STATE OF CALIFORNIA
STATE WATER RESOURCES CONTROL BOARD

In the Matter of the Request of the UNITED STATES DEPARTMENT OF THE INTERIOR, BUREAU OF RECLAMATION For Reconsideration of Order No. WQ 87-3 of the State Water Resources Control Board.	ORDER NO. WQ 88- 7

BY THE BOARD:

On March 19, 1987, the State Water Resources Control Board (State Board or Board) adopted Order No. WQ 87-3. This order approved one of three alternatives proposed by the Bureau of Reclamation (Bureau) of the United States Department of the Interior for cleanup of Kesterson Reservoir and directed the Bureau to implement the alternative within one year of adoption of waste discharge requirements by the California Regional Water Quality Control Board, Central Valley Region (Central Valley Regional Board). By letter dated April 15, 1988, the Bureau requested reconsideration of Order No. WQ 87-3 on the basis of new evidence. In response to the request, the State Board held a hearing on May 24 and 25, 1988, to receive new evidence regarding the cleanup alternative approved by the Board in Order No. WQ 87-3 as well as other cleanup methods not previously considered by the Board. Based upon evidence introduced at this hearing, the Board held an additional hearing on June 23, 1988 to receive testimony on proposed revisions to the time schedule which the Board had imposed on the Bureau for cleanup of Kesterson.

I. BACKGROUND

On February 5, 1985, the State Board adopted Order No. WQ 85-1 and Cleanup and Abatement Order No. 85-1. In these orders the State Board found that the Bureau, as the owner and operator of Kesterson Reservoir, had discharged agricultural wastewater at the site, resulting in conditions of pollution and nuisance. The orders described the history of development of Kesterson Reservoir, a feature of the San Luis Drain. In particular, the orders discussed the water quality problems resulting from the discharge of tile drainage containing selenium and other elements into the reservoir. That discussion will not be repeated here.

In Cleanup and Abatement Order No. 85-1, the Bureau was ordered to cleanup the site by closure of the reservoir, upgrading it to meet applicable regulatory requirements, or other appropriate cleanup alternatives by no later than February 5, 1988. The Bureau was also directed to submit a plan to the State Board by July 5, 1985, specifying the manner in which the Bureau intended to comply with the cleanup order.

The Bureau subsequently elected to close the site and on July 5, 1985, the Bureau submitted a Kesterson Reservoir Closure and Cleanup Plan to the Board. On August 22, 1985, the State Board adopted Order No. WQ 85-5, directing the Bureau to submit a final closure plan by December 1, 1986. In compliance with this directive, the Bureau provided the Board with a Closure and Post-Closure Maintenance Plan (Closure Plan) on December 1.

The Closure Plan proposed a phased approach to cleanup of Kesterson. The first two phases, the Flexible Response Plan and Immobilization Plan, entailed the in-place management of contaminated soils, sediments, and vegetation. Under these plans the southern ponds, Ponds 1 through 8, at the reservoir would be flooded with water containing low concentrations of selenium. The rationale for this management approach was the scientific hypothesis that, as long as reducing conditions were maintained in the pond bottom sediments, through the provision of a water supply and the promotion of bacterial activity, the selenium in the sediments should remain immobilized. In the northern ponds, Ponds 9 through 12, the Bureau proposed management procedures, including tilling, monitoring, and other measures, if necessary.

The third phase, the Onsite Disposal Plan, would be implemented if the first two phases were unsuccessful in achieving cleanup goals proposed by the Bureau for both water and food chain items. Under this plan, the Bureau would construct an onsite landfill to contain contaminated soils, sediments and vegetation. The Bureau proposed to excavate the upper six inches of soil from all of Ponds 1 through 4 and selected areas of Ponds 5 through 12 in order to remove sediments with a selenium concentration greater than 4 parts per million (ppm). After excavation, the entire site would be sampled and additional excavation conducted, as necessary, in order to reduce the mean selenium concentration in the excavated area to below 3 ppm. All excavated materials, in addition to harvested vegetation, would be placed in a 45-acre landfill which would be located in the

western half of Pond 3. The Bureau anticipated that after construction of the landfill about 780 acres of the reservoir would become upland habitat and about 420 acres would become seasonal wetlands.

In Order No. WQ 87-3 the State Board, after reviewing the record and applicable legal standards, approved the Onsite Disposal Plan but disapproved both the Flexible Response and the Immobilization Plans. The Board concluded that there were significant scientific uncertainties associated with the latter two plans and that the plans did not meet regulatory requirements. Order No. WQ 87-3 gave the Bureau one year from the date of adoption of waste discharge requirements by the Central Valley Regional Board for the site to fully implement the Onsite Disposal Plan.

On August 14, 1987, the Central Valley Regional Board adopted waste discharge requirements, Order No. 87-149, for the cleanup and closure of Kesterson. Accordingly, the Bureau was required under State Board Order No. WQ 87-3 to complete construction of the landfill by August 14, 1988.

On April 15, 1988, the Bureau requested reconsideration of State Board Order No. WQ 87-3. This order addresses the Bureau's request.

II. REQUEST FOR RECONSIDERATION

The Bureau has requested reconsideration on the basis of new evidence regarding both the Onsite Disposal Plan approved in Order No. WQ 87-3 and alternative cleanup strategies. The Onsite Disposal Plan was based upon the assumption that excavation of the most contaminated soils and sediments at Kesterson would result in safe concentrations of selenium in surface water, ground water, and the biota. The most significant new information developed by the Bureau since the adoption of Order No. WQ 87-3 is the extent to which seasonal wetlands, or ephemeral pools, pose a threat to wildlife. The Bureau contends that this threat would not be alleviated and, in fact, would be exacerbated if the Onsite Disposal Plan were implemented. Additional Bureau research indicates that neither flooding nor excavation is necessary in order to prevent selenium pollution of the ground water.

In lieu of the Onsite Disposal Plan, the Bureau has proposed an alternative, the "Recommended Cleanup Plan" (Recommended Plan). Unlike the previous Closure Plan, the Recommended Plan now focuses on keeping Kesterson as dry as possible. The Recommended Plan contains three components: management actions for ephemeral pool and upland areas; field trials of cleanup procedures; and monitoring activities.

The management actions recommended by the Bureau are intended to control risks to wildlife at Kesterson. The specific management actions recommended for ephemeral pool areas are dewatering, vegetation management, hazing and provision of an

alternative habitat water supply. The first management activity, dewatering of the Kesterson ponds, is now essentially complete. Vegetation management is proposed to control growth of cattails and other habitat through the use of herbicides and discing in order to make the Reservoir unattractive to wildlife. In addition, biocides would be used to control plants and invertebrates, if necessary, when ephemeral pools form in the winter of 1988-89. Increased hazing in the ephemeral pool areas would complement these activities. In addition, the Bureau proposes to continue both the provision of water for alternative habitat on Kesterson National Wildlife Refuge as well as the delivery of 8,000 to 12,000 acre-feet (af) of interim water to surrounding wetlands in order to make these habitats more attractive to waterfowl and to reduce their use of Kesterson Reservoir. Management activities proposed for upland areas include discing and increased monitoring of food chain items, small mammals, and birds associated with dry habitats.

The field trials of cleanup actions include removal, in-situ containment, and in-situ dissipation techniques. For the ephemeral pool areas, the Bureau is recommending that grading, filling, volatilization, dewatering, leaching, offsite water management, and controlled flooding cleanup techniques be evaluated.

The Bureau proposes to observe the location, extent, and duration of ephemeral pools during the winter of 1988-89 and to use this information to evaluate various grading and filling schemes. Field trials of various techniques to enhance microbial

volatilization rates began in July 1987 and are recommended for continuation in 1988. Microbial volatilization is a natural biological process which results in the depletion of soil selenium through volatilization to the atmosphere. The Bureau is also recommending that a number of dewatering alternatives be evaluated, including spreading or spraying to increase evaporation, hauling water offsite, discharge to Mud Slough or the San Joaquin River, ground water pumping, and deep-well injection. Field tests may be proposed to evaluate the potential for the displacement by controlled flooding of soluble selenium in the vadose zone, the area between the water table and the ground surface, to the shallow ground water aquifer under Kesterson. In addition, the Bureau recommends an evaluation of the extent to which offsite activities, such as flooding of the adjacent duck clubs, affect ephemeral pool formation at the reservoir. Lastly, the Bureau proposes to continue fields tests of permanent flooding which were commenced in the spring of 1986 in order to demonstrate the viability of the Flexible Response Plan.

For upland areas, the Bureau recommends that volatilization, cropping, and excavation cleanup procedures be evaluated. Field tests are proposed to evaluate both plants which extract selenium from subsurface soils and plants which reject selenium uptake. The Bureau is currently testing removal of selenium by excavation, and further tests are proposed.

The third component of the Bureau's Recommended Plan is monitoring. The Bureau is proposing to continue its current monitoring program, which addresses biota, surface and ground water, air quality, and public health.

III. NEW INFORMATION

In 1985 the Bureau began funding a research program proposed by scientists from the University of California at Berkeley (UCB) and Lawrence Berkeley Laboratory (LBL) to study cleanup alternatives for Kesterson Reservoir. This research and monitoring effort is ongoing. The results of the data collection and research efforts undertaken in the last year by the Bureau will be briefly reviewed in the following paragraphs.

A. Ground Water Quality

The Bureau has been conducting both ground water monitoring and laboratory and field experiments which shed light on potential impacts on ground water quality as a result of seepage from the Kesterson ponds. Ground water monitoring results can be broken into two categories, elevated levels of boron and total dissolved solids (TDS) and elevated levels of selenium.

A plume of high boron and TDS drainage water extends to depths ranging from 20 to 140 feet underneath the reservoir and is estimated to extend up to 1,150 feet to the east of the site, adjacent to Ponds 1, 2, and 5. The plume appears to be the result of past seepage from Kesterson Reservoir. It is estimated that, in the absence of further flooding of Kesterson, the plume

will migrate to the northeast, the prevailing direction of the regional ground water flow, at velocities ranging from less than 1 to approximately 160 feet per year, with an average velocity of 20 to 30 feet per year. A fraction of the salts and boron will surface as a result of evapotranspirative fluxes in the lands downgradient of the reservoir. At this time, it is difficult to predict the effect that such surfacing might have on the surface water quality of adjacent lands due to the highly saline soil conditions that prevail in the vicinity of Kesterson.

Elevated ground water selenium concentrations are not widespread in the reservoir. The best current understanding is that selenium has migrated into the upper aquifer in isolated areas, primarily the intersection of Ponds 2, 3, and 4 and along the San Luis Drain adjacent to Ponds 1, 2, 5, and 7. Elevated selenium levels have been correlated with oxidizing conditions and the presence of high nitrate concentrations in the ground water. Nitrate is an oxidizing agent and creates oxidizing conditions in the aquifer which favor the persistence of soluble forms of selenium. In general, however, selenium levels have been declining in the wells where elevated levels were once detected. For example, while 28 of 100 wells sampled in September 1987 had selenium concentrations above 10 parts per billion (ppb), at present, only nine wells currently exceed a selenium level of 10 ppb. The LBL scientists attribute this decline to the dissipation of nitrate in the aquifer, resulting in the reestablishment of reducing conditions. Reducing conditions cause selenium to drop out of solution and become immobilized.

In October 1986 the B
experiment. Soil water sampler
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The last experiment co
directly relates to potential gr
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in the shallow aquifer. A solut

fluorescein dye, which served as a tracer, was injected into the aquifer in two locations. The first site was essentially native ground water, which is reducing, and the second site was located within the plume of oxidizing ground water beneath Pond 2. Samples of the injected solution were withdrawn on a weekly basis. Analysis of the samples indicated that, in the reducing zone, selenite was rapidly removed from solution while selenate removal took approximately 25 days. These results support a conceptual model of rapid adsorption of selenite and a slow reduction of selenate to selenite, followed by rapid adsorption, in a reducing environment. In the oxidizing zone, however, no substantial selenium removal was noted.

B. Surface Water Quality

Monitoring and research results obtained by the Bureau over the past year also address potential surface water quality concerns associated with Kesterson Reservoir. The Bureau intentionally flooded Ponds 1, 2, 5, and 7 as part of an interim management scheme implemented in August of 1986. Samples were collected in these ponded areas from December 1987 to the present. Over the sampling period selenium concentrations ranged from 3 to 36 ppb with an average of 12 ppb.

Selenium concentrations in the ephemeral pool areas, in contrast, were extremely high. The levels ranged from 10 to 2,400 ppb with an average of 159 ppb. The ephemeral pools form during the winter due to rising ground water and rainfall. The most likely sources of selenium in these pools are soluble surface salts, biotic selenium in vegetative mats, and rising vadose zone water.

In May 1986 the Bureau began an experiment to test the efficacy of permanent flooding to immobilize selenium. A 0.8-acre enclosure, called Pond 5e, was constructed in Pond 5, and the enclosure was filled with low selenium ground water. For nearly two years surface water concentrations of selenium in the enclosure have remained below the Bureau's target level of 5 ppb, ranging from 1.5 to 4.1 ppb. Over the past year selenium levels in the larger, permanently flooded areas of Pond 5 were about four times higher than the levels in Pond 5e.

The Bureau has also been monitoring selenium levels in the vadose zone. Soil water samplers were installed at 29 sites throughout Kesterson Reservoir. The data which was collected indicated that concentrations of selenium around 1,000 ppb are typical in the soil pore waters in the top six inches and concentrations around 70 ppb are typical at depths of three feet. Concentrations at a depth of one foot range from 3 to 3,500 ppb with an approximate mean value of 400 ppb. The data supports the conclusion that high concentrations of dissolved selenium are ubiquitous in the pore waters of the vadose zone beneath the reservoir. Further, these high concentrations may be present even though the total selenium concentrations in the soil are low.

C. Biological Monitoring

The Bureau has an ongoing program to monitor the biota at Kesterson. Surveys have revealed an overall decline in waterfowl use, which the Bureau attributes to hazing, a reduction in ponded water due to dewatering, and the development of alternative habitat. While the absolute number of waterfowl

deaths and embryonic abnormalities has decreased, this appears to be due largely to the decreasing usage. Selenium toxicosis continues to be the diagnosed cause of mortality of some birds and to be implicated in other bird mortalities. The most recent data identified selenium poisoning as the primary or secondary cause of death for 56 percent of coots collected at Kesterson Reservoir from January to April 1988. Of the 32 carcasses collected during that period, including coots, ducks, egrets, grebes, and avocets, a primary or secondary diagnosis of selenium toxicosis was made for 50 percent of the birds. In addition, selenium levels in the livers of coots shot in May of 1988 were similar to levels measured in April and May of 1983.

Tricolored blackbirds are not currently using Kesterson Reservoir. In February and March 1988, from 500 to 10,000 birds used the site for feeding and roosting. The birds were last observed using Kesterson on April 19. Tricolored blackbirds are nomadic and, consequently, may move into the reservoir and begin nesting at any time.

Small mammals were also collected at Kesterson in 1987 and 1988. The whole body selenium concentrations in the mammals were in the same ranges as those documented in 1984. Although the levels are elevated, no adverse effects on the small mammals have been demonstrated by the studies done to date. However, a possible threat to predators that eat the small mammals cannot be eliminated. The San Joaquin kit fox is of particular concern.

Dryland vegetation, consisting of saltgrass leaves, and invertebrates, two possible mammal food sources, were sampled at Kesterson Reservoir during April 1988. The mean selenium

concentration for saltgrass and
respectively, on a dry weight ba
approximate the Bureau's cleanup

On the other hand, the
decrease in selenium levels in t
pools, the predominant habitat o
well over cleanup goals.

D. Soil Sampling

The Bureau has been co
sampling over the past year to de
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in water, ranged from 18 to 69 pe
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dry areas, such as ephemeral poo
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the total selenium inventory, pe

Soil cores have also be
depth distribution of selenium.
indicated that selenium concentra
limited to the first six inches c
exception, however. The analyses
of selenium to depths well below

At present, there is no quantitative estimate of the percentage of the total selenium inventory which is present in the upper six inches of soil. The Bureau's qualitative estimates vary. The percentage of selenium currently residing at depths greater than 6 inches has been estimated at less than 25 percent of the total inventory. At the State Board hearing, an LBL scientist estimated that, overall, 50 to 70 percent of the total selenium inventory would be removed under the Onsite Disposal Plan.

E. Pond 5e

Approximately one year after Pond 5e was flooded with low selenium ground water, selenium levels in the biota declined from 63 to 92 percent of their initial values. The decline was observed in rooted and free-floating plants and in herbivorous and predatory species. By June of 1987 selenium levels in organisms at the base of the food chain had decreased to 5 to 10 ppm. During the winter and spring of 1988, however, selenium levels in the biota rose by a factor of 1.7 to 3.3 from their summer low values. As of January 1988, mean selenium concentrations ranged from 10 to 20 ppm. According to LBL scientists, the most recent data suggest the beginning of another decrease in most of the Pond 5e biota. At this point, it is unclear whether selenium levels in the biota represent a final plateau or whether the levels will all decline to seasonal ranges that achieve the Bureau's cleanup goal for food chain items.

Selenium levels in the biota of the larger, flooded areas of Pond 5 also declined prior to dewatering of the pond in the spring of 1988. Over the last year selenium values for both

water and submerged aquatic vegetation in Pond 5 were about four times those in Pond 5e. Levels in selenium in aquatic insects and fish in Pond 5 were about 2 to 3 times those in Pond 5e.

F. Volatilization

The Bureau began field trials of the feasibility of microbial volatilization in the fall of 1987 in Ponds 4 and 11. The theoretical basis for this potential cleanup method is the observation that soil microorganisms can convert various selenium species to dimethyl selenide, a volatile selenium species. Laboratory experiments, as well as the field trials, indicate that enhanced volatilization rates can persist if soil microorganisms are maintained with carbon, moisture, warmth, aeration, and activators, such as zinc, nickel, or cobalt. The experiments conducted to date establish that volatilization can remove at least a portion of the selenium inventory in the upper 6 to 12 inches of soil.

The major area of uncertainty regarding volatization is the length of time required for the technique to reduce the selenium inventory to safe levels. The Bureau has indicated at least one year of field data, or until October 1988, is necessary in order to effectively estimate potential volatilization rates and to determine whether volatilization is a viable cleanup technique. Even this data, however, may be insufficient to quantitatively define the time span for cleanup using this technique because of uncertainties regarding the effects of selenium speciation on volatilization rates.

G. Onsite Disposal Plan

In late April and early May of 1987, the Bureau established test plots in Ponds 6, 9, and 11 to evaluate the effects of scraping the surface soil, which would be required in order to implement the Onsite Disposal Plan. The tests were motivated by the possibility that high concentrations of selenium could accumulate on the surface of the scraped soils. This concern arose because of data indicating that high concentrations of water-soluble selenium are present in pore waters below the scraping depth, climatic conditions in which potential evaporation greatly exceeds mean annual precipitation, and a ground water table very close to the surface which enhances evapotranspirative flow of vadose zone water through the soils to the ground surface.

Each test plot was approximately 24 feet by 30 feet. One-half foot deep scrapes were made in these plots. In early June, a one-half foot scrape was also made in Pond 10. Later one-foot deep scrapes were taken in Ponds 6, 9, and 11.

Due to below normal winter rainfall, persistent flooding occurred only at the Pond 6 site. Beginning in November 1987 rising ground water resulted in ponding on the surface of the one-foot deep scraped plot in Pond 6. Selenium concentrations in the surface water were measured at concentrations as high as 4,120 ppb, and concentrations remained in the range of 1,000 to 2,000 ppb for a four-month period. Selenium levels in the biota were also very high and were generally in the same range as in a nearby unexcavated pool. In

addition, by March 1988 an algae mat had formed in the excavated pond resulting in an increase in the selenium concentration of the surficial sediments from an average of 1.8 ppm to 10 ppm by March 8.

IV. FINDINGS

A. Ground Water

1. Selenium

The Bureau contends that both the ground water monitoring and experimental results indicate that, regardless of the cleanup technique used at Kesterson Reservoir, pollution of the ground water with selenium will not be a problem. The localized areas of elevated selenium levels in the ground water are believed to be the result of high nitrate concentrations in the agricultural drainage water previously discharged at the reservoir. The high nitrate concentrations are believed to have resulted in oxidizing conditions in the shallow aquifer. The LBL scientists conclude that termination of the discharge of drain water in June 1986 should eventually enable chemically reducing conditions in the aquifer to become reestablished, resulting in the immobilization of selenium. This conclusion appears to be supported by monitoring data showing that selenium levels in the shallow aquifer are declining. Based upon the data the Bureau concludes that neither excavation nor flooding is necessary in order to prevent selenium migration to the ground water.

Based upon our review of the data, the Board concurs in the Bureau's contention. Clearly, the most convincing evidence is the ground water monitoring that has been conducted. The Bureau and LBL have developed and monitored an extensive well

network in the reservoir. Their data establish that even though various areas of the reservoir have been managed in different ways over the last few years, soluble selenium has not been observed to any appreciable extent in the ground water system. The experiments which have been conducted, the Pond 1 flooding experiments, laboratory column experiments and the injection experiments, all support the observed monitoring results. Further, while it is clear that elevated selenium levels are still present in isolated areas under the reservoir, we conclude that this selenium will be removed from solution as reducing conditions are reestablished. We, therefore, conclude that pollution of the ground water with selenium is not a significant concern in evaluating a cleanup program for Kesterson.

2. TDS and Boron

Evidence in the record indicates that the past seepage of drainwater from Kesterson has resulted in significant increases in the concentrations of TDS and boron in the ground water underlying and extending some distance to the east of the reservoir. This plume is expected to migrate to the northeast toward the San Joaquin River system. In addition, a portion of the salts and boron is expected to surface in lands downgradient of Kesterson.

There is insufficient evidence in the record to determine whether the past seepage of salts and boron from Kesterson has adversely affected or will adversely affect beneficial uses of surface or ground water in the future. As the Board noted in Order No. WQ 87-3, the shallow ground water

aquifer underlying the reservoir has historically been of marginal quality. Further, as discussed previously, the potential effect of surfacing salts and boron on downgradient lands is difficult to analyze due to the saline character of the soils in this area.

The waste discharge requirements adopted by the Central Valley Regional Board for the Kesterson cleanup require the Bureau to monitor the ground water pollutant plume, to assess the impacts of operation of the reservoir on ground water quality and existing beneficial uses and to provide a plan for cleanup or mitigation of any identified impacts on beneficial uses. Order No. 87-149, Ground Water Specifications F.1. and 2. The Bureau has already submitted the required monitoring plan and mitigation report to the Central Valley Regional Board.

The State Board finds that the waste discharge requirements adequately address potential water quality problems associated with the plume of high TDS and boron ground water from Kesterson. The Central Valley Regional Board will be directed to continue to assess the need for ground water cleanup or mitigation as additional monitoring data becomes available. In particular, the Central Valley Regional Board will be directed to evaluate the need for an updated monitoring program or mitigation plan in light of the Bureau's new cleanup program, including filling.

B. Ephemeral Pool Areas

A number of conclusions can be drawn from evidence in the record regarding the ephemeral pool areas. First, it is

undisputed that the ephemeral pools represent the most significant threat to the biota at Kesterson Reservoir. Selenium concentrations in the surface water and biota in these pools are quite high and have not declined substantially since the cessation of drainwater discharges in 1986.

Secondly, contamination of the ephemeral pools is a problem which must be addressed under any cleanup scenario for Kesterson. The Bureau currently estimates that 331 acres of land would be flooded during the winter at Kesterson under natural conditions.

Third, it can be reasonably be assumed that the extent and duration of ephemeral pools at Kesterson might increase as a result of implementation of the Onsite Disposal Plan. The Bureau at one time estimated that construction of the landfill would increase the areal extent of ephemeral pools by about 190 acres. While the exact increase in acreage is speculative, we conclude that it is reasonable to assume that lowering the ground surface elevation at Kesterson, as required under the Onsite Disposal Plan, would increase the potential area of seasonal flooding.

Fourth, the problem of ephemeral pools at Kesterson would not be addressed in the short-term under the Onsite Disposal Plan. The Bureau's limited data from the Pond 6 excavation experiment suggests that selenium levels in ephemeral pools, post-excavation, would be similar to levels that occur at present. Similarly, the problem would not be directly addressed by volatilization, the cleanup technique currently preferred by the Bureau. Volatilization, like the Onsite Disposal Plan, is

expected to be most effective at removing the surficial selenium inventory. The research data, to date, however, indicates that, while perhaps less than 25 percent of the selenium inventory at Kesterson is below a depth of six inches, problems are likely to persist under either cleanup technique because of the presence of highly concentrated soluble selenium in the vadose zone. This soluble selenium is likely to rise to the surface when the water table rises during the winter months. In addition, in areas where the shallow water table is in close proximity to the ground surface, the subsurface selenium is capable of returning to the ground surface due to evapotranspirative forces. Consequently, high surface water selenium concentrations in the ephemeral pools may result from both the upward movement of subsoil selenium in the rising water table during the winter and the dissolution of surface soil seleniferous salts. The Bureau's research suggests that the availability of selenium for biotic uptake may be less dependent on the total selenium inventory as on the transport and speciation properties of selenium.

Fifth, there is insufficient evidence in the record to determine whether the ephemeral pool problem would be alleviated in the long-term by removal of the surficial selenium inventory, as contemplated under the Onsite Disposal Plan and volatilization technique. It is reasonable to assume that the highly seleniferous surficial sediments at Kesterson will serve as a long-term source of selenium in vadose zone waters if this source is not removed. If the source is eliminated, the high concentrations of selenium in the vadose zone should decrease

over some indefinite time period. While this decrease is expected to occur over time, the issue is subject to scientific uncertainty.

Sixth, we conclude that contamination of the ephemeral pools at Kesterson must be addressed immediately by the Bureau before the start of the 1988-89 winter season. A witness from the United States Fish and Wildlife Service testified during the Board's May 24 hearing that the Service looked at a number of alternatives to address the current seasonal wetness and that the Service expected, based upon experience in other areas, that grading and filling would at least minimize, if not eliminate, the ephemeral pools. We agree.

In its Recommended Plan, however, the Bureau contemplated a one-year delay in evaluating grade and fill schemes. The Bureau proposed to observe the location, extent, and duration of ephemeral pools during the 1988-89 winter season and to use this information to calibrate a ground water model. The model would predict the extent of ephemeral pools under a range of weather and hydrologic conditions both with and without excavation. The information would be used to evaluate various grading and filling options.

At the Board's June 23 hearing, a Bureau representative testified that the Bureau is now prepared to implement measures to eliminate the ephemeral pools before the 1988-89 winter season. The Bureau proposed to fill ephemeral pool areas prior to the start of winter on a priority basis, with the highest priority pools being filled first. The primary factors in

establishing priorities were the likelihood of formation and the extent of past wildlife usage of the pool. The Bureau testified that the amount of fill material that could realistically be used at Kesterson before the start of winter was approximately 235,000 cubic yards - 178,000 from the interior dikes, 22,000 from the exterior dikes, and 60,000 imported from off-site sources. This amount would be used to fill all of Ponds 1 through 6 to the height of the ground water table.

The Bureau estimated that the fill volumes required to fill all of the ephemeral pools to the rising ground water and six inches above the rising ground water were 350,000 and 617,000 cubic yards, respectively. The fill was anticipated to settle from two to four inches, and the margin of error was anticipated to be plus or minus two inches.

Evidence in the record indicates that the threat posed to the biota from the existence of the ephemeral pools is an acute problem. Delay in addressing this concern is, therefore, unwarranted. The Board is convinced that filling all of the ephemeral pools at Kesterson prior to the 1988-89 winter season is feasible. The Bureau will, therefore, be directed to fill all of the ephemeral pools, on a priority basis, by January 1, 1989. There are a number of options available to the Bureau to accomplish this task, including providing appropriate incentives to the contractor selected to do the job and expediting both the contracting and the environmental review process. The Board expects the Bureau to avail itself of these and any other reasonably available means to get the job done. In addition,

given the predicted margin of error and the potential for the fill to settle up to four inches, the Board concludes that the ephemeral pools must be filled up to six inches above rising ground water.

To keep the Board apprised of the Bureau's progress in filling the ephemeral pools, the Bureau will be required to submit status reports to the Board by August 1 and October 1, 1988. In addition, the Bureau will be required to submit an assessment report by April 1, 1989, evaluating the success of the fill program.

Because the existence of ephemeral pools was not highlighted as a concern in the past, the monitoring program approved by the Central Valley Regional Board for Kesterson does not specifically address this issue. The need for such monitoring is apparent. Monitoring should address both visual observations of any pool formation during the winter season and water quality analyses of any pools which form. The Central Valley Regional Board will be required to amend its monitoring program accordingly.

C. Upland Areas

The State Board has concluded that contamination of the ephemeral pools at Kesterson poses an acute problem which must be addressed immediately by the Bureau. There is no evidence in the record, at present, however, that establishes that elevated selenium levels in the upland areas at the reservoir have resulted in adverse environmental impacts. However, the data are sketchy and a definitive finding that upland areas are

environmentally safe cannot be made at this time. In our view, the large selenium inventory at Kesterson poses a potential chronic problem in the upland habitat due to the unknown hazards associated with this inventory. As discussed previously, it is also reasonable to assume that this inventory serves as a source of selenium in pore waters in the vadose zone although the extent to which this occurs is uncertain.

The most promising strategy proposed by the Bureau for addressing this potential chronic problem may be volatilization, which was identified as a potential cleanup technique in the Bureau's Recommended Plan. Another promising strategy to address the selenium inventory in the upland areas at Kesterson appears to be selective cropping. In our view, volatilization, in particular, could be a more attractive cleanup option than the Onsite Disposal Plan for a number of reasons. Volatilization, if feasible, could completely remove the surficial selenium inventory, rather than encapsulating it in-place. Implementation of volatilization, unlike the Onsite Disposal Plan, would not result in lowering of the ground surface elevation. In addition, volatilization, if successful, would not require post-closure maintenance once cleanup levels were attained. The Onsite Disposal Plan, on the other hand, would require post-closure maintenance for as long as the wastes in the landfill posed a threat to water quality. A Bureau consultant also testified at the Board's May 24-25, 1988 hearing that volatilization could be applied throughout the reservoir whereas only about 60 percent of the acreage would be excavated under the Onsite Disposal Plan. Finally, construction of the landfill would require dedication of

about 45 acres of land for this purpose, whereas, with volatilization, all of the reservoir might eventually be available for use as wildlife habitat after the selenium soil concentrations reach safe levels.

The Bureau concedes that, at present, however, there is insufficient data to determine whether volatilization is a viable cleanup option or to determine how long cleanup would take, if it is viable. The field trials to assess the feasibility of this technique will not be completed before October of 1988. In addition, a concern was expressed at the Board's June 23 hearing regarding whether the number of test plots at Kesterson will be sufficient, in any case, to adequately assess the feasibility of volatilization. We share this concern.

State Board Order No. WQ 87-3 required completion of cleanup at the reservoir by August 14, 1988. We have previously found that selenium pollution of the ground water is an insignificant concern and that evidence is lacking of a demonstrable, acute environmental problem induced by the selenium inventory in the upland areas. We, therefore, conclude that, if the Bureau addresses the acute problem associated with the ephemeral pools, more time should be given to the Bureau to demonstrate the viability of volatilization, selective cropping, or other cleanup techniques which eliminates water quality hazards at the site.

Further, initially, the Bureau should be required to conduct a comprehensive upland habitat assessment, in cooperation with the United States Fish and Wildlife Service, to determine if

the selenium load in the upland areas is impacting habitat values. In conjunction with this assessment, the Bureau should immediately develop and implement an upland habitat monitoring program. This assessment will be used by the Board in evaluating the Bureau's final cleanup plan for Kesterson.

A final report on the upland habitat assessment must be submitted to the Board by April 1, 1989. A preliminary report on any available results of the assessment, including all monitoring data collected up to the date of submission of the report, must be filed with the Board by December 1, 1988. The Board recognizes that the results and data submitted in the preliminary report may not be definitive or complete.

D. Recommended Plan

Although the Board finds that certain components of the Bureau's Recommended Cleanup Plan hold promise, the Board concludes that the Recommended Plan, as a whole, is an unacceptable alternative to the Onsite Disposal Plan. The Recommended Plan is not a cleanup plan but rather an open-ended management and research strategy. Under the Recommended Plan, the Bureau contemplates development of a management plan for cleanup of Kesterson, using basically agricultural management techniques, by the latter part of 1990. The Bureau is unable to predict how long cleanup would take, once the management plan is developed. Cleanup could, however, take as long as ten years.

E. Mitigation

In Order No. WQ 87-3 the Board expressed concern about the loss of wetland habitat values for waterfowl as a result of

the pollution of Kesterson Reservoir. This is a continuing concern. Several additional factors bear on the issue of loss of habitat. As mentioned previously, the Bureau's latest approach to management of Kesterson emphasizes keeping the reservoir dry. In addition, the Bureau proposes to continue management activities, such as hazing, maintenance of the 130-acre alternative habitat area, and provision of interim water supplies to surrounding wetlands, which discourage use of the site by waterfowl and other water birds. The filling of ephemeral pools will result in further losses of wetland habitat.

We note that the Bureau's management activities have apparently been successful in reducing wildlife use of Kesterson Reservoir. Because the site continues to adversely impact wildlife and because of the additional loss of habitat values, we again emphasize the need for wetland mitigation. In particular, the Bureau must consider the development of alternative habitat in addition to the 130 acres which have already been developed as part of the mitigation requirements of Regional Board Order No. 87-149.

V. REGULATORY CONSIDERATIONS

A. Subchapter 15

1. Recommended Plan

Order No. WQ 87-3 contains a discussion of the applicable State Board regulations governing waste disposal to land. These regulations, contained in Subchapter 15, Chapter 3 of Title 23 of the California Code of Regulations (Subchapter 15 regulations), address closure of surface impoundments.

The regulations provide essentially two options for closure of a surface impoundment - removal of all contaminated materials and disposal of the materials off-site and closure of the impoundment as a landfill. In addition to these closure options, the Board is authorized under Section 2510(b) of Subchapter 15 to approve specific engineered alternatives provided that certain demonstrations are made.

The Bureau's Recommended Plan does not comply with the closure requirements for a surface impoundment. Nor has the Bureau attempted to demonstrate that its Recommended Plan should be approved, under Section 2510(b), as an alternative to the applicable closure requirements. In fact, the Bureau has not proposed a specific engineered alternative for closure but rather, as discussed previously, has proposed a management and research program.

2. Onsite Disposal Plan

In Order No. WQ 87-3, the State Board found that the Onsite Disposal Plan could be approved, under Section 2510(b), as a specific engineered alternative to the closure requirements of Subchapter 15. One of the key assumptions supporting this finding was that removal of the bulk of the contaminated soils, sediments, and vegetation at Kesterson would provide equivalent water quality protection as that afforded by the Subchapter 15 closure options. See 23, California Code of Regulations, Section 2510(b)(2)(B). Evidence in the record now indicates, however, that the Onsite Disposal Plan, standing alone, will not provide such protection due to the high concentrations of soluble

selenium in the vadose zone below the anticipated excavation depth for the landfill.

In addition, because the Board has found that ground water pollution is not a significant concern and that the threat posed by selenium in the upland areas is uncertain, we conclude that it is appropriate to delay implementation of the Onsite Disposal Plan. Especially, we find that the Bureau should be given additional time to demonstrate whether volatilization is a viable cleanup technique.

3. Final Cleanup Plan

The Bureau anticipates that the one-year field trial for the volatilization technique will be concluded in October of 1988. Due to the urgent need for full cleanup, the Bureau will be given until December 1, 1988 to submit a report, for the approval of the Board, on the viability of volatilization as a cleanup alternative at Kesterson. If the Bureau concludes that it is a viable cleanup technique, the report must demonstrate that volatilization can be approved, under Section 2510(b) of Subchapter 15, as an alternative to the closure requirements of Subchapter 15. Key factors in assessing whether volatilization can be approved as an alternative include: (1) whether volatilization can achieve the cleanup goals identified by the Bureau in its Closure Plan; and (2) whether the technique can achieve the cleanup goals in a timely manner. If the Board finds that volatilization is an approvable alternative, the Bureau will be given until no later than October 1, 1991 to achieve cleanup goals using this process.

If the report indicates that volatilization is not a viable cleanup technique, the Bureau will be given until April 1, 1989 to submit a final cleanup plan, which complies with the closure requirements of Subchapter 15. The Board wishes to stress that an open-ended research proposal, such as the Bureau's Recommended Plan, will be completely unacceptable and should not be submitted as a final remedial plan. Rather, alternatives which the Bureau should consider include but are not limited to implementation of the Onsite Disposal Plan with appropriate management strategies to address the ephemeral pools and implementation of a grade and fill program. Under these circumstances, the Bureau will be given until April 1, 1990, to achieve full cleanup.

B. Toxic Pits Act

In Order No. WQ 85-1, the Board concluded that the liquid waste discharged into Kesterson was a hazardous waste and that Kesterson was therefore subject to the provisions of the Toxic Pits Cleanup Act of 1984, California Health and Safety Code Section 25208 et seq. (Toxic Pits Act). Section 25208.4 of the Toxic Pits Act prohibits the discharge of liquid hazardous wastes or hazardous wastes containing free liquids into a surface impoundment after June 30, 1988, if the impoundment is within one-half mile upgradient from a potential source of drinking water. In Order No. WQ 85-1, the Board found that this prohibition applied to Kesterson.

The term "discharge" is defined in the Toxic Pits Act as "to place, dispose of, or store liquid hazardous wastes or

hazardous wastes containing free liquids into or in a surface impoundment . . . ." Health and Safety Code Section 25208.2(f). "Hazardous wastes" are wastes that are hazardous under Chapter 6.5 of the Health and Safety Code. Id. (k). Although "store" is not defined in the Toxic Pits Act, the term "storage" is defined elsewhere in Chapter 6.5 as "the containment of hazardous wastes, either on a temporary basis or for a period of years, in such a manner as not to constitute disposal or use of such hazardous waste". *Id. Section 25123.*

The Bureau ceased discharging agricultural drainage water into Kesterson in June of 1986, and no drainwater is currently stored in the ponds. As a practical matter, the ponds are now dry. The question then posed is whether the remaining soils, sediments, and vegetation are hazardous such that, when rainfall events occur in the winter months, the ponds would store hazardous wastes containing free liquids.

In Order No. WQ 87-3, the State Board concluded that the contaminated soils, sediments, and vegetation at Kesterson are, at a minimum, a designated waste, as defined in Subchapter 15. The Board decided to defer the question of whether these materials were hazardous to the Department of Health Services (Department). By letter dated August 3, 1987, the Department notified the Bureau that the Department could not make a final waste classification of the Kesterson soils, sediments and vegetation until more data was available. Pending a final waste classification, the Bureau was granted a variance from compliance with the Department's hazardous waste regulations.

In the absence of a final waste classification from the Department, the Board will continue to treat the contaminated soils, sediments, and vegetation at Kesterson as a designated waste. Because we do not treat these wastes as hazardous, we conclude that the Bureau will not be in violation of the prohibition against storage of hazardous wastes containing free liquids when rainfall events occur.

The Natural Resources Defense Council (NRDC) has raised an additional issue regarding the Toxic Pits Act. The NRDC contends that the presence of hazardous levels of selenium in the ephemeral pools is a violation of the Toxic Pits Act. We do not agree.

Evidence in the record indicates that the primary source of soluble selenium in the ephemeral pools is pore water from the vadose zone. This pore water rises to the surface when the ground water table rises during the wet winter months. We do not believe that the presence of selenium in the ephemeral pools, due largely to rising vadose zone water, constitutes a "discharge" for purposes of the Toxic Pits Act.

Certainly, the presence of vadose zone water, under the circumstances, does not constitute the "placement" or "disposal" of wastes into or in a surface impoundment as those terms are traditionally used. Nor does the presence of such water appear to constitute "storage" as defined in Chapter 6.5 of the Health and Safety Code, i.e., "the containment of hazardous wastes . . . in such a manner as not to constitute disposal or use of such hazardous wastes."

It is true that high levels of soluble selenium would not be present in the vadose zone but for the past discharge of waste at Kesterson. Nevertheless, we note that the Toxic Pits Act contains numerous references to the migration of hazardous wastes into the vadose zone. See, e.g., Health and Safety Code Sections 25208.4(b)(2)(A) and (B), (b)(3), (b)(4)(A), (b)(5)(A); 25208.5(d)(2) and (3). The migration of hazardous wastes into the vadose zone is grounds for denial of various exemptions under the Toxic Pits Act as well as for enforcement measures. See, e.g., id. Sections 25208.4(b)(2), 25208.5(d), 25208.6.

These references indicate that the Legislature was well aware that hazardous constitutents can migrate from a surface impoundment into the vadose zone. Further, the references evidence an intent to distinguish between the "discharge" of wastes into or in an impoundment and the subsequent migration of such wastes into the vadose zone. For these reasons, the Board concludes that the presence of rising vadose zone water in wetland areas does not violate the discharge prohibition contained in Section 25208.4 of the Toxic Pits Act.

C. Department Variance

As mentioned above, the Department granted the Bureau a variance from the Department's hazardous waste management regulations, pending a final classification of the Kesterson soil, sediments, and vegetation. The variance was contingent upon the Bureau's management of these wastes in full compliance with State Board Orders Nos. WQ 85-1 and 87-3. The variance also requires the Bureau to notify the Department "of any change in

the operations of your facility, or the characteristics of the waste to be handled". Our reading of the variance indicates that the Bureau will have to notify the Department if the Bureau does not implement the Onsite Disposal Plan.

D. Waste Discharge Requirements

As stated previously, the Central Valley Regional Board adopted waste discharge requirements implementing the Onsite Disposal Plan for Kesterson on August 14, 1987. In addition to regulating the landfill, the requirements include a monitoring program, Monitoring and Reporting Program No. 87-149, a requirement that the Bureau provide both short-term and long-term mitigation for the loss of wetland habitat at Kesterson, and ground water monitoring and mitigation requirements. The wetland mitigation provisions specified that the Bureau must submit a report detailing its proposal for long-term mitigation by January 18, 1988. Section E of Order No. 87-149. An incomplete report has, in fact, been submitted to the Central Valley Regional Board, several months behind schedule. The Central Valley Regional Board has not yet taken action on the report.

Because we conclude that it is appropriate to give the Bureau additional time to demonstrate the viability of volatilization, the Board will hold Order No. 87-149, excluding Monitoring and Reporting Program No. 87-149, Section E, entitled "Mitigation for the Loss of Wetlands", and Ground Water Specifications F.1 and F.2. in abeyance pending final action by the State Board on the Bureau's report on volatilization or the Bureau's final cleanup plan.

E. Cleanup and Abatement Order No. 85-1 and Order No. WQ 87-3

As discussed previously, the time schedule contained in Cleanup and Abatement Order No. 85-1, as amended by Order No. WQ 87-3, requires the Bureau to fully implement the Onsite Disposal Plan by August 14, 1988. For the reasons explained in this Order, we conclude that this time schedule should be amended in order to: (1) require the Bureau to fill all ephemeral pools, on a priority basis, to six inches above the rising ground water by January 1, 1989; and (2) give the Bureau additional time to demonstrate the viability of volatilization. This Order therefore amends the time schedule in Cleanup and Abatement Order No. 85-1, as amended by Order No. WQ 87-3, accordingly.

VI. CONCLUSIONS

For the reasons explained above, the State Board concludes as follows:

1. The Bureau's monitoring and research data support the conclusion that pollution of the ground water with selenium is not a significant concern.

2. The Regional Board should continue to evaluate the need for cleanup or mitigation measures to address elevated levels of TDS and boron in the ground water underlying and adjacent to Kesterson.

3. The most critical water quality threat at Kesterson is selenium contamination of surface water and the biota in the ephemeral pools areas at Kesterson. This problem must be addressed immediately, prior to the 1988-89 winter season.

4. The Regional Board must amend Monitoring and Reporting Program No. 87-149 to address ephemeral pools, in accordance with the provisions of this Order.

5. The Bureau's Recommended Plan does not meet applicable regulatory requirements and is unacceptable.

6. Volatilization, if viable, is a preferable cleanup technique to the Onsite Disposal Plan. Assuming that the Bureau takes appropriate steps to immediately address the ephemeral pool problem, additional time should be granted to the Bureau to demonstrate that volatilization is, in fact, a feasible cleanup option and meets the applicable requirements of Subchapter 15.

7. The waste discharge requirements adopted by the Central Valley Regional Board, excluding the monitoring program, wetland mitigation provisions and ground water specifications, should be held in abeyance pending final action by the State Board on the Bureau's final cleanup plan.

8. The time schedule contained in Cleanup and Abatement Order No. 85-1, as amended by Order No. WQ 87-3, should be amended in accordance with the findings of this Order.

9. The Bureau should conduct a comprehensive upland habitat assessment and develop a monitoring program to assess selenium-related impacts, if any, on habitat values in the upland areas.

VII. ORDER

IT IS HEREBY ORDERED THAT the Bureau shall comply with the following time schedule:

1. The Bureau shall fill all ephemeral pool areas, on a priority basis, to six inches above the rising ground water by January 1, 1989.

a. The Bureau shall submit status reports to the Board on August 1 and October 1, 1988, briefly describing the Bureau's progress in complying with this task. At a minimum, the reports shall include an estimate of the wetland acreage filled to date, location of such wetland areas, and amount of fill used to date.

b. The Bureau shall submit an assessment report to the Board by April 1, 1989, evaluating the success of the fill program.

2. The Bureau shall submit a report, for the approval of the State Board, by December 1, 1988, on the viability of microbial volatilization as a cleanup alternative at Kesterson Reservoir. If the report finds that volatilization is a viable method, the report shall demonstrate that this method can be approved, under Section 2510(b) of Subchapter 15, as an alternative to the closure requirements for a surface impoundment. In particular, the report must demonstrate, at a minimum, that implementation of volatilization will result in achievement of cleanup goals at Kesterson in a timely manner.

3. If volatilization is a viable cleanup technique, the Bureau shall be given until no later than October 1, 1991, to fully achieve cleanup goals using this technique.

4. If the report referenced in Number 2 above indicates that volatilization is not a viable cleanup option at Kesterson, the Bureau shall submit, for the Board's approval, a final cleanup plan by no later than April 1, 1989. The report shall demonstrate that the final cleanup plan can be approved, under Section 2510(b) of Subchapter 15, as an alternative to the closure requirements for a surface impoundment. The report must demonstrate, at a minimum, that implementation of the final cleanup plan will achieve cleanup goals at Kesterson in a timely manner.

5. The Bureau shall be given until no later than April 1, 1990, to fully achieve cleanup goals under the final cleanup plan referenced in Number 4 above.

6. The Bureau shall conduct a comprehensive upland habitat assessment, including a monitoring program, in cooperation with the United States Fish and Wildlife Service, to determine if the selenium load in the upland areas is impacting habitat values.

a. The Bureau shall submit a preliminary report for the approval of the State Board Executive Director by December 1, 1988 describing any results obtained, including any monitoring data, up to December 1.

b. The Bureau shall submit a final report to the Board on the upland habitat assessment by no later than April 1, 1989.

IT IS FURTHER ORDERED THAT waste discharge requirements, Order No. 87-149, excluding the monitoring program,

the requirement for wetland mitigation (Section E of Order No. 87-149), and Ground Water Specifications F.1 and F.2, are hereby held in abeyance pending final State Board action on a final cleanup program for Kesterson.

IT IS FURTHER ORDERED THAT the time schedule contained in Cleanup and Abatement Order No. 85-1, as amended by Order No. 87-3, is hereby amended in accordance with the provisions of this Order.

IT IS FURTHER ORDERED THAT the Central Valley Regional Board shall continue to assess the need for ground water mitigation or cleanup as new monitoring data becomes available. In particular, the Central Valley Regional Board shall assess the need for an updated monitoring program or mitigation plan from the Bureau in light of the Bureau's new cleanup program.

IT IS FURTHER ORDERED THAT the Central Valley Regional Board shall amend Monitoring and Reporting Program No. 87-149 to address monitoring of ephemeral pools, as provided in this Order.

CERTIFICATION

The undersigned, Administrative Assistant to the Board, does hereby certify that the foregoing is a full, true, and correct copy of an order duly and regularly adopted at meeting of the State Water Resources Control Board held on July 5, 1988.

AYE: W. Don Maughan
Darlene E. Ruiz
Edwin H. Finster
Eliseo M. Samaniego
Danny Walsh

NO: None

ABSENT: None

ABSTAIN: None

Maureen Marche'
Administrative Assistant to
the Board