at between 8.1 to 8.3 between years 28 and 233. Sulfate and total dissolved solids concentrations decrease for approximately the first 100 to 150 years of pit filling, but then start increasing slightly with time.

Chemical constituents of concern from a water quality standpoint are predicted to be antimony, total dissolved solids, and sulfate. Antimony concentrations are predicted to range from approximately 0.04 to 0.06 mg/L, which exceeds the primary drinking water standard of 0.006 mg/L. It should be noted that the geochemical model did not account for precipitation of antimony, thus actual antimony concentrations are likely to be lower than predicted. Total dissolved solids and sulfate concentrations gradually increase over time as a result of evapoconcentration of the lake waters, reaching a median predicted value of 740 mg/L and 375 mg/L, respectively, by 233 years postmining.

The lake is predicted to be well oxygenated throughout the entire filling simulation period, except seasonally when algae demand may reduce dissolved oxygen levels in some near surface water. The combined lake is expected to turn over in the autumn and is not expected to become anoxic. Because of the influx of warm ground water, the lake also is not expected to freeze under normal winter conditions.

Although modeling was performed out to 233 years (95 percent of the predicted steady state pit lake elevation), it is not anticipated that the pit water chemistry would be at chemical equilibrium at this time. Evaporation from the lake surface would continue to concentrate levels of total dissolved solids, sulfate, and other major cations and anions in the lake water for the foreseeable future. Precipitation of ferric hydroxide would continue in the future and would continue to remove selected trace metals.

Pit Lake Water Quality Impacts. Based on the hydrologic model (McDonald Morrissey Associates, Inc. 1998), the pit lake is predicted to behave as a long-term hydraulic sink. Therefore, substantial outflow from the pit lake to the surrounding ground water system is not expected. Since the pit lake is not expected to discharge to either surface or ground water, the pit lake is not expected to degrade surrounding waters of the state.

The pit lake is not intended to be a drinking water source for humans or livestock or to be used for recreational swimming. Therefore, standards to protect the lake as a drinking water source, livestock water supply, or for recreational swimming are not applicable. Aquatic standards also are not applicable because there is no intention to use the lake as a fisheries resource. However, fish could be introduced in the pit lake, and the lake would likely be used by waterfowl and terrestrial wildlife. A summary of potential impacts of the pit lake on waterfowl and wildlife is presented in Section 3.4.2.

3.2.2.2 Impacts to the Humboldt River

Impacts to River Flows from Mine Discharge

Background. A Humboldt River regional study area was defined to assess potential impacts from mine discharges. This study area extends along the river from Carlin, Nevada to the Humboldt Sink, as shown in Figure 1-6. This analysis examines the potential impacts to the Humboldt River from recent and potential future mine discharges from the Goldstrike dewatering operations. The following sections describe the analyses and potential impacts related to flow regimes and water quality in the Humboldt River.

The location on the Humboldt River that has received mine discharges is at the Goldstrike Mine discharge outfall, located near the western Eureka County line (Figure 1-6). Given the availability of data and the location of discharge into the Humboldt River, the impact analysis to the Comus gage is more quantitative, and the impact assessment of the river below Comus is more qualitative in nature. As described in Section 3.2.1.3, substantial flow losses occur in the river downstream of Battle Mountain and Comus.

Barrick has an NPDES permit to discharge dewatering water to the Humboldt River at its discharge outfall. To-date, Barrick has discharged water at this location from September 1997 through February 1999 (see Figure 3.2-35). Barrick currently intends to dispose of excess dewatering water (i.e., water not required for

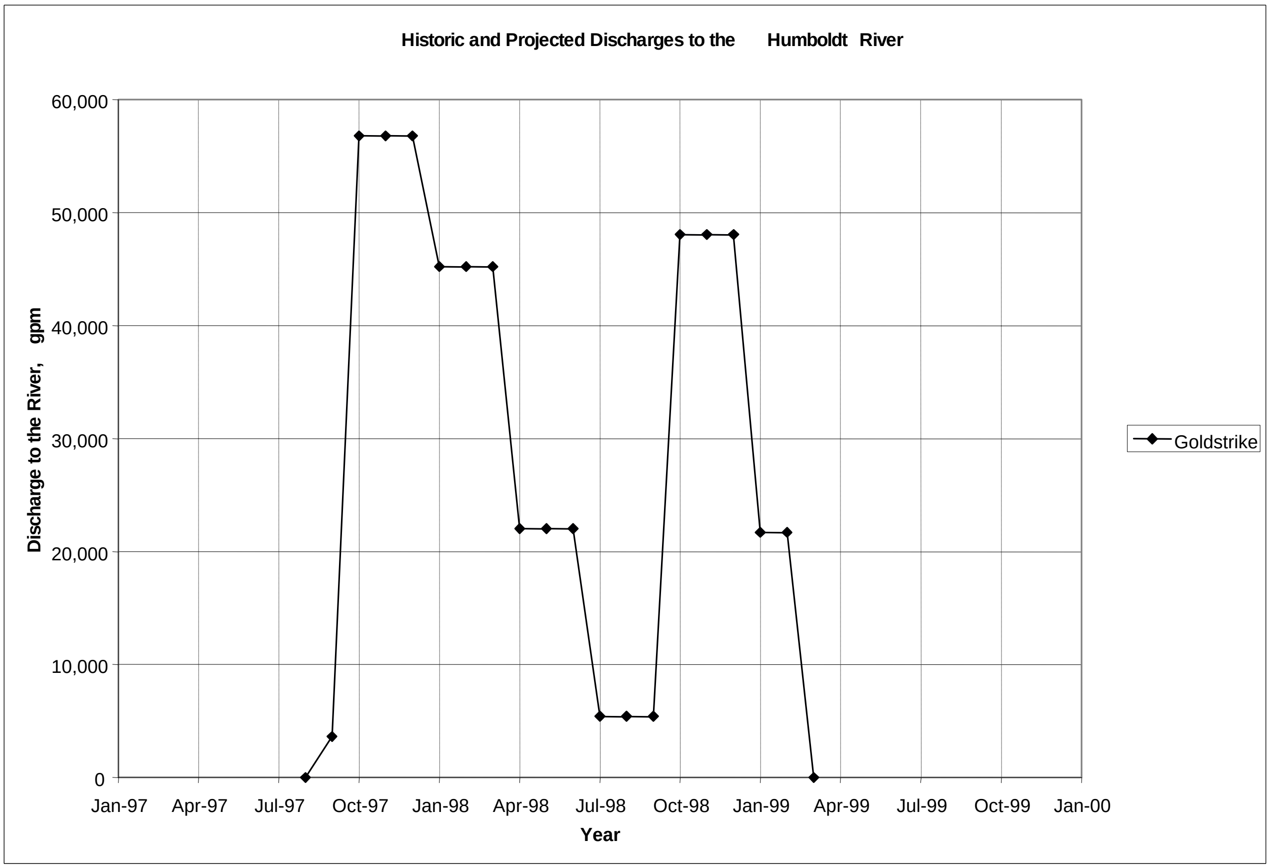


Figure 3.2-35

Goldstrike Mine Discharges to the Humboldt River operating the Goldstrike Mine or for irrigation), in cooperation with Newmont, through infiltration into the rhyolite formation in Boulder Valley. **If additional water disposal were necessary**, Barrick could discharge the remainder, up to 70,000 gpm, to the Humboldt River. The amount of water pumped for dewatering is not equal to the amount of water discharged to the river. A substantial amount of the water is consumed in mining operations, irrigation, infiltration, injection, and other uses. The magnitude of these uses varies seasonally. The remaining flows would be treated, as necessary, to meet Nevada discharge standards prior to release to the river.

Impacts to Date to Humboldt River Flows. Impacts to-date from mining discharges to the Humboldt River were examined by reviewing precipitation and stream gage data. The data review compared flow data for the years 1946-1990 (pre-pumping and pre-discharge) to the flows in the periods when mine dewatering occurred (September 1997 through February 1999) (river flow data for 1999 were not yet available at the time of this document). Available precipitation data, including both snow and total annual precipitation, also were reviewed during this comparison in an effort to put the streamflow data in the context of general climatic conditions in the Humboldt River basin. This review used a simple comparison and rating system that examined several precipitation stations with meaningful data histories in the upper part of the river basin (above Palisade) and several in the lower part of the river basin (below Palisade). No other major influences on streamflows (as described in Section 3.2.1.3) were included in this semi-quantitative review. The results of the data review are shown in Appendix C, Tables C-9 and C-10.

In part, the data examination demonstrates the variation in precipitation and flow regimes over time and from location to location within the basin. In Table C-9 for example, point precipitation data for 1992 at Battle Mountain were approximately 37 percent above normal at that particular location. However, on an area-wide basis using several additional stations, both the upper and lower subbasins had below normal rainfall. In 1991 and 1994, the upper and lower Humboldt River sub-basins differed in precipitation but did not differ substantially in relative streamflows. As northern Nevada generally emerged from several years of drought in the late 1980s and early 1990s, a general increase in streamflows occurred throughout the Humboldt River basin (Table C-10). The years 1995 through 1998 were generally characterized by high precipitation accumulation and correspondingly higher streamflows. Substantially greater increases in streamflows can be seen in 1995 through 1998 data for Battle Mountain and other downstream gages in comparison to the upstream Carlin and Elko data. It is this variation in conditions that is important to flow characterization and analysis of potential impacts.

Goldstrike Mine discharges would enter the Humboldt River below Dunphy and upstream of the Battle Mountain gage. Mine discharges probably had some effect on the greater annual increases in streamflow at that location and farther downstream during the 1997-1998 period (where higher annual flows are evident in the record). However, incremental effects of mine discharges on the river flows are not clearly expressed in the streamflow data alone. In some months, decreases in flow from upstream to downstream are evident. Appendix C, Table C-11 presents the flow variations during the recent higher flow years of 1995 through 1998.

The 1997 data indicate that streamflow increased substantially in the winter and spring prior to Barrick's historical discharges (starting in September 1997). For example, the mean monthly flow for January 1997 at Palisade (above the Goldstrike discharge) is 613 cfs. The 1946-1990 January average is 176 cfs. In contrast to the Palisade data, the mean monthly flow for January 1997 at Battle Mountain is 1,123 cfs, and the 1946-1990 January average is 178 cfs. Similar conditions can be observed in other monthly data for the higher flow years between Palisade and Battle Mountain. It also should be noted that January 1997 flows at Battle Mountain are approximately 80 percent in excess of the maximum 1946-1990 flow for that month, and Goldstrike Mine discharges to the river had not begun. The dramatic flow increases at Battle Mountain probably were caused by regional weather phenomena (such as rain on snow) similar to what occurred in other Nevada river basins at the time. For other months, combined river and mine discharges recorded at the Battle

Mountain gage are all within the historical monthly range of flows (Appendix C, Table C-8).

Between September 1997 and September 1998, comparison between the Dunphy and Battle Mountain data may suggest that a larger portion of the flow increases could be composed of mine discharges (Appendix C, Table C-11). The differences in flows between Dunphy and Battle Mountain during these months are more similar to the magnitudes of the mine discharges. An examination of winter temperature and snowfall data from several weather stations indicates that in earlier high-flow years (1995 through early 1997) the flow increases between the Dunphy and Battle Mountain gages were probably caused by high snowfall in December and January accompanied by warmer than average temperatures. Such conditions increase the potential for rain-on-snow events and snowmelt flooding, and the larger snow accumulations encourage greater runoff in the spring and early summer. In contrast, during the winter of 1997-1998, there were substantial flow increases between the two streamflow gages, but little snow and less monthly precipitation overall than in the previous 2 years. It is likely that the flow conditions between Dunphy and Battle Mountain were affected by Barrick discharges from October 1997 through February 1998. Much higher precipitation than normal occurred later in March through May 1998, and this masks the causes of flow increases between the gages during these and later months. Mine discharges were smaller during the growing season, and irrigation practices and other factors affect the data later in the spring and summer of 1998. In any case, the flow increases between the stations during the discharge period are similar to those that occurred naturally in the years prior to discharge (Appendix C, Table C-11).

Similarly, streamflow data at the Comus gage are influenced by the Goldstrike Mine discharges. Between Battle Mountain and Comus, flow changes in the recent high-flow years generally reflect conditions similar to those upstream. More use (loss) of the mine discharges can be seen in this reach. In addition, there are considerably more months where there are substantial flow decreases between stations, even with the contributions from mine discharges. For all months, the combined river and mine discharges as recorded at the Comus gage are within the historical monthly range of flows (Appendix C, Table C-8).

It should be noted, per the calculations and footnote on Table C-11 of Appendix C, that it is quite possible for part or all of the mine discharges to be withdrawn from the river and consumed by other users of Humboldt River water. This may have occurred as an impact-to-date as reflected in the table entries where substantial flow losses are shown from upstream to downstream gages. In such cases, beneficial impacts to water users may have resulted from the mine discharges.

At times, mine discharges to-date have contributed to flow increases in the Humboldt River. However, this data review indicates that various conditions and water uses contribute to Humboldt River streamflow data, including differences in the size of the drainages being gaged, precipitation accumulation and snowmelt in different parts of the basin, alluvial aquifer gains and losses, agricultural diversions and returns, evapotranspiration, as well as mine discharges. As a result, it is not possible to quantitatively distinguish the incremental increase in flow attributable to the combined mine discharges by a simple comparison of streamflow records. However, qualitative conclusions may be made for some periods using additional data sources (National Climatic Data Center 1999).

In summary, the range of monthly data recorded prior (1946 to 1990) to the pumping and discharge period was compared to the mine discharge period (1997 to 1998) to see if any unusual or anomalous patterns were recorded during the discharge period (Appendix C, Table C-8). The comparison indicates that although some effects on flows may be observed, for all months except January 1997 at Battle Mountain (as explained previously), the range of flows recorded during the Goldstrike discharge period to-date (1997 and 1998) is within the range of flows recorded historically (1946 to 1990). Regional weather conditions, not Barrick water management operations, were probably the cause of the anomalous high flows at Battle Mountain in January 1997. Also, where river flow data are available during the mine discharges (September 1997 to 1998), the conditions in the river were generally similar to other recent high-flow periods (1995 to August 1997). This comparison suggests that mine discharges through 1998 have not resulted in anomalous flow conditions in the river.

Projected Future Impacts to Humboldt River Flows. Estimates of mine discharges to the Humboldt River for this flow analysis were based on actual historic discharges from 1997 through 1998 and estimated potential future mine discharges for the post-1998 period. RTi (1998) provided an estimate of potential future discharges from each of the mines based on information provided by Barrick. In 1999, Barrick provided revised estimates of future mine discharges to the Humboldt River for the Goldstrike Mine (Barrick 1999b). Compared to the earlier estimates (RTi 1998), the revised estimates indicate that the Barrick would no longer discharge to the Humboldt River after the first quarter 1999 (earlier estimates assumed Barrick would discharge from 1999 through 2011). The reduction in discharge and change in discharge periods for the Goldstrike Mine reflect that under the updated water management plans, a larger percentage of the excess mine water would be reinfiltrated or consumed by crop production within the Boulder Valley Hydrographic Area.

Current plans are that no additional water would be discharged to the river in the future; however, as described previously, Barrick has approval from the Nevada Division of Environmental Protection to discharge up to 70,000 gpm to the river (after treatment, if necessary, to meet appropriate water quality standards). Barrick reserves the right to exercise this water management option should it become necessary. For the purposes of estimating potential future flow impacts to the Humboldt River and the sink, this analysis used the future discharge scenario based on the information provided for RTi's earlier work (1998) as depicted in Table 3.2-26. This is considered to be environmentally conservative since it accounts for a higher discharge volume over time than is currently planned.

In order to assess potential future impacts of Barrick's mine discharges to the Humboldt River, Barrick's dewatering discharge scenario was simulated by computer modeling (RTi 1998). The scenario modeled by RTi (1998) included the effects of irrigation withdrawals and returns using the StateMod model (Colorado Division of Water Resources 1996). USGS streamflow data were used as a basis of comparison for an average flow year, high-flow year, and low-flow year.

The StateMod river simulation approach was used to analyze a potential maximum discharge scenario (RTi 1998). In this approach, changes to river flows were estimated by superimposing the monthly mine flows from the maximum predicted cumulative year of dewatering discharge (Table 3.2-26) onto the river flows and running the StateMod computer model. These simulations were conducted for a historic average year, a historic low-flow year, and a historic high-flow year based on streamflow records and data for the period 1946 through 1990. The simulation accounted for seasonal irrigation diversions and returns assuming that future irrigation diversion rates remained similar to historic values (Natural Resources Conservation Service 1997).

For RTi's quantitative evaluation of the Humboldt River upstream of Comus, the average return flow percentage was assumed to be 30 percent, which is midway between agency estimates of return flow percentages (see Section 3.2.1.3). The impact analysis presented for the project is very sensitive to the return flow percentage. Since this number is not known to have been determined explicitly either through experimental or analytical means for the Boulder Flat region or other regions included within the Carlin to Comus reach of the Humboldt River, the 30 percent

Table 3.2-26
Modeled Maximum Goldstrike Mine Discharges to the Humboldt River (monthly average rates)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CFS	137	137	137	0	0	0	5.4	5.4	5.4	137	137	137
GPM	61,435	61,435	61,435	0	0	0	2,422	2,422	2,422	61,435	61,435	61,435

Source: RTi 1998.

return flow percentage used in the subsequent analysis represents a reasonable approximation based on agency estimates (Natural Resources Conservation Service 1997; Testolin 1997).

Average Seasonal Hydrograph Simulation Results. This section describes the effects of the projected discharges to flows in the Humboldt River. As analyzed by RTi (1998), the results presented in Figures 3.2-36 (RTi 1998) and 3.2-37 (RTi 1998) illustrate the simulated flow changes associated with a potential maximum annual discharge. As analyzed by RTi (1998), the results presented in Figures 3.2-36 and 3.2-37 illustrate the combined flows in the river that are predicted at Battle Mountain and Comus when the maximum cumulative mine discharges (Table 3.2-26) are simulated along with a historical average river flow. At the Battle Mountain gage, October shows the largest relative increase in flow (433 percent). The peak flow months of April, May, and June show little relative change at the Battle Mountain gage. In particular, the peak flow for June shows a negligible increase in average flow (0.2 percent).

At the Comus gage, all months except April, May, and June show at least a 20 percent flow increase (and often much larger) in the simulations. The month with the largest relative change in flow is October (540 percent), followed by September, and November. Peak flow months of April, May, and June show negligible increases in average flow at the Comus gage (0.2 percent for June). Changes at Imlay are expected to be similar to the pattern at Comus, but on a smaller scale due to flow losses between the stations.

Low Water Year Simulation Results. As analyzed by RTi (1998), the results presented in Figures 3.2-36 and 3.2-37 illustrate the combined flows in the river that are predicted at Battle Mountain and Comus when the maximum cumulative mine discharges (Table 3.2-26) are simulated along with a historic low-flow year (represented by 1959 historical data). The simulation shows that there is a large relative change to the average monthly flows for the late summer and fall months at both the Battle Mountain and Comus gages under the maximum discharge scenario. The most notable change to the low-flow hydrograph is the shift of water to the low-flow period of October through February. Flow changes at Imlay are expected to be similar to the pattern at Comus, but on a smaller scale due to flow losses between the stations.

High Water Year Simulation Results. As analyzed by RTi (1998), the results presented in Figures 3.2-36 and 3.2-37 illustrate the combined flows in the river that are predicted at Battle Mountain and Comus when the maximum cumulative mine discharges (Table 3.2-26) are simulated along with a historic high-flow year (represented by 1984 historical data). The largest relative change in flows at the Battle Mountain gage occurs from October through December. The largest relative change in flows at the Comus gage occurs from September through December. Flow changes at Imlay are expected to be similar to the pattern at Comus, but on a smaller scale due to flow losses between the stations.

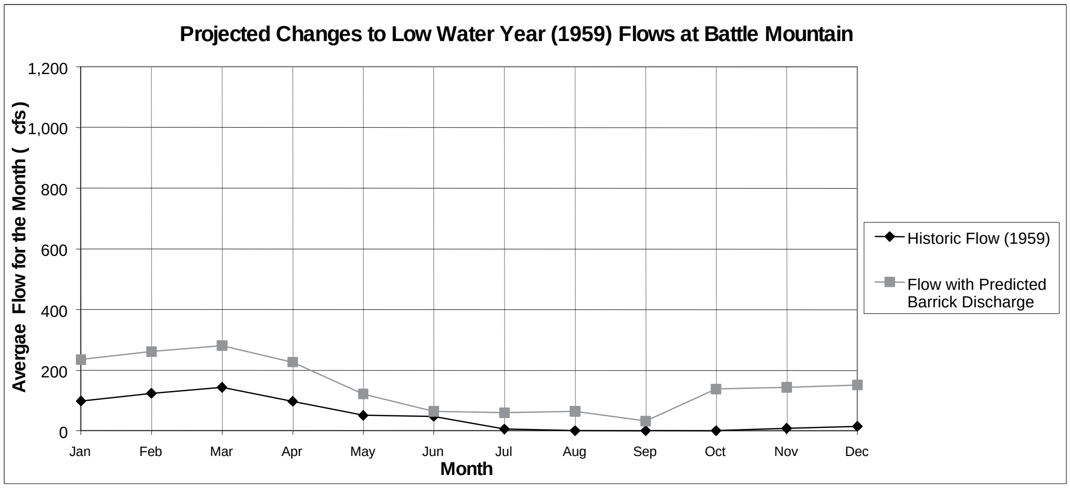
Baseflow Changes in the Humboldt River from Dewatering Effects

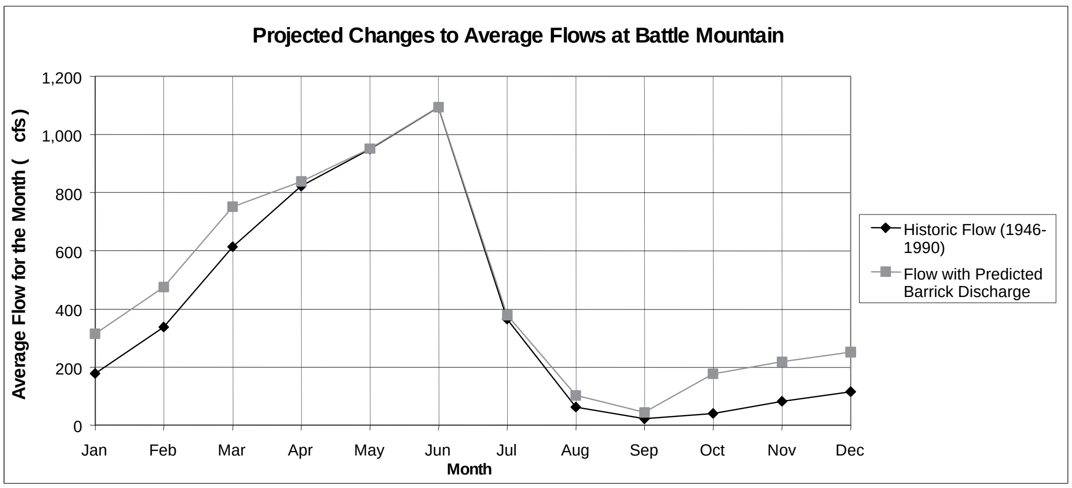
Impacts to Date. There is no evidence that before Barrick began discharging the Goldstrike Mine water management operations had either direct or indirect impacts on Humboldt River flows. As stated previously, historical flows (1946 to 1990) were compared to streamflow data after the initiation of pumping, and no conditions specifically attributable to dewatering were noted. Flows were lower throughout the Humboldt River basin in the early 1990s as a result of drought. Similar occurrences are observable in earlier periods of the historical record prior to mine dewatering.

Projected Future Impacts. Based on projected drawdown at the end of mining and 100 years postmining (Figures 3.2-23 and 3.2-25), substantial baseflow impacts to the Humboldt River from dewatering are not anticipated.

Impacts to Flooding and Flow Geometry from Mine Discharges

Impacts to Date. As discussed in Impacts to Date to Humboldt River Flows, additional mine discharges may have increased Humboldt River flows. Generally, the high-flow months, such as





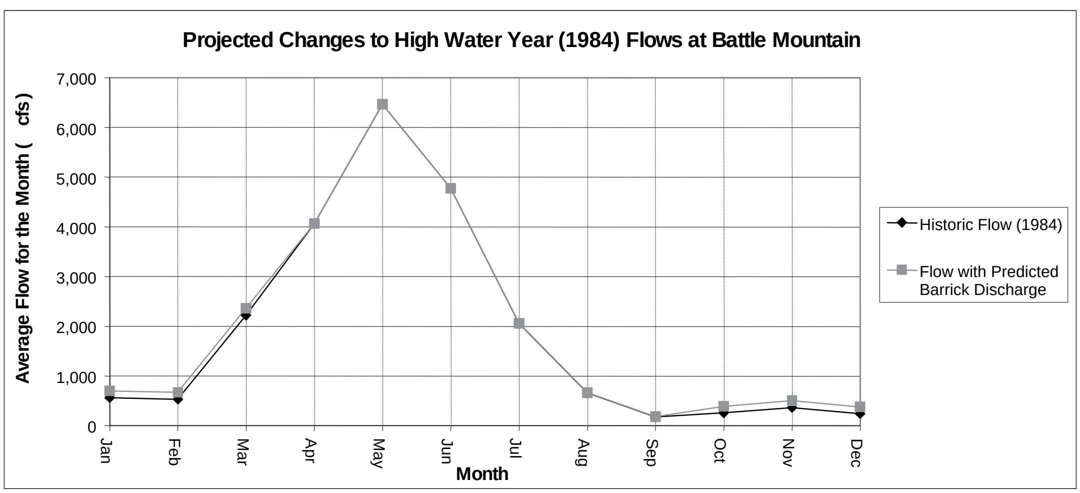
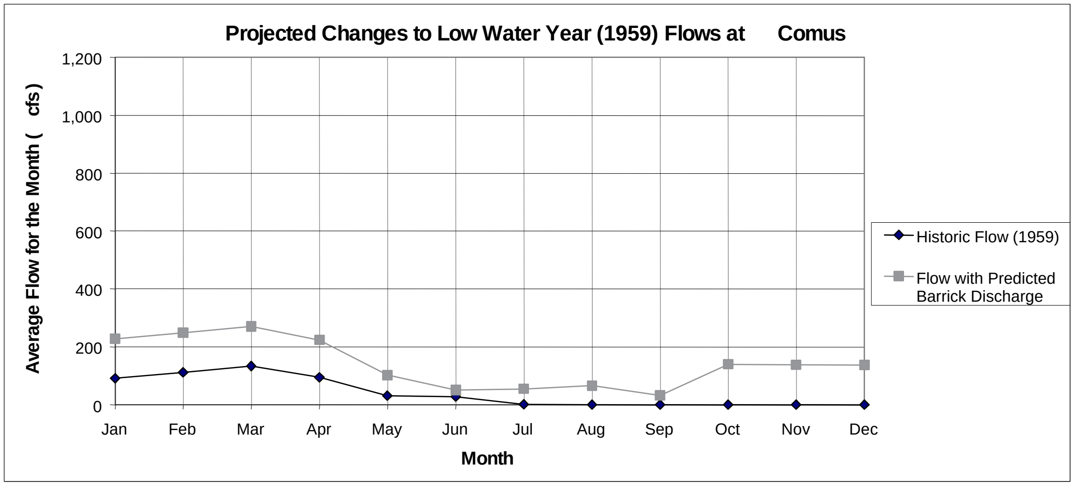
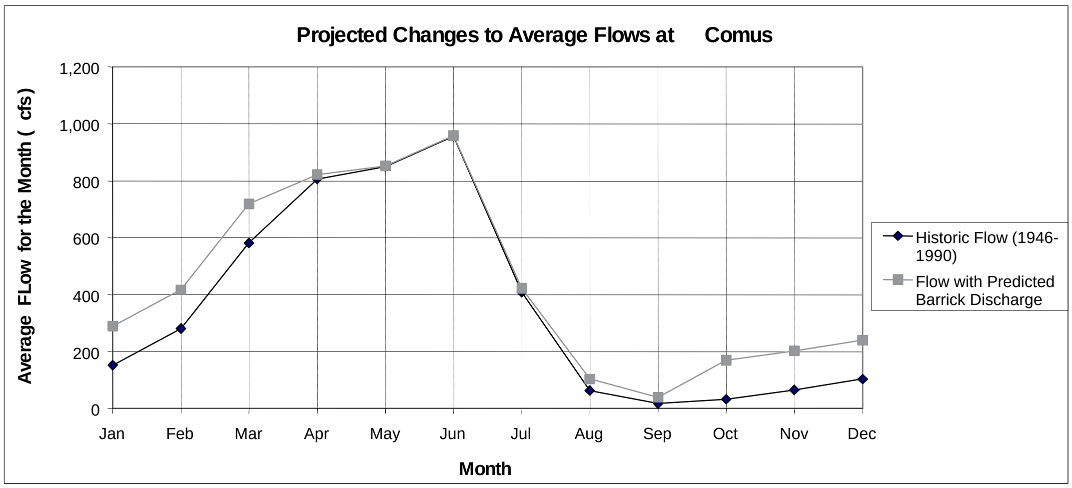


Figure 3.2-36

Projected Changes to Flows at Battle Mountain





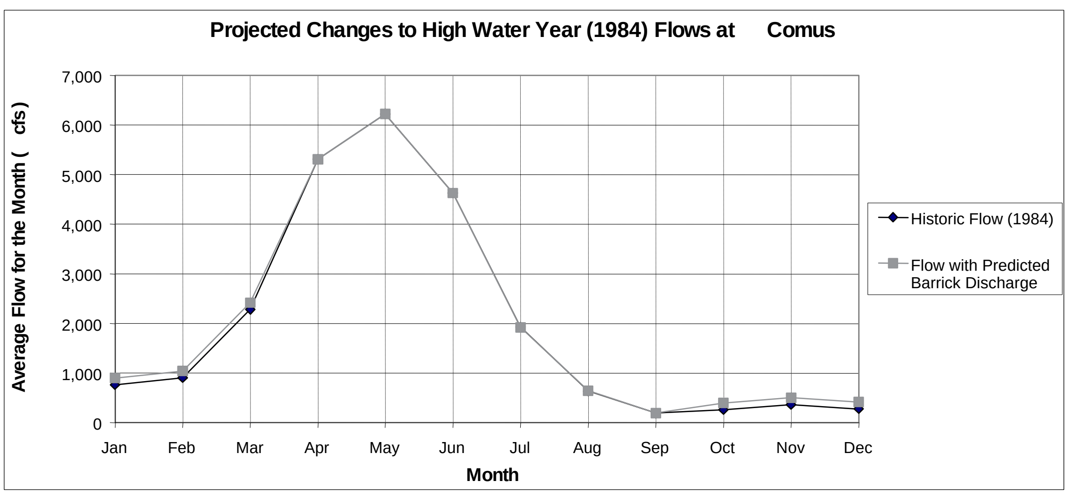


Figure 3.2-37

Projected Changes to Flows at Comus

May and June, have not been substantially affected by the additional discharge. Relative to the natural river flows in those months, the possible increases are small and would have no substantial impact on the flow regime of the Humboldt River during the average peak flow months. Comparably larger increases relative to the natural flows probably occurred in the low-flow fall and winter months. The discharges may have increased the flow depths in the river and added to the width of the river in low-flow months. The extent of the flow geometry increases would vary according to the cross-sectional geometry of the channel. Wider sections would generally undergo less depth increase and more width increase; narrower sections would experience the opposite. Greater depths and flow extent would generally reduce the potential for isolated pools or branches to form in the river during low-flow periods. Changes in flow geometry from the effects of discharges to-date are probably similar (or less) to the projected changes described below.

Projected Future Impacts. Based on the modeling of Barrick's discharge scenario (RTi 1998), a generalized analysis of the mine discharge effects on flow depth and width was conducted using USGS flow measurement data and stage-discharge rating curves. Table 3.2-27 shows the anticipated changes in river stage from the projected maximum mine discharges (Table 3.2-26). As shown in the table, negligible changes are anticipated during the high-flow month of June, but more substantial changes are expected during the low-flow month of October.

These increased flows generally would not create additional flooding along the river upstream of Rye Patch Reservoir. During the highest peak flows (such as may occur during a week in spring in some years), or along constricted reaches of the river during a longer period of relatively high flows (such as may occur during June in most years), limited additional flooding may occur where a change in depth of 1 foot or less would allow the river to escape its banks. The additional inundated area would likely be limited to the immediate vicinity of the river and would generally involve lower elevation hayfields and meadows. The potential for additional flooding downstream of Rye Patch Reservoir is complicated by seasonal streamflow forecasting and its effects on reservoir operations and the regional agricultural infrastructure, as discussed below.

Using a discharge versus river width curve based on USGS information, other potential changes in flow geometry were also examined. High-flow discharges, and thus widths, would remain unchanged. However, low-flow geometries are expected to change. Average October flows at Comus are 32 cfs for the period 1946 through 1996. This translates to a flow surface width of approximately 34 feet. Projected October average flow under conditions of maximum combined mine discharges is 169 cfs. For these conditions, using the same discharge - width curve, the flow width is anticipated to be approximately 72 feet. The calculated change in width is 38 feet. For comparative purposes, this analysis shows that the increases in flow geometry would be relatively larger during low flows than in the peak months.

During low-flow periods (August through February), flooding outside the streambanks is extremely unlikely. Additional mine discharges would not change that condition. The additional discharges would increase the extent of water within the channel banks during the low-flow season and would potentially provide connections between reaches or backwaters that would otherwise be isolated from one another at low-flow stages.

Hydraulic modeling at the discharge outfall location on the river has been done for a mine discharge rate of 156 cfs (70,000 gpm) (Simons & Associates, Inc. 1997). Simons & Associates, Inc. (1997) found that this discharge would cause a water depth increase of 0.1 to 0.2 foot during the high-flow months on the river (generally April through June) and a depth increase of approximately a foot or so during the low-flow months (generally August through November) in the vicinity of the outfall.

Changes in flow velocities would be moderate for the low-flow case (50 cfs) depending on distance from the outfall location. For low flows, the greatest velocity increase would be from approximately 2 feet per second without the discharge to approximately 3.25 or 3.5 feet per second with the discharge. This would occur both upstream and downstream of the outfall (Simons & Associates, Inc. 1997). In general, however, the

Table 3.2-27

Potential Changes in River Stages from Projected Maximum Goldstrike Mine Discharges

USGS Streamgage	Month	Mean Observed Discharge 1946-1990 (cfs)	Observed River Stage 1992-93 Rating (feet)	Mean Simulated Discharge (cfs)	Simulated River Stage 1992-93 Rating (feet)	Simulated Change in Stage (feet)
Battle Mtn.	June	1,093	6.56	1,095	6.56	0.0
	October	41	3.40	177	4.21	0.81
Comus	June	956	6.80	958	6.81	0.01
	October	31	2.49	169	3.55	1.06

Source: USGS 1998b; RTi 1998.

velocity changes would be substantially less than this. For a September case, with low flows on the order of 15 to 20 cfs, the relative change would be greater. For higher natural flows on the river (500 to 2,000 cfs), modeling indicates that historical velocities near the Barrick outfall have ranged from approximately 1 to 6 feet per second, depending on the flow rate and the specific cross section of the river (Simons & Associates, Inc. 1997). Modeling indicates that over the range of higher natural flows, streamflow velocities at the same cross sections would be virtually unchanged with Barrick's added discharge.

Impacts to Channel Characteristics and Controls

Impacts to Date. Effects related to stream erosion, sedimentation, and channel geometry from the discharges are likely to have been small. The Humboldt River channel naturally undergoes large-scale erosion, sedimentation, and position shifts below the point where mine discharges are combined at the Barrick outfall. Qualitatively, the effects of mine discharges are expected to be less than those associated with other man-made causes, such as grazing and other land uses, or natural processes.

Channel stability impacts to-date from recent historical mine discharges of up to approximately 57,000 gpm (127 cfs) have not been documented. However, the release of over 100 cfs of relatively clear (sediment-free) water for approximately 3 months during the low-flow time of year has likely induced additional deepening and possibly widening of the low-flow section of the river channel. Similar impacts would likely result from future discharges.

Projected Future Impacts. If mine discharges occur in the future, they would intensify existing channel instability in the reach extending approximately 3 miles upstream and downstream from the Barrick outfall. Depending on flow velocities and the type of channel disturbance, adjustments may occur both upstream and downstream of the disturbance. Both upstream and downstream effects may occur because of overall adjustments in the channel system throughout the locale. Additionally, if the mine discharges, existing instability along the river near the Comus gage and immediately upstream may be exacerbated. Low-flow channel expansion (deepening and/or widening) is likely to be the most noticeable effect, since low flows would be most affected by future mine discharges.

These channel effects would probably be obscured or obliterated by subsequent spring runoff. Average annual peak flows in the river are approximately 1,100 cfs, and the bankfull flow (recurrence interval of 2.33 years) is estimated to be approximately 1,500 cfs in the river reach between Dunphy and Argenta. Over time, these peak flows would have a greater influence on overall channel morphology and sedimentation than the smaller mining discharges. As discussed previously, the relative increases in mean annual peak discharges from the mine dewatering are not expected to be substantial. Sediment deposition that may occur during the low-flow season would likely be entrained in the higher spring runoff flows.

Impacts to Rye Patch Reservoir Operations and Irrigation Operations Downstream

Background. Rye Patch Dam and Reservoir are part of the Humboldt Project, which was authorized by Congress to provide irrigation water to approximately 40,000 acres of agricultural land in the Lovelock Valley (Bureau of Reclamation 1995). Construction of Rye Patch Dam was completed in 1936, and in 1941 the operation and maintenance of all Humboldt Project facilities, including the dam, reservoir, conveyances, and other facilities, were transferred by the Bureau of Reclamation to the Pershing County Water Conservation District. The locations of Rye Patch Reservoir and the Lovelock area are shown in Figure 1-6.

The greatest potential for adverse impacts to Rye Patch Reservoir and irrigation district from mine water discharges occurs in high water years. In normal and dry years, a positive impact is derived from the benefit of additional flows (Hodges 1998). Normally, additional water can be stored in the reservoir and distributed among the adjudicated rights with beneficial results.

Impacts to Date. Adverse impacts could result in high-flow years from additional flows exceeding the reservoir storage limitations and conveyance capacities of the canals and gates. Releases from Rye Patch Reservoir above 1,500 cfs create damage to the irrigation infrastructure and cause flooding of agricultural fields (Hodges 1998). When high flows are not accurately predicted on a seasonal basis, mining discharges can exacerbate the problem of operating Rye Patch Reservoir to preserve emergency storage and minimize flooding and structural damages downstream. If storage conditions at Rye Patch Reservoir were such that flows from upstream had to be directly passed through the reservoir, an additional 100 to 200 cfs in the river from mine dewatering discharges would take up approximately 7 to 14 percent of the 1,500 cfs drain capacity that could otherwise have been used to convey flows downstream without damaging the irrigation infrastructure.

The tops of the spillway gates at Rye Patch Dam are the highest elevation at which the reservoir can control releases to the river downstream. Gaging data at the reservoir for 1997 indicate that the pool elevation was within 1 foot of the top of the gates from mid-June until the third week of August. In addition, the reservoir pool was at or above the controlled storage elevation (the tops of the spillway gates) from June 30 to July 11, and again from July 26 through August 10 (USGS 1998a). None of these circumstances was a result of Goldstrike Mine discharges to the river, which did not begin until September 1997.

For 3 weeks in June 1998, Rye Patch Reservoir operated at very high storage levels. During this time, the reservoir reached its highest level on record (USGS 1999). For approximately 2 weeks, flow passed over the gates, placing a storage surcharge on the reservoir and allowing essentially uncontrolled discharge to the river and agricultural areas downstream. Flow in the river downstream of Rye Patch Dam reached approximately 2400 cfs. Barrick discharged approximately 130 cfs to the river during the previous winter and spring. It is possible that some of the mine dewatering discharge contributed to high-flow conditions at Rye Patch Reservoir and downstream, and thus contributed to impacts from excess water in these locations. The degree of Barrick's contribution is difficult or impossible to assess, since rainfall and river flows were exceptionally high on a regional basis during this period (see Tables C-9 and C-10, Appendix C). Barrick's nominal discharge represents approximately 5 percent of the flow in the river below Rye Patch Dam during the June period, but actually would have been much less due to attenuation and withdrawals between the location and timing of the dewatering discharge and the conditions at the reservoir.

Projected Future Impacts. As discussed above, Barrick currently does not intend to discharge dewatering water to the Humboldt River. However, under the terms of its NPDES permit, Barrick could discharge up to 70,000 gpm to the Humboldt River at its discharge outfall from 1999 through the end of mining. Therefore, this SEIS analyzes a dewatering discharge scenario provided by Barrick in 1997 (RTi 1998), as discussed previously under "Projected Future Impacts to Humboldt River Flows."

In normal to wet years, agricultural lands in the Humboldt Sink area may be flooded (Hodges 1998). In former years, river flows during August and September generally could be held at Rye Patch Reservoir, and downstream flooding could be minimized. The Nevada State Engineer has determined that any additional flows in the river are to be passed through the reservoir. If Barrick discharges in the future, this discharge may add mine water to naturally-occurring high-water conditions during wet years. The additional flow contributed by Barrick could combine with natural runoff phenomena to produce higher risk of damage to reservoir infrastructures or lands below Rye Patch Reservoir.

It is important to recognize that predicting surface water supplies from year to year is a difficult task, and a number of natural and man-made variables influence seasonal water storage and availability in the region. If additional discharges occur to the river from Barrick's mine water management program, whether or not they would produce adverse or beneficial impacts would depend on complex interactions between natural hydrologic variability and the responses of water managers. However, based on Barrick's recent projections, it is unlikely that Barrick would need to discharge excess mine dewatering water to the Humboldt River (Barrick 1999b). Therefore, impacts to Rye Patch Reservoir operations and irrigation operations are unlikely.

Impacts to Water Levels at the Sinks

Impacts to Date. The Goldstrike Mine discharges have totaled approximately 81,000 acre-feet between September 1997 and February 1999. Approximately 49,000 acre-feet were discharged during calendar year 1998. Of this volume, approximately 35,000 acre-feet were released during non-irrigation periods, and approximately 30 percent of the remainder (4,200 acre-feet) eventually returned to the river. Some or all of this water (39,200 acre-feet) was probably lost to channel seepage, evapotranspiration, or other consumptive uses. Between Battle Mountain and Imlay, approximately 65,000 acre-feet/year were lost from the river system as an average from 1946 to 1990. An additional 20,000 acre-feet/year are estimated to be lost at Rye Patch and Pitt-Taylor reservoirs through seepage and evaporation (Eakin 1962), and further losses from seepage, diversions, and evapotranspiration occur below Rye Patch. Thus, generally very little of the mine discharges may have reached the sinks.

Projected Future Impacts. For the Humboldt Sink, general estimates of evapotranspiration and occasional outflows to the Carson Sink are on the order of 110,000 acre-feet/year, including approximately 57,000 acre-feet passing the Lovelock gage on the river, approximately 43,000 acre-feet from irrigation returns, and 11,000 acre-feet from direct rainfall. Barrick's current projections indicate that it is unlikely that Barrick would need to discharge excess mine dewatering water to the Humboldt River in the future (Barrick 1999b). In the unlikely event that it becomes necessary for Barrick to discharge at a high rate (such as up to 70,000 gpm) for an extended period (several months), depending on the season and natural flow contributions, it is possible that Barrick's discharge could incrementally contribute to temporary effects in terms of greater water depths and areal extent at the Humboldt Sink and possible spillover into the Carson Sink. Spillover into the Carson Sink historically has been a natural periodic occurrence. However, depending on the timing of the discharge, it is possible that only a fraction of the water would reach the sink due to losses from diversions, evaporation, evapotranspiration, and seepage in route.

Impacts to Humboldt River Surface Water Rights

It is not anticipated that the additional mine discharges have created or would create major long-term impacts on surface water rights within the Humboldt River basin. Water resources within the basin have been over-appropriated historically, and the temporary nature of the discharges would not relieve that situation. It is possible that more existing rights may have been fulfilled to varying degrees during the period of mine discharges, or would be fulfilled during any future discharges if they occur. This would be a beneficial impact during the discharge duration. The amounts, locations, and timing of these further fulfillments would vary considerably depending on the seniority of rights and the volume of discharge. The further uses of water would depend largely on the existing agricultural infrastructure and future marketplace demands.

Impacts to Water Quality

Background. In compliance with the provisions of the Clean Water Act, Barrick has an NPDES permit from the Nevada Bureau of Water Pollution Control authorizing dewatering discharges to the Humboldt River. Barrick's NPDES permit became effective on July 10, 1996, and expires on July 10, 2001, at which time the permit could be reauthorized for another 5-year period. Barrick's Boulder Valley outfall began discharging on September 16, 1997, and ended in February 1999 as illustrated in Figure 3.2-35. The NPDES permit (NV0022675) contains effluent limitations, monitoring and reporting requirements, and a list of conditions. The effluent limitations are designed such that water quality constituent concentrations would not exceed stream water quality standards established for the protection of identified beneficial uses.

Impacts to Date. Barrick's discharges recorded between September 1997 and February 1999 were within their permit limitations (no significant non-compliance). Significant non-compliance of an NPDES permit is defined by criteria that include: (1) exceedence of a 30-day average limit any 4 out of 6 months, (2) exceedence of a 30-day average limit by a factor of 1.4 or greater for any 2 out of 6 months, or (3) judgement of significant impact to human health or the environment by Nevada Bureau of Water Pollution Control Staff (Livak 1999). No significant non-compliance violation has been documented under the current NPDES operating permit (Livak 1999).

Projected Future Impacts. As stated in Chapter 1.0, Barrick currently does not anticipate future discharges to the Humboldt River. However, the mine's NPDES permit would allow for the discharge of up to 70,000 gpm on a year-round basis. Based on the discharged water quality to-date, it is assumed that if the mine were to discharge, the discharge water quality would meet the requirements of the NPDES permit limitations as it has in the past. Therefore, provided that the mine discharges are in accordance with the permit limitations, impacts to water quality in the river are not anticipated.

Even though the historic and any projected future mine discharges are anticipated to be within their permit limitations, there is concern that the mine discharge would contribute additional loads of inorganic constituents to the Humboldt River and eventually to the Humboldt Sink. If the mine discharge substantially increased the loads of inorganic constituents to the sink, these loads potentially would be available through evapoconcentration processes to increase concentrations in the sink.

As stated in Section 3.2, Affected Environment, the water quality of the Humboldt Sink wetland areas has been studied and monitored on an intermittent basis since 1987 jointly by the USGS and U.S. Fish and Wildlife Service (USGS 1991; Seiler et al. 1993; Seiler and Tuttle 1997). The studies concluded that arsenic, boron, mercury, molybdenum, sodium, un-ionized ammonia, selenium, and dissolved solids exceeded biological effects levels or Nevada standards for the protection of aquatic life. In addition, the U.S. Fish and Wildlife Service has identified arsenic, boron, chromium, copper, fluoride, lithium, manganese, mercury, molybdenum, selenium, thallium, uranium, zinc, and TDS as constituents of concern for the Humboldt Sink. Causes of contamination were identified as irrigation drainage, hydrogeologic setting, historic mining activities, and drought (Seiler and Tuttle 1997).

Database. Estimates of mine discharges to the Humboldt River for this loading analysis were based on actual historic discharges for the 1997 through 1998 period and estimated potential future mine discharges for the post-1998 period. Barrick (1997) provided an estimate of potential future discharges. In 1999, Barrick provided revised estimates of future mine discharges to the Humboldt River for the Goldstrike Mine (Barrick 1999b). Compared to the earlier estimates (Barrick 1997), the revised estimates indicate that the Goldstrike Mine would no longer discharge to the Humboldt River after the first quarter 1999 (earlier estimates assumed Goldstrike would discharge from 1999 through 2011). The reduction in discharge and change in discharge periods for the Goldstrike Mine reflect that under the updated water management plans, a larger percentage of the excess mine water would be reinfiltrated or consumed by crop production within the Boulder Valley Hydrographic Area. For the purposes of estimating potential load to the Humboldt River and the sink, this analysis used the discharge scenario based on the information provided in Barrick 1997. This discharge scenario, which has Barrick discharging an average of 25 cfs from 1997 through 2011, is considered to be environmentally conservative since it accounts for a higher discharge volume over time and correspondingly higher loads.

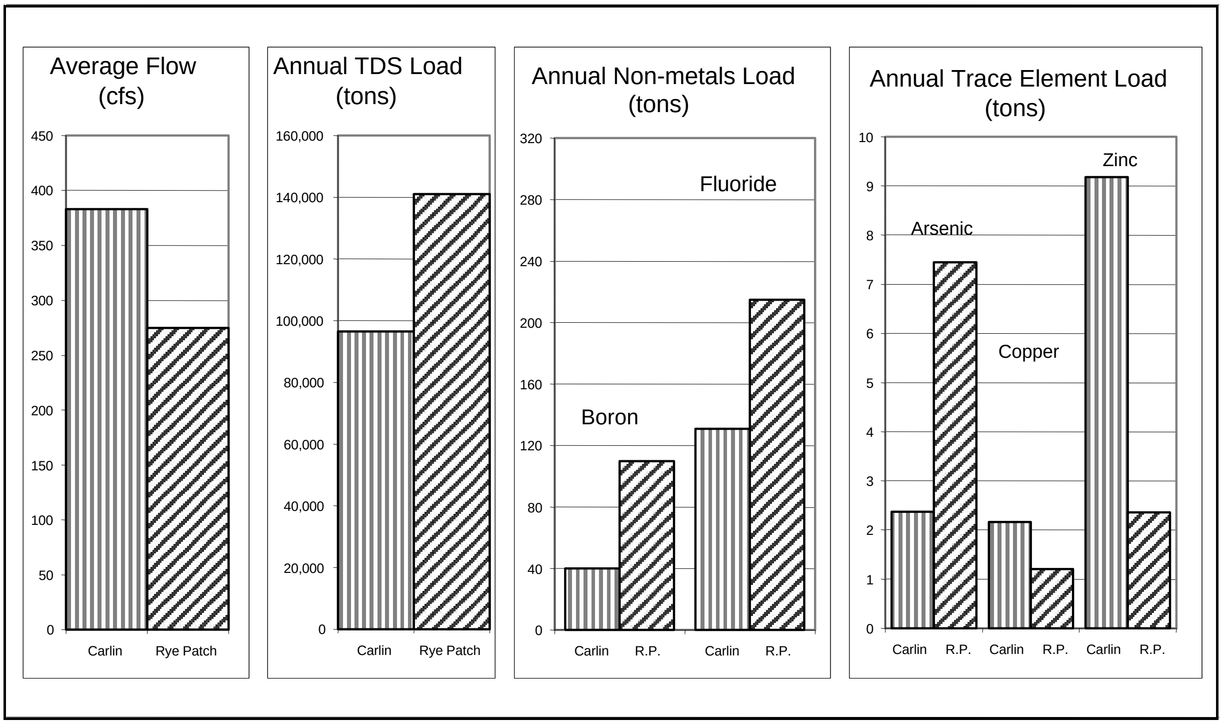
Available water quality information was compiled for the Humboldt River for all stations located between Carlin and the Humboldt Sink. For determining premine loading conditions, only samples for which both water quality and instantaneous river flow were measured at the time of sampling were considered. Water quality data are available for most of the gage sites shown in Figure 1-6. The most representative information on premine water quality in the Humboldt River exists for the Carlin gage for the April 1979 through April 1991 period, and at the Rye Patch gage for the October 1974 through July 1986 period (see Figure 1-6). Data from other water quality stations were much less complete and were not considered in this evaluation. The Carlin site was selected for evaluation since it represents conditions in the upstream reach of the Humboldt River study area. The Rye Patch site was selected to represent conditions in the lower portion of the river immediately above the Lovelock agricultural development.

Below the Rye Patch gage, a large percentage of river flows are diverted for irrigation. The Humboldt River and the Army Drain are the primary sources of flow to Humboldt Lake; the Toulon Drain is the primary source of flow to Toulon Lake. Only a few samples are available to define the load for each of these three sources of flow to the Humboldt Sink (Humboldt River immediately above the sink, Army Drain, and Toulon Drain) for the premine discharge period (prior to 1992). Because of the limited data, actual premine discharge load to the sink cannot be quantified. However, the data were used to qualitatively describe the relative potential increases in loads to the sink from the cumulative mine discharge.

Representative water quality data from recent discharge periods were used to estimate average constituent concentrations for Barrick's Boulder Valley outfall discharge. Of the constituents of concern identified by the U.S. Fish and Wildlife Service, water quality data were not available to calculate average concentrations of chromium, lithium, manganese, mercury, molybdenum, selenium, sodium, thallium, and uranium in the mine discharge. In general, either water quality data were not available for these constituents or meaningful average concentrations could not be calculated because the majority of the water quality analyses were reported to be below the detection limit.

Approach. Based on available data from the Humboldt River and the Barrick discharge, representative loads were calculated for TDS and dissolved arsenic, boron, copper, fluoride, and zinc. Using both the concentration of a chemical constituent in water and the associated flow rate or volume, the amount of the chemical constituent transported during a fixed time interval (or load) was calculated. Units of load are typically provided in pounds per day (lbs/day) or tons per year (tons/yr). These calculations were performed to estimate the premine loads in the river and the additional loads added to the river from the mine discharge. The estimated increased dissolved loads from the mine were then compared to premine conditions at various points along the river and at the sink. It is important to understand that the loads from the Barrick Boulder Valley outfall represent a maximum load that could be transported to the sink. As described below, for certain constituents (such as heavy metals), the actual load transported to the sink would likely be less than the initial loads delivered to the river at the outfall, since some of the load would be removed through adsorption or precipitation during transport.

Loads for TDS and dissolved arsenic, boron, copper, fluoride, and zinc in the Humboldt River prior to any discharges from the Boulder Valley outfall were evaluated at Carlin (above the mining area) and near Rye Patch (downstream of the Barrick Boulder Valley outfall and upstream from the Humboldt Sink). As can be seen in Figure 3.2-38, there is a substantial decrease in flow from Carlin downstream to Rye Patch. Figure 3.2-38 illustrates that between Carlin and Rye Patch there also is a decrease in dissolved



Comparison of the estimated average annual dissolved load transported by the Humboldt River at the Carlin and Rye Patch gages prior to mine discharges.

Figure 3.2-38

Estimated Average Annual Premine Loads at the Carlin and Rye Patch Gages copper and zinc loads, but an increase in TDS and dissolved boron, fluoride, and arsenic loads.

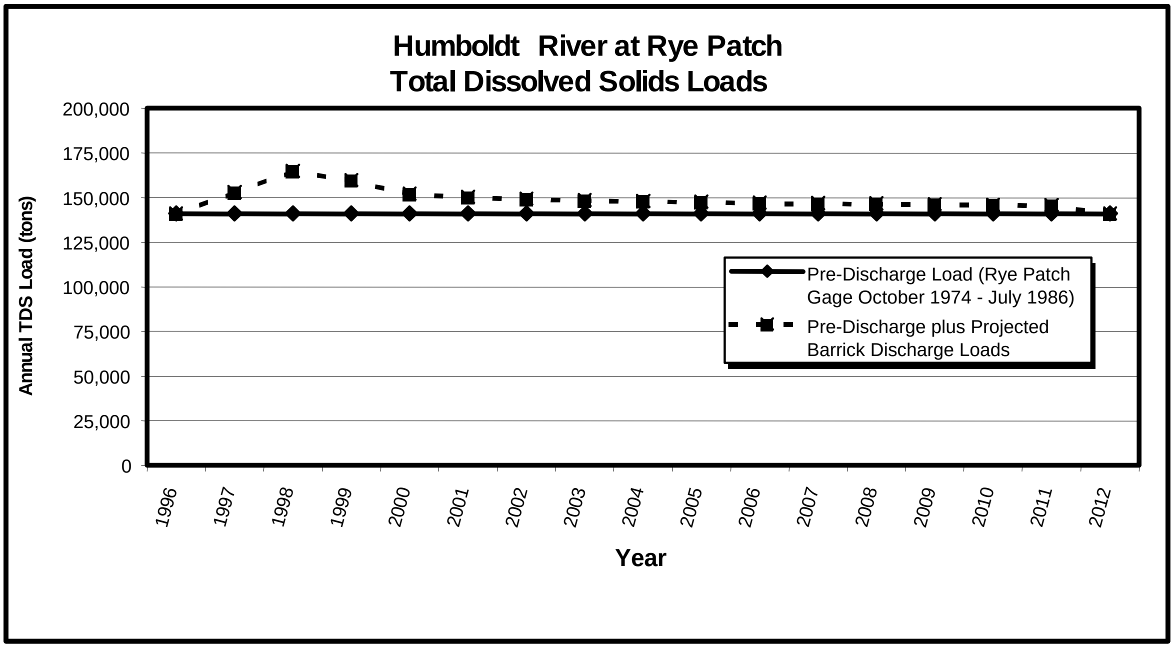
Increases in TDS, arsenic, boron, and fluoride loads prior to mine discharges (Figure 3.2-38) are likely the result of sources providing additional loads to the river section. Fluoride and most of the elements that influence TDS loads are also likely to be very mobile (not readily removed from the water column by mechanisms such as adsorption or precipitation) in relatively dilute concentrations such as those measured in the Humboldt River. Therefore, dissolved loads of these parameters entering the river flow would most likely be transported to the sink. In well-oxygenated waters, such as the Humboldt River from Carlin to Rye Patch, dissolved arsenic and boron generally form negatively charged oxides (Hem 1992; Drever 1997). These oxides also tend to be relatively mobile and would likely be transported to the sink.

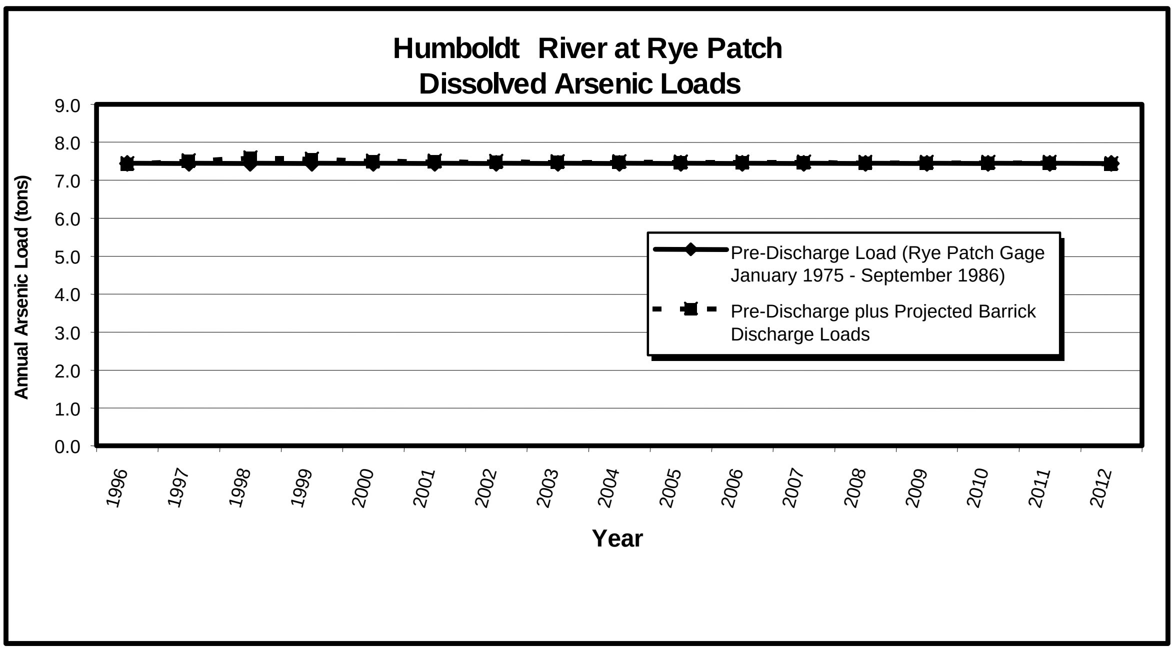
Decreases measured in dissolved copper and zinc loads between Carlin and Rye Patch (Figure 3.2-38) could be the result of adsorption or precipitation reactions removing these parameters from the Humboldt River flows. At neutral pH values such as those measured in the river, these metals tend to form solid precipitates or adsorb onto suspended and sediment particles (Drever 1997; Hart and Hines 1995). Precipitates and suspended particles may then settle out of the water column, reducing the total metals load transported by the river. Figure 3.2-38 illustrates that only a fraction of these parameter dissolved loads introduced to the Humboldt River above the Rye Patch gage are likely to travel to the sink.

The average annual dissolved loads calculated for the Rye Patch gage were used to evaluate potential increases in load to the Humboldt River from the Barrick Boulder Valley outfall discharge. The Rye Patch gage was selected for evaluation since the main concern is potential increases in dissolved constituent loads downstream of the mine outfall and to the Humboldt sink. As shown in Figures 3.2-39, 3.2-40, and 3.2-41, for most years the loads from mine discharge represent only a slight increase when compared to premine loads at the Rye Patch gage. For the purposes of this discussion, all potential increases in dissolved loads are discussed in terms of the annual average relative percent increase over average premining loads. The difference in TDS load increases to approximately 17 percent in 1998, and then drops to negligible levels after 2000. The dissolved arsenic load remains relatively minor throughout the discharge period. The dissolved boron load shows peak increases of 35 percent in 1998, then decreasing to less than 10 percent by 2005. Dissolved copper, fluoride, and zinc loads show very similar trends. Loads of all three constituents peak in 1998 at less than 25 percent and then decrease to minor amounts by 2001. It should be noted that dissolved loads from copper and zinc (and other heavy metals) would likely decrease during transport by the Humboldt River from precipitation and adsorption processes. Therefore, actual increases in dissolved copper and zinc loads observed at the sink are anticipated to be less than the loads discharged by the mine.

In addition to the average annual load increases, the total potential increases in dissolved loads from the mine discharge were evaluated at the Rye Patch gage for the 15-year Barrick discharge period (1997 to 2011). As illustrated in Figure 3.2-42, the mine discharge over the 15-year period at the Rye Patch gage represents a potential increase of less than 10 percent for TDS, arsenic, copper, fluoride, and zinc and a 14 percent increase for boron. These increases at the Rye Patch gage represent dissolved loads that could potentially reach the Humboldt Sink during the mine discharge period.

<u>Potential Increases in Loads to the Sink from Barrick's Boulder Valley Outfall</u>. Between the Rye Patch gage and the Humboldt Sink, a large percentage of the Humboldt River flows are diverted and routed through the Lovelock agricultural area. This diversion and return flow system includes approximately 50 miles of main canals, 100 miles of lateral drains, and 130 miles of open return channels (Seiler et al. 1993). Discharge from the agricultural drains is one of the primary sources of water to the sink. Discharge water from the drains historically has contained concentrations of TDS, arsenic, boron, mercury, molybdenum, sodium, and un-ionized ammonia; these concentrations have exceeded biological effects levels or Nevada standards for the protection of aquatic life (Seiler et al. 1993). The agricultural discharge results in a substantial

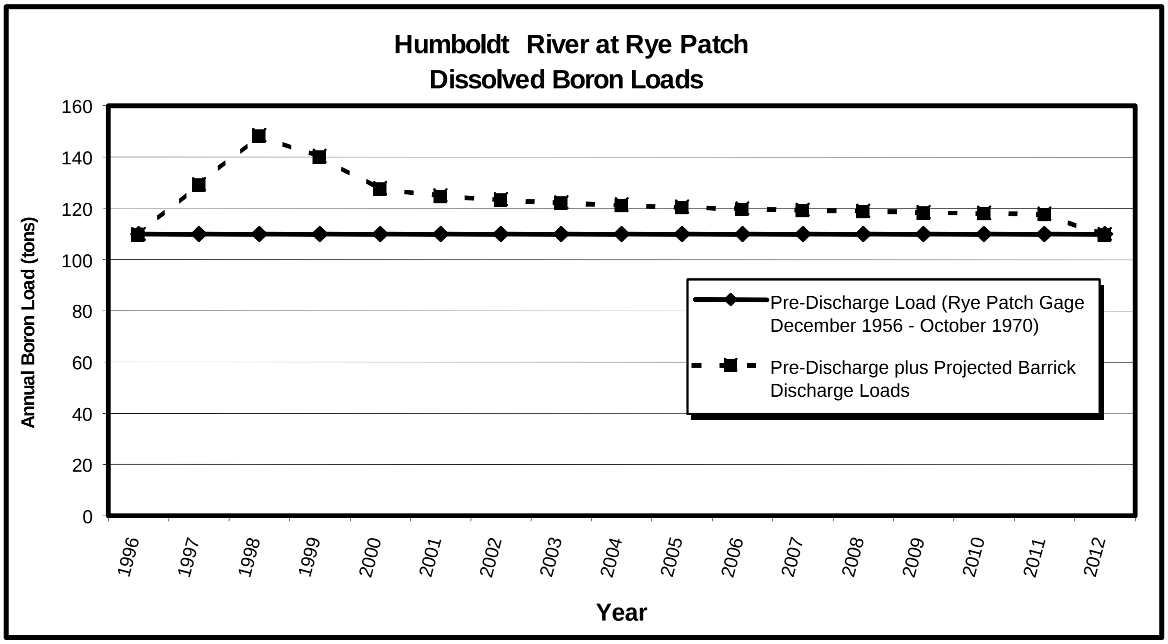


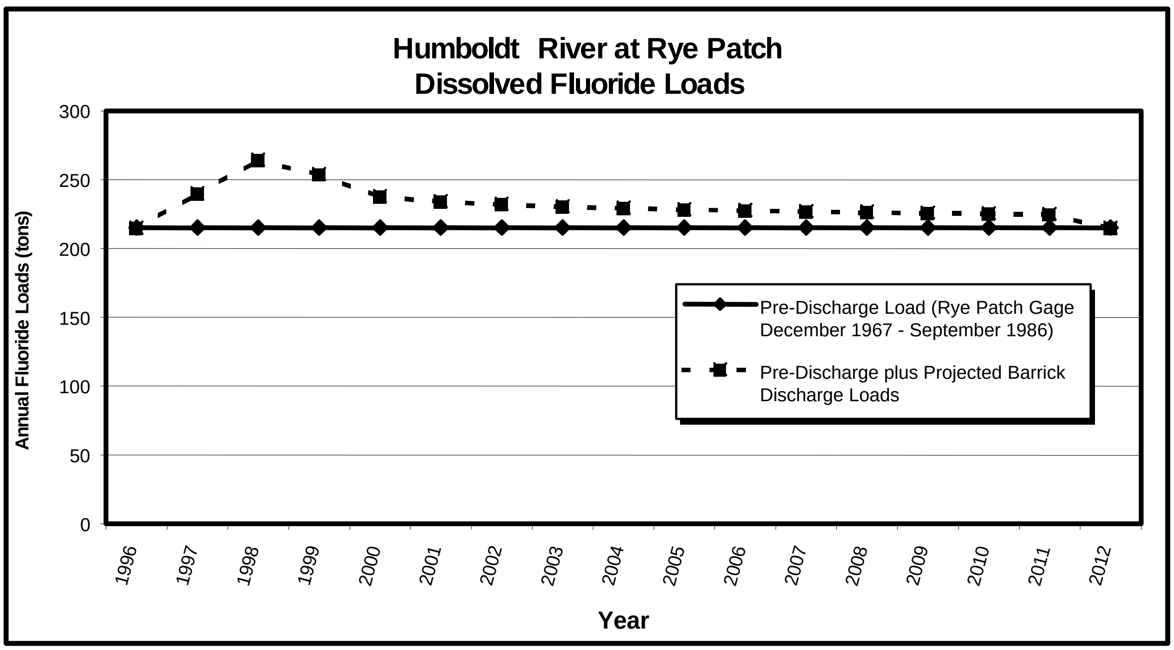


Potential maximum increases in annual loads of TDS and dissolved arsenic resulting from Barrick's historic and projected future mine discharges at the Rye Patch gage over the mine discharge period.

Figure 3.2-39

Potential Maximum Increases in Annual Loads of TDS and Arsenic at the Rye Patch Gage

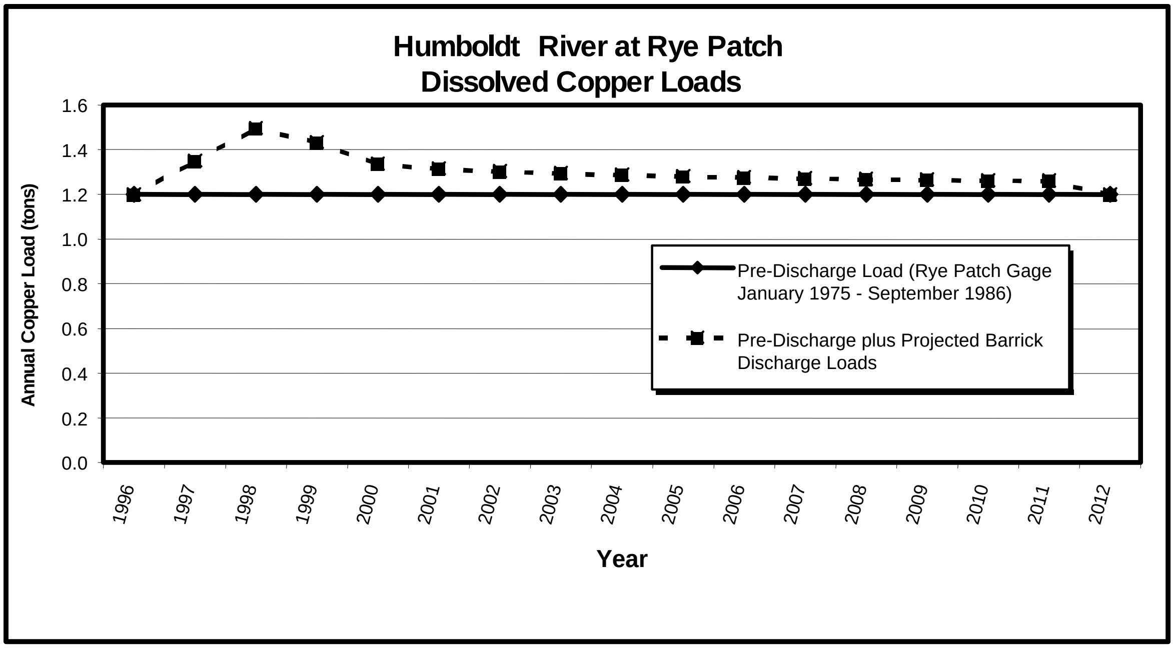


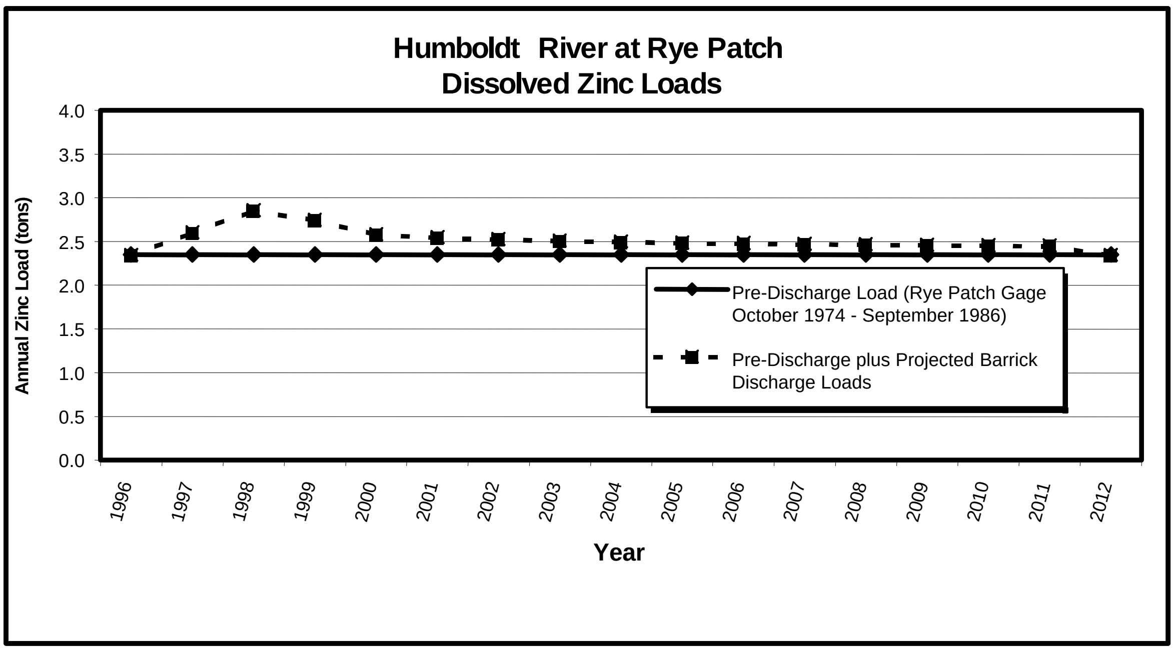


Potential maximum increases in annual dissolved loads of boron and fluoride resulting from Barrick's historic and projected future mine discharges at the Rye Patch gage over the mine discharge period.

Figure 3.2-40

Potential Maximum Increases in Annual Loads of Boron and Fluoride at the Rye Patch Gage

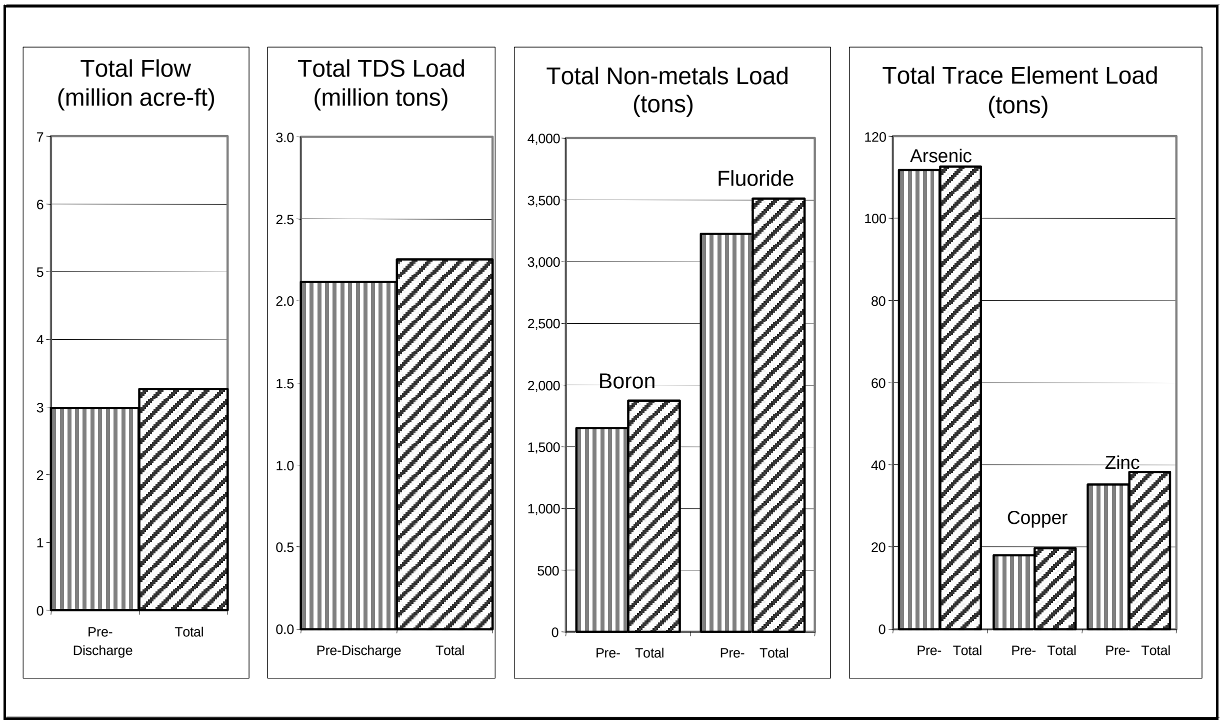




Potential maximum increases in annual dissolved loads of copper and zinc resulting from Barrick's historic and projected future mine discharges at the Rye Patch gage over the mine discharge period.

Figure 3.2-41

Potential Maximum Increases in Annual Loads of Copper and Zinc at the Rye Patch Gage



Comparison of the dissolved loads without Barrick discharge contribution (vertical fill) with the total postmine discharge loads (slashed fill) over the entire historic and projected future discharge period (1997-2011) at the Rye Patch gage.

Figure 3.2-42

Total Potential Increase in Loads During the Mine Discharge Period (1997-2011) at Rye Patch Gage increase in loads between the Rye Patch gage and the terminal wetlands at the sink.

The Humboldt Sink wetlands are part of the WMA, and they include Toulon Lake and Humboldt Lake. The primary source of water for Toulon Lake is the Toulon Drain. The principal sources of water for Humboldt Lake are discharges from the Army Drain and the Humboldt River. Actual discharges to the sink are not known since discharges from the drains and the lower Humboldt River are not monitored on a regular basis. In addition, water quality data for the drains and the Humboldt River are limited.

Streamflow records for the lower Humboldt River exist for 1950 to 1959. Using these limited monitoring records, the average annual discharge to the sink from the river was estimated to be approximately 57,000 acre-feet with an additional 42,000 acre-feet being discharged from irrigation return flows. A few water quality samples were taken between 1987 and 1990 at the Toulon Drain, the Army Drain, and the Humboldt River at Lovelock. These limited data were used to calculate a preliminary estimate of the premine loads entering the sink wetlands. The potential mine loads then were added to the estimated premine loads entering the sink to provide a preliminary evaluation of potential increases in loads to the sink. The results of this evaluation of the sink are presented in Figure 3.2-43. Due to the very limited data and simplifying assumptions, this evaluation should be viewed as a very rough approximation. The estimated loads are presented to provide a reference for evaluating the relative magnitude of change in loads represented by the combined mine discharges.

Figure 3.2-43 presents a comparison of the estimated average annual dissolved loads transported by the Humboldt River at the Rye Patch gage with the estimated average annual dissolved loads discharged to the Humboldt Sink (represented by the combined loads calculated for the Humboldt River near Lovelock, Toulon Drain, and Army Drain). Based on the available data, and the assumptions for discharge to the sink, there appears to be a major increase in TDS and dissolved arsenic, and boron loads between the Rye Patch gage and the point of discharge into the Humboldt Sink (Figure 3.2-43). This plot also suggests that dissolved fluoride loads increase slightly, and dissolved copper and zinc loads actually decrease between Rye Patch and the sink. Since premine loads of TDS, arsenic, boron, and fluoride were higher in the drains and lower Humboldt River than at Rye Patch, the potential increase in dissolved load (as a percentage of premine) resulting from the Barrick Boulder Valley outfall discharge is anticipated to be much less at the sink than at the Rye Patch gage. Substantial increases in dissolved copper and zinc loads are not anticipated since there is a general decrease in metal loads from Carlin to Rye Patch and then to the sink. This suggests that precipitation and adsorption processes during transport would likely remove a substantial percentage of the dissolved metals load.

In conclusion, constituent loads from Barrick's Boulder Valley outfall discharges would likely increase TDS and dissolved boron, and fluoride loads in the sink over the mine discharge period. However, the relative magnitudes of these potential increases do not appear to be substantial, as illustrated in Figure 3.2-44. Depending on concentrations in the sink, parameter solubilities, and other physical and biological factors, increased loads to the sink could potentially result in increased concentrations in the sink wetlands. However, the amount of surface water stored in the sink at any one point and the amount of flow received by the sink wetlands appear to be the primary controlling factors for water quality of the wetlands.

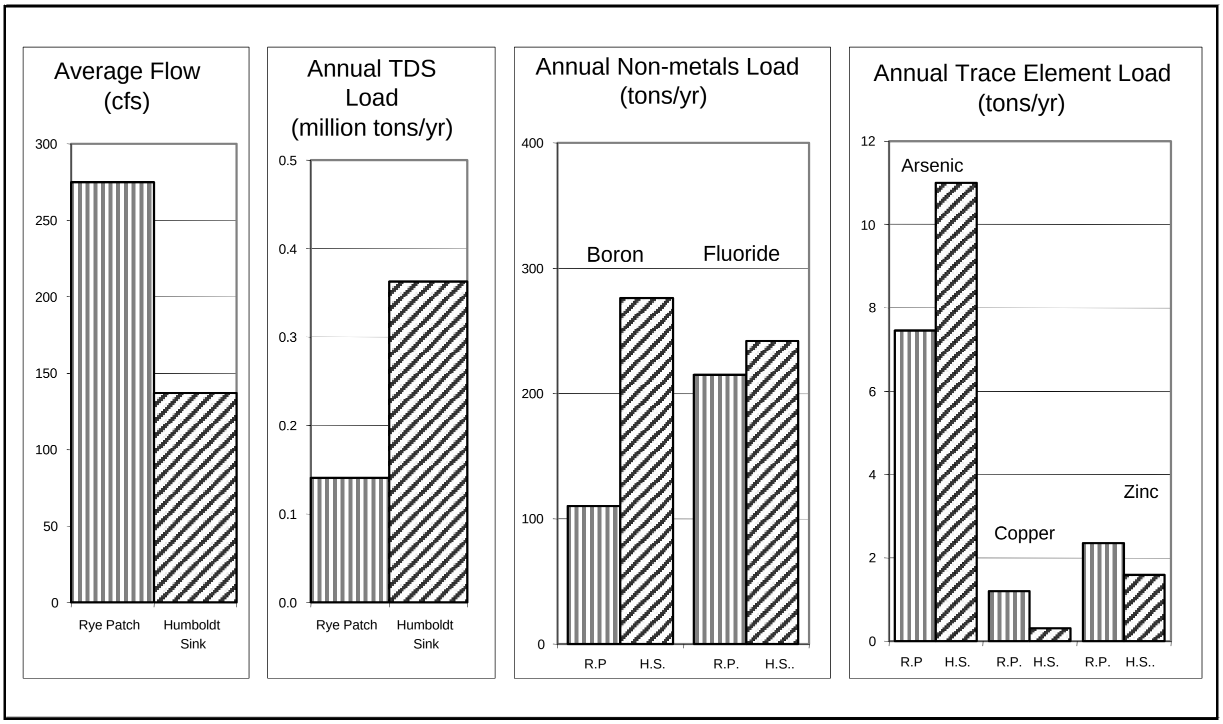
3.2.3 Monitoring and Mitigation

3.2.3.1 Mine Dewatering and Localized Water Management Activities

Monitoring and mitigation measures are in place for the Goldstrike Mine based on the Betze Project Final EIS (BLM 1991b) and the Meikle Mine Finding of No Significant Impact and Decision Record (BLM 1994c). The following monitoring and mitigation measures are proposed based on the potential water resources impacts identified in this Supplemental EIS.

<u>Perennial Springs, Seeps, and Streams</u>

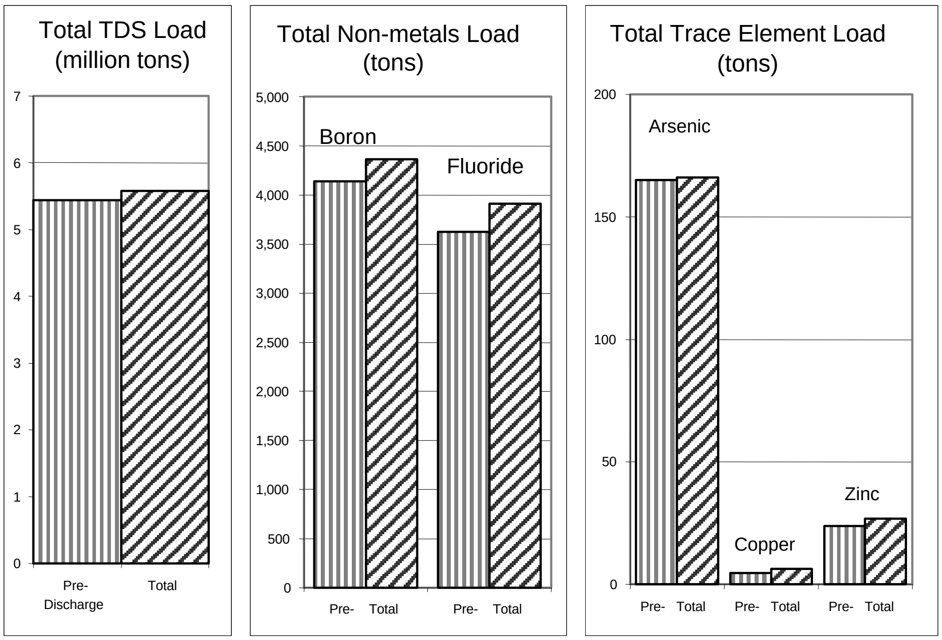
A spring, seep, and stream monitoring program would continue for selected sites to monitor



Comparison of the estimated average annual dissolved load transported by the Humboldt River at the Rye Patch gage with dissolved load discharge to the Humboldt Sink (Humboldt River near Lovelock, Toulon Drain, and Army Drain). Note that estimated loads discharged to the sink are based on very limited flow and water quality data.

Figure 3.2-43

Comparison of Average Annual Loads at Rye Patch Gage vs. Humboldt Sink (Premine Discharge)



Comparison of the dissolved loads without any Barrick discharge contribution (vertical fill) with the potential total dissolved loads during the discharge period (slashed fill) over the entire historic and projected future discharge period (1997-2011) at the Humboldt Sink. Note that 1) estimate of loads to the sink are based on very limited premine data; and 2) actual mine contributed loads reaching the sink could be less than total potential (see text for additional explanation).

Figure 3.2-44

Total Potential Increase in Loads During the Mine Discharge Period at the Humboldt Sink reductions in flow from mine dewatering activities. Reductions in baseflow could occur both during project operation and for an extended period following cessation of mining. Flow and water quality are monitored monthly at stream stations and annually in representative spring sites, and the results are provided to the BLM. This monitoring program would be reviewed at least annually and revised as necessary in conjunction with the BLM. Spring monitoring would continue through the end of mining and for up to 30 years postmining. If monitoring indicates that flow reductions have occurred and that these flow reductions are likely the result of mine-induced drawdown, the following measures would be implemented:

1. A resource inventory would be conducted to identify the areal extent and magnitude of impacts to flow in springs, seeps, or perennial stream reaches that may have been impacted (in addition to the selected spring, seep, or stream monitoring stations included within the current monitoring program). The results of the inventory would clearly identify all springs, seeps, and stream reaches that appear to be impacted by mine-induced drawdown.

2. The BLM would evaluate the available information to determine if mitigation is required. If mitigation is required, a detailed site-specific mitigation plan to repair or replace the impacted perennial water resources would be prepared. Mitigation would depend on the actual impacts and site-specific conditions and could include a variety of measures:

   - Augmenting or replacing flows by drilling well(s) and pumping, or piping water from other nearby sources to restore the average historic baseflow at the perennial water resource (seep, spring, or stream). Any replacement water source used to augment or replace flows would meet the water quality criteria applicable for the historic beneficial use (such as aquatic life, irrigation, or livestock watering).

   - On-site or off-site improvements including stream (or spring) bank stabilization, fencing to limit grazing, installation of guzzlers, or other measures, to enhance water yield.

3. An approved site-specific mitigation plan would be implemented, followed by monitoring and reporting to measure the effectiveness of the implemented measures. If initial mitigation is unsuccessful, the Authorizing Officer may require implementation of additional site-specific mitigation measures.

4. Barrick would be responsible for funding all monitoring, resource inventories, mitigation plan development, and implementation of mitigation measures required by the BLM.

Water Supply Wells and Surface Water Rights

Barrick would continue to monitor surface and ground water to determine the extent of drawdown as required by the State Engineer. Adverse impacts to water rights (surface water or ground water) would be mitigated as required by the Nevada Division of Water Resources. Where mitigation is necessary, mitigation measures could include lowering an affected pump, deepening an existing well, drilling a replacement well, or providing a replacement water supply of equivalent yield and general quality. Impacts to individual surface water right holders would be mitigated on a case-by-case basis as required by the Nevada Division of Water Resources.

3.2.3.2 Humboldt River Monitoring and Mitigation Measures

No further discharges to the Humboldt River are currently planned for Goldstrike Mine water management operations. As previously described, impacts to-date from previous discharges are minor and are within the normal historical range of flows and channel conditions for the river. USGS streamgaging stations are in place at Dunphy upstream of the discharge outfall and at Battle Mountain downstream. Sampling and characterization programs currently are in place as a result of state and federal permit approvals.

If additional discharges to the river are planned at some point in the future, Barrick would be responsible for periodically inspecting and surveying the river channel (in plan view as well as cross-sectionally) for approximately 1 mile upstream and 3 miles downstream of the outfall prior to the releases. Repeat measurements should occur on a periodic basis, as determined by discussions with federal and state agencies, to monitor changes in river characteristics before, during, and after the discharge period. This would allow a baseline assessment of river geometry trends and structural conditions to be established before the discharges and would provide an indication of possible impacts (or the lack of impacts). Areas of instability, such as meander cutoffs, accelerated bank erosion, or scour holes, should be noted and described. Contact should be maintained with other water users along the river (particularly agricultural users and water districts) prior to and during discharges so that their water management operations can be modified accordingly. The existing condition of diversion structures, bridges, or other river controls would be noted prior to discharge. If direct impacts to channel geometry trends or to structures along the river occur as a result of Barrick's discharges, Barrick would conduct repair or mitigation activities appropriate to its estimated level of responsibility. If needed, these activities may consist of installing bed or bank protection (e.g., riprap or articulated mattresses) and scour protection measures at bridges, and repairing or protecting other structures along the river.

3.2.4 Residual Effects

3.2.4.1 Mine Dewatering and Localized Water Management Activities

At the completion of dewatering activities, ground water inflow is predicted to result in the development of a pit lake in the Betze-Post Pit. After hydraulic steady-state is reached, evaporation would result in a net loss of approximately 2,700 acre-feet of water per year. Assuming a total recharge of approximately 19,300 acre-feet/year (McDonald Morrissey Associates, Inc. 1998) for the Boulder Flat Hydrographic Area, evaporation from the pit lake would represent a loss of approximately 7 percent of the total ground water recharge. This long-term change in the ground water balance is considered a residual impact.

The continuous inflow of ground water into the lake to replace water lost through evaporation is predicted to maintain a cone of depression that extends up to approximately 7 miles northwest and 11 miles south-southeast from the center of the Betze-Post Pit. This permanent drawdown would be maintained by continuous inflow of ground water into the pit lake to replace water lost through evaporation. Successful implementation of mitigation measures would eliminate most residual impacts to water resources. However, adequate mitigation measures for permanently reducing the rate of ground water discharge, or baseflow, at some spring and stream locations may not be available. A permanent reduction in surface discharge would constitute a residual impact.

3.2.4.2 Residual Effects to the Humboldt River

No residual impacts to flow rates or their seasonal distribution in the Humboldt River are expected to occur as a result of current and projected future water management operations.

The amended reclamation plan for the Boulder Valley discharge system (Barrick 1996b) specifies that the rip-rap placed upstream and downstream of the outfall pipe will remain in place after the rest of the conveyance and treatment system is removed and the disturbed area is reclaimed. This would temporarily stabilize the river position at that location for an unknown period of years or decades. Without inspection and maintenance, the bank and channel reinforcement would ultimately fail and the local river geometry would more or less return to its previous dynamic state. In the meantime, the river position may be held at the location of the riprap structure while meanders and cutoffs form elsewhere along the reach. This may accelerate lateral channel migration at other locations and structures immediately upstream and downstream of the remaining outfall structure.

3.2.5 Irreversible and Irretrievable Commitment of Resources

An estimated 1,085,000 acre-feet of water would be extracted during Goldstrike Mine dewatering and postmining pumping. Of this amount, approximately 440,000 acre-feet would be consumed by the mining and milling operation crop irrigation or lost from evaporation. The remaining approximately 645,000 acre-feet would be reinfiltrated or discharged to the Humboldt River system. The net reduction of ground water during the life of the project (440,000 acre-feet) is an irretrievable commitment of a ground water resource. It should be noted that this 440,000 acre-feet of water includes mine dewatering water consumed during crop irrigation in Boulder Valley. It is likely that much of this crop irrigation would have occurred (through ground water pumping in Boulder Valley) even without water provided by the Goldstrike Mine water management system.

The continuous inflow of ground water into the pit lake to replace water lost through evaporation is predicted to maintain a long-term cone of depression that would extend up to approximately 7 miles northwest and 11 miles south-southeast from the center of the Betze-Post Pit. After hydraulic steady-state is reached, net evaporation would result in a net loss of approximately 2,700 acre-feet/year. This resultant loss of ground water through evaporation would persist into the future and represents an irreversible commitment of water resources.