARTHMOVING EQUIPMENT - ONE POND											
TOTAL FIXED ANNUAL COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL POND COST:	1720	2320	2440	2880	3260	3700	4010	4390	4660	5000	5240
TOTAL ANNUAL OPERATING COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL COST:	1720	2320	2440	2880	3260	3700	4010	4390	4660	5000	5240
TOTAL ANNUAL HOURS REQUIRED:	20	22	23	26	30	33	36	38	40	43	45
III) OPTION A - SIMPLE (PLAIN) SETTLING - NEW EARTHMOVING EQUIPMENT - FOUR PONDS											
TOTAL FIXED ANNUAL COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL POND COST:	5040	6670	7010	8320	9370	10700	11530	12700	13420	14490	15130
TOTAL ANNUAL OPERATING COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL COST:	5040	6670	7010	8320	9370	10700	11530	12700	13420	14490	15130
TOTAL ANNUAL HOURS REQUIRED:	48	60	64	72	80	88	92	100	104	112	116
IV) OPTION A - SIMPLE (PLAIN) SETTLING - OLD EARTHMOVING EQUIPMENT - FOUR PONDS											
TOTAL FIXED ANNUAL COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL POND COST:	4640	6100	6400	7620	8560	9790	10540	11640	12280	13280	13850
TOTAL ANNUAL OPERATING COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL COST:	4640	6100	6400	7620	8560	9790	10540	11640	12280	13280	13850
TOTAL ANNUAL HOURS REQUIRED:	56	72	76	84	96	104	112	120	128	132	140
V) OPTION B - RECIRCULATION - NEW EARTHMOVING EQUIPMENT - ONE POND											
TOTAL FIXED ANNUAL COST:	3490	5070	6030	6380	9820	12140	19340	19540	19940	21390	22980
TOTAL ANNUAL POND COST:	1890	2550	2690	3160	3590	4070	4410	4830	5120	5500	5760
TOTAL ANNUAL OPERATING COST:	8790	17690	19250	19300	19670	21372	32280	32320	32370	55770	57400
TOTAL ANNUAL COST:	14160	25310	27970	28840	33080	37580	56030	56680	57430	82660	86140
TOTAL ANNUAL HOURS REQUIRED:	69	75	76	80	85	89	93	95	98	102	104
VI) OPTION B - RECIRCULATION - OLD EARTHMOVING EQUIPMENT - ONE POND											
TOTAL FIXED ANNUAL COST:	3490	5070	6030	6380	9820	12140	19340	19540	19940	21390	22980
TOTAL ANNUAL POND COST:	1720	2320	2440	2880	3260	3700	4010	4390	4660	5000	5240
TOTAL ANNUAL OPERATING COST:	8750	17650	19210	19260	19630	21330	32240	32280	32330	55730	57360
TOTAL ANNUAL COST:	13960	25040	27680	28520	32710	37170	55590	56210	56930	82130	85580
TOTAL ANNUAL HOURS REQUIRED:	69	75	76	80	85	89	93	95	98	102	104

TABLE VIII-3 (CONT.)
MEDIUM OPEN CUT
SUMMARY

			MODEL								
PROCESS FLOW IN GPM	1000	2000	2250	3000	4000	5000	6000	7000	8000	9000	10000
VII) OPTION B - RECIRCULATION - NEW EARTHMOVING EQUIPMENT - FOUR PONDS											
TOTAL FIXED ANNUAL COST:	3390	4850	5800	6050	9440	11710	18790	18940	19300	20600	22150
TOTAL ANNUAL POND COST:	5040	6670	7010	8320	9370	10700	11530	12700	13420	14490	15130
TOTAL ANNUAL OPERATING COST:	9700	18640	20200	20260	20650	22380	33300	33350	33410	56810	58450
TOTAL ANNUAL COST:	18130	30150	33010	34630	39460	44790	63610	64990	66140	91910	95730
TOTAL ANNUAL HOURS REQUIRED:	124	140	145	155	165	175	181	190	196	205	211
VIII) OPTION B - RECIRCULATION - OLD EARTHMOVING EQUIPMENT - FOUR PONDS											
TOTAL FIXED ANNUAL COST:	3390	4850	5800	6050	9440	11710	18790	18940	19300	20600	22150
TOTAL ANNUAL POND COST:	4640	6100	6400	7620	8560	9790	10540	11640	12280	13280	13850
TOTAL ANNUAL OPERATING COST:	9540	18480	20040	20110	20500	22220	33140	33190	33260	56660	58290
TOTAL ANNUAL COST:	17570	29430	32240	33770	38500	43720	62470	63770	64840	90540	94290
TOTAL ANNUAL HOURS REQUIRED:	132	152	157	167	181	191	201	210	220	225	235
IX) OPTION C - CHEMICAL TREATMENT OF TOTAL FLOW - NEW EARTHMOVING EQUIPMENT											
TOTAL FIXED ANNUAL COST:	1140	1300	1300	1300	1470	1470	1630	1630	1790	1790	1960
TOTAL ANNUAL POND COST:	730	910	950	1160	1280	1480	1580	1760	1850	2020	2100
TOTAL ANNUAL OPERATING COST:	12020	21870	24320	31700	41550	51380	61230	71060	80910	90740	100590
TOTAL ANNUAL COST:	13880	24080	26580	34160	44290	54330	64430	74450	84550	94560	104640
TOTAL ANNUAL HOURS REQUIRED:	82	127	137	171	215	260	304	348	392	436	480
X) OPTION C - CHEMICAL TREATMENT OF TOTAL FLOW - OLD EARTHMOVING EQUIPMENT											
TOTAL FIXED ANNUAL COST:	1140	1300	1300	1300	1470	1470	1630	1630	1790	1790	1960
TOTAL ANNUAL POND COST:	680	850	880	1080	1180	1380	1460	1640	1720	1890	1950
TOTAL ANNUAL OPERATING COST:	12020	21870	24320	31700	41550	51380	61230	71060	80910	90740	100590
TOTAL ANNUAL COST:	13840	24020	26510	34080	44200	54220	64320	74330	84420	94420	104500
TOTAL ANNUAL HOURS REQUIRED:	82	128	139	173	217	262	306	351	395	439	483

TABLE NO. VIII-4
PLACER MINING WASTEWATER OPTIONS
1987 COSTING STUDY
LARGE OPEN CUT
SUMMARY

			MODEL								
PROCESS FLOW IN GPM	1000	2000	2500	3000	4000	5000	6000	7000	8000	9000	10000
I) OPTION A - SIMPLE (PLAIN) SETTLING - NEW EARTHMOVING EQUIPMENT - ONE POND											
TOTAL FIXED ANNUAL COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL POND COST:	2770	3810	4320	4700	5370	6060	6590	7180	7630	8160	8570
TOTAL ANNUAL OPERATING COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL COST:	2770	3810	4320	4700	5370	6060	6590	7180	7630	8160	8570
TOTAL ANNUAL HOURS REQUIRED:	16	22	24	25	29	32	34	37	39	41	43
II) OPTION A - SIMPLE (PLAIN) SETTLING - OLD EARTHMOVING EQUIPMENT - ONE POND											
TOTAL FIXED ANNUAL COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL POND COST:	2330	3190	3630	3930	4480	5070	5510	6010	6380	6840	7170
TOTAL ANNUAL OPERATING COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL COST:	2330	3190	3630	3930	4480	5070	5510	6010	6380	6840	7170
TOTAL ANNUAL HOURS REQUIRED:	19	26	28	30	35	38	41	44	47	50	52
III) OPTION A - SIMPLE (PLAIN) SETTLING - NEW EARTHMOVING EQUIPMENT - FOUR PONDS											
TOTAL FIXED ANNUAL COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL POND COST:	6720	9050	10380	11230	12730	14450	15650	17150	18170	19530	20440
TOTAL ANNUAL OPERATING COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL COST:	6720	9050	10380	11230	12730	14450	15650	17150	18170	19530	20440
TOTAL ANNUAL HOURS REQUIRED:	44	56	60	64	72	80	84	88	96	100	104
IV) OPTION A - SIMPLE (PLAIN) SETTLING - OLD EARTHMOVING EQUIPMENT - FOUR PONDS											
TOTAL FIXED ANNUAL COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL POND COST:	5730	7640	8810	9510	10740	12230	13220	14520	15360	16560	17300
TOTAL ANNUAL OPERATING COST:	0	0	0	0	0	0	0	0	0	0	0
TOTAL ANNUAL COST:	5730	7640	8810	9510	10740	12230	13220	14520	15360	16560	17300
TOTAL ANNUAL HOURS REQUIRED:	52	64	72	76	84	92	100	108	113	120	124
V) OPTION B - RECIRCULATION - NEW EARTHMOVING EQUIPMENT - ONE POND											
TOTAL FIXED ANNUAL COST:	3580	5270	6590	6690	10180	12540	19950	20100	20540	22150	23780
TOTAL ANNUAL POND COST:	2770	3810	4320	4700	5370	6060	6590	7180	7630	8160	8570
TOTAL ANNUAL OPERATING COST:	16460	34520	37640	27670	38050	41280	62880	62910	62980	110750	113910
TOTAL ANNUAL COST:	22810	43600	48560	49060	53590	59880	89410	90190	91150	141060	146260
TOTAL ANNUAL HOURS REQUIRED:	70	78	81	82	88	92	95	99	102	104	107
VI) OPTION B - RECIRCULATION - OLD EARTHMOVING EQUIPMENT - ONE POND											
TOTAL FIXED ANNUAL COST:	3580	5270	6590	6690	10180	12540	19950	20100	20540	22150	23780
TOTAL ANNUAL POND COST:	2330	3190	3630	3930	4480	5070	5510	6030	6380	6840	7170
TOTAL ANNUAL OPERATING COST:	16420	34480	37600	37630	38010	41240	62840	62870	62940	110710	113870
TOTAL ANNUAL COST:	22330	42930	47820	48250	52670	58850	88290	89010	89860	139700	144820
TOTAL ANNUAL HOURS REQUIRED:	73	82	85	87	94	98	102	106	110	113	116

TABLE VIII-4 (CONT.)
LARGE OPEN CUT
SUMMARY

PROCESS FLOW IN GPM	1000	2000	MODEL 2500	3000	4000	5000	6000	7000	8000	9000	10000
VII) OPTION B - RECIRCULATION - NEW EARTHMOVING EQUIPMENT - FOUR PONDS											
TOTAL FIXED ANNUAL COST:	3430	4940	6130	6190	9600	11890	19100	19190	19560	20930	22490
TOTAL ANNUAL POND COST:	6720	9050	10380	11230	12730	14450	15650	17150	18170	19530	20440
TOTAL ANNUAL OPERATING COST:	17380	35470	38610	38640	39050	42300	63910	63960	64030	111810	114980
TOTAL ANNUAL COST:	27540	49460	55120	56060	61370	68640	98650	100291	101770	152300	157910
TOTAL ANNUAL HOURS REQUIRED:	124	140	146	151	162	173	179	185	195	201	207
VIII) OPTION B - RECIRCULATION - OLD EARTHMOVING EQUIPMENT - FOUR PONDS											
TOTAL FIXED ANNUAL COST:	3430	4940	6130	6190	9600	11890	19100	19190	19560	20930	22490
TOTAL ANNUAL POND COST:	5730	7640	8810	9510	10740	12230	13220	14520	15360	16560	17300
TOTAL ANNUAL OPERATING COST:	17230	35320	38450	38490	38890	42150	63750	63800	63880	111650	114820
TOTAL ANNUAL COST:	26390	47890	53390	54180	59230	66270	96060	97510	98800	149130	154610
TOTAL ANNUAL HOURS REQUIRED:	132	148	158	163	174	185	195	205	211	221	227
IX) OPTION C - CHEMICAL TREATMENT OF TOTAL FLOW - NEW EARTHMOVING EQUIPMENT											
TOTAL FIXED ANNUAL COST:	1140	1300	1300	1300	1470	1470	1630	1630	1790	1790	1960
TOTAL ANNUAL POND COST:	920	1180	1290	1490	1660	1910	2040	2270	2390	2600	2700
TOTAL ANNUAL OPERATING COST:	23850	44010	54080	64150	84300	104440	124600	144740	164890	185030	205190
TOTAL ANNUAL COST:	25910	46500	56670	66940	87430	107820	128270	148640	169070	189420	209840
TOTAL ANNUAL HOURS REQUIRED:	127	217	263	307	397	487	577	666	756	846	935
X) OPTION C - CHEMICAL TREATMENT OF TOTAL FLOW - OLD EARTHMOVING EQUIPMENT											
TOTAL FIXED ANNUAL COST:	1140	1300	1300	1300	1470	1470	1630	1630	1790	1790	1960
TOTAL ANNUAL POND COST:	810	1020	1110	1290	1430	1650	1770	1970	2070	2260	2340
TOTAL ANNUAL OPERATING COST:	23850	44010	54080	64150	84300	104440	124600	144740	164890	185030	205190
TOTAL ANNUAL COST:	25800	46340	56490	66740	87200	107560	127990	148340	168750	189080	209480
TOTAL ANNUAL HOURS REQUIRED:	128	219	264	309	399	489	579	668	758	848	937

TABLE NO. VIII-5
PLACER MINING WASTEWATER OPTIONS
1987 COSTING STUDY
SMALL DREDGE
SUMMARY

		MODEL									
PROCESS FLOW IN GPM	1000	1660	2000	3000	4000	5000	6000	7000	8000	9000	10000
I) OPTION A - SIMPLE (PLAIN) SETTLING - NEW EARTHMOVING EQUIPMENT											
TOTAL FIXED ANNUAL COST:	4000	4460	7180	8250	10610	11480	13020	15400	25010	32930	40770
TOTAL ANNUAL POND COST:	2860	3600	3930	4850	5540	6250	6800	7310	7880	8320	8740
TOTAL ANNUAL OPERATING COST:	22730	27010	35700	48440	52910	57230	57410	87070	96460	105680	114900
TOTAL ANNUAL COST:	29580	35080	46800	61530	69060	74960	77230	109780	129350	146930	164400
TOTAL ANNUAL HOURS REQUIRED:	87	95	98	106	113	119	125	130	135	139	143
II) OPTION A - SIMPLE (PLAIN) SETTLING - OLD EARTHMOVING EQUIPMENT											
TOTAL FIXED ANNUAL COST:	4000	4460	7180	8250	10610	11480	13020	15400	25010	32930	40770
TOTAL ANNUAL POND COST:	2600	3260	3550	4390	510	5660	6150	6600	7130	7520	7900
TOTAL ANNUAL OPERATING COST:	22710	26990	35690	48430	52900	57210	57390	87050	96450	105670	114880
TOTAL ANNUAL COST:	29300	34720	46410	61060	68520	74350	76560	109060	128590	146120	163550
TOTAL ANNUAL HOURS REQUIRED:	92	101	106	115	124	131	137	143	149	155	160
III) OPTION B - RECIRCULATION - NEW EARTHMOVING EQUIPMENT											
TOTAL FIXED ANNUAL COST:	2460	2610	2640	3080	3120	3530	4000	4050	4360	4420	4470
TOTAL ANNUAL POND COST:	1230	1540	1670	2000	2390	2640	2860	3070	3260	3440	3610
TOTAL ANNUAL OPERATING COST:	9910	9940	14140	14200	18420	18470	18530	22740	22780	27000	27010
TOTAL ANNUAL COST:	13600	14090	18450	19290	23930	24630	25380	29850	30400	34850	35090
TOTAL ANNUAL HOURS REQUIRED:	71	75	76	80	82	85	87	89	91	92	95
IV) OPTION B - RECIRCULATION - OLD EARTHMOVING EQUIPMENT											
TOTAL FIXED ANNUAL COST:	2460	2610	2640	3080	3120	3530	4000	4050	4360	4420	4470
TOTAL ANNUAL POND COST:	1130	1400	1520	1820	2170	2390	2600	2780	2950	3120	3270
TOTAL ANNUAL OPERATING COST:	9890	9920	14130	14190	18400	18460	18510	22730	22770	26980	26990
TOTAL ANNUAL COST:	13470	13930	18280	19080	23700	24380	25100	29550	30080	34510	34730
TOTAL ANNUAL HOURS REQUIRED:	74	78	79	83	86	90	92	95	97	99	101
V) OPTION C - CHEMICAL TREATMENT OF TOTAL FLOW - NEW EARTHMOVING EQUIPMENT											
TOTAL FIXED ANNUAL COST:	5180	5840	8560	9670	12220	13130	14850	27150	35080	43100	1630
TOTAL ANNUAL POND COST:	3010	3850	4200	5190	5930	6680	7280	7820	8430	8900	9350
TOTAL ANNUAL OPERATING COST:	35450	42070	54330	70700	80250	88000	92430	127000	148840	168510	188280
TOTAL ANNUAL COST:	43690	51770	67100	85550	98400	107820	114560	152070	184410	212500	240730
TOTAL ANNUAL HOURS REQUIRED:	249	341	386	522	654	787	918	1050	1180	1311	1440
VI) OPTION C - CHEMICAL TREATMENT OF TOTAL FLOW - OLD EARTHMOVING EQUIPMENT											
TOTAL FIXED ANNUAL COST:	5180	5840	8560	9670	12220	13130	14850	17250	27150	35080	43100
TOTAL ANNUAL POND COST:	2770	3490	3800	4690	5360	6050	6580	7070	7620	8050	8450
TOTAL ANNUAL OPERATING COST:	35440	42060	54320	70690	80240	87990	92520	126990	148830	168500	188260
TOTAL ANNUAL COST:	43390	51390	66680	85040	97810	107160	113850	151300	183590	211620	239810
TOTAL ANNUAL HOURS REQUIRED:	255	349	394	531	666	799	932	1065	1196	1327	1458

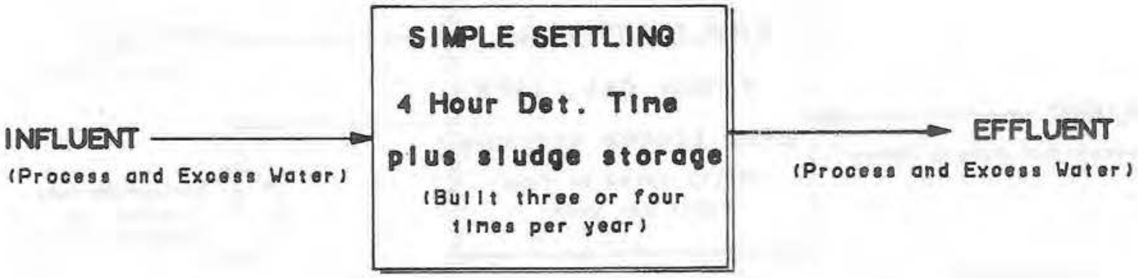
TABLE NO. VIII-6
PLACER MINING WASTEWATER OPTIONS
1987 COSTING STUDY
LARGE DREDGE
SUMMARY

PROCESS FLOW IN GPM	1000	2000	3000	MODEL 3800	4000	5000	6000	7000	8000	9000	10000
I) OPTION A - SIMPLE (PLAIN) SETTLING - NEW EARTHMOVING EQUIPMENT - ONE PRIMARY POND											
TOTAL FIXED ANNUAL COST:	4120	7400	8570	10940	10990	11980	13570	15990	25940	33890	41800
TOTAL ANNUAL POND COST:	3390	4670	5760	6440	6590	7430	8090	8700	9370	9900	10400
TOTAL ANNUAL OPERATING COST:	33320	56360	71170	77650	77670	84020	84200	127990	141450	154710	167970
TOTAL ANNUAL COST:	40830	64430	85500	95020	95250	103420	105860	152680	176750	198500	220170
TOTAL ANNUAL HOURS REQUIRED:	116	129	139	147	148	156	162	168	174	180	185
II) OPTION A - SIMPLE (PLAIN) SETTLING - OLD EARTHMOVING EQUIPMENT											
TOTAL FIXED ANNUAL COST:	4120	7400	8570	10940	10990	11980	13570	15990	25940	33890	41800
TOTAL ANNUAL POND COST:	3070	4220	5210	5810	5950	6710	7310	7850	8460	8940	9390
TOTAL ANNUAL OPERATING COST:	33310	52350	71150	77640	77650	84000	84190	127970	141440	154700	167950
TOTAL ANNUAL COST:	40500	63970	84930	94390	94590	102690	105070	151810	175830	197530	219140
TOTAL ANNUAL HOURS REQUIRED:	122	138	150	159	160	170	177	184	192	198	204
III) OPTION B - RECIRCULATION - NEW EARTHMOVING EQUIPMENT											
TOTAL FIXED ANNUAL COST:	2490	2680	3140	3180	3190	3650	4120	4180	4550	4610	4670
TOTAL ANNUAL POND COST:	1550	2070	2580	2850	2920	3320	3590	3840	4170	4390	4590
TOTAL ANNUAL OPERATING COST:	14430	20690	20750	26990	26990	27050	27110	33340	33390	39620	39640
TOTAL ANNUAL COST:	18470	25440	26470	33020	33090	34010	34820	41360	42100	48610	48900
TOTAL ANNUAL HOURS REQUIRED:	97	102	107	110	110	114	116	119	121	123	125
IV) OPTION B - RECIRCULATION - OLD EARTHMOVING EQUIPMENT											
TOTAL FIXED ANNUAL COST:	2490	2680	3140	3180	3190	3650	4120	4180	4550	4610	4670
TOTAL ANNUAL POND COST:	1420	1890	2350	2600	2660	3020	3270	3490	3800	3990	4180
TOTAL ANNUAL OPERATING COST:	14430	20690	20750	26990	26990	27050	27110	33340	33390	39620	39640
TOTAL ANNUAL COST:	18340	25260	26240	32760	32830	33720	34500	41020	41730	48220	48490
TOTAL ANNUAL HOURS REQUIRED:	100	106	111	115	115	119	122	126	128	131	133
V) OPTION C - CHEMICAL TREATMENT OF TOTAL FLOW - NEW EARTHMOVING EQUIPMENT											
TOTAL FIXED ANNUAL COST:	5320	8810	9600	12570	12630	13680	15450	17890	28150	36150	44230
TOTAL ANNUAL POND COST:	3630	5020	6190	6920	7090	7980	8690	9350	10060	10640	11180
TOTAL ANNUAL OPERATING COST:	49650	75920	99200	111690	112510	123630	129330	179280	206750	231740	256810
TOTAL ANNUAL COST:	58610	89750	114990	131180	132230	145280	153480	206520	244970	278530	312220
TOTAL ANNUAL HOURS REQUIRED:	352	552	749	904	944	1137	1331	1523	1715	1907	2098
VI) OPTION C - CHEMICAL TREATMENT OF TOTAL FLOW - OLD EARTHMOVING EQUIPMENT											
TOTAL FIXED ANNUAL COST:	5320	8810	9600	12570	12630	13680	15450	17890	28150	36150	44230
TOTAL ANNUAL POND COST:	3290	4530	5590	6240	6400	7210	7850	8440	9090	9600	10090
TOTAL ANNUAL OPERATING COST:	49640	75900	99190	111680	112500	123610	129320	179260	206740	231720	256790
TOTAL ANNUAL COST:	58250	89240	114380	130490	131520	144500	152620	205590	243980	277480	311110
TOTAL ANNUAL HOURS REQUIRED:	359	562	760	917	957	1152	1347	1541	1734	1927	2119

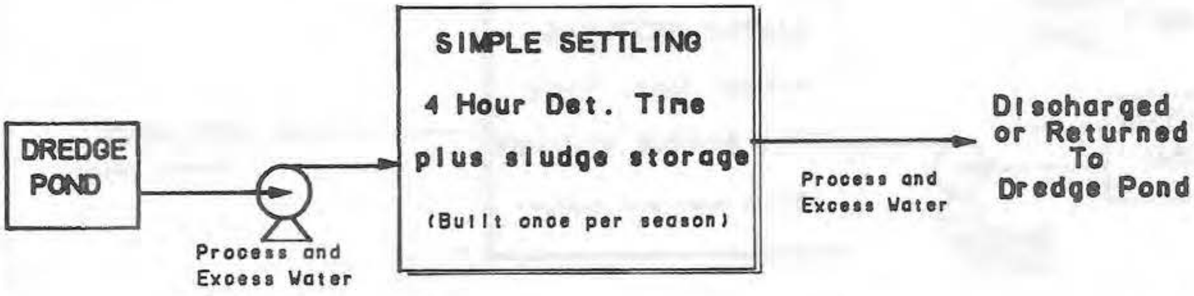
FIGURE VIII-1 PLACER MINING WASTEWATER TREATMENT OPTIONS

SIMPLE (PLAIN) SETTLING

OPTION -A- OPEN CUT - 1 POND



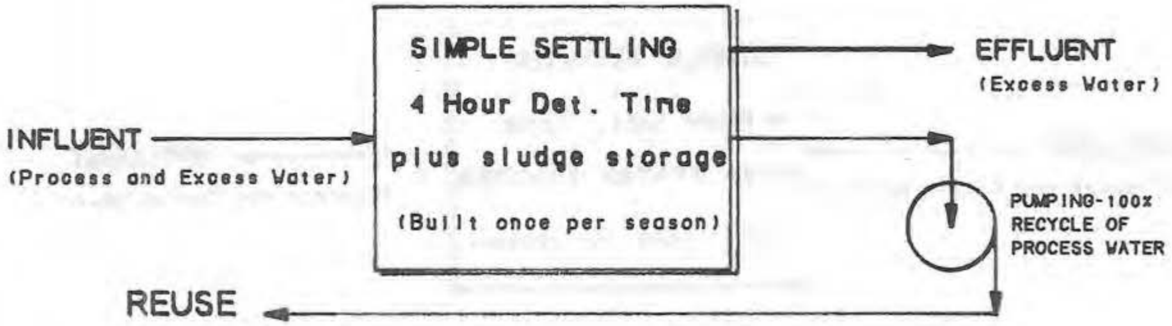
OPTION -A- OPEN CUT - 3 OR 4 PONDS



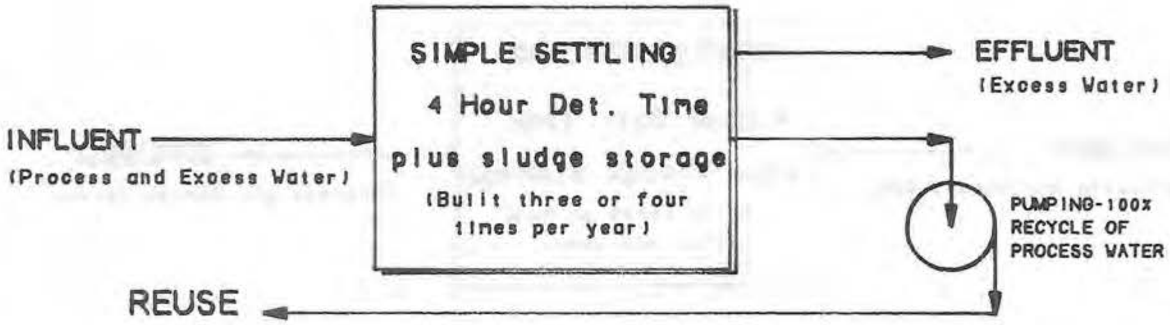
OPTION -A- DREDGE

FIGURE VIII-2 PLACER MINING WASTEWATER TREATMENT OPTIONS

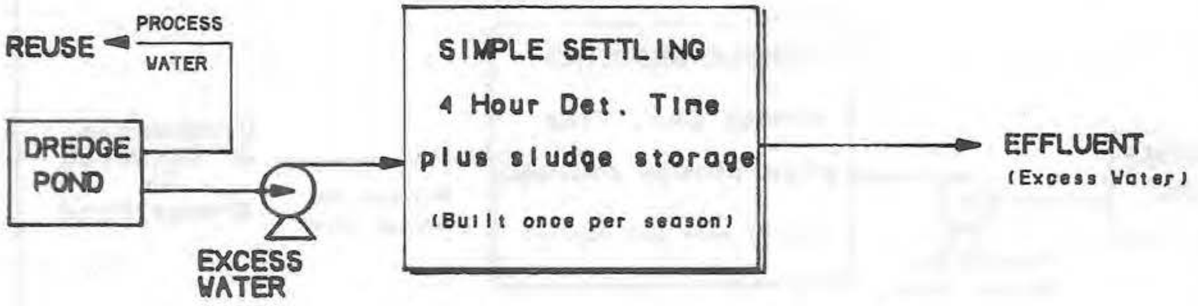
RECIRCULATION



OPTION -B- OPEN CUT - 1 POND



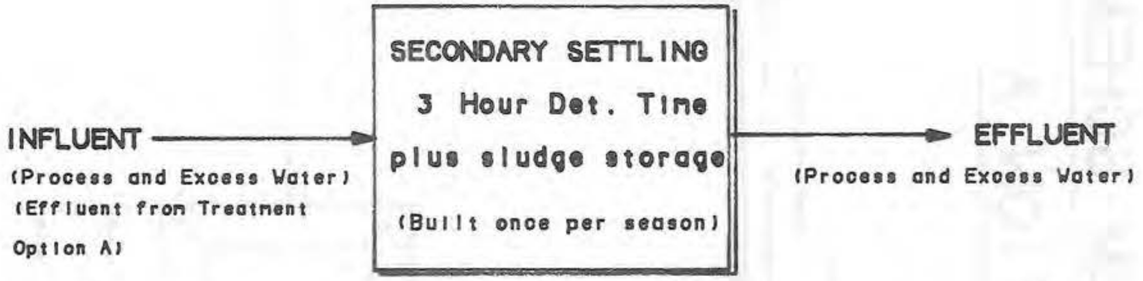
OPTION -B- OPEN CUT - 3 OR 4 PONDS



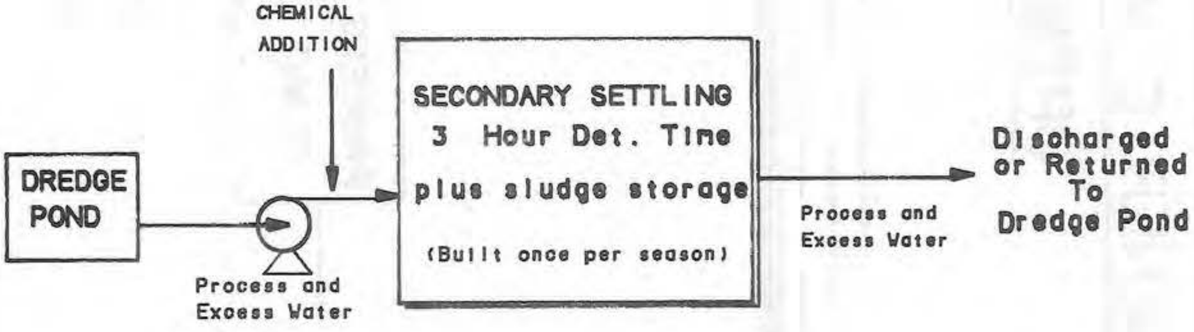
OPTION -B- DREDGES

FIGURE VIII-3 PLACER MINING WASTEWATER TREATMENT OPTIONS

CHEMICALLY AIDED SETTLING



OPTION -C- OPEN CUT



OPTION -C- DREDGE

FIGURE VIII-4 PLACER MINING INDUSTRY

GENERIC WATER SYSTEM SCHEMATIC

OPEN CUT - OPTION A

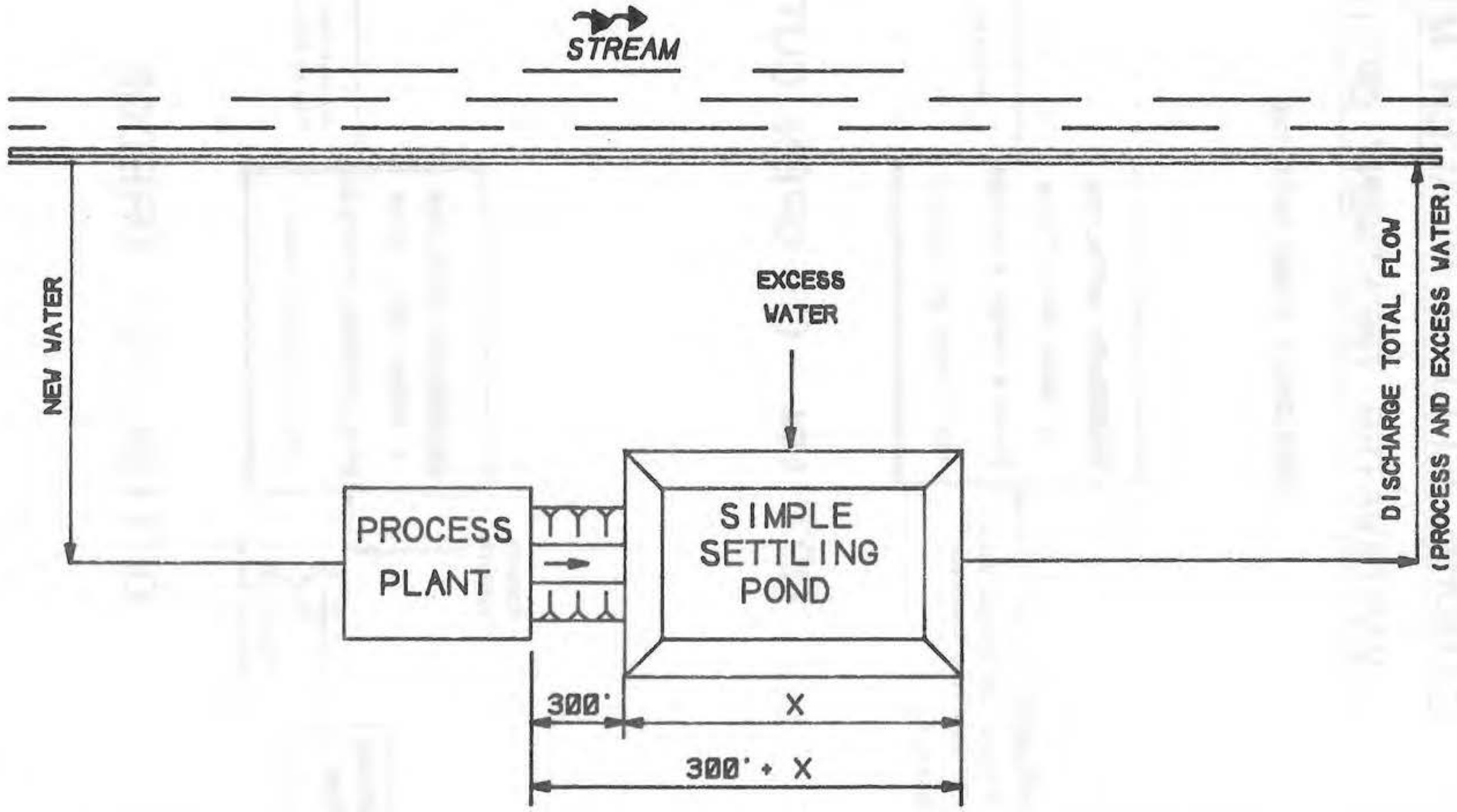


FIGURE VIII-5 PLACER MINING INDUSTRY
GENERIC WATER SYSTEM SCHEMATIC
OPEN CUT - OPTION B

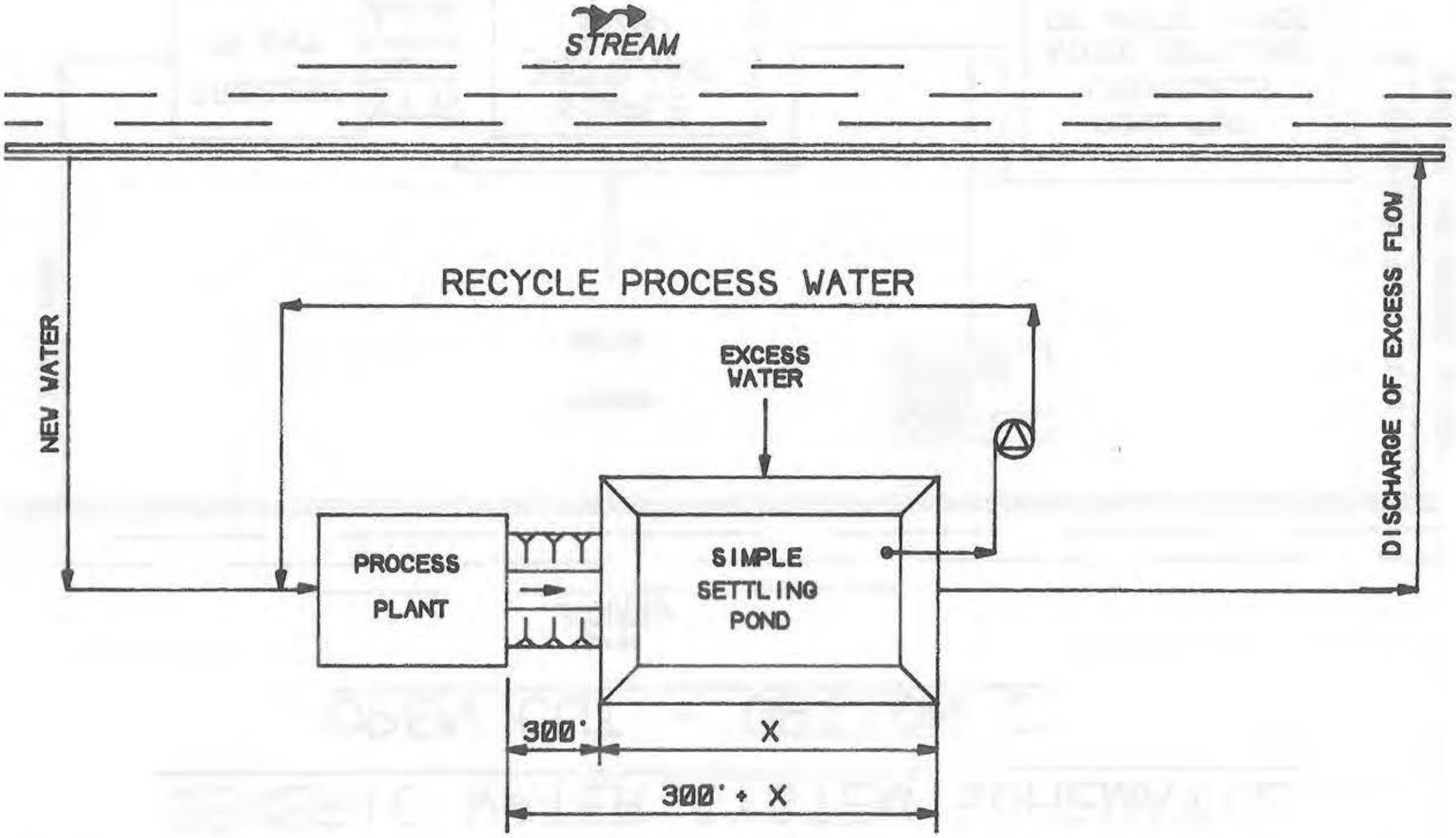


FIGURE VIII-6 PLACER MINING INDUSTRY
GENERIC WATER SYSTEM SCHEMATIC
OPEN CUT - OPTION C

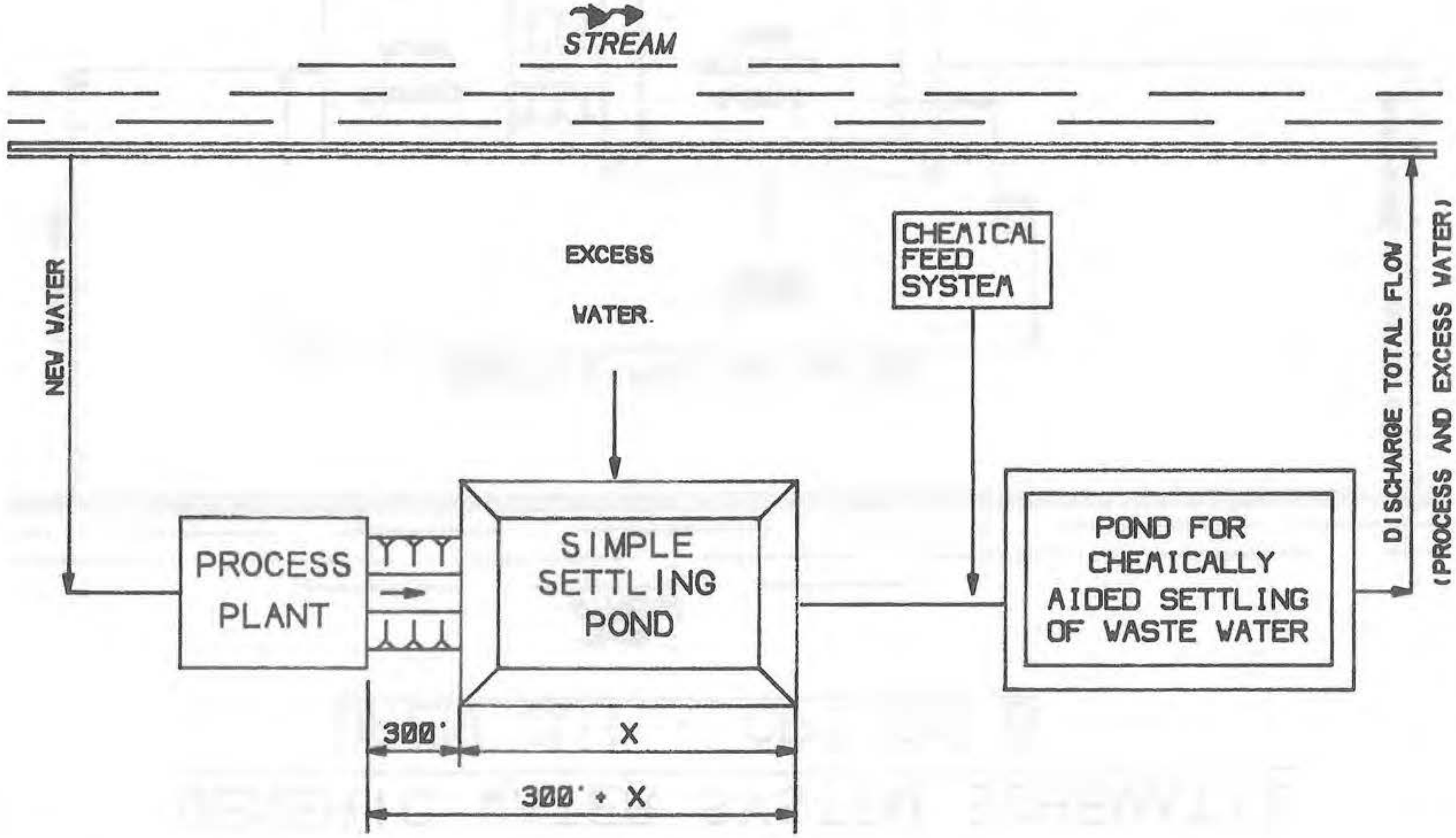


FIGURE VIII-7 PLACER MINING INDUSTRY
GENERIC WATER SYSTEM SCHEMATIC
DREDGE MINING - OPTION A

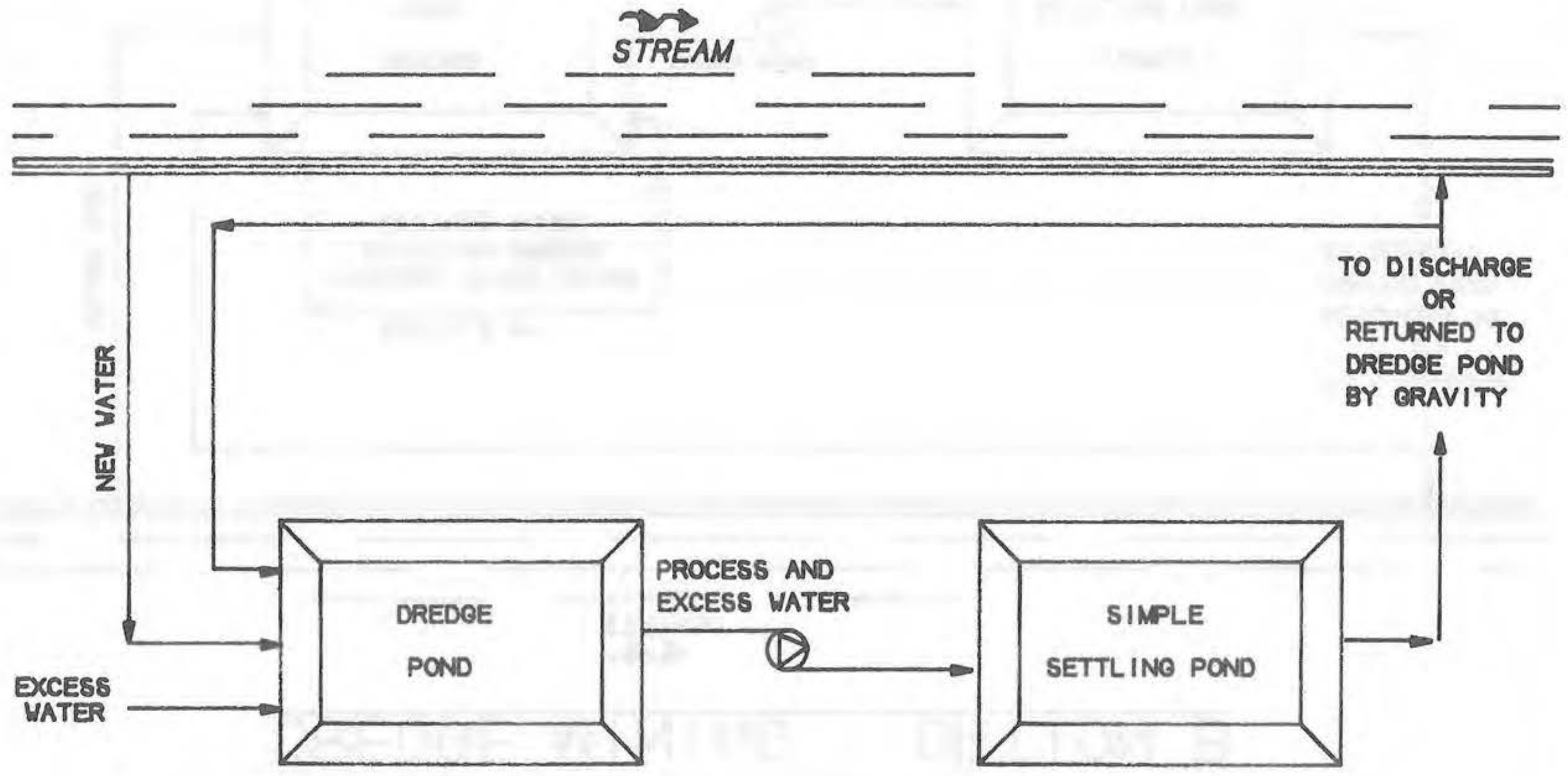


FIGURE VIII-8 PLACER MINING INDUSTRY
GENERIC WATER SYSTEM SCHEMATIC
DREDGE MINING - OPTION B

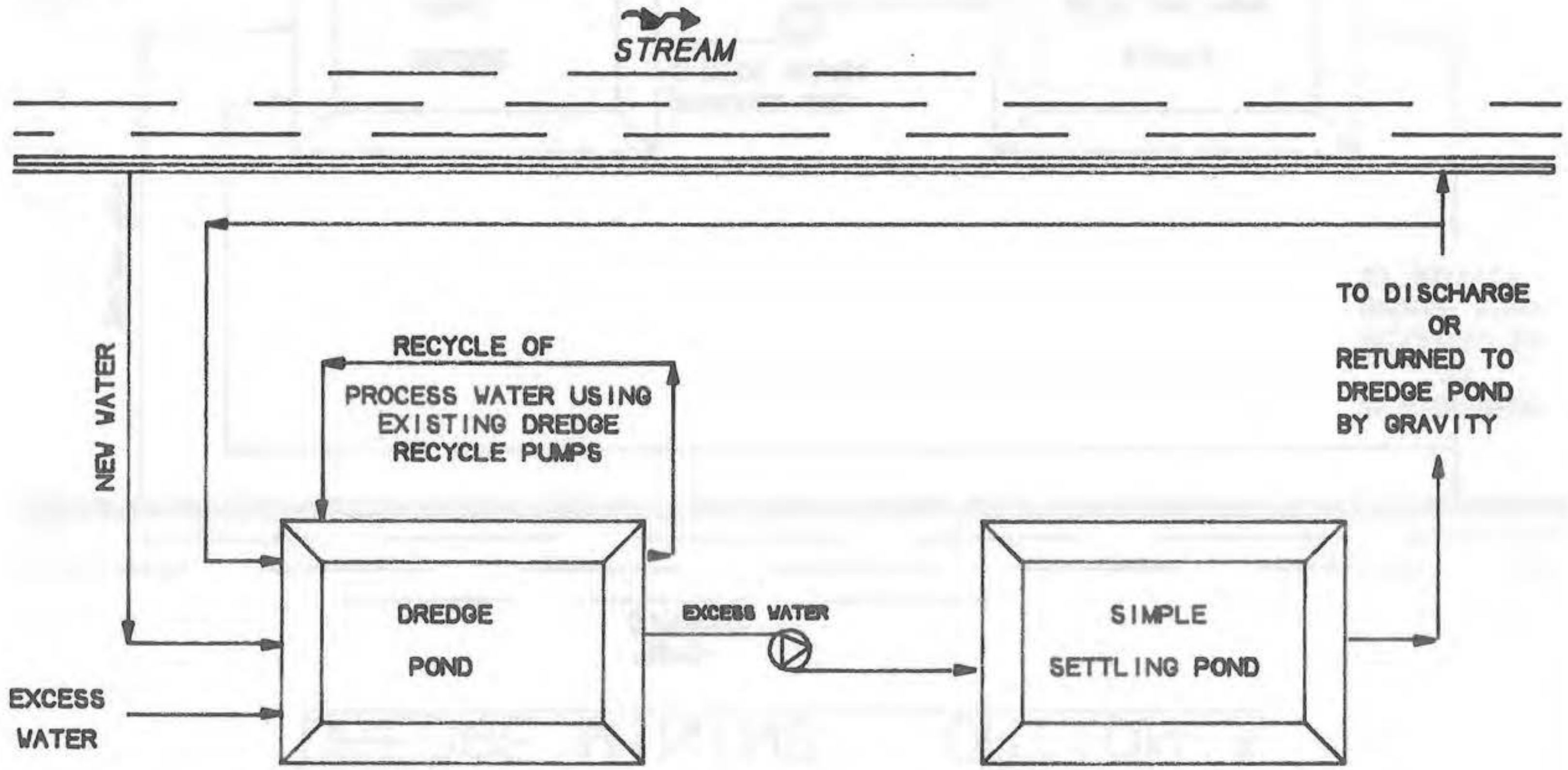


FIGURE VIII- 9 PLACER MINING INDUSTRY
GENERIC WATER SYSTEM SCHEMATIC
DREDGE MINING - OPTION C

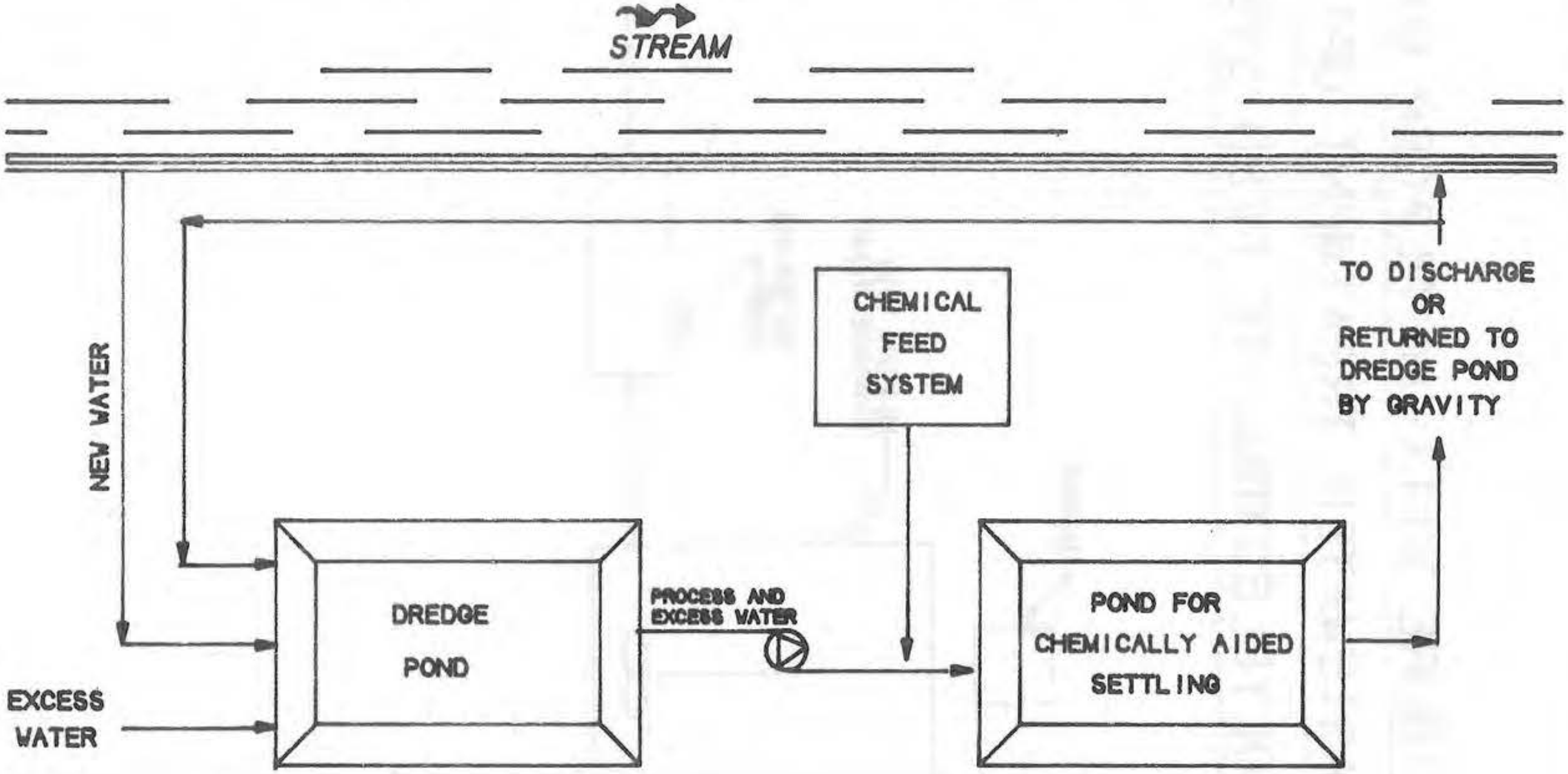


FIGURE VIII-10 PLACER MINING WASTEWATER TREATMENT OPTIONS POLYELECTROLYTE FEED SYSTEMS

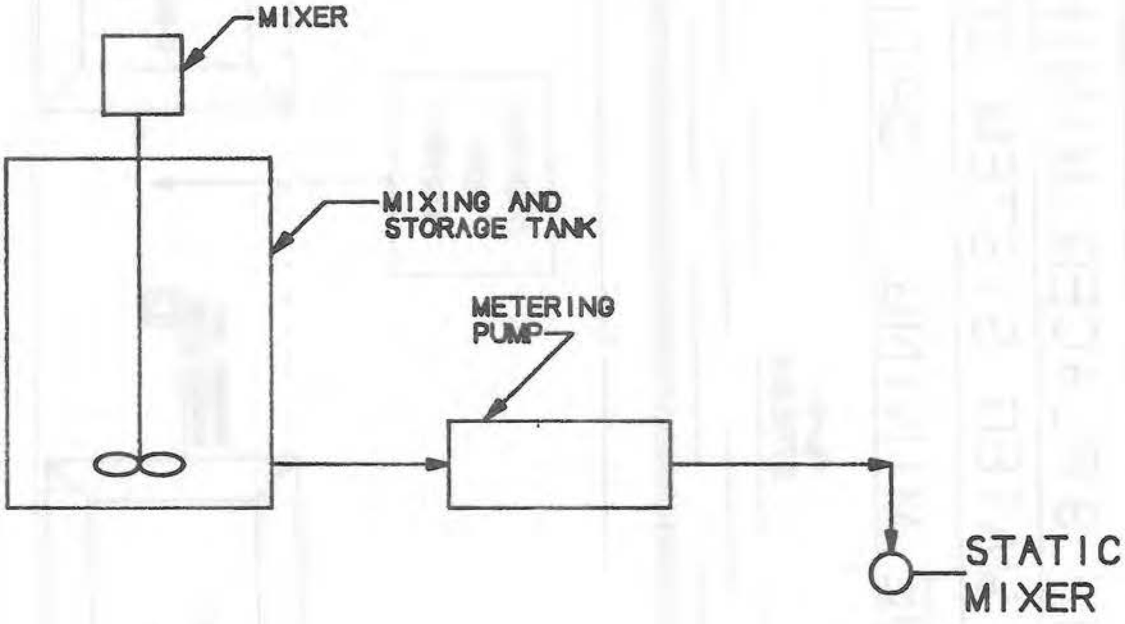


FIGURE VIII-11 1987 PLACER MINING COSTING STUDY

POLYELECTROLYTE COST PER 100 HOURS OPERATION

BASED ON POLY COST $2.25 PER POUND

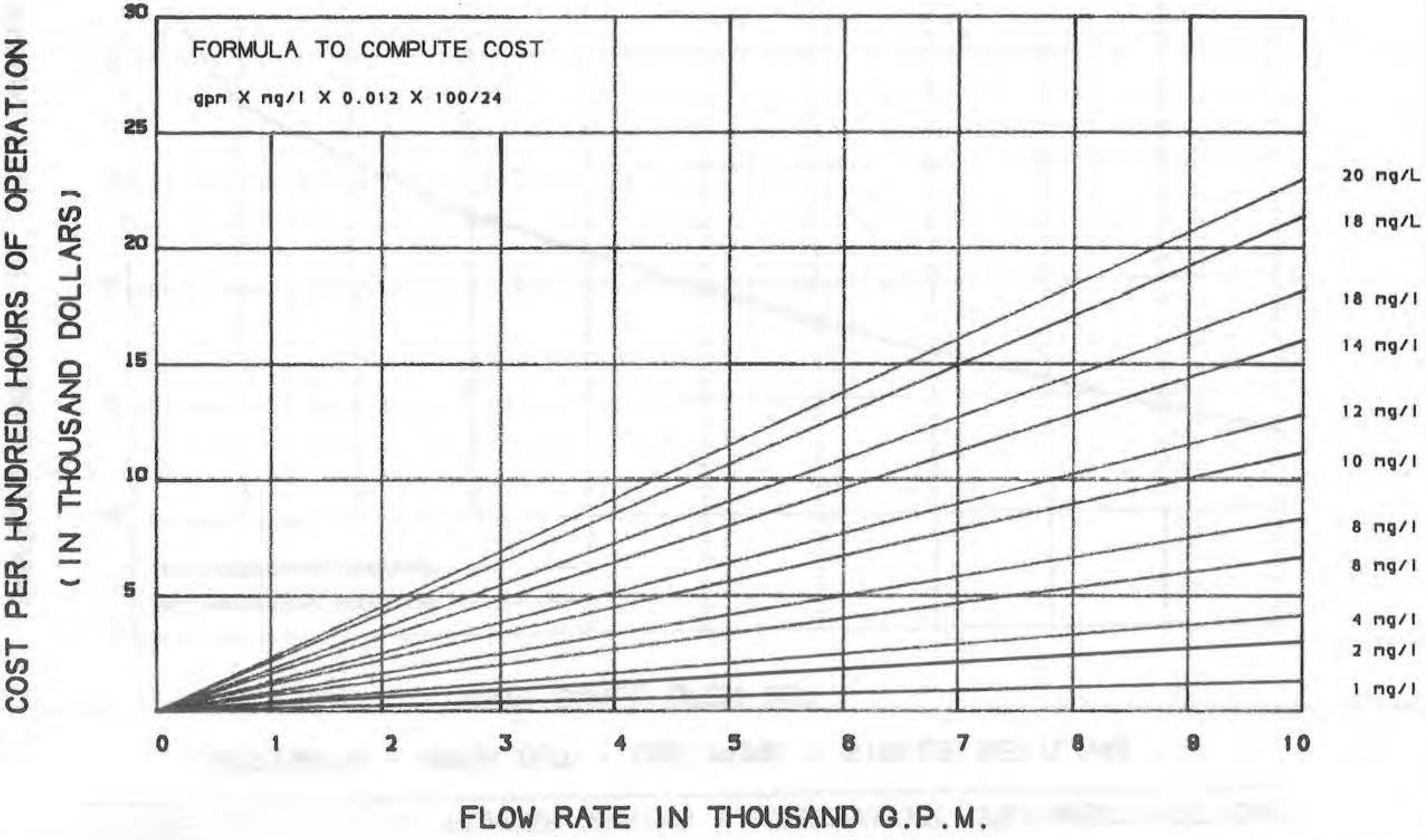


FIGURE No. VIII-12 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION A - OPEN CUT - ONE POND - SIMPLE SETTLING

VERY SMALL OPEN CUT

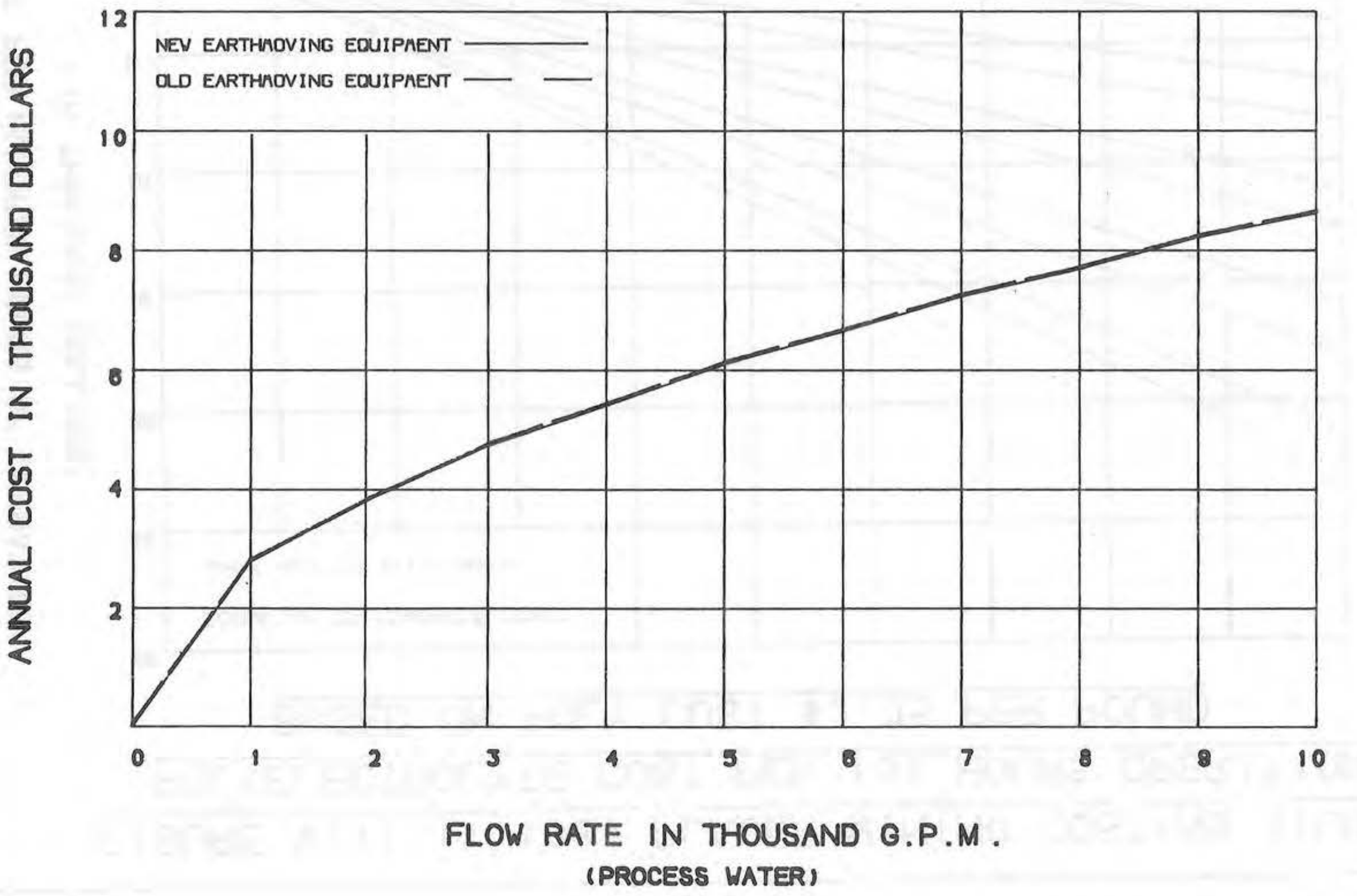


FIGURE No. VIII-13 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION A - OPEN CUT - ONE POND - SIMPLE SETTLING
SMALL OPEN CUT

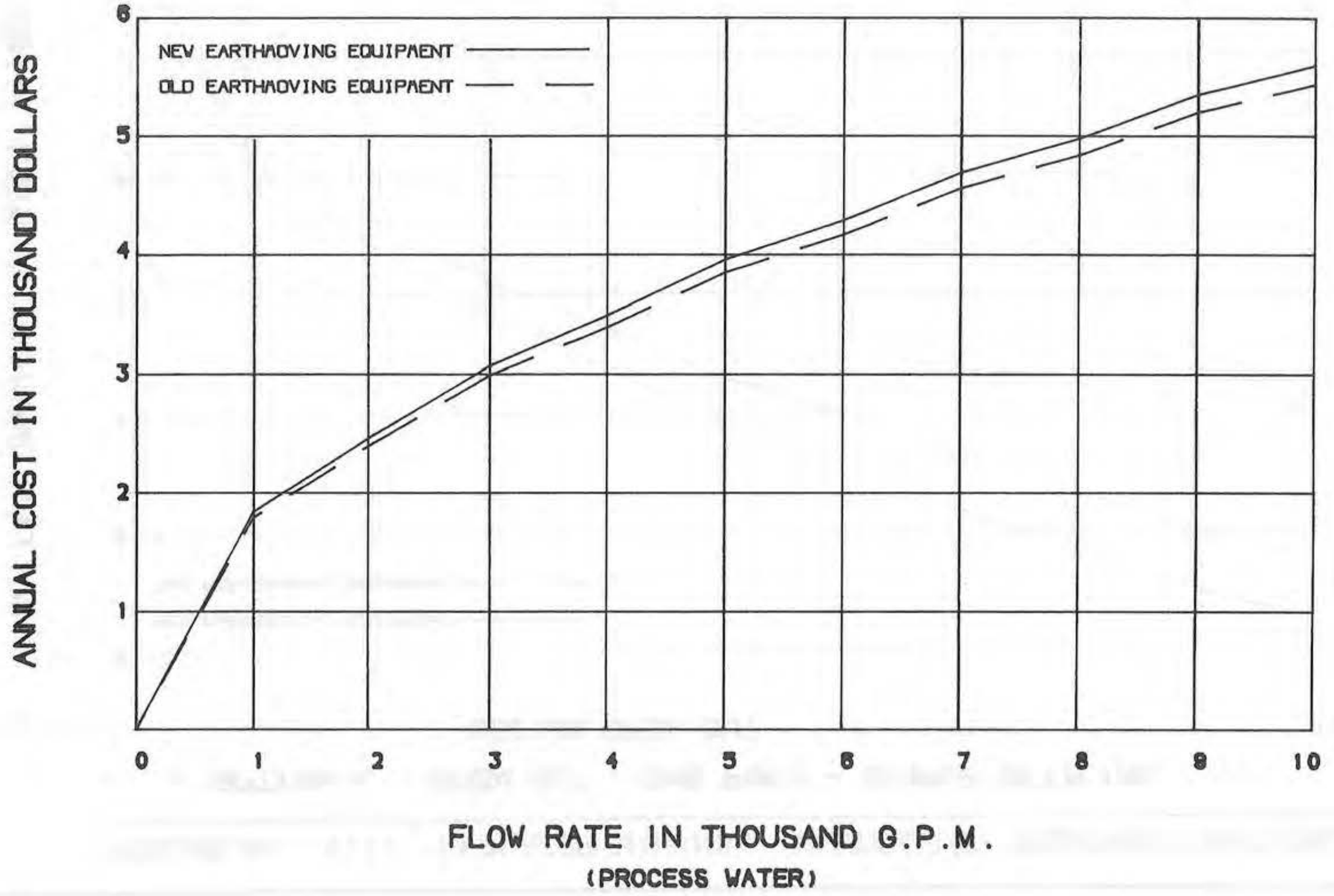


FIGURE No. VIII- 14 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION A - OPEN CUT - ONE POND - SIMPLE SETTLING

MEDIUM OPEN CUT

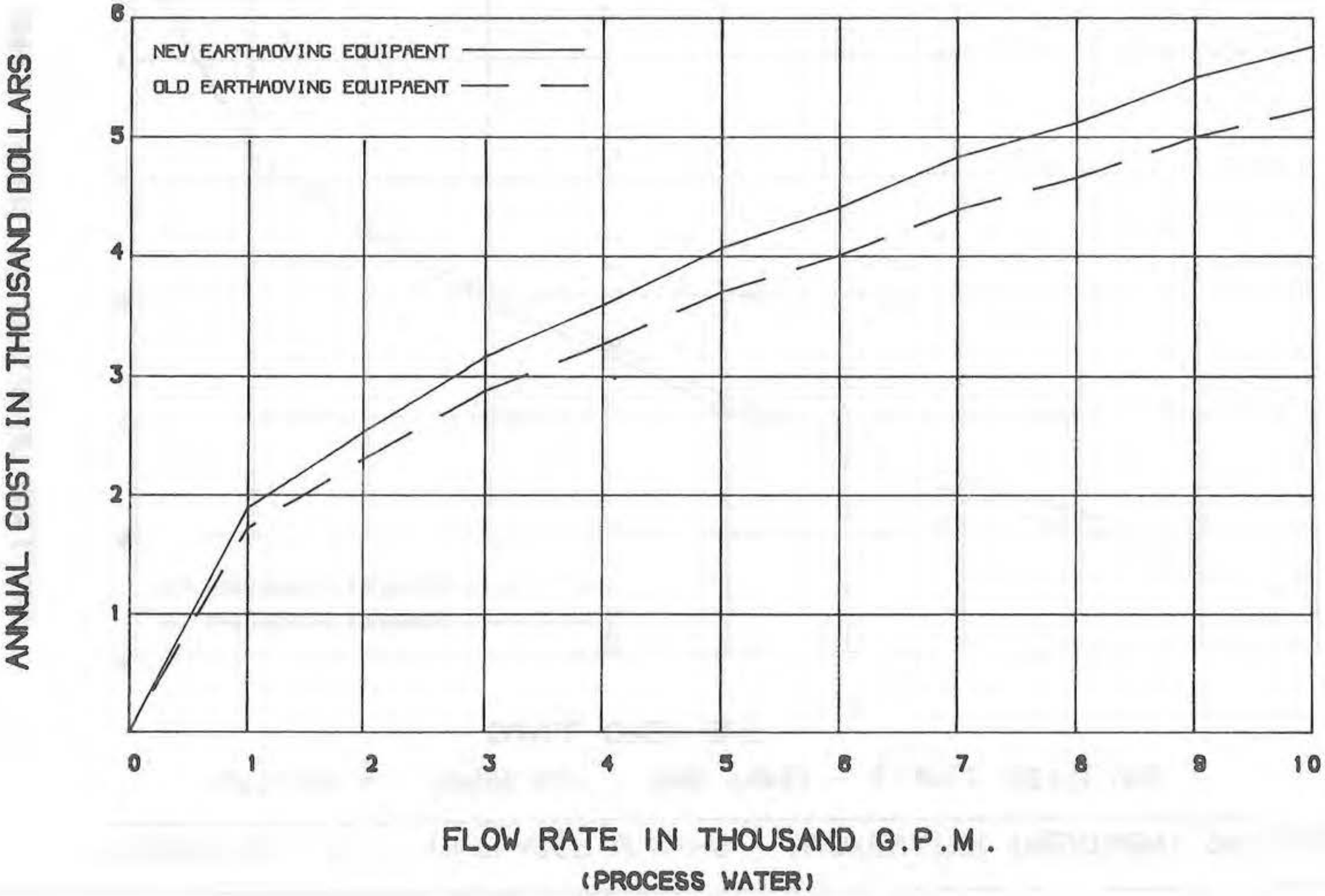


FIGURE No. VIII-15 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION A - OPEN CUT - ONE POND - SIMPLE SETTLING

LARGE OPEN CUT

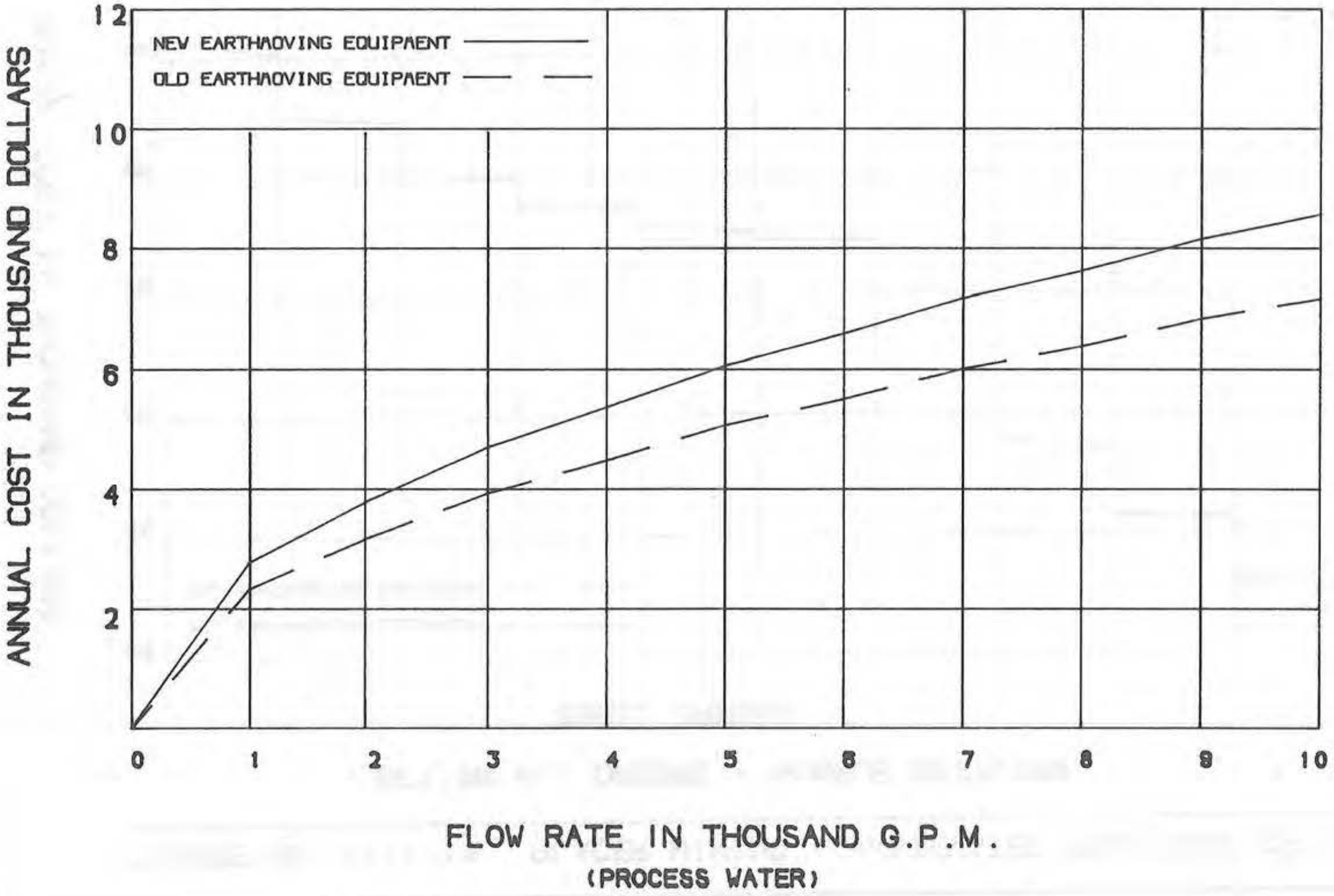


FIGURE No. VIII-16 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION A - DREDGE - SIMPLE SETTLING

SMALL DREDGE

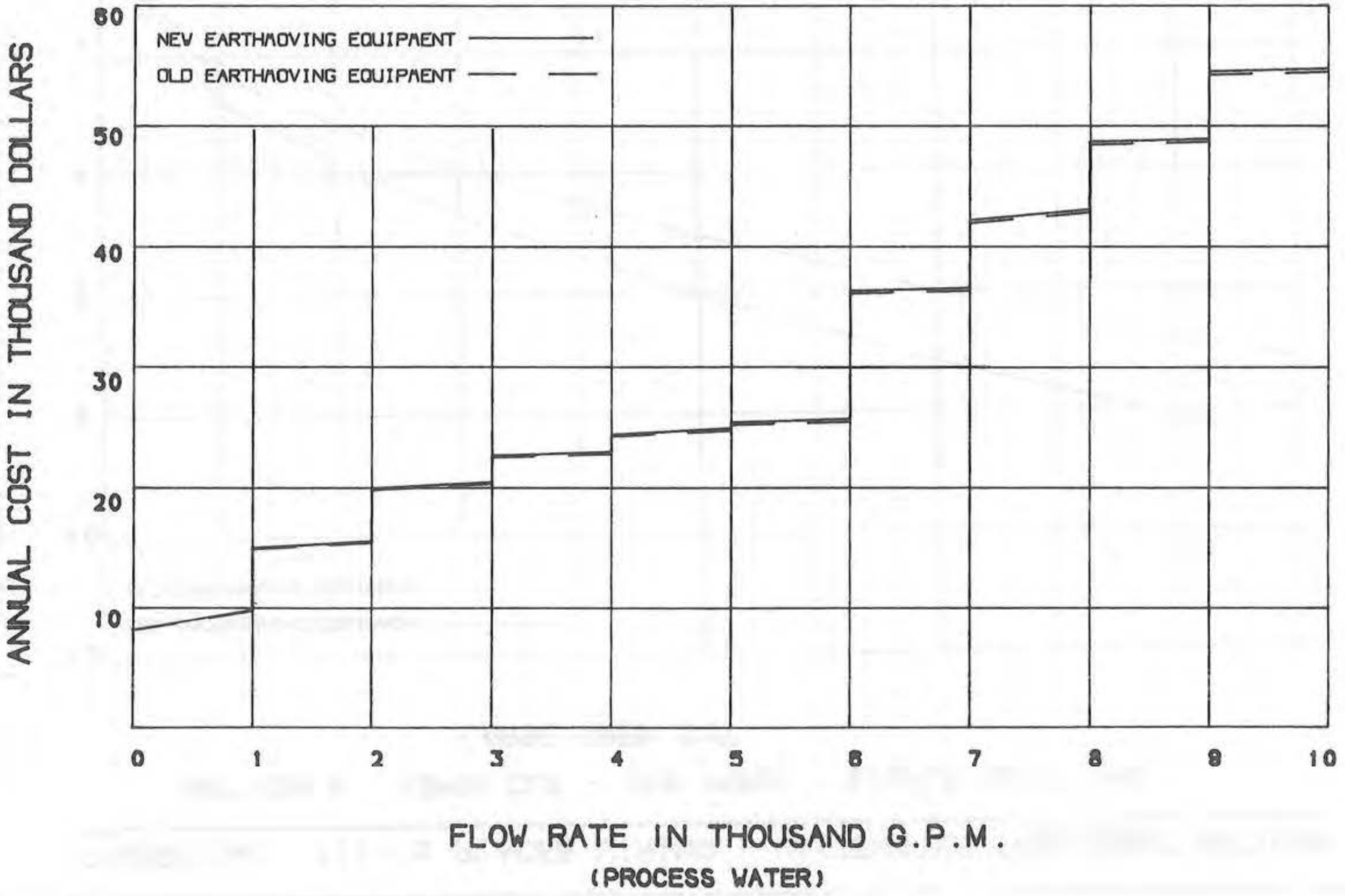


FIGURE No. VIII- 17 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION A - DREDGE - SIMPLE SETTLING
LARGE DREDGE

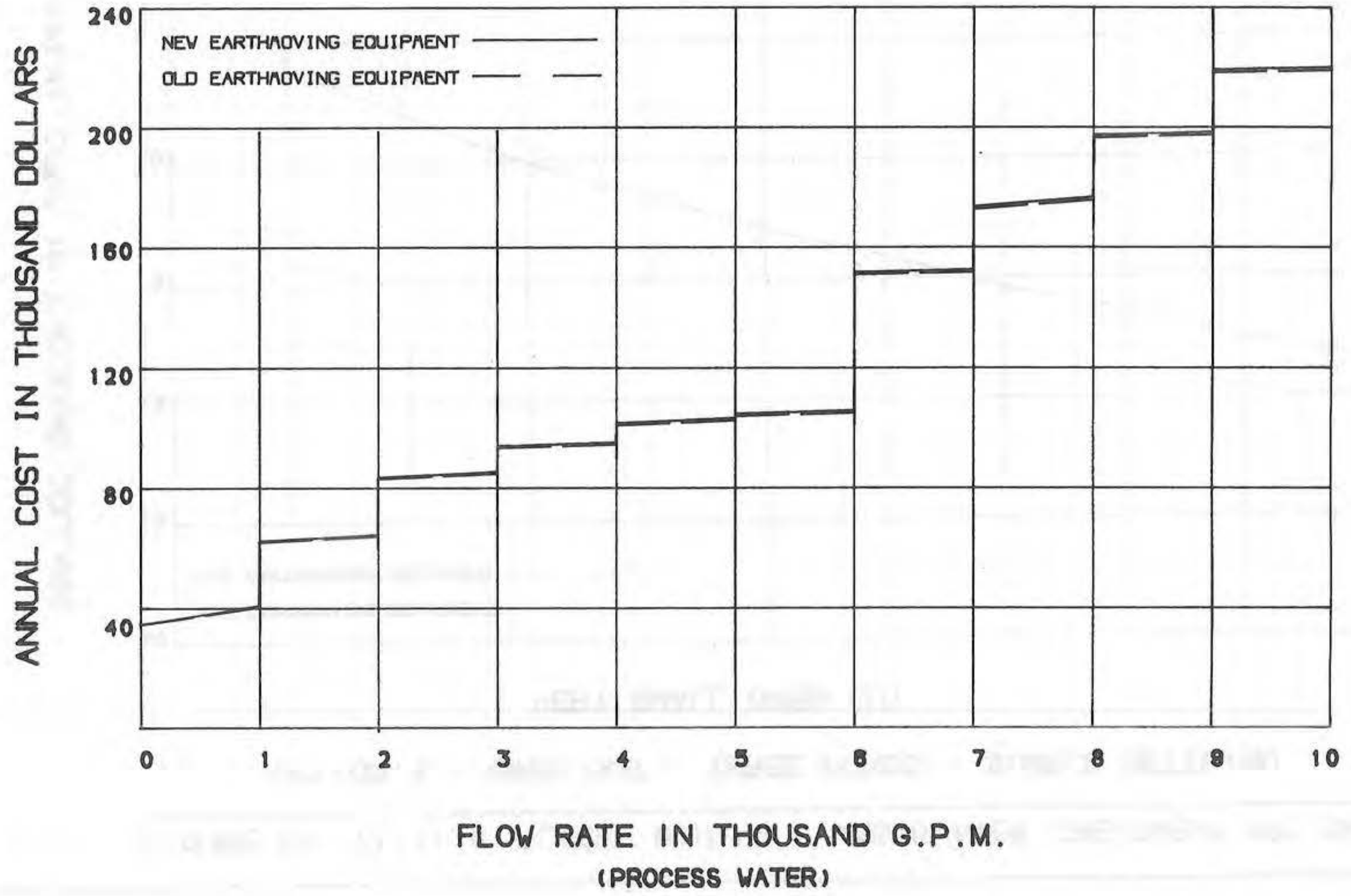


FIGURE No. VIII-18 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION A - OPEN CUT - THREE PONDS - SIMPLE SETTLING

VERY SMALL OPEN CUT

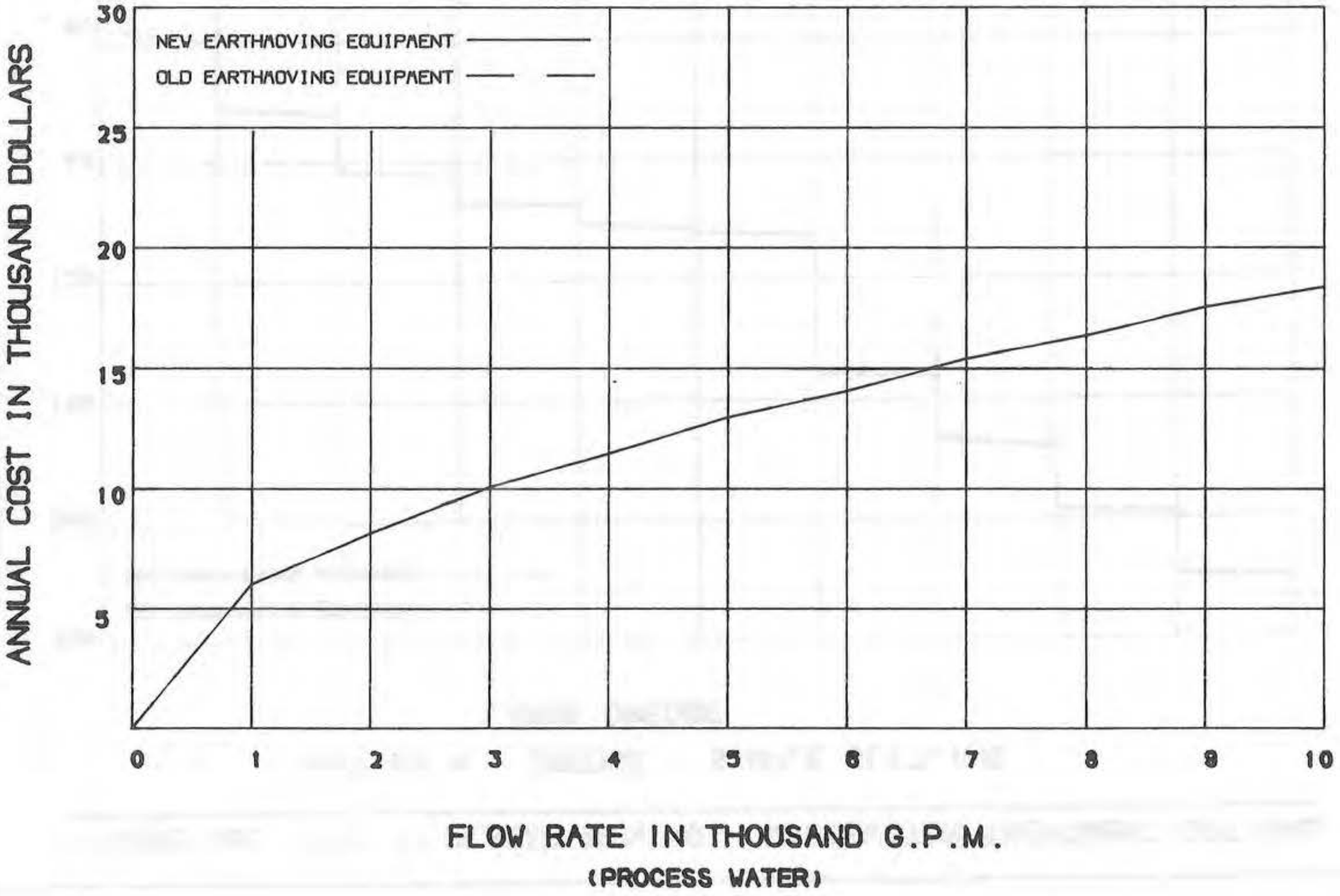


FIGURE No.VIII-19 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION A - OPEN CUT - FOUR PONDS - SIMPLE SETTLING

SMALL OPEN CUT

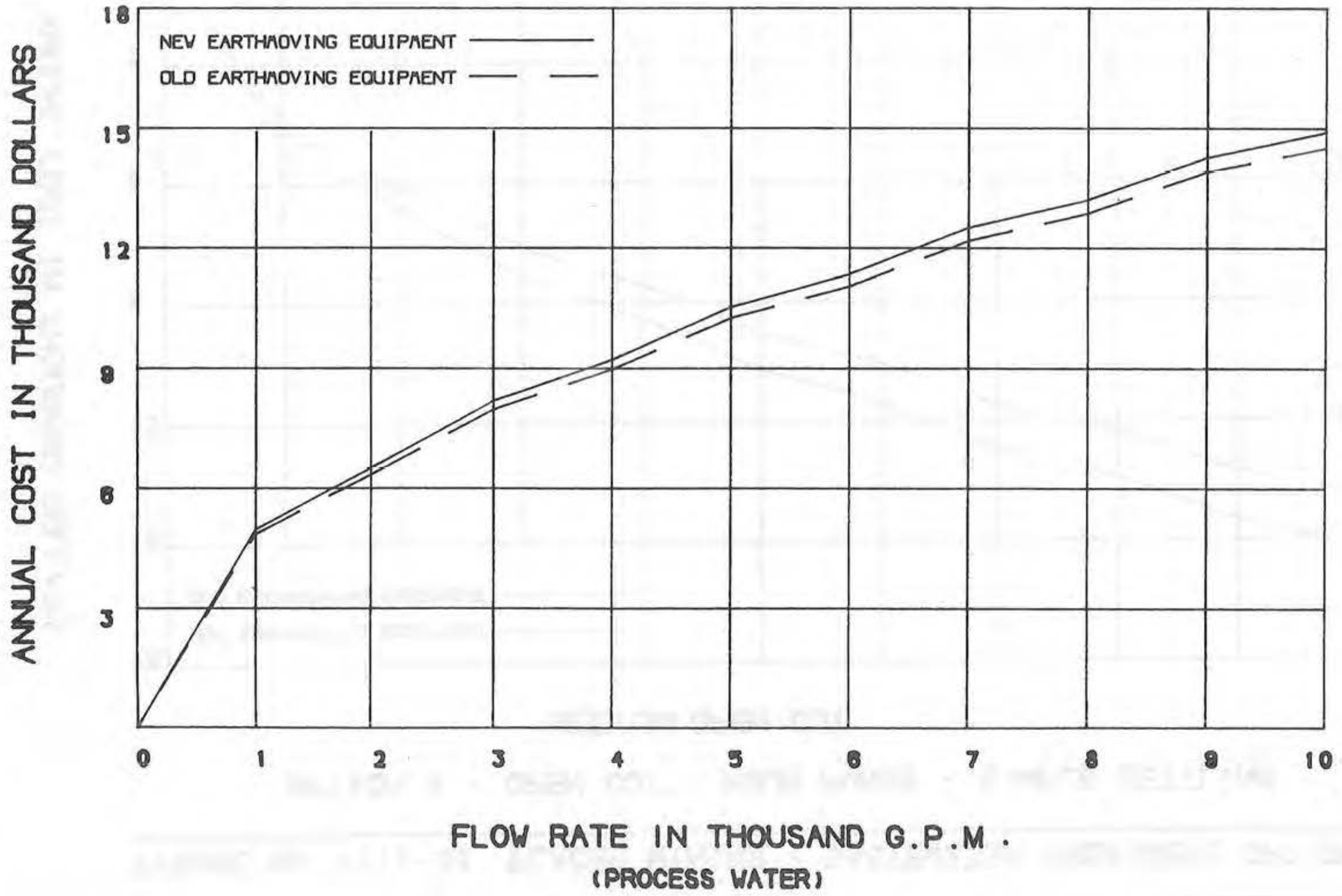


FIGURE No. VIII-20 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION A - OPEN CUT - FOUR PONDS - SIMPLE SETTLING

MEDIUM OPEN CUT

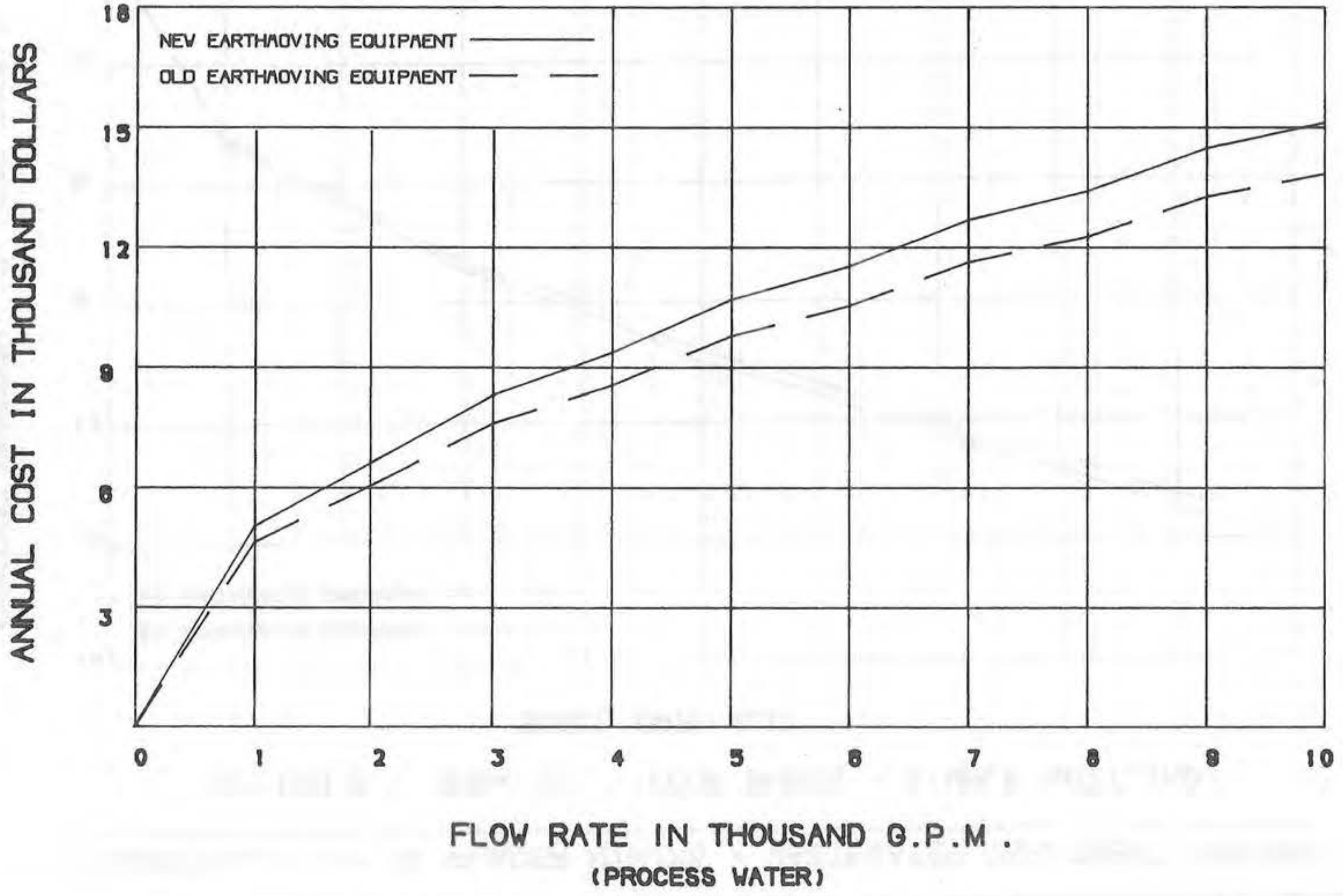


FIGURE No. VIII-21 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION A - OPEN CUT - FOUR PONDS - SIMPLE SETTLING

LARGE OPEN CUT

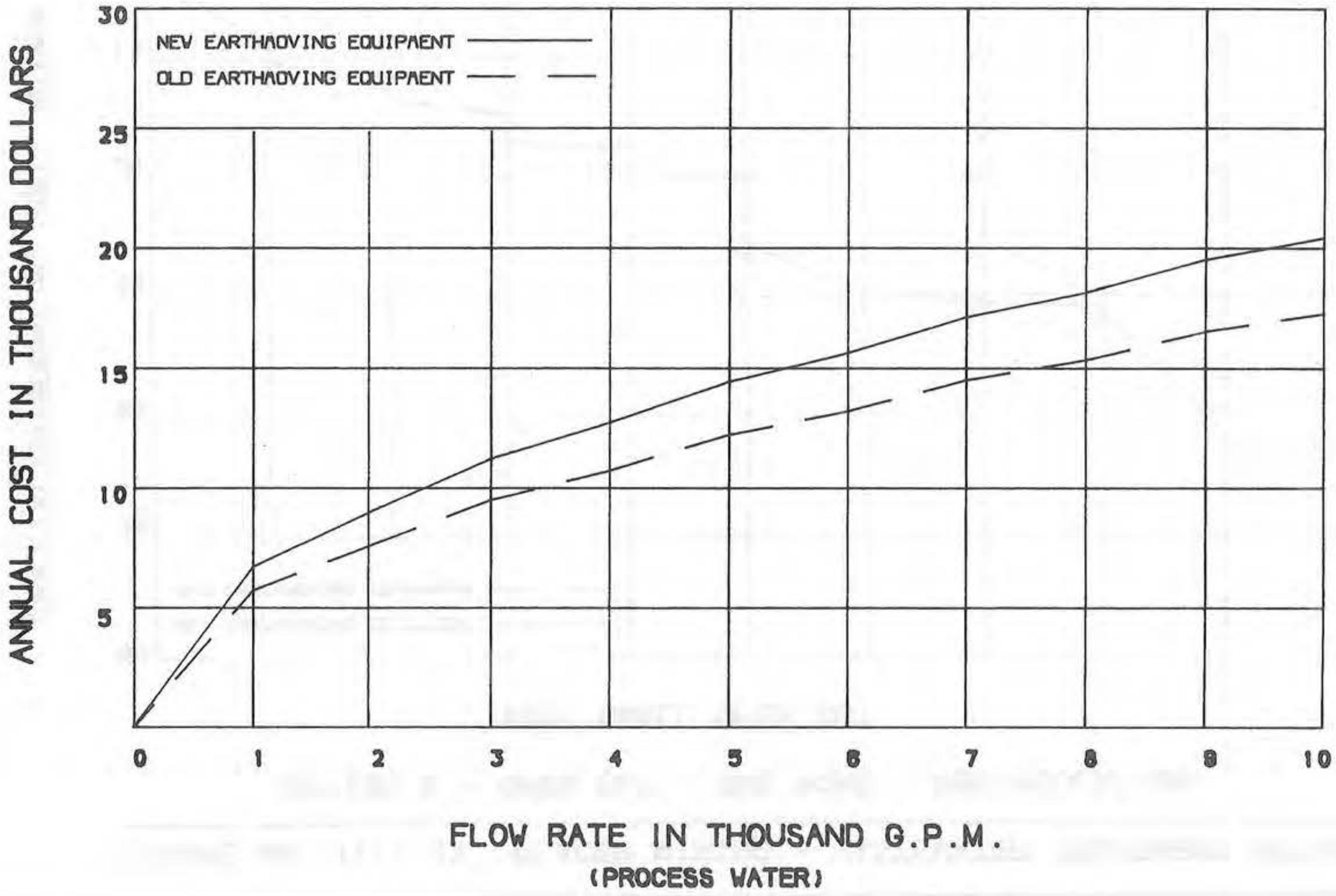


FIGURE No. VIII-22 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION B - OPEN CUT - ONE POND - RECIRCULATION

VERY SMALL OPEN CUT

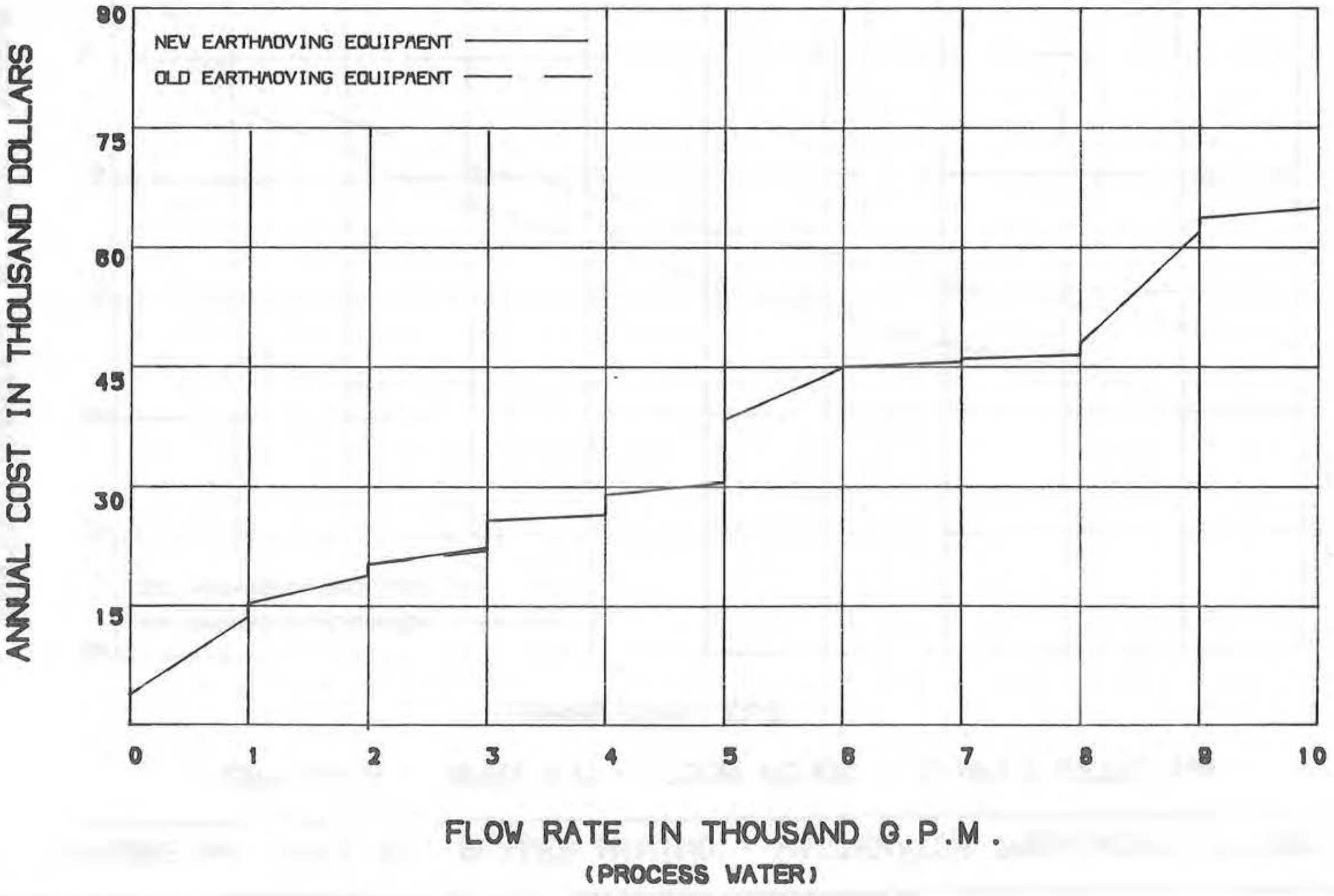


FIGURE No. VIII-23 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION B - OPEN CUT - ONE POND - RECIRCULATION

SMALL OPEN CUT

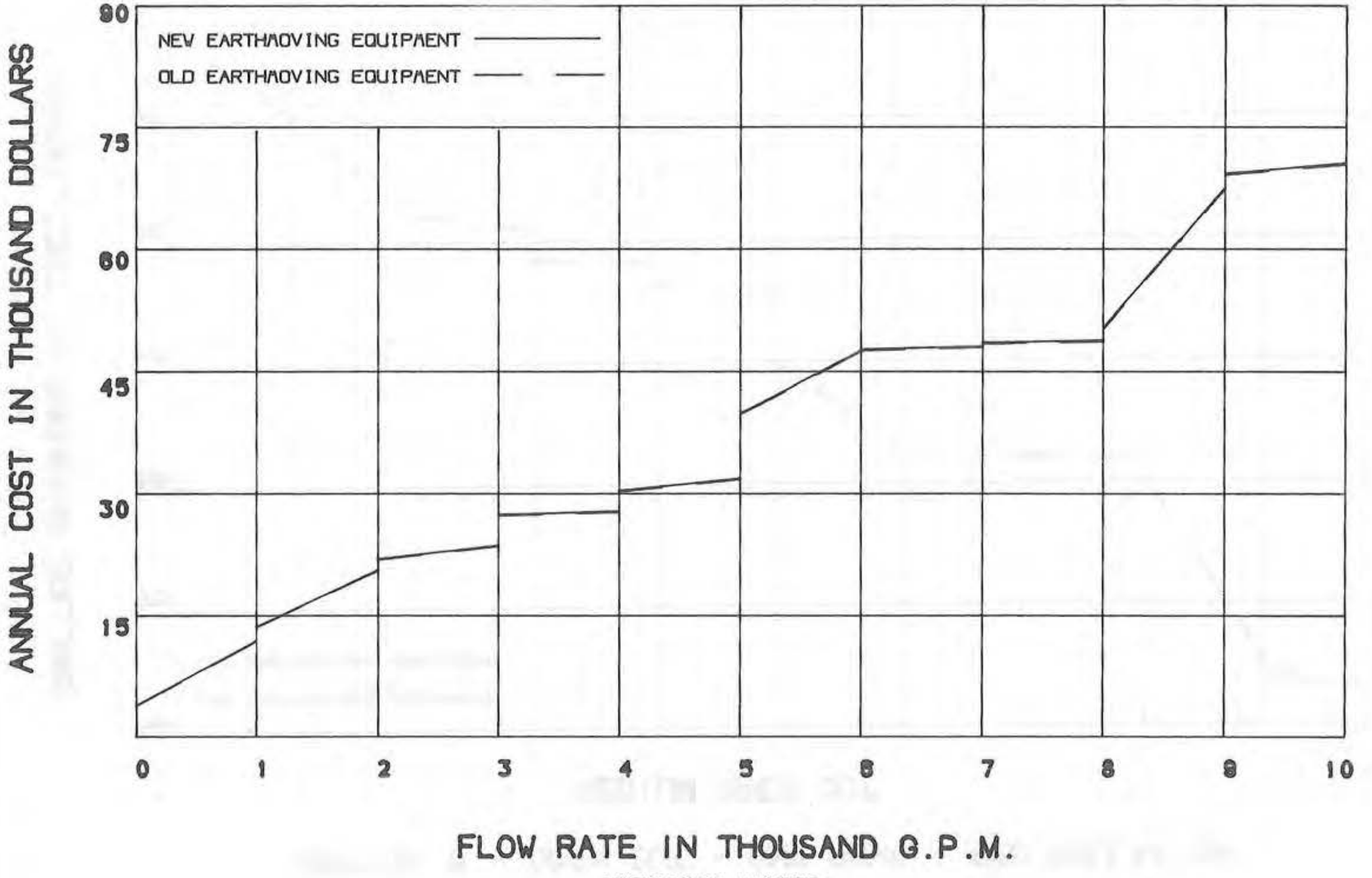


FIGURE No. VIII-24 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION B - OPEN CUT - ONE POND - RECIRCULATION

MEDIUM OPEN CUT

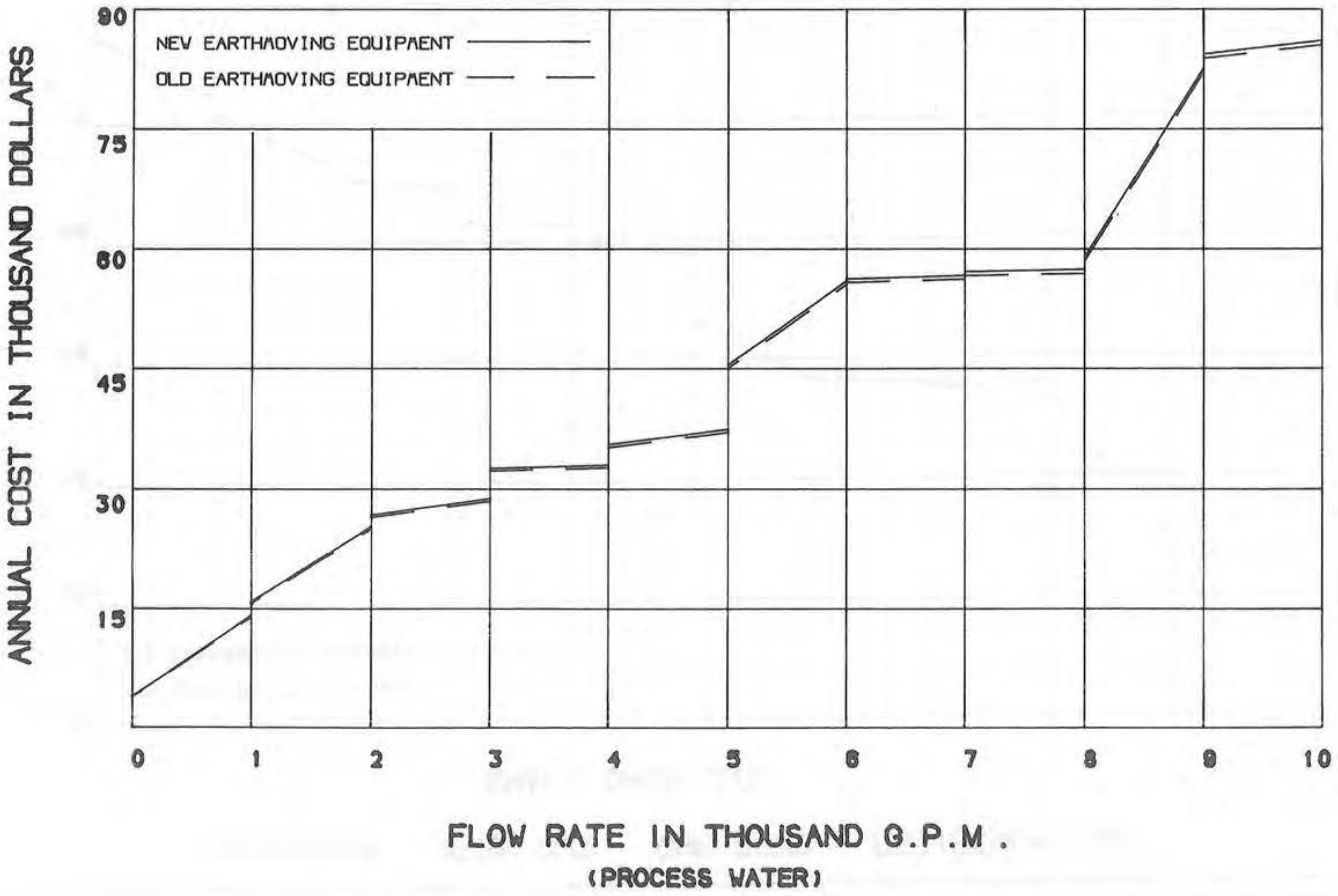


FIGURE No. VIII-25 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION B - OPEN CUT - ONE POND - RECIRCULATION

LARGE OPEN CUT

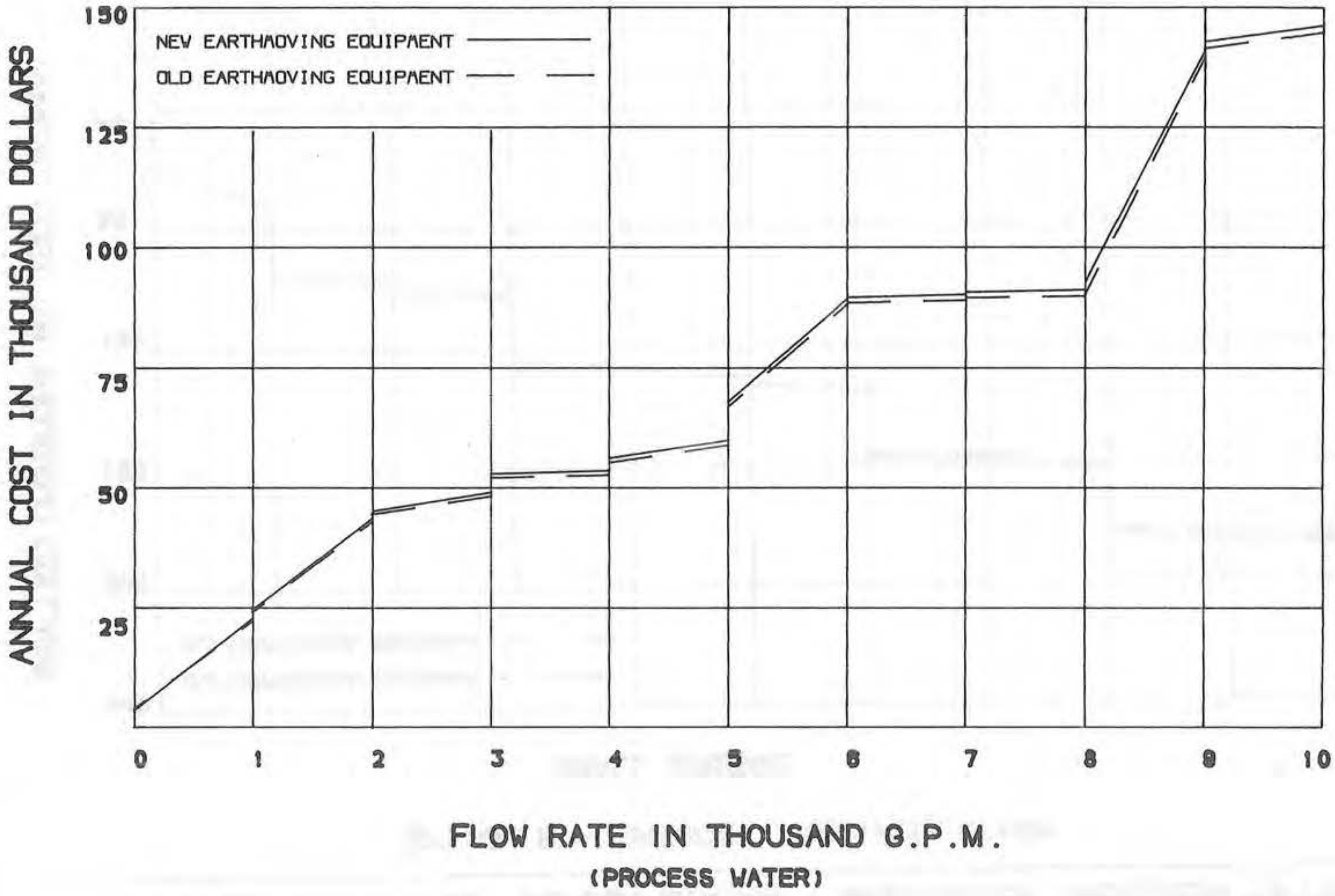


FIGURE No. VIII-26 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION B - DREDGE - RECIRCULATION

SMALL DREDGE

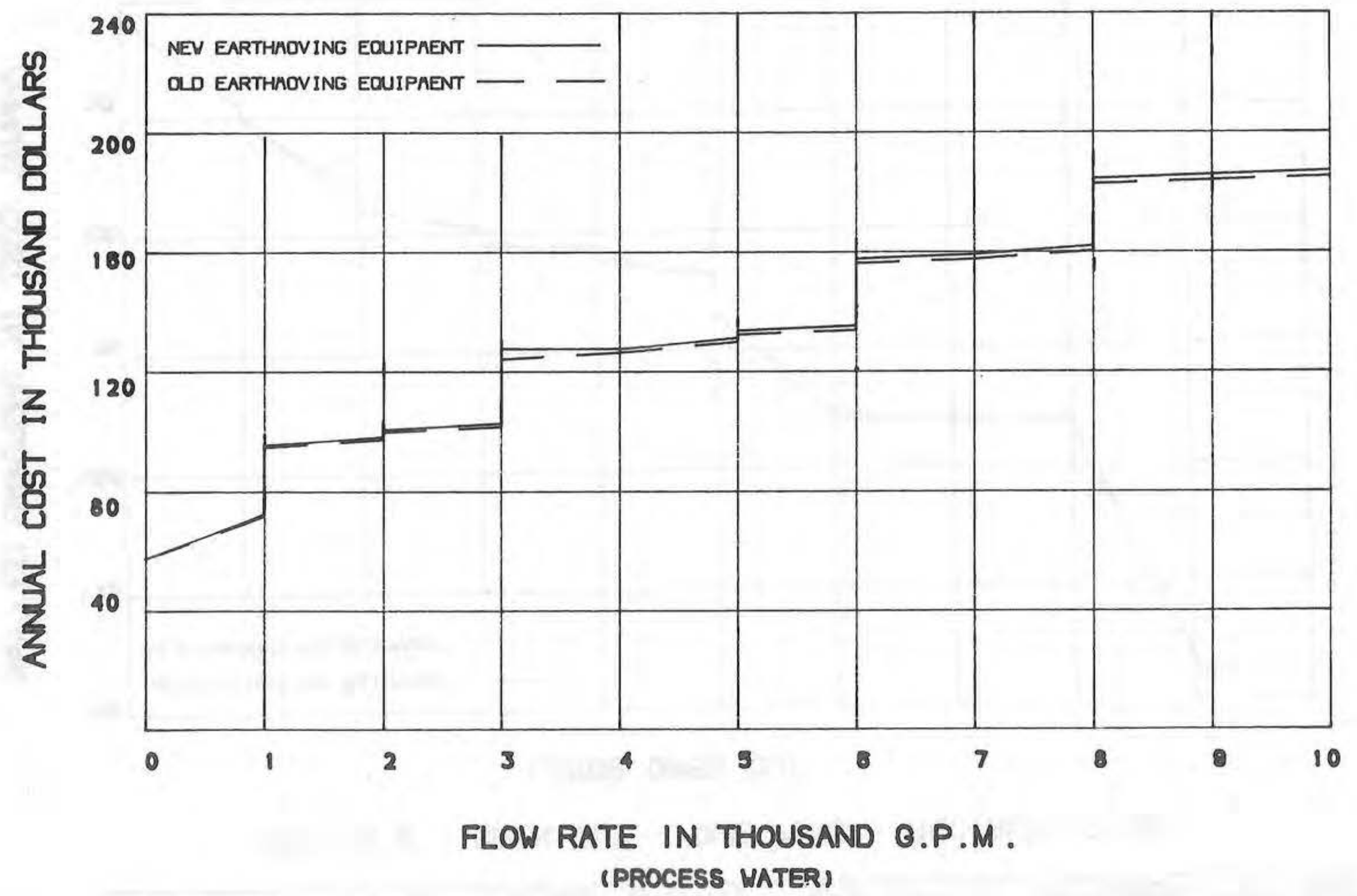


FIGURE No. VIII-27 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION B - DREDGE - RECIRCULATION

LARGE DREDGE

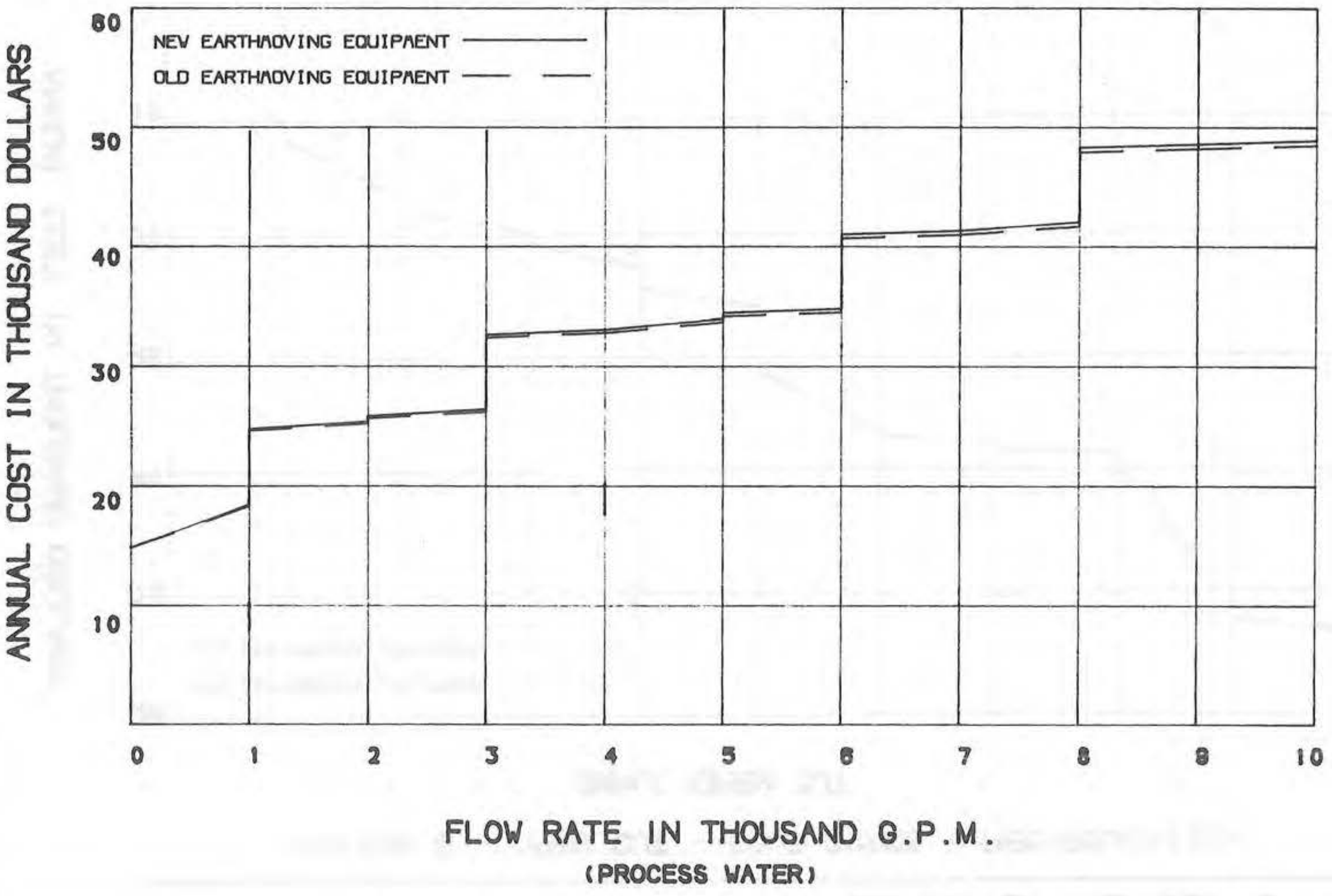


FIGURE No. VIII-29 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION B - OPEN CUT - FOUR PONDS - RECIRCULATION

SMALL OPEN CUT

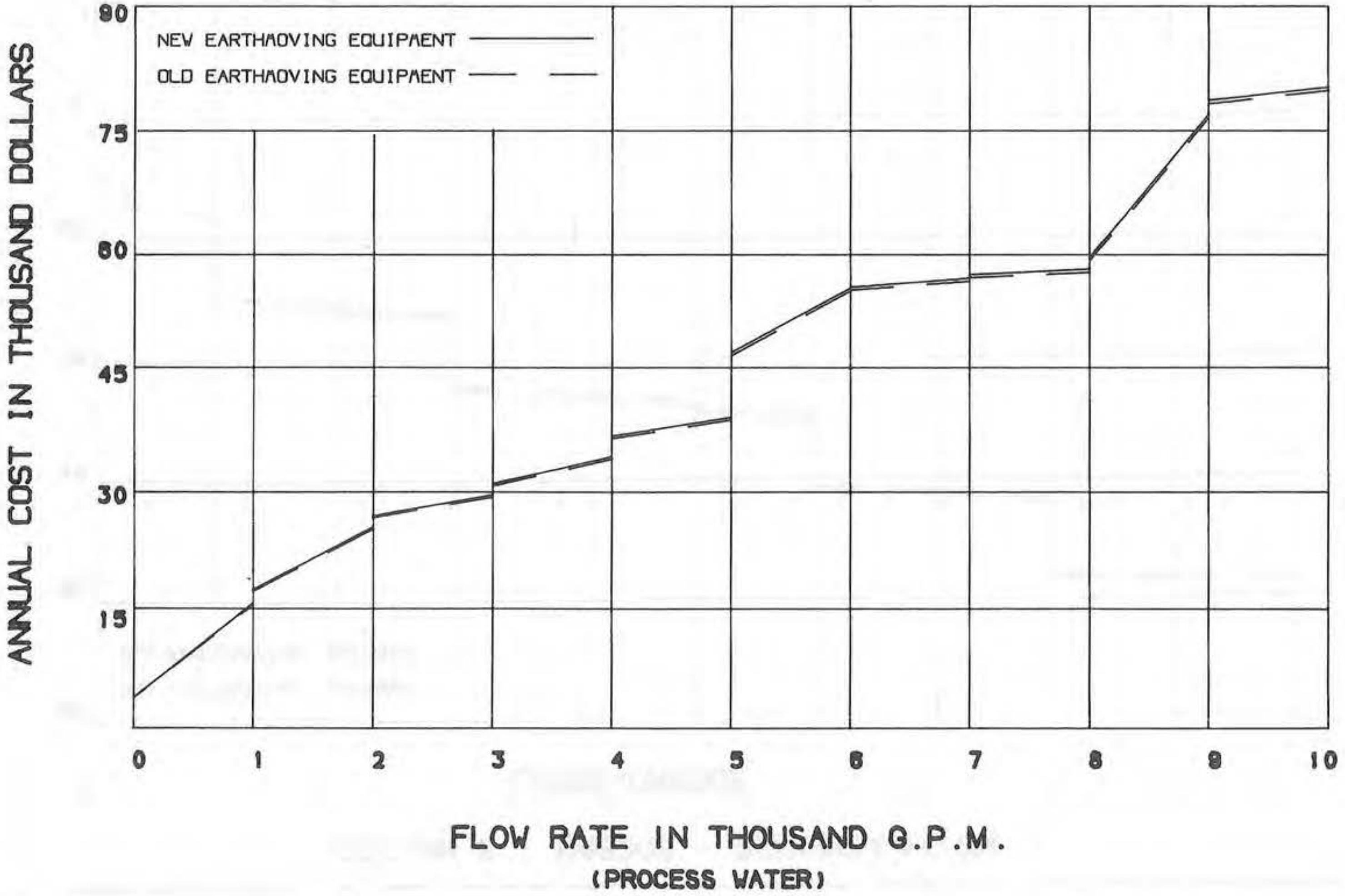


FIGURE No. VIII-28 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION B - OPEN CUT - THREE PONDS - RECIRCULATION

VERY SMALL OPEN CUT

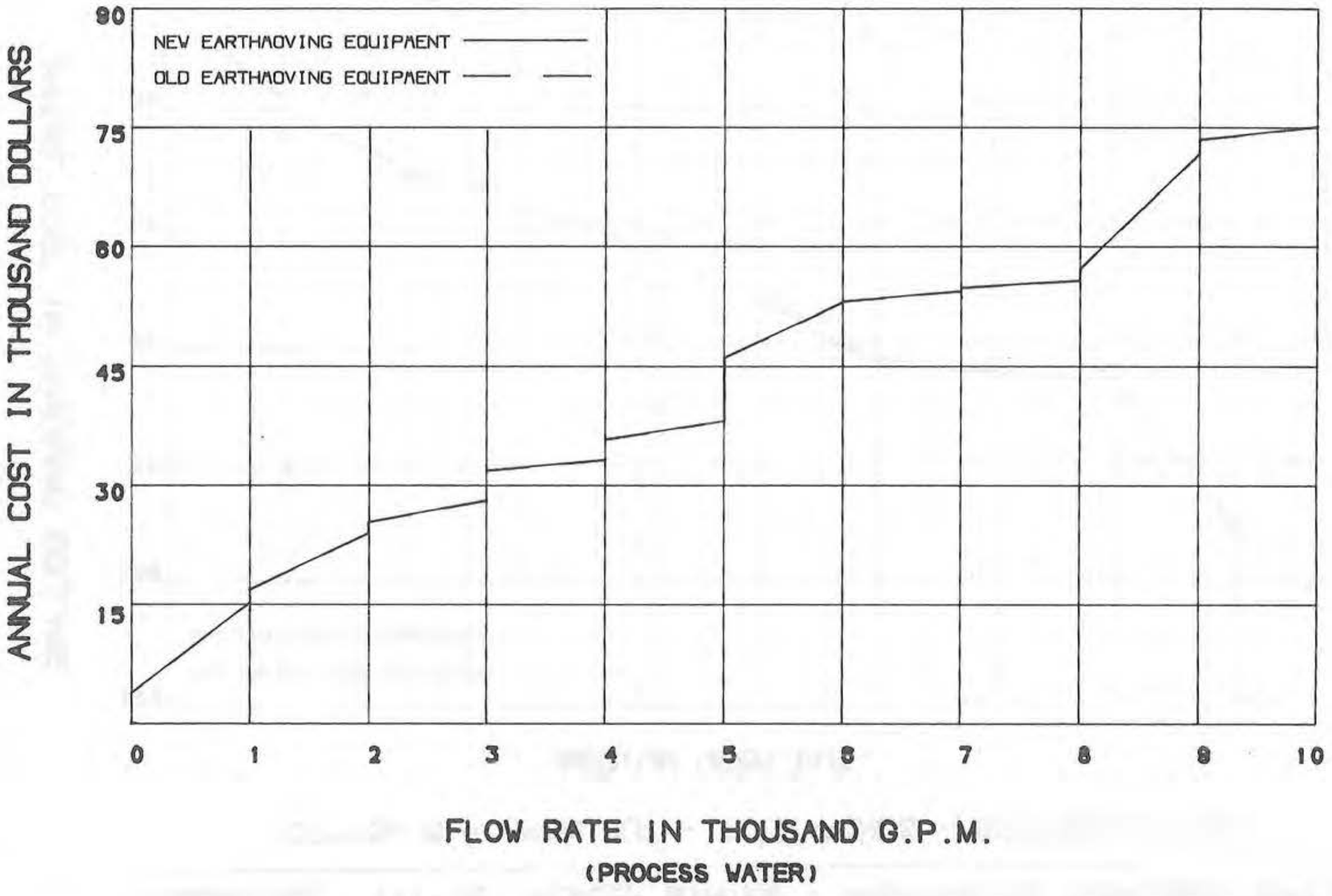


FIGURE No. VIII-30 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION B - OPEN CUT - FOUR PONDS - RECIRCULATION

MEDIUM OPEN CUT

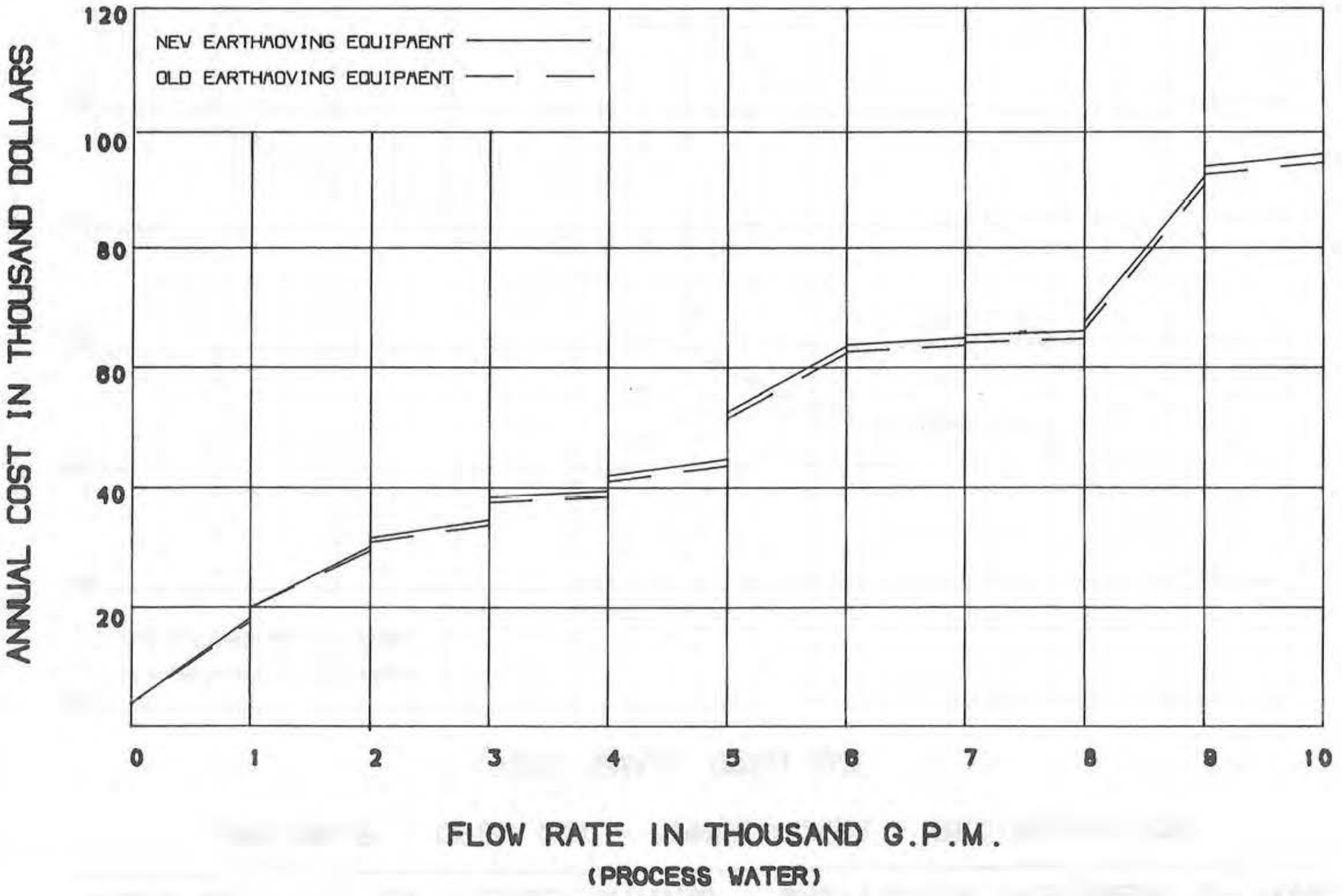


FIGURE No. VIII-31 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION B - OPEN CUT - FOUR PONDS - RECIRCULATION

LARGE OPEN CUT

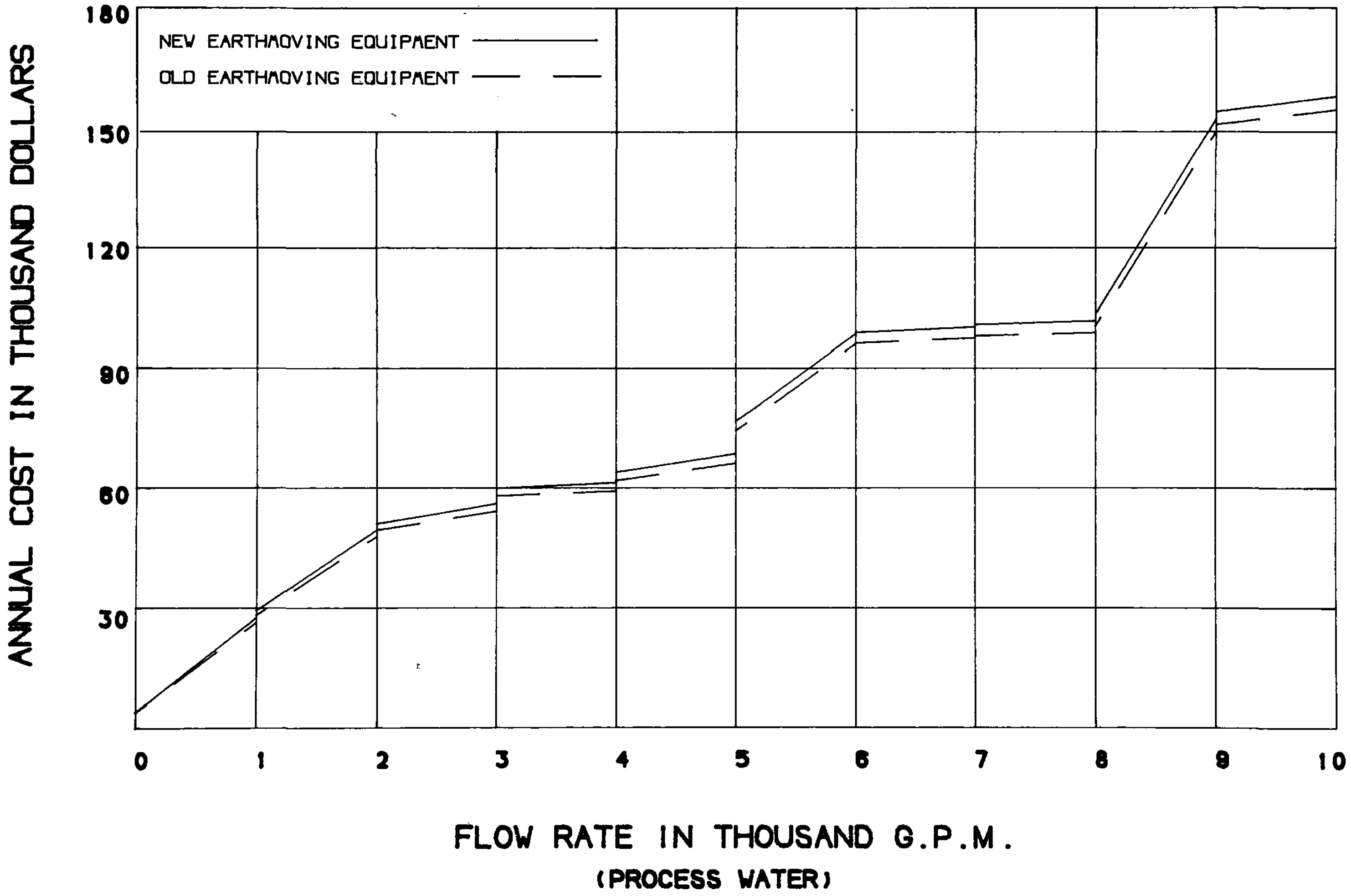


FIGURE No. VIII-32 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION C - OPEN CUT - CHEMICAL TREATMENT OF TOTAL FLOW

VERY SMALL OPEN CUT

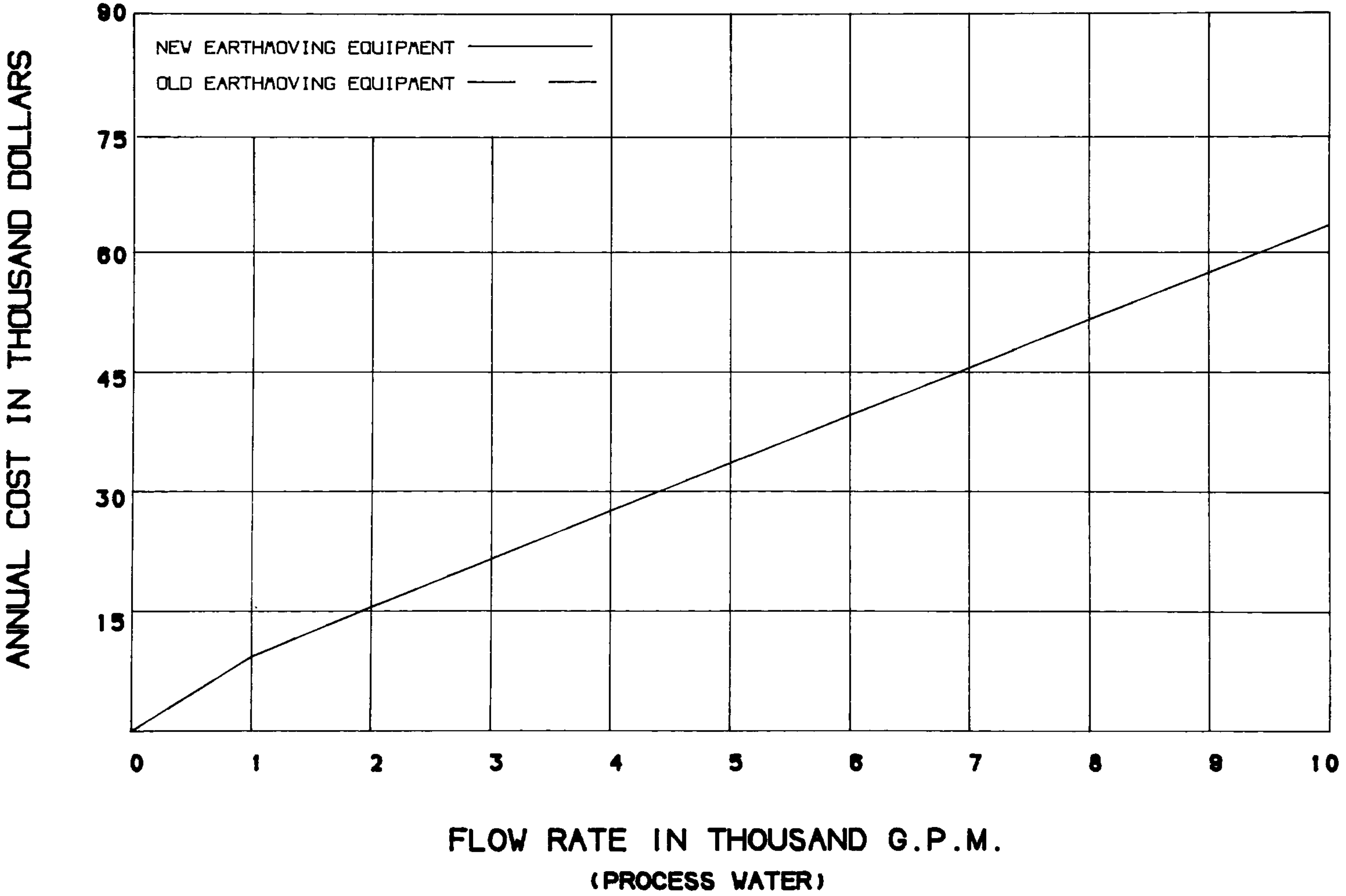


FIGURE No. VIII-33 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION C - OPEN CUT - CHEMICAL TREATMENT OF TOTAL FLOW

SMALL OPEN CUT

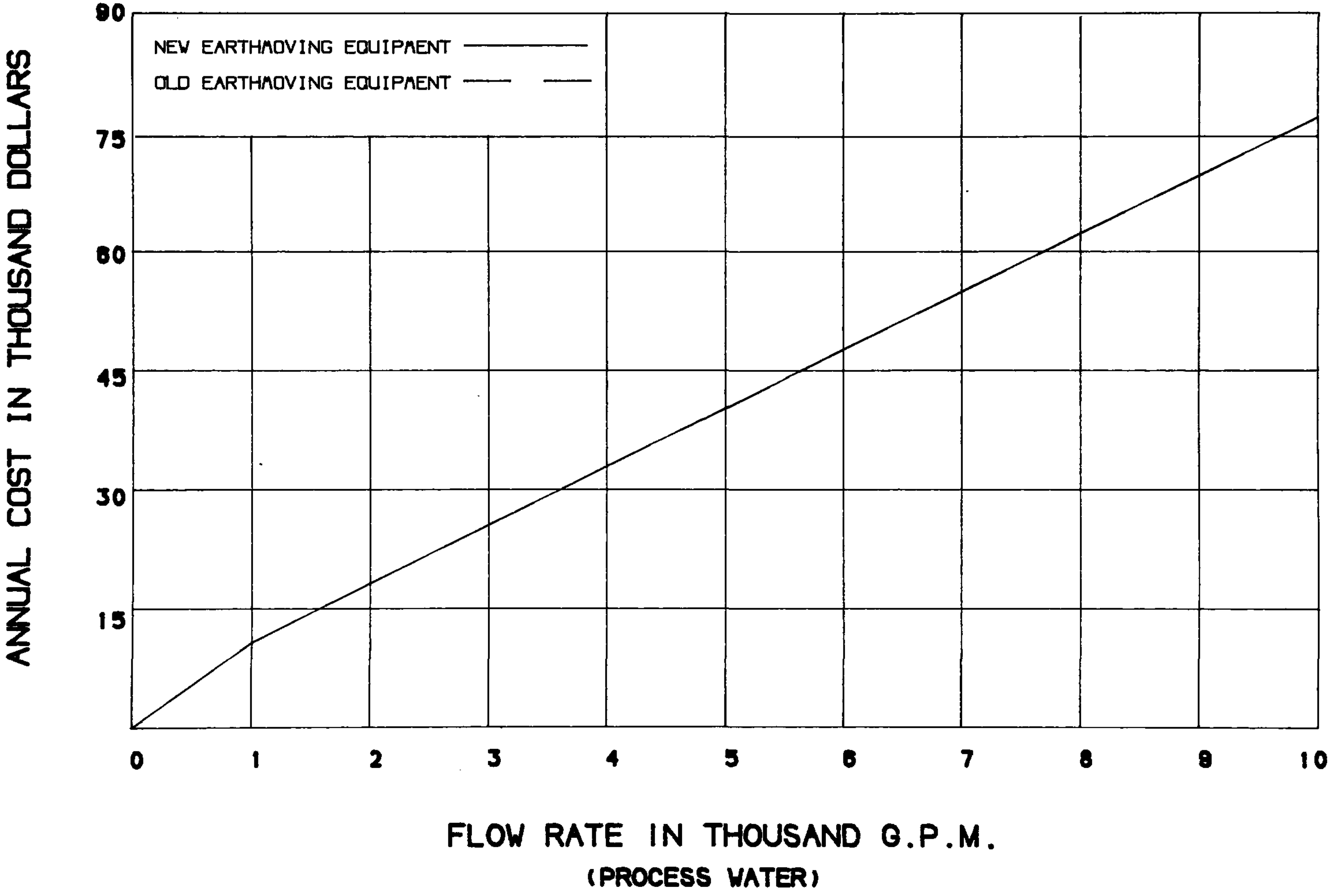


FIGURE No. VIII-34 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION C - OPEN CUT - CHEMICAL TREATMENT OF TOTAL FLOW

MEDIUM OPEN CUT

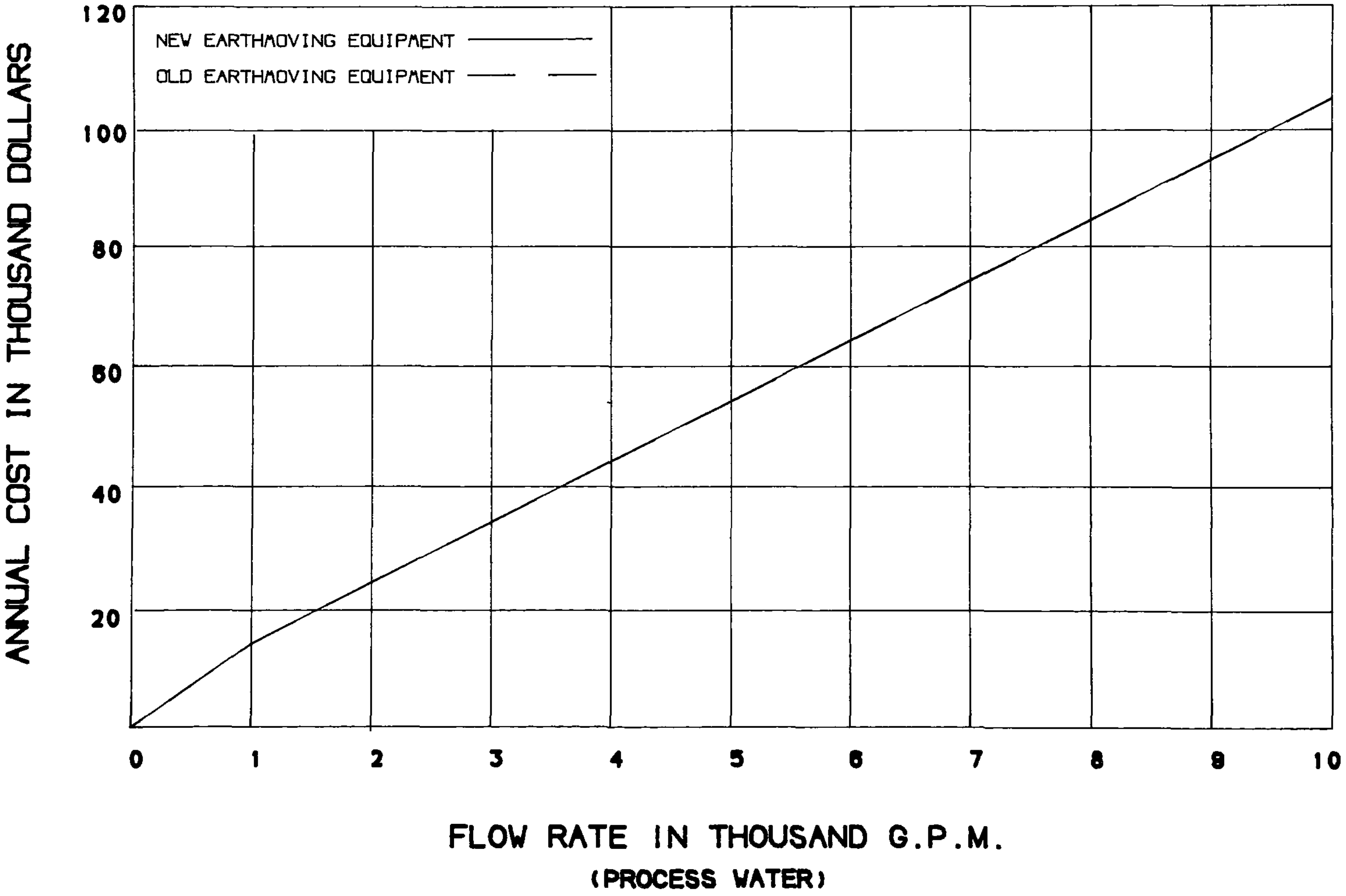


FIGURE No. VIII-35 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION C - OPEN CUT - CHEMICAL TREATMENT OF TOTAL FLOW

LARGE OPEN CUT

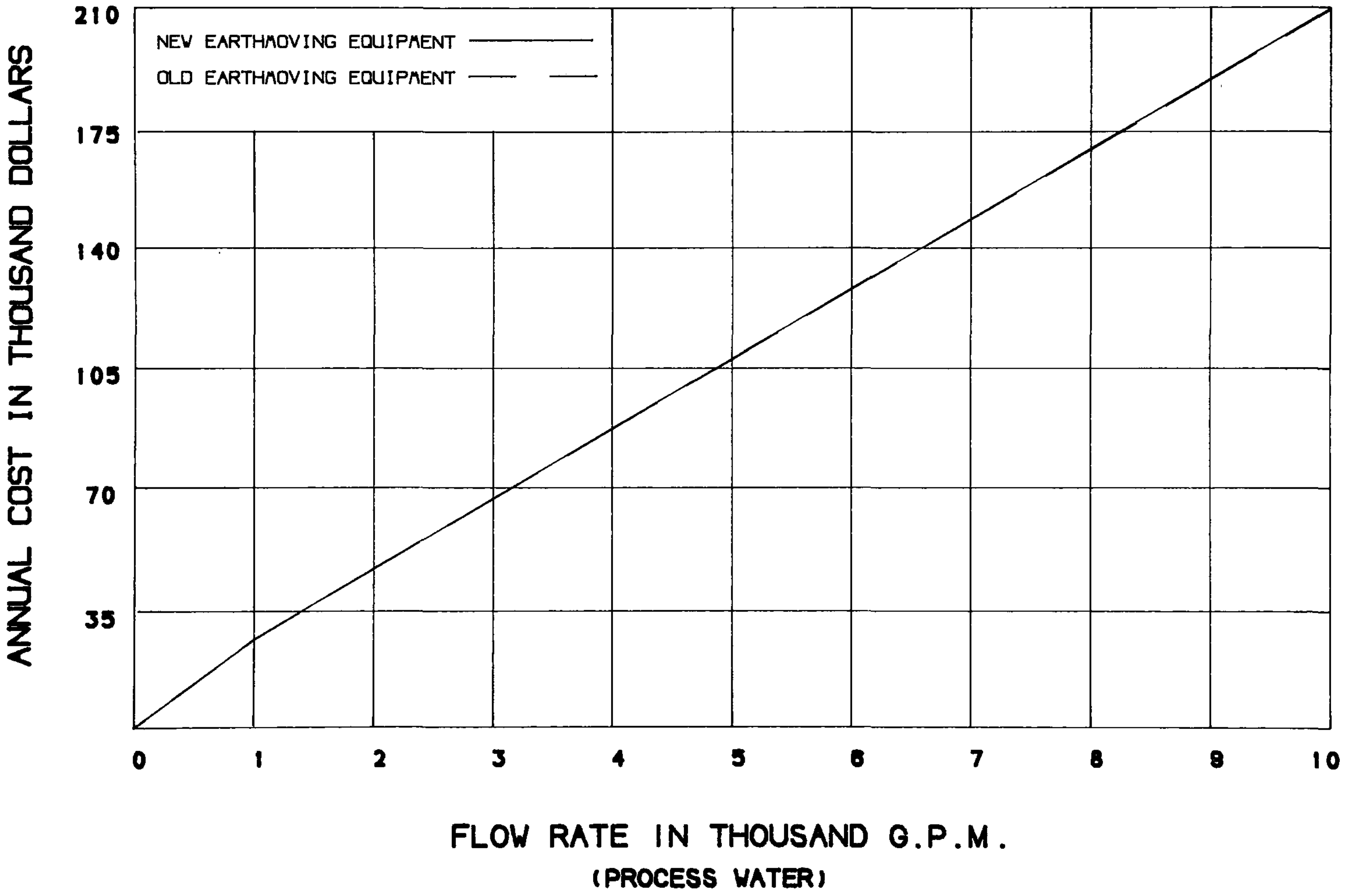


FIGURE No. VIII-36 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION C - DREDGE - CHEMICAL TREATMENT OF TOTAL FLOW

SMALL DREDGE

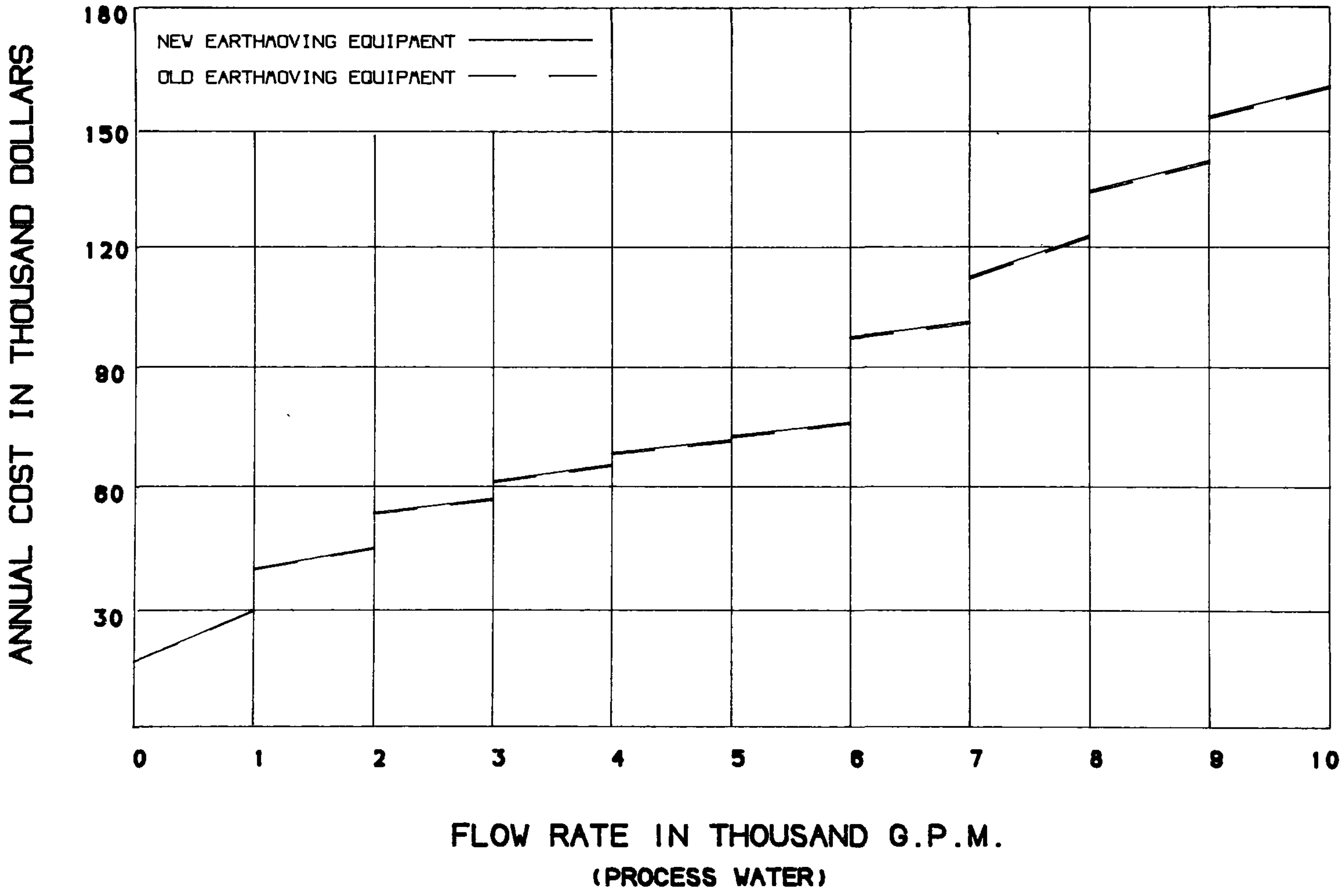
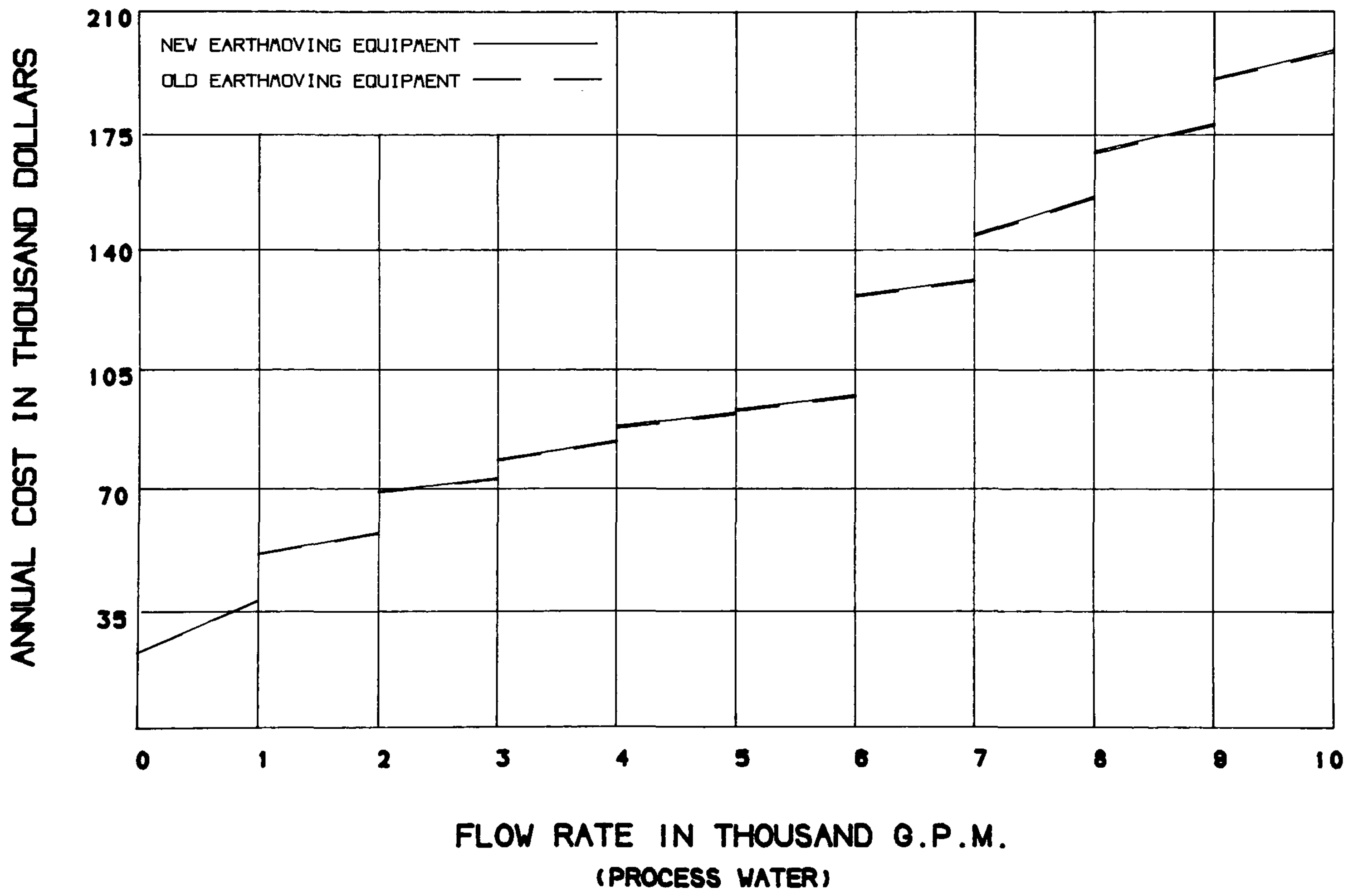


FIGURE No. VIII-37 PLACER MINING - WASTEWATER TREATMENT OPTIONS

OPTION C - DREDGE - CHEMICAL TREATMENT OF TOTAL FLOW

LARGE DREDGE



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SECTION IX

BEST PRACTICABLE TECHNOLOGY (BPT)

This section defines the effluent characteristics attainable through the application of the best practicable control technology currently available (BPT) as required by Section 301(b)(1)(A) of the Clean Water Act. BPT reflects the performance by plants of various sizes, ages, and processes within the gold placer mine subcategory. Particular consideration is given to the treatment already in place.

BPT limitations for eleven subcategories of the ore mining category were promulgated in 1978 and were upheld in the courts (see Kennecott Copper Corp. v. EPA, 612 F.2d 1232 (10th Cir. 1979)). Effluent limitations for gold placer mines were not promulgated at that time and have been delayed until additional information could be developed. While the initial date for compliance with BPT (1977) has passed, EPA is promulgating BPT because BPT is a necessary baseline for BCT, BAT, and other requirements of the CWA.

The effluent limitations and standards for all ore mining and dressing facilities regulated by Subpart M (Gold Placer Mines) are applicable to point source discharges from active mines, active mills, and beneficiation plants and are not applicable to closed or abandoned mines or mills, or to discharges from mine areas being reclaimed, or to point or non-point sources from areas outside of the mine area. These effluent limitations apply to facilities discharging wastewater from mines that produce gold or gold bearing ores from gold placer deposits and the beneficiation processes to recover gold or gold bearing ore which use gravity separation methods. This regulation does not apply to gold mines extracting ores (hard rock ores and mines) other than gold placer deposits nor to the gold ore mills associated with hard rock mines regardless of the extraction process used in those mills. This regulation does not apply to the wastewaters from gold or gold ore extraction processes from gold placer deposits that use cyanide or other chemicals for leaching gold or to extraction processes that use froth flotation methods. These effluents are regulated in the 1982 rulemaking for ore mining.

The data and information contained in this document apply primarily to the process wastewater discharges from the beneficiation process. The promulgated effluent limitations and standards apply to this process wastewater and to mine drainage. However, any other waters such as surface water, and infiltration (groundwater) which becomes commingled with the beneficiation process water or wastewater is also subject to these limitations and standards.

SUBCATEGORIZATION OF GOLD PLACER MINES

As discussed in Section IV, for the purposes of developing effluent limitations guidelines and standards, gold placer mining is defined as a separate subcategory in the Ore Mining and Dressing point source category. The gold placer mine subcategory establishes a small size cutoff for both open-cut mines and dredges. While these small operations are not regulated by those limitations and standards, they are required by the provisions of the CWA to obtain an NPDES permit for any discharges to waters of the United States. Mines that process less than 1,500 cu yds of ore per year, or dredges processing less than 50,000 cu yds per year, and operations in open water (e.g., open marine waters, bays, or major rivers) are not regulated by this gold placer mine subpart. Mines that process less than 1,500 cu yds of ore per year generally are intermittent, recreational, prospecting, development, or assessment operations. Because of the diversity among these operations, the preferable approach is to develop effluent limits for them based on the permit writer's best professional judgment. Dredges processing less than 50,000 cu yd per year are not included because their existence was brought to the attention of the Agency very late in the regulatory process and the Agency was unable to develop, in a timely manner, the technical data and economic models that are basic to regulation. This small number of dredges can be regulated using the permit writer's best professional judgment. Operations conducted in open waters are not covered because the Agency has little information as to number, location, or applicable technologies for these facilities. Permits for these operations will be based on the permit writer's best professional judgment.

The final economic impact analysis of gold placer mines did not indicate any need for subcategorization based on economic factors related to any of the technical options considered or to the sizes of the facilities regulated. The obvious physical differences in open-cut mines and dredges make it appropriate to separately identify these entities in the regulation. No further subcategorization of the industry was found to be necessary.

TECHNICAL APPROACH TO BPT

The factors considered in identifying BPT include: 1) the total cost of applying the technology in relation to the effluent reduction benefits to be achieved from such application; 2) the size and age of equipment and facilities involved; 3) the processes employed; (4) non-water quality environmental impacts, (including energy requirements), and (5) other factors the Administrator considers appropriate. These factors are considered below. The Act does not require or permit consideration of water quality problems attributable to particular point sources or subcategories, or water quality requirements in particular water bodies in setting technology-based effluent limitations and standards. Accordingly, water quality considerations are not the basis for selecting the BPT (see Weyerhaeuser Company v. Costle, 590 F.2d 1011 (D.C. Cir. 1976)).

The cost-benefit inquiry for BPT is a limited balancing, committed to EPA's discretion, which does not require the Agency to quantify benefits in monetary terms (see, e.g., American Iron and Steel Institute v. EPA, 526 F.2d 1027 (3rd Cir. 1975)). To balance costs in relation to effluent reduction benefits, EPA considers the volume and nature of existing discharges, the volume and nature of discharges expected after application of BPT, the general environmental effects of the pollutants, and the cost and economic impacts of the required pollution control level.

In general, the BPT level represents the average of the best existing performances of plants of various ages, sizes, processes or other common characteristics. Where existing performance is uniformly inadequate, BPT technology may be transferred from a different subcategory or category. Limitations based on transfer technology must be supported by a conclusion that the technology is, indeed, transferable and a reasonable prediction that it will be capable of achieving the prescribed effluent limitations (see Tanners' Council of America v. Train, 540 F. 2d 1188 (4th Cir. 1976)). BPT focuses on end-of-pipe treatment rather than process changes or internal controls, except where such are common industry practice.

The Agency studied gold placer mines to identify the processes used and the wastewaters generated by mining and beneficiation. Raw wastewater from the beneficiation process at gold placer mines, sampled by the Agency over four years, averaged 20,000 mg/l TSS. The beneficiation processes at these mines produce over two million tons per year of water born solids (TSS) in the extraction process.

As discussed in Section VII, the control and treatment technologies available to gold placer mines include both in-process and end-of-pipe technologies. Based on the pollutants found in the wastewater discharge (described in Section V) and the pollutants selected for consideration for control (see Section VI), the following four technologies were considered as possible bases for BPT.

1. Simple Settling - Settling ponds can be installed as single large ponds, but they often are installed in an arrangement of two or more ponds in series. Simple settling removes water-borne solids found in wastewater, and the ponds in series further reduce settleable solids and total suspended solids (TSS) loadings in each of the sequential ponds. The principal involved is the retention of the wastewater long enough to allow the solids (particulates) to settle while keeping the velocity of the flow to a minimum approaching quiescent settling conditions. Sludge storage is critical and must be considered in the design and construction of a pond.

Virtually all commercial gold placer mines operating since 1984 have settling ponds of varying numbers, sizes, and efficiencies. The effluent limitations contained in NPDES permits for gold placer mines were based on the use of settling ponds; as a result, the technology is available and in use by the industry. However, sampling data and other information on existing ponds indicate that many ponds are inadequately designed, constructed, or maintained to consistently produce an acceptable effluent quality or concentration of solids (settleable solids and TSS). Treatment facilities to control solids with simple settling technology are designed to provide 4 hours of settling in well-constructed and well-operated ponds. These ponds reduce the flow velocity to a minimum and have sufficient volume available to accommodate sludge accumulation and to preclude remixing or cutting of solids from the sludge back into the effluent. As discussed in Section VII, the long-term achievable level for solids, based on 1986 data from existing treatment at placer mines, is less than 0.2 ml/l settleable solids. Field tests indicate settleable solids are reduced to less than 0.2 ml/l with about 3 hours quiescent settling as determined by the 1984 and 1986 Alaskan placer mining study and testing program. Adding an hour to the quiescent settling time derived from settling tests will provide a retention time in an actual pond with an adequate margin of reliability considering the pond "end effects" on the wastewater. Finally, Discharge Monitoring Reports (DMR) from 107 mines which reported to Region X in 1984 revealed over 2,600 individual grab samples with settleable solids at 0.2 ml/l or less. This represented approximately 25 percent of the total number of mines reported on the DMR.

2. Recycle of Process Wastewater - Recycle of process water from simple settling ponds is discussed in detail in Section VII and is an in-process treatment technology. Recycle of any portion of the process water requires the addition of a suitable pump and piping back to the gold recovery process facility.

3. Recirculation of Process Wastewater - As applied to gold placer mining, recirculation is the continued reuse of water as the transport medium for solids (ore) to or through the classification process, the beneficiation process, and the wastewater treatment process. This technology is discussed in greater detail in Section VII.

4. Coagulation and Flocculation - The use of flocculants is also discussed in detail in Section VII. The Agency has very limited information on the use of coagulation and flocculation by gold placer mines in the United States, but this technology is used by wastewater treatment facilities in many industrial categories, by many mines and mills in other ore mining subcategories, and by coal mines and coal preparation plants. Flocculant addition and coagulation increase the size of particles for settling by forming flocs (large particles) which settle faster because of the increased weight and size. Pilot testing of the use of flocculants was conducted at placer mines which indicates that attainable effluent limitations for

coagulation and flocculation are zero settleable solids and less than 100 mg/l TSS.

OPTION SELECTION

Three options for control of wastewater pollutants were considered for BPT. These are simple settling, simple settling plus recycle or recirculation, or simple settling plus coagulant aids. The reasons for selection or rejection of these options follows. Each technology option may apply equally to mines or dredges.

Simple settling is a mature technology which is commonly practiced throughout the subcategory. It therefore conforms to the minimum considerations for BPT of demonstrated availability. Hence, simple settling could become the basis for BPT providing no other more stringent and appropriate technologies are available.

Simple settling with recycle or recirculation reduces the quantities of pollutants discharged. However, it requires in-process changes and is not commonly practiced throughout the subcategory. The in-process nature of recirculation and the lack of common practice throughout the subcategory make this technology unacceptable as the basis for BPT.

Chemically aided settling or flocculation is also discussed in detail in Section VII. As indicated in that discussion, the application of flocculation is neither demonstrated nor commonly practiced within the subcategory. Therefore, it is unacceptable as the technology basis for BPT.

Because technology options including recirculation and flocculation are not acceptable as the basis for BPT, simple settling has been selected as the basis for BPT. Figure IX-1 (p. 231) illustrates an example of simple settling at an open cut mine. This technology requires the removal of settleable solids from all process wastewater to less than 0.2 ml/l before discharge.

Implementation of the BPT limitations nationwide for open-cut mines and dredges combined will remove annually from estimated raw waste 387,499 kg (852,379 pounds) toxic metals and 1,838,592 metric tons (kkg) (2,021,351 tons) TSS. In Alaska alone, 177,004 kg (389,407 pounds) toxic metals and 889,373 kkg (978,319 tons) TSS will be removed by implementation of BPT. The total annual cost of achieving BPT at gold placer mines is $1.25 million for the Alaska gold placer mines and $2.42 millon for all gold placer mines. There is no projected capital cost for achieving BPT.

The economic impact on the subcategory is discussed in detail in the "Economic Impact Analysis of Effluent Limitations and Standards for the Placer Gold Mining Industry." EPA feels that the benefit of the BPT effluent limitations justifies the cost of implementation.

BPT FOR GOLD PLACER MINES

The following effluent limitations represent the degree of effluent reduction attainable by the application of the best practicable control technology currently available (BPT).

Except as provided in 40 CFR 125.30-125.32, any existing point source subject to this subpart must achieve the following effluent limitations representing the degree of effluent reduction attainable by the application of the best practicable control technology currently available (BPT):

(a) The concentration of pollutants discharged in process wastewater from an open-cut mine plant site shall not exceed:

Effluent Limitations	
Effluent Characteristics	Instantaneous Maximum
Settleable Solids	0.2 ml/l

b) The concentration of pollutants discharged in process wastewater from a dredge plant site shall not exceed:

Effluent Limitations	
Effluent Characteristics	Instantaneous Maximum
Settleable Solids	0.2 ml/l

SPECIALIZED PROVISIONS FOR GOLD PLACER MINES: STORM EXEMPTION

Although permittees in the gold placer mine subcategory will be entitled to upset and bypass provisions specified in NPDES permits, this regulation establishes the specific conditions which must be met in order to be eligible for the storm exemption established as part of the technology-based requirements of this regulation. The Agency recognizes that mines, in particular surface mines, should not be required to construct treatment for the maximum precipitation event, or series of precipitation events, that could occur with the resulting effects on wastewater and mine drainage discharge flows. The Agency, therefore, established for gold placer mines the criteria to be used by gold placer miners in designing, constructing, and maintaining the wastewater treatment facilities, i.e., that the facilities must be able to contain and treat the maximum volume of wastewater resulting from processing ore during a 4-hour period plus the volume that would be discharged from a 5-year, 6-hour precipitation event. The storm exemption requires that ponds be designed to retain the volume of wastewater generated during a 6-hour processing period. The final rule is based on the retention of process water that would be generated during a 4-hour period, since, as discussed in Section VII, the Agency bases the limitations in this regulation on a 4-hour retention period. If the operator complies with this provision, the operator has an affirmative defense against an enforcement action for any violation if he complies with the notification requirements of 122.41(m) and (n) of the general permit regulation. The storm exemption supersedes the general upset and bypass provisions of the general NPDES permit regulations only with respect to precipitation events. The upset and bypass provisions in the general permit regulations are available in all other applicable situations. The storm exemption as it applies to gold placer mining is included below:

If, as a result of precipitation (rainfall or snowmelt), a source has an overflow or discharge of effluent which does not meet the applicable limitations or standards, the source may qualify for an exemption from such limitations and standards with respect to such discharge if the following conditions are met:

The 5-year, 6-hour storm event was chosen as the level at which the storm exemption would apply because the mine life of most gold placer mines is projected to be about five to 7 years and the pond size envisioned at proposal had a six hour retention time. On the basis of subsequent data, the projected pond size has been reduced to four hours, but the storm exemption remains unchanged.

(i) The treatment system is designed, constructed, and maintained to contain or treat the maximum volume of untreated process wastewater which would be discharged, stored, contained, and used or recycled by the beneficiation process into the treatment system during a 4-hour operating period without an increase in volume from precipitation or infiltration, plus the maximum volume of water runoff resulting from a 5-year, 6-hour precipitation event. In computing the maximum volume of water which would result from a 5-year, 6-hour precipitation event, the operator must include the volume which would result from the plant site contributing runoff to the individual treatment facility.

(ii) The operator takes all reasonable steps to maintain treatment of the wastewater and minimize the amount of overflow.

(iii) The source is in compliance with the BMP in 140.148 and related provisions of its NPDES permit.

(iv) The operator complies with the notification requirements of the NPDES regulations contained in 40 CFR 122 8122.41 (m) and (n). The storm exemption is designed to provide an affirmative defense to an enforcement action. Therefore, the operator has the burden of demonstrating to the appropriate authority that the above conditions have been met.

GUIDANCE FOR IMPLEMENTING THE STORM EXEMPTION

Following is guidance for implementation of the storm exemption provision presented above to assist permit writers to include the provision in NPDES permits and for mine operators who wish to design, construct, and maintain their treatment facilities to qualify for the provision.

1. The exemption is available only if it is included in the operator's permit. Many existing permits have exemptions or relief clauses stating requirements other than those set forth above. Such relief clauses remain binding until the storm exemption is incorporated into the operator's permit.

2. The storm provision is an affirmative defense to an enforcement action. Therefore, there is no need for the permitting authority to evaluate each settling pond or treatment facility permitted.

3. The relief only applies to the increase in flow caused by precipitation on the facility and surface runoff.

4. Relief is granted as an exemption to the requirements for normal operating conditions when there is an overflow, increase in volume of discharge, or discharge from a by-pass system caused by precipitation.

5. The provision does not grant, nor is it intended to imply, the option of ceasing or reducing efforts to contain or treat the runoff resulting from a precipitation event or snowmelt regardless of the intensity of the precipitation. The operator must continue to operate the treatment facility to the best of the operator's ability during and after any precipitation.

6. Relief can be granted from all effluent limitations and standards, i.e., in BPT, BAT, and NSPS.

7. In general, the relief is intended for discharges from tailings ponds, settling ponds, holding basins, lagoons, etc., that are associated with and are a part of treatment facilities. The relief most often will be based on the construction and maintenance of these settling facilities to "contain" a volume of water.

8. The term "contain" for facilities which are allowed to discharge must be considered in conjunction with the term "treat" discussed in paragraph 10 below. The containment requirement is

intended to ensure that the facility has sufficient capacity to provide 4 hours of settling time for the volume resulting from a 5-year, 6-hour precipitation event. This is the settling time required to "treat" influent so that it meets the daily effluent limitations and standards. The theory is that a settling facility with sufficient volume to contain the runoff from a 5-year, 6-hour rainfall plus 4 hours' discharge of normal process wastewater and normal combined waste streams (e.g., without an increase in volume from precipitation) can provide a minimum 4-hour retention time for settling of the wastewaters even if the pond is full at the time the storm occurs. The water entering the pond as a result of the storm is assumed to follow a last-in, last-out principle. Because of this, the "contain" and "maintain" requirement for facilities which are allowed to discharge does not require providing for draw down of the pool level during dry periods. The volume can be determined from the top of the stage of the highest dewatering device to the bottom of the pond at the time of the precipitation event. There is no requirement for relief to be based on the facility being emptied of wastewater prior to the rainfall or snowmelt upon which the exemption is provided. The term "contain" for facilities which are allowed to discharge means the wastewater facility's holding pond or settling pond was designed to include the volume of water that would result from a 5-year, 6-hour rainfall.

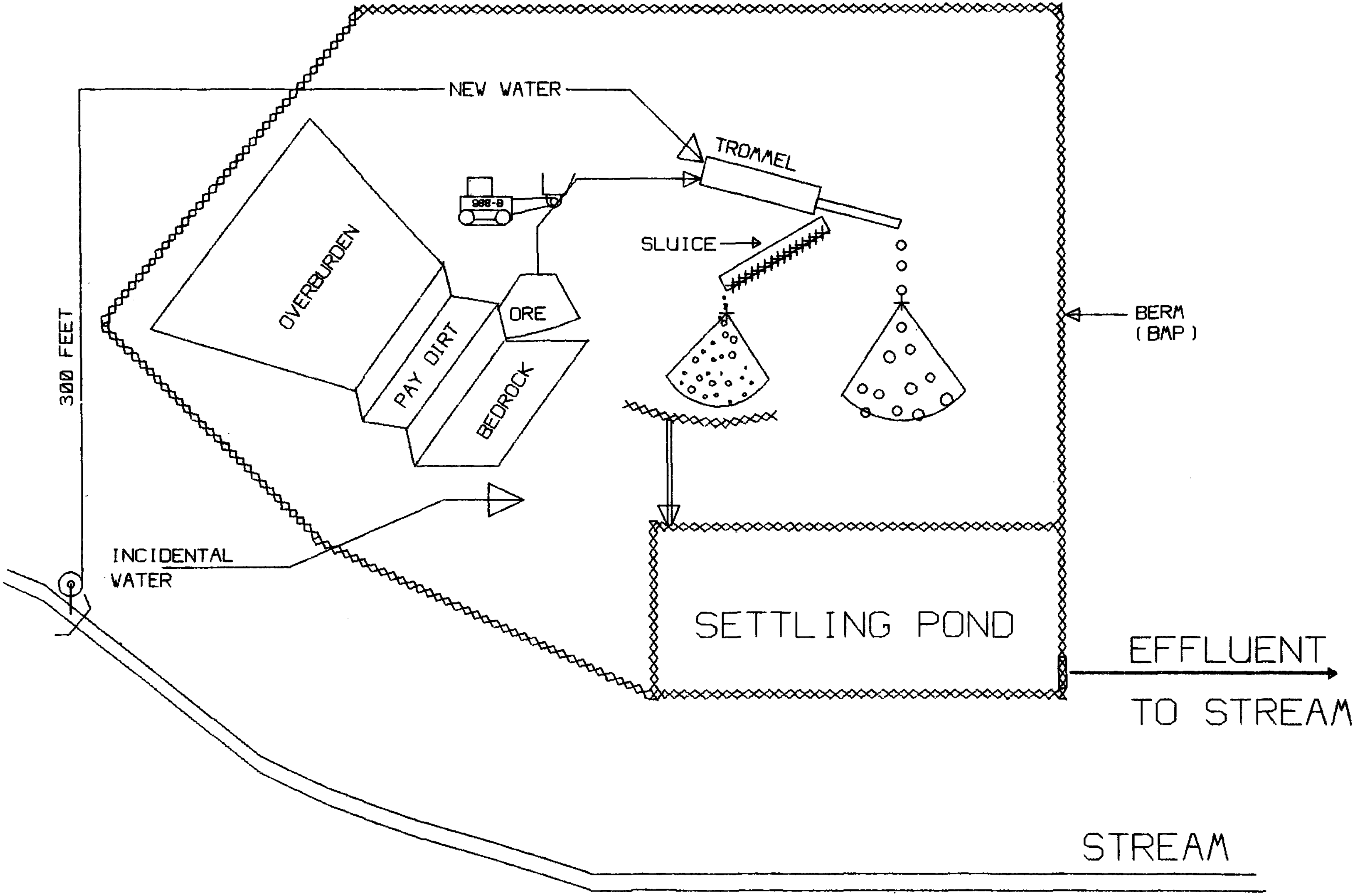
9. The term "treat" applies to facilities which are allowed to discharge, and means the wastewater facility was designed, constructed, and maintained to meet the daily maximum effluent limitations for the maximum flow volume in a 4-hour period. The operator has the option to "treat" the flow volume of water that would result from a 5-year, 6-hour rainfall in order to qualify for the storm water exemption. To compute the maximum flow volume, the operator includes the maximum flow of wastewater including mine drainage and groundwater infiltration during normal operating conditions without an increase in volume from precipitation plus the maximum flow that would result from a 5-year, 6-hour rainfall. The maximum flow from a 5-year, 6-hour rainfall can be determined from the Water Shed Storm Hydrograph, Penn State Urban Runoff Model, or similar models.

10. The term "maintain" is intended to be synonymous with "operate." The facility must be operated at the time of the precipitation event to contain or treat the specified volume of wastewater. Specifically, in making a determination of the ability of a facility to contain a volume of wastewater or to provide 4 hours of retention of wastewater to treat a volume or flow, sediment and sludge must not be permitted to accumulate to such an extent that the facility cannot hold the volume of wastewater resulting from 4 hours of normal process wastewater discharge and normal combined waste streams plus the volume resulting from a 5-year, 6-hour rainfall. That is, sediment and sludge must be removed as required to maintain the specific volume of wastewater required for the exemption, or the embankment must be build up or graded to maintain a specific

volume of wastewater required, or a new settling pond must be built and used.

11. The term "contain" for facilities treating only process wastewater subject to no discharge means the wastewater facility is designed, constructed, and maintained to hold, without a point source discharge, the volume of water that would result from a 5-year, 6-hour rainfall, in addition to the normal amount of water which would be in the wastewater facility for recirculation and reuse to the beneficiation process, e.g., without an increase in volume from precipitation. The operator treating only process wastewater must provide for freeboard under normal operating conditions equivalent to the volume that would result from a 5-year, 6-hour rainfall on the beneficiation process area (including the ponds).

This storm exemption is applicable to all effluent limitations and standards, i.e., BPT, BAT, and NSPS.



OPEN CUT MINE - BPT

Figure IX - 1

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SECTION X

BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE (BAT)

The effluent limitations in this section apply to existing direct dischargers. A direct discharger is a facility which discharges or may discharge pollutants into waters of the United States. This section presents information on direct dischargers and, in addition, presents total subcategory data.

The factors considered in assessing the best available technology economically achievable (BAT) include the age of equipment and facilities involved, the processes employed, process changes, non-water quality environmental impacts (including energy requirements), and the costs of application of such technology (CWA Section 304(b)(2)(B)). BAT technology represents the best available economically achievable performance of plants of various ages, sizes, processes, or other shared characteristics. BAT may include process changes or internal controls, even when these are not common industry practice.

TECHNICAL APPROACH TO BAT

Input to BAT selection includes all materials discussed and referenced in this document. As discussed in Section V, sampling and analysis programs were conducted to evaluate the presence or absence of toxic pollutants. A series of pilot-scale treatability studies was performed at several locations to evaluate BAT alternatives.

Consideration was also given to:

1. Age and size of facilities and equipment involved
2. Process(es) employed
3. In-process control and process changes
4. Economic achievability of the potential BAT alternative control or treatment technologies
5. Non-water quality environmental impacts (including energy requirements)

In general, the BAT technology level represents the best economically achievable performance of plants of various ages, sizes, processes, or other shared characteristics. BAT may include feasible process changes or internal controls, even when not in common industry practice. This level of technology also considers those plant processes and control and treatment technologies which at pilot-plant and other levels have demonstrated both technological performance and economic viability at a level sufficient to justify investigation.

The Agency has reviewed a variety of technology options and evaluated the available possibilities to ensure that the most effective and beneficial technologies were used as the basis for BAT. EPA examined technology alternatives which could be applied as the gold placer mine BAT options and which would represent substantial progress toward prevention of environmental pollution beyond progress achievable by BPT.

The Clean Water Act requires consideration of costs in BAT selection but does not require a balancing of costs against effluent reduction benefits (see Weyerhaeuser v. Costle, 11 ERC 2129 (DC Cir. 1978)). In developing the proposed BAT, however, EPA has given substantial weight to the reasonableness of costs and the reduction of pollutants discharged. The Agency has considered the volume and nature of discharge before and after application of BAT alternatives, the general environmental effects of the pollutants, and the costs and economic impacts of the required pollution control levels. The options presented represent a range of costs so as to assure that affordable alternatives remain after the economic analysis. The rationale for the Agency's selection of BAT effluent limitations is summarized below.

BAT OPTION SELECTION

EPA considered the same treatment and control options discussed in Section VII which were considered for BPT as the technology options for BAT: simple settling, total recirculation of process wastewater, and coagulation or flocculation of wastewater. EPA also reviewed the various BAT factors listed above to determine whether different BAT effluent limitations for certain groups of gold placer mines might be appropriate.

Wastewater pollutant levels and pollutant concentrations achievable by each option were determined using the same information and data discussed in Section IX for achievable BPT limitations.

For all gold placer mines subject to this regulation, the end-of-pipe technology basis for the promulgated BAT limitation is the model BPT technology (simple settling) plus recirculation of all of the process water from the settling pond. Figure X-1 (p. 239) illustrates an example of simple settling with recirculation for an open cut mine. Discharge of any excess water, which has commingled with the process water, is allowed after treatment to achieve 0.2 ml/l settleable solids. The pollutant specifically limited under BAT is settleable solids (SS) on the excess water at 0.2 ml/l. EPA is not requiring any more stringent limitations because the Agency has not identified any more stringent technologies demonstrated to control process wastewater pollutants from these groups of gold placer mines.

Dredges which mine placer gold appear to be physically different from open cut mines because of there physical configuration. This physical difference also applies to the siting and use of settling ponds to achieve the BPT and BAT limitations and NSPS. As shown in Figure VIII-8 (p. 190) the BAT treatment system for a dredge is essentially similar to the BAT treatment system for an open cut mine. Because of the different configuration of a dredge caused by the dredge pond and the pattern of spoil disposal behind the dredge, the settling pond is located on top of the spoil immediately behind the dredge. This allows the process water to be pumped up to the settling pond for clarification when it is necessary to remove additional solids not removed in the dredge pond and recirculated to the dredge pond by gravity. It also allows any excess water which may be generated in the dredge mining operation to be discharged by gravity when discharge is permitted. This configuration for dredge gold placer mines was observed by EPA during the 1987 mining year.

Implementation of the BAT limitations for open cut mines and dredges will remove annually from estimated raw waste 453,998 kg (998,656 pounds) toxic metals and 1,977,140 kkg (2,174,854 tons) TSS from all gold placer mines in the U.S. In Alaska alone, 207,379 kg (456,234 pounds) toxic metals and 956,912 kkg (1,052,604 tons) TSS will be removed by implementation of BAT. The total annual cost of achieving BAT at gold placer mines is $1.94 million for the Alaska gold placer mines and $3.87 million for all gold placer mines; the projected capital costs for achieving BAT are $2.77 million for Alaska and $5.32 million for all gold placer mines, respectively.

A repeated concern of industry commenters is that recirculation of wash water reduces gold recovery in a sluice because of the higher concentrations of TSS found in recirculated wastewater compared to once-through wash water. However, no conclusive data have been offered by the industry to quantify any loss or, if there is a loss, what TSS concentration starts to effect a loss. Lacking any hard and verifiable data from industry, EPA decided to conduct its own tests to obtain data on the effect of recirculation on gold recovery. As discussed in Section VII of this document, EPA funded studies to ascertain if a loss of recoverable gold occurred in a pilot-scale sluice when the TSS concentration in the wash water was varied from almost zero to about 200,000 mg/l. The results of the tests provide EPA the only hard and verifiable data on the effect of TSS concentration on gold recovery.

These tests indicate that over 99 percent of the gold is effectively recovered regardless of the TSS concentration in the wash water, e.g., recirculation does not affect the recovery of gold in the size range of +100 mesh. The tests also indicate there may be some migration of the recovered gold down the sluice to lower riffles as the TSS concentration increases, but settling of the recirculation water for 3 hours would reduce the TSS concentration to approximately 1,670 mg/l and, in turn, reduce any migration. Therefore recirculation of all of the process water will not materially affect gold recovery in a sluice.

BAT FOR GOLD PLACER MINES

The following effluent limitations represent the degree of effluent reduction attainable by the application of the best available technology economically achievable (BAT).

Except as provided in 40 CFR 125.30-125.32, any existing point source subject to this subpart must achieve the following effluent limitations representing the degree of effluent reduction attainable by the application of the best available technology economically achievable (BAT).

(a) The volume of process wastewater which may be discharged from an open-cut mine plant site shall not exceed the volume of infiltration, drainage, and mine drainage waters which is in excess of the make-up water required for operation of the beneficiation process. The concentration of pollutants in process wastewater discharged from an open-cut mine plant site shall not exceed:

Effluent Characteristics	Effluent Limitations Instantaneous Maximum
Settleable Solids	0.2 ml/l

(b) The volume of process wastewater which may be discharged from a dredge plant site shall not exceed the volume of infiltration, drainage, and mine drainage waters which is in excess of the make-up water required for operation of the beneficiation process. The concentration of pollutants in process wastewater discharged from a dredge plant site shall not exceed:

Effluent Characteristics	Effluent Limitations Instantaneous Maximum
Settleable Solids	0.2 ml/l

The implementation of technology to attain BAT effluent limitations will not create any additional air pollution emissions. The amount of solid waste generated by the technology for BAT limitations is negligible compared to the amount generated by mining and processing. Land requirements for settling ponds at open cut mines and at dredges are no more than the requirements for BPT. There is a small increase in anticipated land requirements for recycling hardware. However, land already mined will generally be available.

Recirculation of process wastewater at open cut mines will create an increase in energy consumption for power to drive recirculation pumps. At many mines, gravity flow is used to bring water to the beneficiation process and these mines will require the addition of a pump, piping and a means to drive the pump. Most mines do not have electricity available for such pumps, and EPA believes the mining operations probably will purchase a form of skid-mounted diesel or gasoline direct drive engine-pump. In determining the cost to implement the no discharge of process water requirement by recirculation, EPA included the cost to purchase a skid-mounted unit and the fuel to run the unit for those mines that were determined not to have these facilities. However, in actual practice, EPA has observed that many mines are already using pumps to supply wash water either one time through or with recirculation of process water. Those mines with pumps to supply wash water will have little if any increase in energy consumption to recirculate 100 percent of the process water.

There also will be an increase in energy consumption to provide power for the equipment to build and maintain the wastewater treatment facilities (settling and holding ponds). However, in determining the cost to implement the technology for simple settling, recycle, or recirculation, EPA used the value of the equipment and operating time-cost for the equipment and the equipment operator's time already at the mine. The equipment time for building and maintaining ponds is a small part of the total equipment hours available in a mining season; the energy consumption to build and maintain ponds is a small part of the total energy requirement for mining in a season.

The Clean Water Act does not require a balancing of costs against effluent reduction benefits for BAT. However, included in the record supporting the rulemaking is the Agency's report "Cost Effectiveness Analysis of Effluent Limitations for the Placer Gold Mining Industry" which calculates the effectiveness of the proposed regulation by estimating pounds of pollutants removed weighted by an estimate of their toxicity, e.g., pound-equivalents removed. Non-regulated pollutants are included when they are removed incidently as a result of a particular treatment technology. The cost-effectiveness of BAT is estimated to be $3 per pound equivalent removed. The cost per pound of solids removed by BPT is less than $ 1.

STORM EXEMPTION

The storm exemption which applies to BPT also applies to BAT and NSPS. This exemption is discussed in Section IX.

TABLE X-1

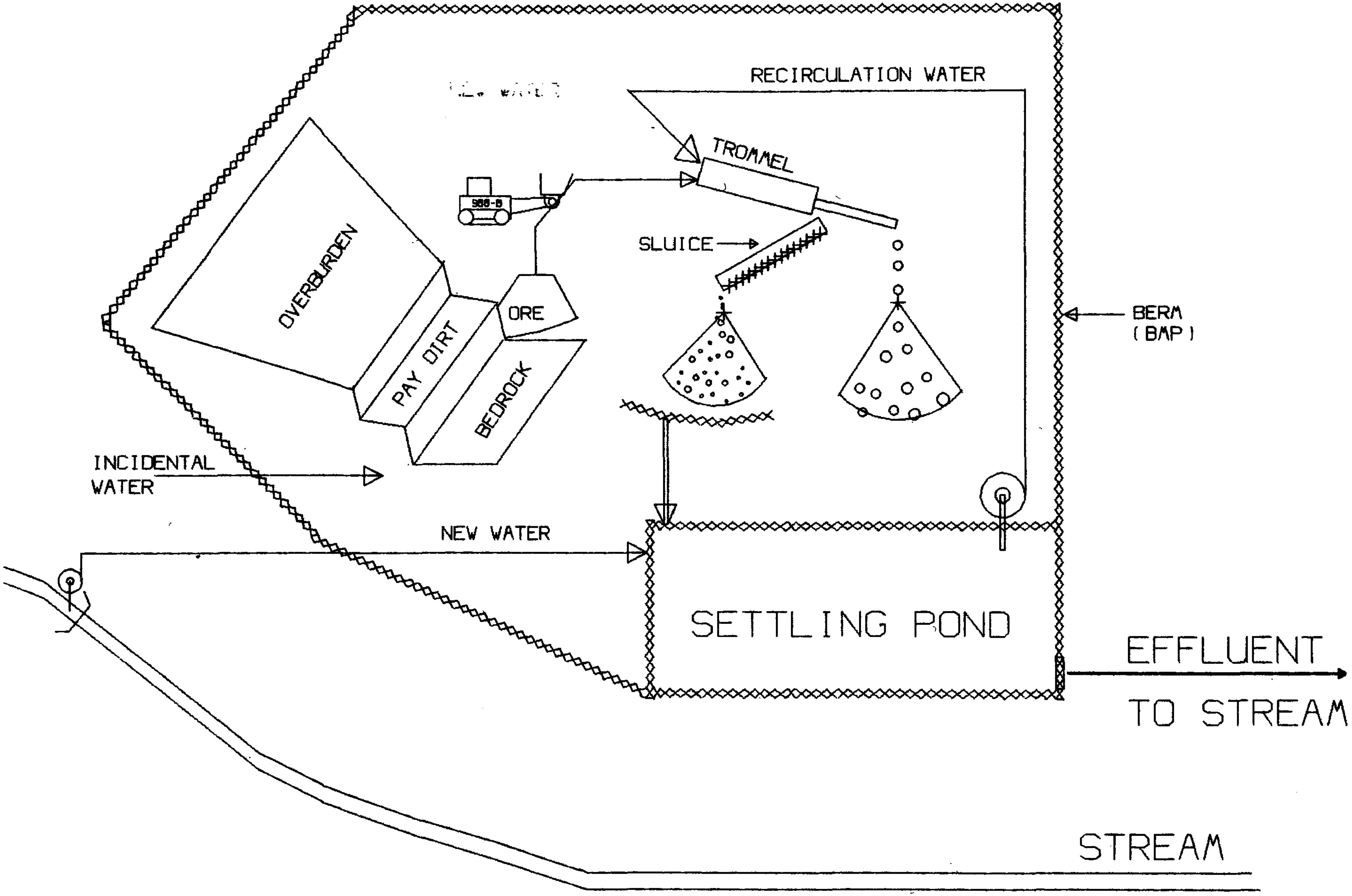
Pollutant Reduction Benefits

NATIONWIDE

Pollutant	RAW WASTE	BPT		BAT	
		Removed	Discharged	Removed	Discharged
TSS (kkg)	2005010	1837592	167418	1977140	27870
(ton)	2205511	2021351	184160	2174854	30657
Toxic (kg)	467317	387499	79818	453998	13319
Metals(lb)	1028097	852379	175718	998656	29441

ALASKA ONLY

Pollutant	RAW WASTE	BPT		BAT	
		Removed	Discharged	Removed	Discharged
TSS (kkg)	970401	889373	81028	956912	13489
(ton)	1067441	978319	89131	1052604	14837
Toxic (kg)	213463	177004	36459	207379	6084
Metals(lb)	468618	389407	79211	456234	12384



OPEN CUT MINE - BAT

Figure X - 1

SECTION XI

NEW SOURCE PERFORMANCE STANDARDS (NSPS)

Under Section 306 of the Clean Water Act, new source performance standards are to be based upon best available demonstrated technology (BDT). New facilities have the opportunity to implement the best and most efficient ore mining and milling processes and wastewater technologies. Congress, therefore, directed EPA to consider the best demonstrated process changes and end-of-pipe treatment technologies capable of reducing pollution to the maximum extent feasible.

BAT for gold placer mines is based on the most stringent demonstrated technology for treating gold placer mine wastewaters. New source performance standards therefore can not be more stringent, but must be equivalent to the BAT limitations. It is expected that the new source wastewaters will be similar to process wastewaters of existing sources. Therefore, the costs to treat and pollutant removal efficiencies from new sources are expected to be similar to existing sources.

The new source criteria contained in the NPDES regulation does not adequately address several unique features of gold placer mining (as discussed below). EPA therefore feels that these criteria could not reasonably be applied to determine new source placer mines, and that it would be more appropriate to adopt a list of factors for the Regional Administrator (RA) to use in determining, on a case-by-case basis, whether a gold placer mine is a new source under the Act. The adoption of industry-specific criteria for designation of new sources is consistent with the new source criteria contained in the NPDES regulations, since 40 CFR section 122.29(b)(1) states that the NPDES provisions apply "except as otherwise provided in an applicable new source performance standard." Furthermore, EPA has adopted a similar approach to determining the existence of new source mining operations where the characteristics of the subcategory warranted specialized treatment (see new source criteria for coal mining, 40 CFR Section 434.11(j)).

Applying the new source determination language of Section 306 of the Act to gold placer mining is problematic due to two unique standard operating conditions of these operations. Under the statute, the date on which construction of a facility begins determines whether it is considered a new source. "Construction" is defined in Section 306(a)(5) as "any placement, assembly, installation of facilities or equipment (including contractual obligations to purchase such facilities or equipment) at the premises where such equipment will be used, including site preparation work at such premises."

However, gold placer mines, by their nature, are mobile operations. First, they continually move up or down a stream as they mine a pay streak, and they often relocate their mining activities within a claim or among different claims in search of ore containing recoverable gold. Second, due to climatic conditions, Alaskan gold placer mines can only operate during the summer months.

Under the literal application of the term "construction", a gold placer mine could be viewed as a "new" new source every time it moves to a new location since the mine, in a sense, installs facilities and equipment at different "premises." Therefore, over time, virtually all gold placer mines would have to be re-permitted as new sources.

Also, Alaskan gold placer mines would be defined as new sources every spring, when they restarted their operations after being shut down for the winter season. It is characteristic of all such mines that some or all of their equipment is removed from the mining site each fall, and replaced in the spring. This activity, characteristic of all continuous, ongoing gold placer mine operations in the state, does not necessarily indicate the commencement of new mining activities. However, a literal statutory application in this case would result in a large number of facilities needing to be re-permitted as new sources on an annual basis.

Designating all gold placer mines to be new sources by virtue of their continual movement would ignore that this is standard practice among existing gold placer mine operations. The Agency believes that such a literal interpretation of the statutory language would appear to run counter to the intent of the CWA, which clearly envisions a distinction between new and existing sources.

Similarly, interpreting seasonal reconstruction of facilities to require permitting as a new source might be consistent with a literal reading of Section 306, but EPA believes that such an approach would ignore a unique aspect of gold placer mines operating in cold climates. It would be inappropriate to consider the entire Alaskan gold placer mining industry to be new sources every spring, as the EPA does not believe that Congress intended in Section 306 to designate large numbers of facilities in an entire subcategory as new sources solely because climatic conditions dictate the routine, yearly dismantling and rebuilding of their operations.

Given these two special conditions within the industry, rejection of the literal application of the term "construction" can also be based on the realization that defining all gold placer mines as new sources due to seasonal or standard operational changes would not advance the purposes of Section 306. Congress adopted that provision in order to ensure that new facilities, which could institute production process changes, met the most stringent pollution control requirements (see Conf. Rep. 1236, 92nd Cong., 2d Sess., 127-129). However, these facilities will already be controlled by BAT limitations based on the most stringent pollution control technology that is available to gold placer mining. As NSPS is being set equal to BAT, designating every gold placer mine as a new source each season would not result in any more stringent levels of control than those already established for existing sources.

The mobile nature of gold placer mines also demonstrates why the new source criteria contained in Section 122.29(b) of the NPDES regulations are not appropriate for the determination of new source gold placer mines. Section 122.29(b)(1), interpreted literally, would also cause any movement by a mine to classify it as a new source since, arguably, a mine that moves upstream or to a new location is being "constructed at a site at which no other source is located." However, EPA noted in adopting the new source criteria that they were not designed to address mobile operations.

Section 511(c) of the CWA provides that the issuance by EPA of NPDES permits to new sources is subject to the provisions of the National Environmental Policy Act (NEPA). Therefore, to the extent issuance of such permits might constitute major federal actions significantly affecting the environment, NEPA requires the preparation of an environmental assessment and, if appropriate, an environmental impact statement prior to permit issuance (see 40 CFR Section 122.29(c)).

Instead of categorically classifying all gold placer mines as new sources because of the mobile and seasonal nature of their operations, the new source criteria in this regulation are to be considered by the Regional Administrator (RA) or Director of a state agency administering an NPDES program (Director) as the basis for determining when a mine has sufficiently altered location or discharges such that the mine is a new source. The main effect of this determination, as discussed above, is that the designation may result in the conducting of an environmental review being required in accordance with NEPA.

The factors listed below must be taken into account in determining whether a gold placer mine is a new source, and are intended to guide the permit writer in assessing all of the circumstances of a particular mine. It is possible that characteristics of gold placer mining operations may vary widely and EPA, therefore, may not have anticipated all the circumstances relevant to a new source determination. A number of other factors might be considered by the RA or Director during a new source determination. For example, the retaining berms and ponds of a previous mine have been destroyed by storms or snow melt, making complete reconstruction necessary.

The RA or Director shall designate new source gold placer mines based on consideration of whether one or more of the following factors applies after the date of promulgation:

a) The mine will operate outside of the permit area which is covered by a currently valid NPDES permit.

b) The mine significantly alters the nature or quantity of pollutants discharged.

c) The mine discharges into a stream into which it has not discharged under its currently valid NPDES permit.

d) The mine will operate in a permit area that has not been mined during the term of the currently valid NPDES permit.

e) Such other factors as the Regional Administrator or state Director deems relevant.

EPA is unable to identify any more stringent limitations based upon a demonstrated technology for gold placer mines covered by this regulation other than simple settling plus recirculation of all process wastewater. As discussed elsewhere, chemically aided settling is not at this time a demonstrated technology at gold placer mines. The other technologies examined by the Agency, including filter dams and tundra filters, are available only on a site specific basis and therefore are not appropriate as the basis of nationally applicable, uniform effluent limitations guidelines and standards.

The Agency does not foresee that these NSPS should pose a barrier to entry for new source placer mines, as the new source standards are equivalent to the existing source standards. In fact, the new sources can design for more efficient process water use and maximize wastewater reduction, thereby reducing the size and cost of pollution control facilities. Given this design advantage, there are no reasons why newly designed systems should at most equal the cost of retrofitted systems.

NSPS FOR GOLD PLACER MINES

Any new source subject to this subpart must achieve the following NSPS representing the degree of effluent reduction attainable by the application of the best available demonstrated technology:

(a) The volume of process wastewater which may be discharged from an open-cut mine plant site shall not exceed the volume of infiltration, drainage, and mine drainage waters which is in excess of the make-up water required for operation of the beneficiation process. The concentration of pollutants in process wastewater discharged from an open-cut mine plant site shall not exceed:

Effluent Characteristics	Effluent Limitations Instantaneous Maximum
Settleable Solids	0.2 ml/l

(b) The volume of process wastewater which may be discharged from a dredge plant site shall not exceed the volume of infiltration, drainage, and mine drainage waters which is in excess of the make-up water required for operation of the beneficiation process. The concentration of pollutants in process wastewater discharged from a dredge plant site shall not exceed:

Effluent Characteristics	Effluent Limitations Instantaneous Maximum
Settleable Solids	0.2 ml/l

(c) Notwithstanding any other provision of this chapter, the Regional Administrator or Director of a State agency with authority to administer the NPDES program shall in designating new source gold placer mines take into account and base the decision on whether one or more of the following factors has occurred after promulgation of this regulation.

1. The mine will operate outside of the permit area which is covered by a currently valid NPDES permit.
2. The mine significantly alters the nature or quantity of pollutants discharged.
3. The mine discharges into a stream into which is has not discharged under its currently valid NPDES permit.
4. The mine will operate in an area that has not been mined during the term of the currently valid NPDES permit.
5. Such other factors as the Regional Administrator or state Director deems relevant.

STORM EXEMPTION

The storm exemption which applies to BPT and BAT also applies to NSPS. This exemptions is discussed in greater detail in Section IX.

SECTION XII

PRETREATMENT STANDARDS

Section 307(b) of the Act requires EPA to promulgate pretreatment standards for both existing sources (PSES) and new sources (PSNS) of pollution which discharge their wastes into publicly owned treatment works (POTW). These pretreatment standards are designed to prevent the discharge of pollutants which pass through, interfere with, or are otherwise incompatible with the operation of POTW. In addition, these standards must require pretreatment of pollutants, such as certain metals, that limit POTW sludge management alternatives. The legislative history of the Act indicates that PSES are to be technology-based and, with respect to toxic pollutants, analogous to BAT.

EPA did not promulgate PSES or PSNS in the ore mining and dressing point source category in the 1982 rulemaking nor is it promulgating such standards for the gold placer mining subcategory, since there are no known or anticipated discharges to POTW.

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SECTION XIII

BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY (BCT)

Section 301(b)(2)(E) of the Act requires categories and classes of point sources, other than publicly-owned treatment works, to achieve effluent limitations that require the application of the best conventional pollutant control technology (BCT) for control of conventional pollutants as identified in Section 304(a)(4). BCT is not an additional limitation; rather, it replaces BAT for the control of conventional pollutants. The pollutants that have been defined as conventional by the Agency, at this time, are biochemical oxygen demand, suspended solids, fecal coliform, oil and grease, and pH.

Section 304(b)(4)(B) of the Act requires that, in setting BCT, EPA must consider: the age of equipment and facilities involved, the process employed, the engineering aspects of the application of various types of control techniques, process changes, non-water quality environmental impacts (including energy requirements), and other factors the Administrator deems important. Candidate technologies must also pass a two-part test of "cost reasonableness."

The only conventional pollutant of concern in gold placer mining wastewater is total suspended solids (TSS). The Agency has not identified any demonstrated technology that provides reliable removal of TSS; therefore, no BCT regulations are being promulgated at this time.

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SECTION XIV

BEST MANAGEMENT PRACTICES

Section 304(e) of the Clean Water Act authorizes the Administrator to prescribe "best management practices" (BMP) to prevent the release of toxic and hazardous pollutants from plant site runoff, spillage or leaks, sludge or waste disposal, and drainage from raw materials storage associated with or ancillary to the manufacturing or treatment process. In gold placer mines, surface water flows (drainage), infiltration, and mine drainage may contribute significant amounts of pollutants to navigable waters.

The gold placer mine subcategory has limitations on the storm water runoff, mine drainage, and groundwater infiltration and seepage which enters the treatment system and is commingled with process wastewater. Similarly, the runoff from the plant site area is included in the wastewater controlled by effluent limitations guidelines and standards.

Minimizing the volume of water allowed to enter the plant site and commingle with the process water is environmentally desirable, because reducing the volume of incidental water allowed to enter the plant site reduces the volume of water which must be discharged and thereby reduces the mass of pollutants which are discharged to waters of the United States. Diversion of water around a plant site to prevent its contact with the active mine and the pollution-releasing materials is an effective and widely applied control technique at many ore mines.

The BMP explained below and included in the regulation are necessary for control of the drainage and infiltration water at gold placer mines, as well as to prevent release of pollutants removed by treatment processes to the receiving streams under various types of climatic and seasonal conditions. These BMP represent good mining practices which are commonly practiced in all well-operated mining operations.

(a) Surface Water Diversion: The free flow of surface waters into the plant site area shall be interrupted and these waters diverted around and away from incursion into the plant site area.

Such diversion may be accomplished by appropriate means such as the construction of dikes, berms, or ditches to convey the water away from or around the plant site. For the purpose of this requirement, the plant site area is defined as the area occupied by the mine, necessary haulage ways from the mine to the ore processing equipment, the area occupied by the ore processing equipment, the areas occupied by the wastewater treatment facilities, and the storage areas for waste materials and solids removed from the wastewaters during treatment.

This BMP requirement applies both during the active mining season and at all other times. It applies for the plant site in active use and to plant site areas no longer in active use after active operations have ceased.

(b) Berm Construction: Berms, including any pond walls, dikes, low dams, and similar water retention structures shall be constructed in a manner such that they are reasonably expected to reject the passage of water.

This may be achieved by utilizing on-site materials in a manner that the fine sealing materials such as clays are mixed in the berms with coarser materials. Berms should be toed into the underlying earth, constructed in layers or lifts, and each layer thoroughly compacted to ensure mechanical and watertight integrity of the berms. Other impermeable materials such as plastic sheets or membranes may be used inside the berms when sealing fines are unavailable or in short supply. The side slope of berms should be not greater than the natural angle of repose of the materials used in the berms or a slope of 2:1, whichever is lower.

(c) Pollutant Materials Storage: Measures shall be taken to assure that pollutant materials removed from the process water and wastewater streams will be retained in storage areas and not discharged or released to the waters of the United States.

These measures may include location of the storage ponds and storage areas to assure that they will not be washed out by reasonably predictable flooding or by the return of a relocated stream to its original stream bed. The overflows from ponds and storage areas should be protected from erosion by riprap or rock plating. Submerged discharges or constant level discharge pipes through retention dikes should be used where practicable.

This requirement applies both during the active mining season and at all other times as well as after active mining operations have moved to new locations.

(d) New Water Control: The amount of new water allowed to enter the plant site for use in ore processing shall be limited to the minimum amount required as make-up water for processing operations.

New water is defined as water from any discrete source such as a river, creek, lake, or well which is deliberately allowed or brought into the plant site. Control mechanisms should limit the flow of new water to the amount needed to supplement other waters for gold ore processing make-up requirements and shutting off the flow or exclude new water when the ore processing segment of the facility is not being operated.

(e) Maintenance of Water Control and Solids Retention Devices: All water control devices such as diversion structures and berms and all solids retention structures such as berms, dikes, pond structures, and dams shall be maintained to continue their effectiveness and to protect from unexpected and catastrophic failure.

The structures should be inspected on a regular basis for any signs of structural weakness or incipient failure. Whenever such weakness or incipient failure becomes evident, repair or augmentation of the structure to reasonably ensure against catastrophic failure shall be made immediately.

This BMP shall apply both during the active mining season and at all other times as well as after active mining operations have moved to new locations.

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SECTION XV

ACKNOWLEDGEMENTS

This document has been prepared by the staff of the Industrial Technology Division (ITD) with assistance from technical contractors, other EPA offices and other persons outside of EPA. This section is intended to acknowledge the contribution of the persons who have contributed to the development of this report.

The initial effort on this project was carried out by Frontier Technical Associates (FTA) under the direction of Dr. P. Michael Terlecky. Specific efforts by FTA included a treatability study of mines in Alaska, performed in 1983 in cooperation with Kohlmann Ruggiero Engineers, Inc. (KRE), sampling at mines in the lower 48 states in 1984, and the report "Reconnaissance Sampling and Settling Column Test Results at Alaskan Placer Gold Mines," November 15, 1984. FTA sampling efforts were lead by Mr. David M. Harty. In addition, FTA produced the Proposal version of this development document. Much of the information developed by FTA was incorporated or updated in this draft.

Field sampling efforts were also conducted by Kohlmann Ruggiero Engineers, P.C. under the direction of Mr. Dominick Ruggiero. KRE sampling studies were conducted from 1983 through 1986, and resulted in the following reports: "Treatability Testing of Placer Gold Mine Sluice Water in Alaska, U.S.," May 11, 1984; "1984 Alaskan Placer Mining Study and Testing Report," January 31, 1985; "1985 Alaskan Placer Mining Study Report on Gathering Background Data and Estimating the Method Detection Limit of Settlable Solids in Wastewaters Discharged from Gold Placer Mining Operations," January 22, 1986; and "1986 Alaskan Placer Mining Study Field Testing Program Report," March 5, 1987. In 1984, Mr. Charles F. Herbert, a minerals consultant, accompanied KRE on their site visits, and contributed the "Report on Nineteen Gold Placer Mines, Alaska," July 20, 1984. Mr. Ruggiero provided considerable technical support in preparing both the previous and current versions of this document. KRE worked under subcontract to WESTEC Services, Inc. for the majority of these efforts.

Two field studies were performed by L.A. Peterson and Associates under the direction of Mr. Laurence A. Peterson. The reports resulting from these studies are "Investigation of the Effect of Total Suspended Solids Levels on Gold Recovery in a Pilot Scale Sluice," September 1984, and "Evaluation of the Effect of Suspended Solids on Riffle Packing and Fine Gold Recovery in a Pilot Scale Sluice," September 1986. The first of these efforts was performed under subcontract to KRE, and the second was performed under WESTEC.

WESTEC assisted in two field sampling efforts. In 1986, Mr. Scott Davis of WESTEC assisted Mr. Willis Umholtz and Mr. Dominick Ruggiero of KRE in a full-scale flocculent study, and co-authored the associated report "1986 Placer Mining Full-Scale Field Investigations Chemical Treatment," November 7, 1986. Also in 1986, Mr. Peter Crampton of WESTEC (and later Mr. Scott Davis) participated in a pilot-scale study conducted by the U.S. Bureau of Mines, investigating the effect of polyethylene oxide flocculation on gold placer mining wastewater. Ms. Jamie McIntyre served as WESTEC Project Manager in the last months of preparation of this document.

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Technical supervision of the preparation of this document and the completion of the gold placer mine project was provided by Mr. Ernst P. Hall, Chief, Metals Industry Branch with technical supervision of earlier segments provided by Mr. William A. Telliard, Chief, Energy and Mining Branch, Mr. Devereaux Barnes, Acting Director, Industrial Technology Division, and Mr. Jeffery D. Denit, Director, Industrial Technology Division.

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SECTION XVII

GLOSSARY

Act, the - The Federal Water Pollution Control Act as amended (33 U.S.C. 1251, 1311, and 1314(b) and (c), P.L. 92-500); also called the Clean Water Act (CWA) and amendments through 1986.

Active mining area - An area where work or other activity relating to the extraction, removal, or recovery of any ore is being conducted. This includes areas where secondary recovery of ore is being conducted but, for surface mines, specifically does not include any area of land on or in which grading to return the land to the desired contour has been completed and reclamation work has begun.

Administrator - Administrator of the U.S. Environmental Protection Agency, whose duties are to administer the Act.

Amalgam - An alloy of mercury with gold or another metal. In the case of placer gold, a "dry" amalgam, that is, one from which all excess mercury has been removed by squeezing through chamois leather, will contain nearly equal proportions of gold and mercury.

Amalgamation - The extraction of precious metals from their ores by treatment with mercury.

Assay - To determine the amount of metal contained in an ore: 1) the act of making such a determination; 2) the result of such a determination.

Assessment work - The annual work upon an unpatented mining claim in the public domain necessary under U.S. law for the maintenance of the possessory title thereto.

Auriferous - Containing gold.

Bank run - The measurement of material in place, such as gravel in the deposit before excavation. In gold placer work, values normally are reported as cents per cubic yard and, unless specified otherwise, this means a cubic yard in place, or bank run.

Bedrock - The solid rock underlying auriferous gravel, sand, clay, etc., and upon which the alluvial gold rests. In placer use, the term "bedrock" may generally be applied to any consolidated formation underlying the gold-bearing gravel. Bedrock may be composed of igneous, metamorphic, or sedimentary rock (see False bedrock).

Bench - The surface of an excavated area at some point between the material being mined and the original surface of the ground on which equipment can be set, moved, or operated. A working road or base below a highwall as in contour stripping.

Bench placer - Gravel deposits in ancient stream channels and flood plains which stand above the present streams.

Berm - A horizontal barrier built for the purpose of strengthening and increasing the stability of a slope or to catch or arrest slope slough material; "berm" is sometimes used as a low dam to impound or deflect water.

Beneficiation area - The area of land used to stockpile ore immediately before the beneficiation process, the area of land used for the beneficiation process, the area of land used to stockpile the tailings immediately after the beneficiation process, and the area of land from the stockpiled tailings to the treatment system, e.g., holding pond or settling pond, and the area of the treatment system.

Beneficiation process - The dressing or processing of gold bearing ores for the purpose of (a) regulating the size of, or recovering, the ore or product; (b) removing unwanted constituents from the ore; and (c) improving the quality, purity, or assay grade of a desired product.

Best Available Demonstrated Technology (BDT) - Treatment required for new sources as defined by Section 306 of the Act.

Best Available Technology Economically Achievable (BAT) - The level of technology applicable to effluent limitations for industrial discharges to surface waters as defined by Section 301(b)(2)(A) of the Act.

Best Practicable Control Technology Currently Available BPT) - Treatment required by July 1, 1977, for industrial discharge to surface waters as defined by Section 301(b)(1)(A) of the Act.

Biochemical Oxygen Demand (BOD) - The amount of dissolved oxygen required to meet the metabolic needs of anaerobic microorganisms in water rich in organic matter.

Blowdown - A portion of water in a closed system which is removed or discharged in order to prevent a buildup of deleterous material such as dissolved solids.

Bucket-line dredge - A dredge in which the material excavated is lifted by an endless chain of buckets. Also known as Connected-bucket dredge. The type of bucket-line dredge generally employed in gold placer mining is a self-contained digging, washing, and disposal unit operating in a pond and capable of digging, in some cases, more than 100 feet below water.

Its machinery is mounted on a shallow-draft hull and the dredge backfills its working pit (pond) as it advances. The capacity of individual buckets is used as a measure of dredge size. For example, an "18-foot dredge" is equipped with buckets each having a struck capacity of 18 cubic feet.

Bullion - Unrefined gold that has been melted and cast into a bar. In gold placer mining, the gold sponge obtained by retorting amalgam is commonly melted with borax or other fluxes, then poured into a bullion bar.

Cation - The positively charged particles in solution of an electrolyte.

Cationic flocculants - In flocculation, surface active substances which have the active constituent in the positive ion. Used to flocculate and neutralize the negative charge residing on colloidal particles.

Chemical analysis - The use of a standard chemical analytical procedure to determine the concentration of a specific pollutant in a wastewater sample.

Chemical Oxygen Demand (COD) - A specific test to measure the amount of oxygen required for the complete oxidation of all organic and inorganic matter in a water sample which is susceptible to oxidation by a strong chemical oxidant.

Clarification - A physical-chemical wastewater treatment process involving the various steps necessary to form a stable, rapid settling floc and to separate it by sedimentation. Clarification may involve pH adjustment, precipitation, coagulation, flocculation, and sedimentation.

Clarifier - A basin, usually made of steel or concrete, the primary purpose of which is to allow settling of suspended matter in a liquid.

Clean-up - 1) The operation of harvesting gold or other valuable material from the recovery system of a dredge, hydraulic mine, or other placer operation.

Coagulation - The treatment process by which a chemical added to wastewater acts to neutralize the repulsive forces that hold waste particles in suspension.

Coagulants - Materials that induce coagulation and are used to precipitate solids or semisolids. They are usually compounds which dissociate into strongly charged ions.

Coarse gold - The word "coarse," when applied to gold, is relative and is not uniformly applied. Some operators consider course gold to be that which remains on a 10-mesh screen. Others consider individual particles weighing 10 milligrams or more to be coarse gold. Some apply the term to any particle that is relatively thick as compared to its diameter and can easily be picked up with the fingers.

Composite wastewater sample - A combination of individual samples of water or wastewater taken at selected intervals to minimize the effect of the variability of the individual sample. Individual samples may have equal volume or may be proportioned to the flow at time of sampling.

Concentrate - 1) To separate a metal or mineral from its ore or from less valuable material; 2) the product of concentration.

Conventional pollutants - pH, BOD, fecal coliform, oil and grease, and TSS.

Cyclone - The cone-shaped apparatus used as a classifying (or concentrating) separator into which pulp is fed so as to take a circular path--coarser and heavier fractions of solids report at the apex of the long cone (bottom) while finer particles overflow from the central vortex (top).

Denver jig - Pulsation-suction diaphragm jig for fine material, in which makeup (hutch) water is admitted through a rotary valve adjustable as to the portion of the jigging cycle over which a controlled addition of water is made.

Deposit - Term used to designate a natural occurrence of a useful mineral, coal, or ore in sufficient extent and degree of concentration to permit exploitation.

Detention time - The time allowed for solids to collect in a settling device. Theoretically, detention time is equal to the volume of the device divided by the flow rate. The actual detention time is determined by the operating parameters of the tank.

Discharge - Outflow from a pump, drill hole, piping system, channel, weir, or other discernable, confined, or discrete conveyance (see also "point source").

Discharge head - The vertical distance from the center of a pump to the center of the discharge outlet where the water is delivered, to which must be added the loss due to friction of the water in the discharge pipe.

Discovery claim (Alaska) - A claim covering the initial discovery. Subsequent claims are commonly designated as one above, two above, three above; one below, two below, etc., depending on their position in relation to the discovery claim.

Drag line - A power excavator equipped with a long boom and a heavy digging bucket that is suspended from a hoisting line and is pulled toward the machine by means of a "drag" line. By manipulating the two lines (wire ropes), the bucket can be caused to dig, carry, or dump the excavated material. Such a machine is more properly called a "dragline excavator."

Drainage water - Incidental surface waters from diverse sources such as rainfall, snow melt, or permafrost melt.

Dredge - A self-contained combination of an elevating excavator (e.g., bucket-line dredge), the beneficiation or gold-concentrating plant, and a tailings disposal plant, all mounted on a floating barge.

Drift - A mine passageway driven horizontally within the mine.

Drift (geol.) - Any rock material, such as boulders, till, gravel, sand, or clay, transported by a glacier and deposited by or from the ice or by or in water derived from the melting of the ice.

Drift mining - A method of mining gold-bearing gravel by means of constructing drifts from shafts, or other underground openings, as distinguished from surface methods for placer mining.

Effluent - The liquid, such as treated or untreated wastewater, that flows out of a unit operation, reservoir, or treatment plant. The influent is the incoming stream.

Engineering site visit - The purpose of an engineering site visit (sometimes referred to simply as a "site visit") is to acquire on-site and operational and mechanical (and sometimes economic) information about a particular industrial site. Usually, water sampling is not a part of an engineering site visit.

EPA - Environmental Protection Agency.

Expanded metal riffles (expanded metal lath) - A type of punched-metal screen. The style commonly used in gold placer mining, for saving fine gold, consists of a latticework of diamond-shaped openings (about 3/4" x 1-1/2") separated by raised metal strands that have a decided slope in one direction. When installed as riffles, with the slope leaning upstream or downstream, eddies form beneath the overhangs, thus creating conditions well-suited for the saving of fine gold. When used as riffles, expanded metal is generally placed over cocoa matting or carpeting material.

Fine gold 1) Pure gold, i.e., gold of 1000 fineness.

Fineness - The proportion of pure gold relative to other substances, in bullion or in a natural alloy, expressed in parts per thousand.

Fines - 1) A term that refers to the smaller particle sizes (approximately 100 mesh); 2) the sand or other small-sized components of a placer deposit.

Five-year, 6-hour precipitation event - The maximum 6-hour precipitation with a probable recurrence interval of once in 5 years as established by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, or equivalent regional or rainfall probability information.

Flocculants - Any substances which will cause fine particles to adhear to form larger particles. Lime, alum, and ferric chloride are examples of inorganic flocculants and polyelectrolytes are organic flocculants.

Free gold - Gold uncombined with other substances. Placer gold.

Giant - See Hydraulic giant.

Glacial - Pertaining to, characteristic of, produced or deposited by, or derived from a glacier.

Gold dust - A term once commonly applied to placer gold, particularly gold in the form of small particle size.

Grab sample - A single sample taken instantaneously.

Grain - A unit of weight equal to 0.0648 gram, 0.04167 pennyweight, or 0.002083 troy ounce. There are 480 grains in a troy ounce.

Gram - A unit of weight in the metric system equal to 15.432 grains, 0.643 pennyweight, or 0.03215 troy ounce. There are 31.104 grams in a troy ounce.

Gravel - A comprehensive term applied to the water-worn mass of detrital material making up a placer deposit. Placer gravels are sometimes arbitrarily described as "fine" gravel, "heavy" (large) gravel, "boulder" gravel, etc.

Gravity separation methods - The treatment of mineral particles which exploits differences between their specific gravities. The separation is usually performed by means of sluices, jigs, classifiers, spirals, hydrocyclones, or shaking tables.

Grizzly - A device for the coarse screening or scalping of bulk materials to remove the large waste component. Usually an iron or wood grating, it serves as a heavy-duty screen to prevent large rocks or boulders from entering a sluice or other recovery equipment.

Ground sluicing - A mining method in which the gravel is excavated by water not under pressure. A natural or artificial water channel is used to start the operation, and while a stream of water is directed through the channel or cut, the adjacent gravel banks are brought down by picking at the base of the bank and by directing the water flow as to undercut the bank and aid in its caving. Sluice boxes may or may not be used. Where not used, the gold is allowed to accumulate on the bedrock awaiting subsequent clean-up. A substantial water flow and adequate bedrock grade are necessary.

Head - Pressure exerted by a column of fluid.

Highwall - The unexcavated face of exposed overburden in a surface mine, or the face or bank on the uphill side of a contour strip mine excavation.

Hillside placer - A gravel deposits intermediate between the creek and bench placers; their bedrock is slightly above the creek bed, and the surface topography shows no indication of benching.

Hydraulic dredge - A dredge in which the material to be processed is excavated and elevated from the bottom of a stream or pond by means of a pump or a water-powered ejector. Large hydraulic dredges may be equipped with a digging ladder, which carries the suction pipe, and a motor-driven cutter head arranged to chop up or otherwise loosen material directly in front of the intake pipe. Dredges having this configuration employ a deck-mounted suction pump, and they may carry the mineral recover equipment on board the dredge or, more commonly, they may transport the excavated material by means of a pipe line to a recovery plant mounted on independent barges or on the shore. (See Bucket-line dredge).

Hydraulic giant - The nozzle assembly used in hydraulic mining. The giant is provided with a swivel, enabling it to be swung in a horizontal plane, and it may be elevated or depressed in a vertical plane. Nozzle sizes range from 1 to 10 inches in diameter, and the larger sizes are provided with a deflector or a specific configuration, enabling them to be moved with little effort. In California, giants discharging as much as 15,000 gallons per minute in a single stream, at a nozzle pressure of over 200 pounds per square inch, have been used. The giant is also known as a "monitor." Both terms stem from manufacturer's trade names.

Hydraulic lift - A suction lift (a piping arrangement) which utilizes water pressure to pick up and transport material (ore) to the sluice. The hydraulic lift provides prewash to the ore prior to sluicing.

Hydraulic washing - Mining by washing lighter sand and dirt away with water, leaving the desired heavier mineral.

Hydraulic mining - A method of mining in which a bank of gold-bearing earth or gravel is washed away by a powerful jet of water and carried into sluices where the gold separates from the earth by its specific gravity.

Hydraulic monitor - See Hydraulic giant.

Hydraulicking - Mining by the hydraulic method.

ICP - Inductively coupled plasma. An atomic emission spectrometric method for trace element analysis of water and waste method 200.7.

IFB metals - Twenty-seven metallic analytes determined by ICP or atomic absorption (furnace) procured by EPA-ITD's routine Invitation-for-BID (IFB)-type contracts.

Infiltration water - That water which permeates through the earth into the plant site.

Influent - The liquid, such as untreated or partially treated wastewater, that flows into a reservoir, process unit, or treatment plant. The effluent is the outgoing stream.

Jig - A machine in which heavy minerals are separated from sand or gangue minerals on a screen in water by imparting a reciprocating motion to the screen or by the pulsation of water through the screen. Where the heavy mineral is larger than the screen openings, a concentrate bed will form on top of the screen; where the heavy mineral particles are smaller than the screen openings, a fine-size concentrate will be collected in a hutch beneath the screen.

Jigging - Process used to separate coarse materials in the ore by means of differences in specific gravity in a water medium.

JTU - Jackson Turbidity Unit. Unit of turbidity measured using a candle turbidimeter. (See NTU.)

Lagoon - Man-made pond or lake which is used for storage, treatment, or disposal of wastes. Lagoons can be used to hold wastewater for removal of suspended solids, to store sludge, to cool water, or for stabilization of organic matter by biological oxidation. They also can be used as holding ponds, after chemical clarification and to polish the effluent.

Marine placer - A deposit of placer-type minerals on the ocean or sea bottom beyond the low-tide line as distinguished from beach placers. Some marine placers may contain material related to beach deposits formed during periods of low sea level; others may contain stream-type placers or mineral concentrations formed on land and later drowned by a lowering of the coastal region.

Mine - A place where work or other activity related to the extraction or recovery of ore is performed.

Mine area - The land area from which overburden is stripped and ore is removed prior to moving the ore to the beneficiation area.

Mine drainage - Any water drained, pumped, or siphoned from a mine.

Mining claim - That portion of the public mineral lands which a miner, for mining purposes, takes and holds in accordance with the mining laws. A mining claim may be validly located and held only after the discovery of a valuable mineral deposit (see Discovery).

Mining patent - A document by which the Federal Government conveys title to a mining claim.

Monitor - See Hydraulic giant.

Muck (Alaska) - A permanently frozen overburden that can overlie placer gravels in the interior of Alaska. It is composed of fine mud, organic matter, and small amounts of volcanic ash. It varies in depth (thickness) from less than 10 feet to 100 feet or more.

National Pollution Discharge Elimination System (NPDES) permits - NPDES permits are issued by the EPA or an approved state program in order to regulate point source discharge to public waters.

Native gold - 1) Metallic gold found naturally in that state e.g., placer gold.

New water - Water from any discrete source such as a river, creek, lake, or well which is deliberately allowed or brought into the plant site.

Nonconventional pollutants - Any one pollutant not defined as conventional or toxic pollutants under the Clean Water Act.

NTU - Nephelometric Turbidity Unit. A unit of turbidity measured with a nephelometer, usually measured against a formazin polymer standard. Nephelometric turbidity units will approximate units derived from a candle turbidimeter but will not be identical to them (see JTU).

Nugget - 1) A water-worn piece of native gold. The term is restricted to pieces of some size, not mere "colors" or minute particles. Fragments and lumps of vein gold are not called "nuggets," for the idea of alluvial origin is implicit. 2) Anything larger than, say, one pennyweight or one gram may be considered a nugget.

Open cut mine - Any form of recovery of ore from the earth's surface except by a dredge.

Ore - Gold placer deposit consisting of metallic gold-bearing gravels, which may be: residual, from weathering of rocks in-situ; river gravels in active streams; river gravels in abandoned and often buried channels; alluvial fans; sea beaches; and sea beaches now elevated and inland. Ore is the raw "bank run" material measured in place before being moved by mechanical or hydraulic means to a beneficiation process.

Overburden - Worthless or low-grade surface material covering a body of useful mineral. The frozen muck covering dredge gravels in Central Alaska is an example of placer overburden.

Pan - 1) A shallow, sheet-iron vessel with sloping sides and a flat bottom used for washing auriferous gravel or other materials containing heavy minerals. It is usually referred to as a "gold pan " but is more properly called a "miners' pan." Pans are made in a variety of sizes, but the size generally referred to as "standard" has a diameter of 16 inches at the top, 10 inches at the bottom, and a depth of 2-1/2 inches. Pans made of copper, or provided with a copper bottom, are sometimes used for amalgamating gold. 2) To wash earth, gravel, or other material in a pan to recover gold or other heavy minerals.

Panning - Washing gravel or other material in a miners' pan to recover gold or other heavy materials.

Pay dirt - Auriferous gravel rich enough to pay for mining or working it.

Pennyweight - A unit of weight equal to 24 grains, 0.05 troy ounce, or 1.5552 grams.

Permafrost - Permanently frozen ground (see Muck).

Permit area - The area of land in which active mining and related activities are allowed under the terms of an NPDES permit. Usually, this is specifically delineated in an NPDES permit or permit application, Alaska Tri-agency permit application, or similar document specifying the mine location, mining plan, and similar data.

Placer deposit - A mass of gravel, sand, or similar material resulting from the crumbling and erosion of solid rocks and containing particles or nuggets of gold, platinum, tin, or other valuable minerals that have been derived from the rocks or veins.

Plant site - the area occupied by the mine, necessary haulage ways from the mine to the beneficiation process, the beneficiation area, the area occupied by the wastewater treatment facilities, and the storage areas for waste materials and solids removed from the wastewaters during treatment.

Process wastewater - All water used in and resulting from the beneficiation process (e.g., the water used to move the ore to and through the beneficiation process, the water used to aid in classification, and the water used in gravity separation), mine drainage, and infiltration and drainage waters which commingle with mine drainage or waters resulting from the beneficiation process.

Point source - Any discernible, confined, and discrete conveyance including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, or vessel or other floating craft from which pollutants are or may be discharged.

Priority pollutants - Those pollutants included in Table 1 of Committee Print No. 95-30 of the "Committee on Public Works and Transportation of the House of Representatives," subject to the Clean Water Act of 1977.

Recirculation - The continued use of water internally within a process. As used in gold placer mining, recirculation is the continual use of the same water used as the transport medium for solids (ore) to or through the classification, beneficiation, and solids separation (wastewater treatment) processes. Recirculation and 100 percent or total recycle may be similar or even identical.

Reconnaissance - A site visit to gather data with or without taking samples.

Recycle - The return and reuse of wastewater to a process after treatment.

Residual placer - Essentially, an in situ enrichment of gold or other heavy mineral caused by weathering and subsequent removal of the lode, or other parent material, leaving the heavier, valuable mineral in a somewhat concentrated state. In some cases, a residual placer may be essentially an area of bedrock containing numerous gold-bearing veinlets that have disintegrated by weathering to produce a detrital mantle rich enough to mine. In some parts of California, such areas are known as "seam diggings."

Riffle - 1) A designed trap across the bottom of a sluice made of expanded metal, angle iron, railroad ties, blocks or slats of wood or stones and arranged in such a manner that openings are left between them down the sluice to create eddies to trap the gold; the whole arrangement at the bottom of the sluice is usually called "the riffles." 2) A shallow extending across the bed of a stream; a rapid of comparatively little fall in a stream.

Riprap - Stone of various sizes placed on a surface to prevent erosion.

River mining - The mining of part or all of a river bed after diverting the river by means of a flume or tunnel, or by use of wing dams to divert the river from the working area.

Rocker - A short, sluice-like trough fitted with riffles and transverse curved supports, permitting it to be rocked from side to side, used to recover placer gold or other heavy minerals.

Runoff - That part of precipitation that flows over the land surface from the area upon which it falls.

Sediment - Solid material settled from suspension in a liquid medium.

Sedimentation - The gravity separation of settleable, suspended solids in a treatment facility.

Settleable solids - The particulate material (both organic or inorganic) which will settle in 1 hour, expressed in milliliters per liter (ml/l), as determined using an Imhoff cone and the method described for "Residue-Settleable" in 40 CFR Part 136.

Settlement Agreement of June 7, 1976 - Agreement between the U.S. Environmental Protection Agency (EPA) and various environmental groups, as instituted by the U.S. District Court for the District of Columbia, directing the EPA to study and promulgate regulations for a list of chemical substances referred to as Appendix A Pollutants.

Settling pond - A pond, natural or artificial, for removal of solids from water.

SIC - Standard Industrial Classification (code).

Slime - Extremely fine particles derived from ore, associated rock, clay, or altered rock.

Sludge - Accumulated solids separated from a liquid during processing.

Sluice - To cause water to flow at high velocities for wastage, excavation, ejecting debris, etc.

Sluice box - An elongated wooden or metal trough, equipped with riffles and usually a bottom matting, through which alluvial material is washed to recover its gold or other heavy minerals.

Sluiceplate - A shallow, flat-bottomed steel hopper arrangement at the head end of a sluice box. A bulldozer generally is used to push gold-bearing gravel onto the sluiceplate, from where it is washed into the sluice by water issuing from a large pipe or by means of a small hydraulic giant.

Slurry - Solid material conveyed in a liquid medium.

Specific gravity - The weight of a substance as compared with the weight of an equal bulk of pure water, e.g., placer gold, with a specific gravity of about 19, is 19 times heavier than water.

Spiral concentrator - A wet-type gravity concentrator in which a sandwater mixture, flowing down a long, spiral-shaped launderer, separates via gravity differentials into concentrate and tailings fractions. The concentrates are taken off through ports while the tailings flow to waste at the bottom.

SS - Settleable solids

Strip - To remove the overlying earth or low-grade or barren material from a mineral deposit.

Suction dredge - See Hydraulic dredge.

Suction lift - The vertical distance from the level of the water supply to the center of a pump, to which must be added the loss due to friction of the water in the suction pipe.

Sump - Any excavation in a mine for the collection of water for pumping.

Suspended solids - (1) Solids which either float on the surface of or are in suspension in water, wastewater, or other liquids and which are removable by a 0.45 micron filter. (2) The quantity of material removed from wastewater in a laboratory test, as prescribed in "Standard Methods for the Examination of Water and Wastewater" and referred to as nonfilterable residue measured in mass per unit volume (e.g., mg/l TSS).

Swell - The expansion or increase in volume of earth or gravel upon loosening or removal from the ground. The average swell of gravel is around 25 percent and sometimes is as high as 50 percent.

Table - A concentration process whereby a separation of minerals is effected by flowing a pulp across a riffled plane surface inclined slightly from the horizontal, differentially shaking in the direction of the long axis, and washing with an even flow of water at right angles to the direction of the motion.

Tailings - The washed material which issues from the end of a sluice or other recovery device in a placer operation.

Thaw points - Pipes driven into frozen gravel through which water or steam is circulated, for weeks or months, to thaw the ground ahead of mining. Once thawed, the ground does not freeze again; thawing is usually carried out one to two seasons ahead of the mining operation.

Total Suspended Solids (TSS) - are the residue retained on a standard glass-fiber filter after filtration of a well-mixed water sample expressed in milligrams per liter (mg/l) using the method described for Total Suspended Solids Dried at 103°-105° in 209C Standard Methods for Examination of Water and Wastewater, 16th Edition.

Treatability study - A study to determine the pollutant removal effectiveness of a wastewater treatment technology.

Trommel - A heavy-duty revolving screen used for washing and removing the rocks or cobbles from placer material prior to treatment in the sluices or other gold recovery equipment.

Troy ounce - One-twelfth part of a pound of 5,760 grains, i.e., 480 grains. It equals 20 pennyweights, 1.09714 avoirdupois ounces, 31.1035 grams, or 31,103 milligrams. This is the ounce designated in all assay returns for gold, silver, or other precious metals.

TSS - Total Suspended Solids.

Turbidity - An expression of the optical property that causes light to be scattered and absorbed rather than transmitted in straight lines through the sample. Turbidity in water is caused by the presence of suspended particles.

Water Duty - A measure of the effectiveness of water use employed in mining. The definition of water duty varies widely in different parts of the world.

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