U.S. Department of the Interior
Bureau of Reclamation
Mid-Pacific Region

-085

SPRING CREEK HEAVY METAL POLLUTION STUDY
July 1983

INTRODUCTION

PURPOSE

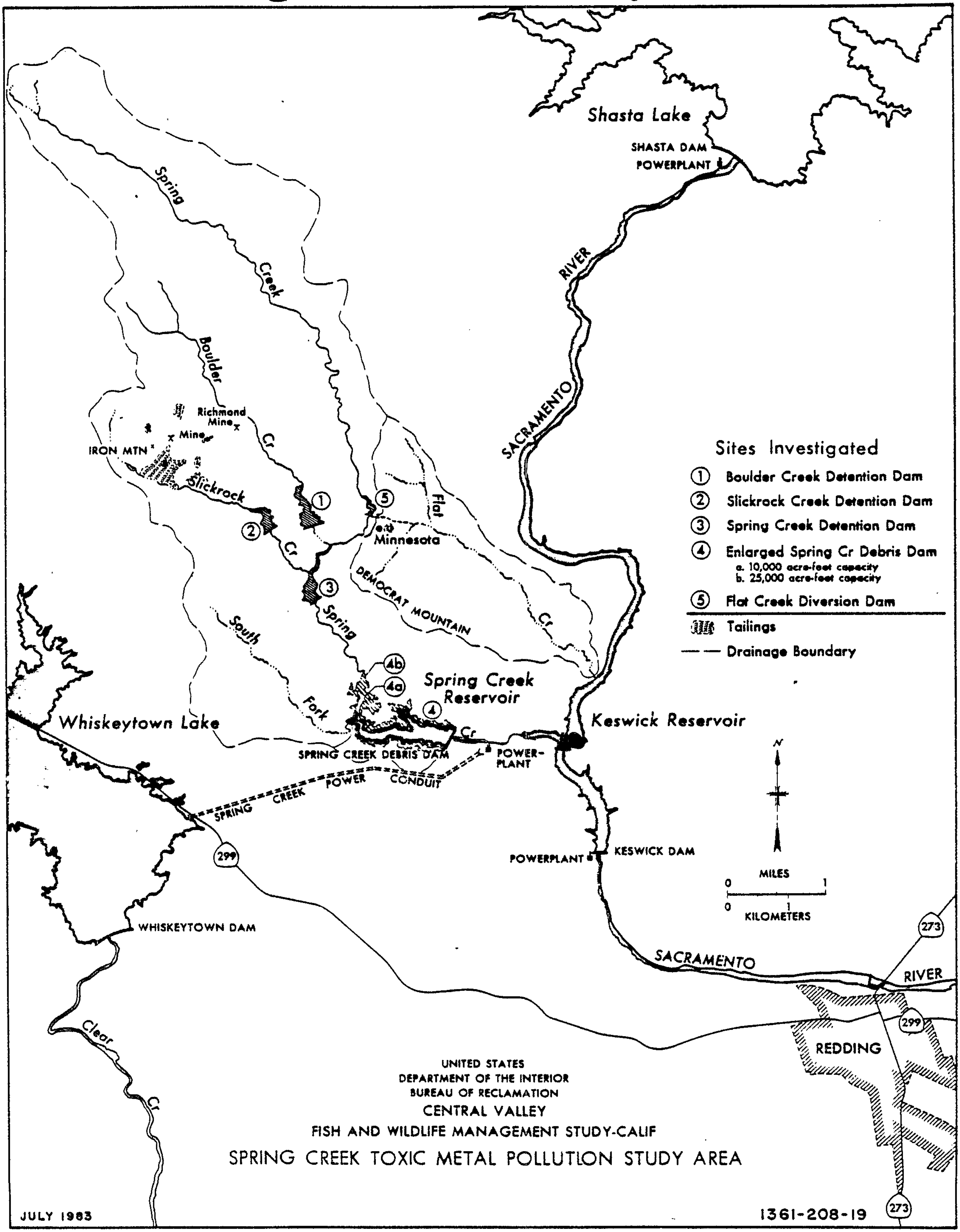
This brochure summarizes the findings of the Bureau of Reclamation's (USBR) investigation of the Spring Creek heavy metal pollution problem. The investigation was conducted under the umbrella of the Central Valley Fish and Wildlife Management Study (CVF&WMS). The CVF&WMS was initiated to develop a comprehensive plan for the management of fish and wildlife resources, coordinated with existing and future development of water and related land resources in the Central Valley.

To protect the Sacramento River system from heavy metal pollution from Spring Creek, the Central Valley Regional Water Quality Control Board (Regional Board), California Department of Fish and Game (DFG), and USBR entered into a Memorandum of Understanding (MOU) in 1980. Under the MOU, the DFG was to conduct further research into the effects of toxic metal concentrations on chinook salmon and the Regional Board was to undertake studies to identify and evaluate alternative measures for source control of acid mine waste waters. The Regional Board also adopted waste discharge requirements for improved operation by the one existing mining discharger in the Spring Creek watershed. The USBR was charged with the responsibility of evaluating structural and operational water management alternative solutions for toxicity control in the Spring Creek area. As an interim measure, the MOU set fishery protection criteria guiding USBR operation of Spring Creek, Shasta, Keswick, and Whiskeytown Reservoirs to provide sufficient dilution flows.

The purpose of the meeting to be held July 28, 1983, in Redding is to present the findings of the USBR's study of various potential structural and operational water management alternative solutions and provide an opportunity for public comment. These comments will be considered in preparing the final report on the study to the Commissioner of the Bureau of Reclamation.

THE AREA

The area investigated is the Spring Creek and Flat Creek Basins, located in northern California. The Spring Creek Basin lies west of the Sacramento River between Shasta Dam and the city of Redding (figure 1). Spring Creek flows southeasterly for a distance of about 12 miles to the Spring Creek Reservoir. Spring Creek's major tributaries--Boulder Creek around the northeastern side of Iron Mountain, and Slickrock Creek around the southern side--flow into Spring Creek about 2 miles north of Spring Creek Reservoir. Water released from Spring Creek Reservoir enters the Sacramento River at Keswick Reservoir, about a mile to the east.



Shasta Lake
SHASTA DAM
POWERPLANT
RIVER
SACRAMENTO
Spring
Creek
Boulder
Cr
Richmond
Mine
IRON MTN
Mine
Slickrock
Cr
Minnesota
Flat
Cr
DEMOCRAT MOUNTAIN
Spring
South
Fork
Spring Creek
Reservoir
Cr
Whiskeytown Lake
SPRING CREEK DEBRIS DAM
POWER-
PLANT
SPRING CREEK POWER CONDUIT
Keswick Reservoir
KESWICK DAM
POWERPLANT
Sites Investigated
① Boulder Creek Detention Dam
② Slickrock Creek Detention Dam
③ Spring Creek Detention Dam
④ Enlarged Spring Cr Debris Dam
a. 10,000 acre-feet capacity
b. 25,000 acre-feet capacity
⑤ Flat Creek Diversion Dam
Tailings
Drainage Boundary
N
MILES
0
1
0
1
KILOMETERS
299
WHISKEYTOWN DAM
Clear
Cr
SACRAMENTO
RIVER
273
299
REDDING
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL VALLEY
FISH AND WILDLIFE MANAGEMENT STUDY-CALIF
SPRING CREEK TOXIC METAL POLLUTION STUDY AREA
JULY 1983
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273

Figure 1

The Flat Creek Basin lies east of the Spring Creek Basin. Flat Creek enters the Sacramento River about 3/4 mile above the confluence of the river with Spring Creek. Flat Creek is an intermittent stream and flows during the summer are often nonexistent.

The area has been the scene of considerable mining activity since the late 1800's. From about 1880 to 1962, several ores (chiefly: copper, gold, silver, zinc, and pyrite) formed the basis of Iron Mountain operations. Active mining ceased after 1962, when the mine could no longer be operated profitably.

PROBLEM

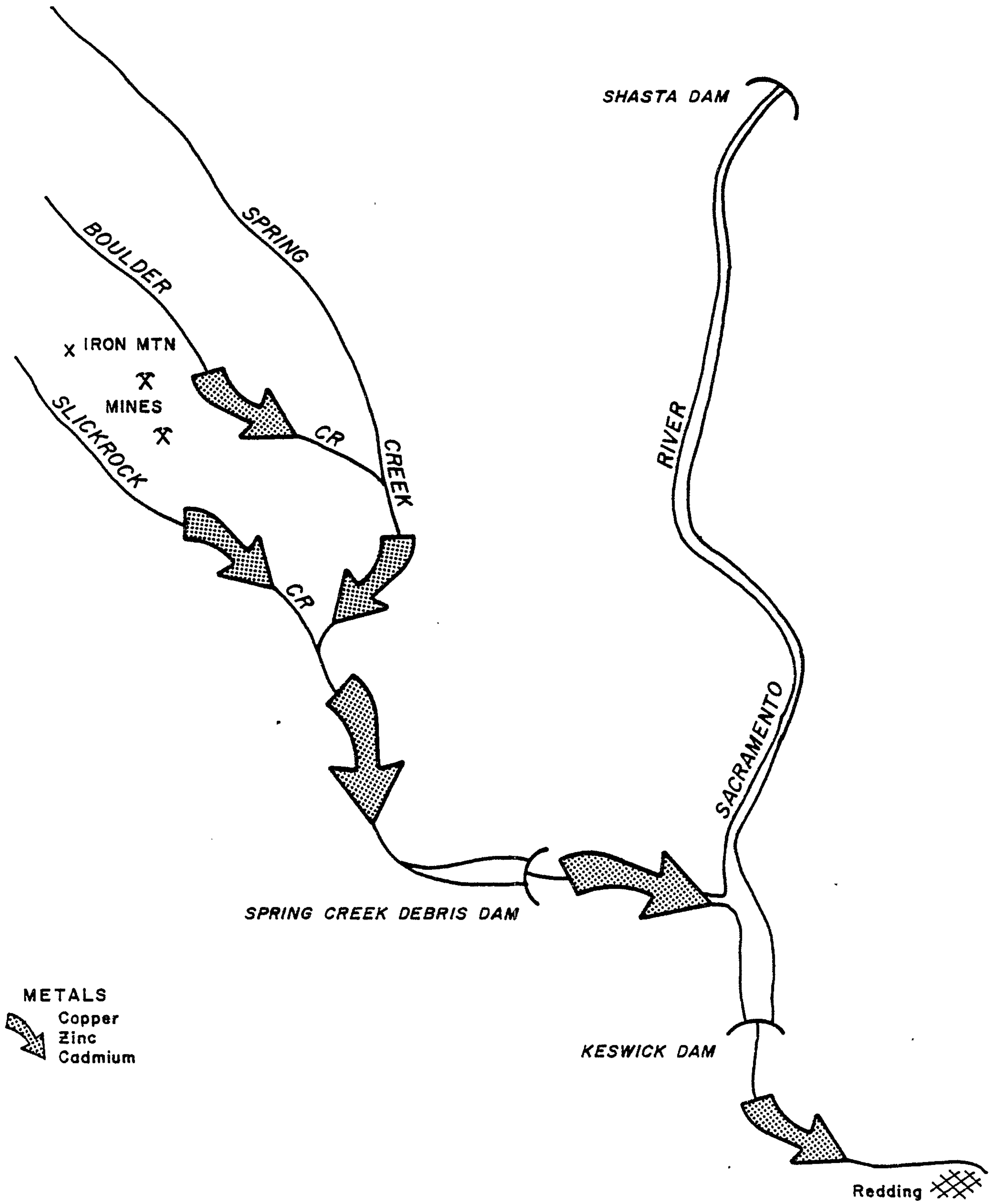
The mine waste pollution problems originating in the Spring Creek Basin have long been recognized. In 1940, the California Department of Fish and Game (DFG) pointed out that, since a salmon collecting station was proposed at Keswick Dam, the copper content of Spring Creek was a serious matter. Indeed, following completion of the Shasta-Keswick Dam complex in 1945, salmon were forced to spawn below Keswick Dam. Large numbers of fish were killed by undiluted toxic flows in the 1950's and 1960's. Figure 2 shows the route of heavy metals entering the Sacramento River from the Spring Creek watershed.

Following the completion of Spring Creek Debris Dam by the USBR in 1963, it was believed that toxic mine waste waters containing heavy metals such as copper, zinc, and cadmium could be controlled by this structure to levels safe for fish. Controlled releases from the reservoir could be made when sufficient dilution flows were available from Shasta, Keswick, and Whiskeytown Reservoirs. During periods of very heavy rainfall, however, the storage capability of Spring Creek Reservoir has sometimes been exceeded and uncontrollable spills can cause serious fish kills during the fall and late-fall salmon spawning runs. If this situation remains unresolved it will pose a threat to the future of chinook salmon runs in the upper Sacramento River and thus a threat to a valuable fishery and environmental resource.

STRUCTURAL AND OPERATIONAL WATER MANAGEMENT ALTERNATIVES

From a structural point of view, polluted waters from Spring Creek could be regulated to a greater extent by providing additional storage capacity in the system, especially during periods of heavy rainfall. Three methods of increasing storage capability were investigated: construction of new detention dams, enlargement of the existing Spring Creek Debris Dam, and reduction of the quantity of water requiring storage. The following are the alternatives which have been evaluated (figure 1):

No Action - The no action alternative is used as a base from which to measure the effectiveness of water management alternatives for solving the heavy metal toxicity problem. No action means that no new structures are built, but the two existing copper treatment plants at the mine site



ROUTE OF
HEAVY METALS ENTERING SACRAMENTO RIVER SYSTEM

JULY 1983

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Figure 2

are properly operated and maintained, and Shasta, Keswick, Whiskeytown, and Spring Creek Reservoirs are operated according to the release criteria contained in the MOU.

Alternative 1 - Construct a detention dam on Boulder Creek about 1,400 feet upstream from its confluence with Spring Creek.

Alternative 2 - Construct a detention dam on Slickrock Creek about 3,000 feet upstream from its confluence with Spring Creek.

Alternative 3 - Construct a detention dam on Spring Creek located about 13,000 feet upstream from the existing Spring Creek Debris Dam.

Alternative 4 - Enlarge the existing Spring Creek Debris Dam and Reservoir from its existing 5,800 acre-foot capacity to:

4a - 10,000 acre-feet (an increase of 4,200 acre-feet).

4b - 25,000 acre-feet (an increase of 19,200 acre-feet).

Alternative 5 - Divert flows (up to 800 cubic feet per second) from upper Spring Creek into Flat Creek near the old town of Minnesota.

Table 1 shows that, for a comparable increase in storage, enlargement of Spring Creek Debris Dam costs much less than construction of new detention dams. Also, it is possible to gain a much greater amount of storage at the existing Spring Creek Debris Dam site than at the other sites. The Flat Creek diversion costs even less but is capable of saving only a maximum of 1,600 acre-feet of storage per day.

TABLE 1
Costs of Increased Storage

	Increase Storage by:	
Alternative	4,200 acre-feet	19,200 acre-feet
No Action	0	0
1	$26,000,000	*
2	$30,000,000	*
3	$24,000,000	*
4a	$16,500,000	-
4b	-	$39,000,000
5	$5,500,000**	-

* In these cases, it would be either physically impossible to attain the storage level or the cost of doing so would be extremely high.

** The increase in storage under this alternative is limited to a maximum of 1,600 acre-feet.

Based on these estimates, the alternatives of enlarging Spring Creek Debris Dam and diverting upper Spring Creek into Flat Creek (Alternatives 4a, 4b, and 5) were selected for more detailed study. It was necessary to determine whether an enlarged Spring Creek Debris Dam alone, a diversion to Flat Creek alone, or a combination of the two structures would be required to solve the problem. The size of an enlarged Spring Creek Debris Dam required to accomplish the objective also was to be determined.

Concurrently with the USBR's efforts of formulating water management alternative solutions to the toxicity problem, the Regional Board; Environmental Protection Agency; California Department of Health Services; and Iron Mountain Mines, Inc., are focusing their efforts on resolving this problem by treatment of the toxic mine waters at the source. Because there is a relationship between the amount of toxic metal pollution control accomplished at the mine site and that which can be provided by additional storage capacity on Spring Creek, there are a great number of alternatives involving each of these possibilities separately or in combination. To facilitate the evaluation of the merits of these alternatives and the many variables involved in each, a computer analysis was performed. This analysis required making some assumptions regarding the levels of source pollution control that could reasonably be expected.

COMPARISON OF ALTERNATIVE SOLUTIONS

COMPUTER ANALYSIS

The Spring Creek toxicity model was developed to compute the estimated concentrations of copper, zinc, and cadmium in the Sacramento River below Keswick Dam with each of the potential alternative solutions. The computer model also considered potential future levels of source control of the toxic mine waters.

The model used the predicted copper, zinc, and cadmium concentrations to estimate Sacramento River salmon mortalities. These mortality estimates were based on DFG biological studies and data on the distribution of salmon by river location, time of year, and life stage, which were compiled and summarized by the U.S. Fish and Wildlife Service. Project accomplishments with the various structures were computed in terms of reductions in estimated historical chinook salmon mortalities for an average annual spawning run. (An average annual run was estimated to be about 127,000 spawners.) Table 2 compares the effectiveness of the alternative solutions under two assumed levels of toxic metal source control. Level A represents the present situation, when existing copper treatment plants are operating. With this level, 57 percent of the copper but no zinc are controlled at the source. Level B represents removal of 82 percent of the copper and 80 percent of the zinc at the source. This optimum situation could be achieved through treatment of tailings piles, open pits, mine portals, and more advanced treatment of polluted waters.

TABLE 2
Effectiveness of Alternative Solutions
in Reducing Estimated Historical Chinook Salmon Mortalities
in an Average Rainfall Year

Alternative	Annual Mortality Reduction A	Annual Mortality Reduction B
No Action	0	0
4a	855	0
4b	9,050	4,920
5	125	4,160
4a with 5	855	4,920
4b with 5	36,040	4,920

A - Present, 57% of copper removed
B - Optimum, 82% of copper and 80% of zinc removed

From table 2 it can be seen that under situation A, the present level of source control, only two alternatives appreciably reduce salmon mortality. Alternative 4b, enlargement of Spring Creek Debris Dam to 25,000 acre-feet, would decrease average annual mortalities by about 9,050 spawners, Alternative 4b with 5, the diversion to Flat Creek with the Spring Creek Debris Dam enlargement to 25,000 acre-feet, is the most effective, decreasing mortalities by about 36,040 spawners.

If a high degree of pollution control at the source is attained (situation B) then only about 4,000 to 5,000 spawners would be saved through water management alternatives.

In order to compare the potential alternative solutions in terms of their cost effectiveness in increasing the annual spawning run by reducing salmon mortality, an economic analysis was made.

ECONOMIC ANALYSIS

Construction costs, interest during construction, and annual operation and maintenance costs were estimated for each of the five structural alternatives. Taken together, construction costs and interest during construction are the investment costs; these costs were annualized and added to annual operation and maintenance costs to determine the total annual project costs. These costs are shown in table 3.

TABLE 3
Costs of Alternatives (x$1,000)

Alternative	Investment Cost	Annual Investment Cost	Annual Operation & Maintenance	Total Annual Cost
4a	18,646	1,469	9	1,478
4b	42,883	3,379	17	3,396
5	5,879	463	11	474
4a with 5	24,525	1,932	20	1,952
4b with 5	48,762	3,842	28	3,870

Preliminary estimates also were made for implementing the more advanced level of toxic metal source control. The total cost of this higher level of treatment would be about $1,322,000 annually. There is a possibility that precious metals could be recovered, but this potential cost offset has not been included in this analysis.

Table 4 lists the estimated reduction in salmon mortality and cost effectiveness (in terms of annual cost per salmon saved) of the structural alternatives investigated by the USBR as well as the alternative of achieving an advanced level of toxic metal pollution control at the source.

TABLE 4
Cost Effectiveness of Alternatives

Alternative	Annual Reduction in Salmon Mortality		Annual Cost per Salmon Saved ($)	
	A	B	A	B
4a	855	0	1,725	-
4b	9,050	4,920	375	690
5	125	4,160	3,760	115
4a with 5	855	4,920	2,280	395
4b with 5	36,040	4,920	105	785
Advanced Source Control	31,120	-	40	-

A - Present, 57% of copper removed
B - Optimum, 82% of copper and 80% of zinc removed

From table 4 it can be seen that, with the present level of 57 percent source control of copper only, Alternative 4b with 5 achieves the greatest level of mortality reduction. However, the most cost-effective measure, at $40 per salmon saved, is additional source control of heavy metals.

With the more advanced level of source metal removal (82 percent of the copper and 80 percent of the zinc), it appears that the diversion to Flat Creek, Alternative 5, at $115 per salmon saved, possibly could provide some additional cost-effective protection.

RELATED STUDIES

A study recently completed for the Regional Board evaluated means of controlling toxic metal discharges from surface areas such as tailings piles and open pits at Iron Mountain Mine. Another study is nearing completion on removal of the heavy metals from waters discharging from the mine portals.

The Environmental Protection Agency, Department of Health Services, and the Regional Board have developed a proposal for a remedial investigation and feasibility study which will build upon the Board's previous studies and further define future actions. Monies for the study would come from Federal and State superfunds for toxic waste cleanup. With funding, the study is expected to be completed in late 1984.

Iron Mountain Mines, Inc., is currently exploring the feasibility of reactivating the mine. If the mine is reactivated, the owners will be required to comply with stringent Federal and State water quality standards for active mining operations, which would probably improve source control of heavy metals even beyond the level of 82 percent copper and 80 percent zinc removal considered in this study.

Implementation of future source control actions, either through use of superfunds or through reactivation of the mine, possibly could be initiated as early as 1986.

YOUR IDEAS

Use this page to write down any notes, ideas, or questions you would like to ask. If you are unable to attend the public meeting on July 28, 1983 to present your thoughts or preferences, please write them down and send them to us. Attach extra sheets, if needed.

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