Prepared in cooperation with the
BUREAU OF LAND MANAGEMENT

POTENTIAL EFFECTS OF MINING

The potential effect on each of seven water-related characteristics or features is ranked in table 3 and figures 5-13 for each hydrographic area in the Humboldt River Basin, on the basis of the ranking criteria listed in table 2.

Ground-Water Levels

For most of the mining operations in the basin, detailed information on the local geology and the amount and rate of ground-water withdrawals was not available to accurately determine the extent of ground-water drawdown near a mining activity. For some mining operations, potential changes in ground-water levels were estimated from pumpage reports filed by the mining companies with the Nevada Division of Water Resources (NDWR). A listing from NDWR of permitted ground-water withdrawals for mining purposes also was used in this analysis. Of the active mines in the basin, 20 report the monthly quantity of ground water withdrawn, at least quarterly; 4 other mines file ground-water-withdrawal reports and maps showing the changes in ground-water levels for each quarter. For mines that are not required to submit reports to NDWR, information on the size of the operation, based on the number of employees listed in the 1993 Directory of Nevada Mine Operations (Nevada Division of Industrial Relations, 1994), and the NDWR well permits were used to estimate possible changes in water levels at those operations. The estimates of water-level changes are less reliable for the mines where information on water withdrawals is not reported.

At the *local* distance (less than 2 mi), water-level drawdowns near at least one mine in each of 11 hydrographic areas of the basin potentially may reach a maximum of about 100 ft or greater at some point within the *local* area during the next 5 years (fig. 5A and table 3). In eight other hydrographic areas, drawdowns potentially may reach a maximum of about 20 ft or greater, but probably less than 100 ft.

At the *areal* distance (2-6 mi), drawdowns in five hydrographic areas potentially may reach a maximum of about 100 ft or greater (fig. 5B and table 3). In 10 other hydrographic areas, drawdowns potentially may reach a maximum of about 20 ft or greater, but probably less than 100 ft.

At the *regional* distance (greater than 6 mi), drawdowns in one hydrographic area potentially may reach a maximum of about 100 ft or greater (fig. 5C and table 3). In three other hydrographic areas, drawdowns potentially may reach a maximum of about 20 ft or greater, but probably less than 100 ft.

Springs

Specific information is sparse for springs in the basin. The ranks for this characteristic, therefore, were developed on the basis of the presence or absence of springs on USGS 1:100,000-scale topographic maps within the *local* and *areal* distances of the mining activity, and whether the springs are used for public supply. Determination of whether the mine activity is in the recharge area of the spring was beyond the scope of this study. Springs, particularly in the mountainous areas, can issue from perched, shallow flow systems and thus not be connected to a deeper ground-water flow system. Flow rates and seasonal variations were not determined.

During the next 5 years, at least one mine will be operating in each of 17 hydrographic areas in the basin where springs are within the *local* distance (fig. 6A and table 3).

In 20 hydrographic areas (fig. 6B and table 3), mines will be operating where springs are within the *areal* distance. The ground-water source for Carlin (fig. 3) is a spring in hydrographic area 52 and is within 6 mi of a mine in hydrographic area 51. This is the only public-supply source that is near a major mining activity. The ground-water recharge area for Carlin spring is mostly in hydrographic area 51. The water in part of this recharge area appears to have been intercepted by mining withdrawals (R.W. Plume, U.S. Geological Survey, oral commun., 1994). However, no change in flow rate of the spring has been noticed.

Perennial Streams

The Humboldt River and its major tributaries are perennial. Most of the minor tributaries in the basin, however, are either seasonally dry or are perennial in the mountains and intermittent in the valleys. Information on the flow rates for most of these streams is sparse. Information on the hydrologic connections between stream reaches and aquifers that could be affected by specific mines also is sparse. The ranks for this characteristic, therefore, were based on whether or not perennial streams, as shown on USGS 1:100,000-scale topographic maps, are within the *local* or *areal* distance of a mining activity. Although the location where a stream changes from perennial to intermittent is shown as fixed on the map, this location actually varies seasonally and annually.

During the next 5 years, mines could be operating in 13 hydrographic areas in the basin within the *local* distance of a perennial stream (fig. 7A and table 3). In three other hydrographic areas, at least one mine could be operating within the local distance of either a perennial or intermittent stream that may be affected by mine-water releases, dams, or other mining activities.

In 15 hydrographic areas, mines could be operating at the areal distance from a perennial stream (fig. 7B and table 3). In three other hydrographic areas, at least one mine could be operating within the *areal* distance of either a perennial or intermittent stream that may be affected by mine-water releases, dams, or other mining activities.

Shallow Ground-Water Areas

Areas where ground water is consumed by evapotranspiration (evaporation and plant transpiration) are considered shallow ground-water areas. The proximity of the ground water to the surface is reflected in the dominant surface vegetation. In areas where the ground-water level is generally within 3 ft of the surface, grasses characteristically are the predominant vegetative cover (Robinson, 1958). In areas where the ground-water level is generally from 3 to 15 ft from the surface, shrub phreatophytes (plants, such as rabbitbrush, that obtain their water from a permanent ground-water supply) characteristically are the predominant vegetation. Areas where the ground-water level is generally more than 15 ft below the surface are not considered shallow ground-water areas; in those areas, xerophytes (plants, such as sagebrush, that obtain their water from the available soil moisture) are the predominant vegetation. For determination of the rankings for this characteristic, an existing 1:1,000,000-scale delineation of areas where the shallow ground water is consumed by evaporation and transpiration was used (Harrill and others, 1988).

During the next 5 years, mining activity in six hydrographic areas in the basin (fig. 8A and table 3) could result in a change in the vegetation at a shallow ground-water area within the *local* distance of a mine.

In five hydrographic areas, mining activity could result in a change in the vegetation at shallow ground-water areas within the *areal* distance of mining operations (fig. 8B and table 3).

Sediment Transport

Sediment transport in streams is an important process because of the potential effects of the accompanying erosion and deposition. In the upper reaches of the streams, ground-water inflow is a large part of the streamflow during most of the year. A reduction or an increase in ground-water or surface-water contributions to streamflow will change the streamflow characteristics, such as the flow velocities, channel widths, and stream depths and may affect the amount of sediment that is transported. Typically, as streamflow and velocity increase, segments of the channel become more susceptible to erosion and sediment transport. Conversely, as streamflow and velocity decrease, sediment transport declines and sediment is deposited in the streambed channel. Channels that receive or may receive water from active mine operations were ranked as being most susceptible to changes in sediment transport. Other mining activities, such as trenching and drilling, that may cause a change in streamflows that could affect sediment movement were also included in this evaluation.

During the next 5 years, mining activity in three hydrographic areas in the basin (fig. 9A and table 3) could result in a change in sediment transport as a result of changing streamflow characteristics within the *local* distance of a mine site. At nine other hydrographic areas, mining activity could cause possible changes in sediment transport because of water-level declines within the *local* distance of a mine.

At the *areal* distance from the mine operations, changes in sediment transport due to streamflow augmentation could occur in three hydrographic areas (fig. 9B and table 3). In eight other hydrographic areas, mining activity could cause possible changes in sediment transport because of water-level declines within the *areal* distance of a mine.

Agricultural Irrigation

All agriculture in the basin, as well as elsewhere in the State, is dependent upon irrigation. Long-term changes in availability of water for irrigation, as a result of mining, could make irrigation economically unfeasible. Most of the major agricultural areas in the basin have been established for several decades; the amount of land irrigated varies yearly as a result of water availability, crop prices, and agricultural practices. Drawdowns caused by irrigation pumping are limited to the irrigated (*local*) areas and generally range from 0 to more than 80 ft. Land-use maps at the 1:250,000 scale compiled by the U.S. Geological Survey for most of the basin (U.S. Geological Survey, 1979, 1983a-e, 1984a-c) were used to determine the major irrigation areas in the basin. The ranks for this characteristic were based on the presence or absence of known irrigation within the *local* and *areal* distances from any mines.

During the next 5 years, mining activity could be taking place in one hydrographic area within the *local* distance of an irrigated area (fig. 10A and table 3). Mine operations in five hydrographic areas could include irrigated areas at the *areal* distance from a mine (fig. 10B and table 3).

Fish and Wildlife Habitat

Big horn sheep, wild horses, and trout are among the fauna that live in the Humboldt River Basin. Nevada is the driest State in the Nation, and even a small variation in the amount of ground water and surface water is enough to affect the areas where fish and wildlife are found. The ranks for this characteristic were based on the expected changes to springs, streamflow, or shallow ground-water areas; if two or more of these features were ranked as having changes, those changes may affect wildlife habitat. If a change in only one of the three features was expected, the effect on wildlife habitat could not be estimated.

During the next 5 years, mining activity in 11 hydrographic areas in the basin could affect water resources that in turn may affect fish and wildlife habitat within the *local* distance from the mine (fig. 11A and table 3). In 10 other hydrographic areas, where at least one mine in each hydrographic area is operating, the potential effects of mining activity on the fish and wildlife are unknown.

In 15 hydrographic areas, changes in the water resources within the *areal* distance from mining operations may affect fish and wildlife habitat (fig. 11B and table 3). In six other hydrographic areas, where at least one mine in each hydrographic area is operating, any changes that mining activity may have on the fish and wildlife are unknown.

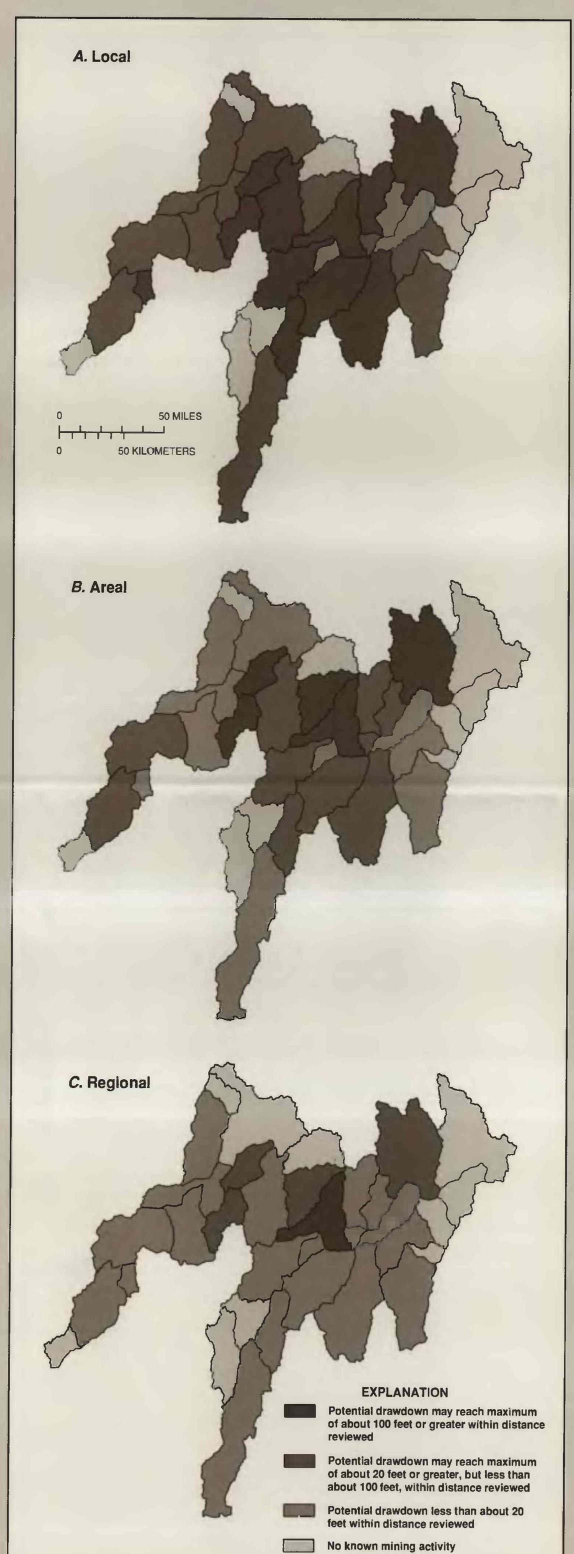


Figure 5. Potential effects on ground-water levels within *(A) local* distance (less than 2 miles), *(B) areal* distance (2-6 miles), and *(C) regional* distance (greater than 6 miles) of mining activity, by hydrographic area.

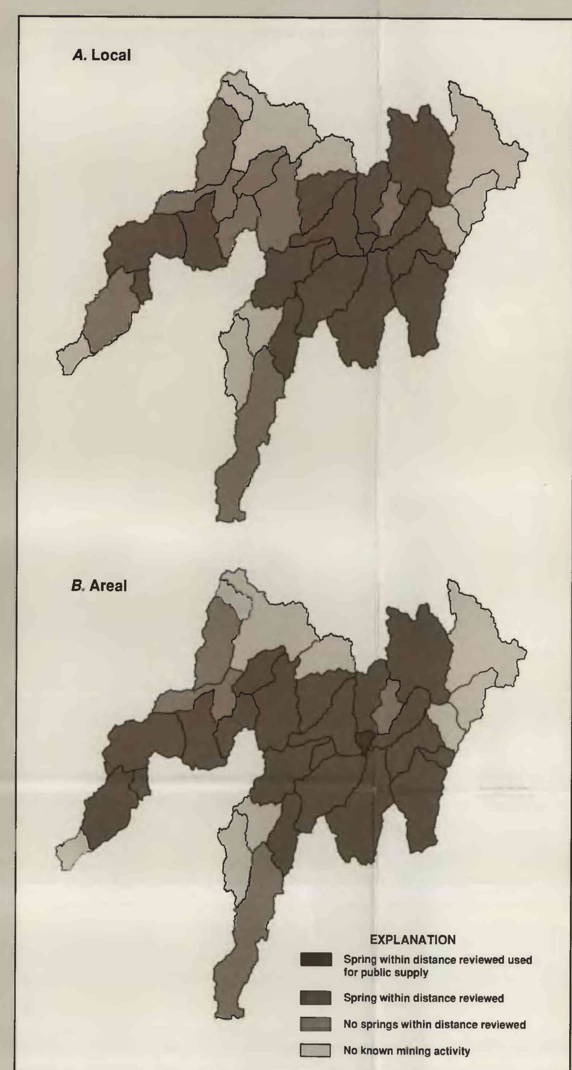


Figure 6. Potential effects on springs within *(A) local* distance (less than 2 miles) and *(B) areal* distance (2-6 miles) of mining activity, by hydrographic area.

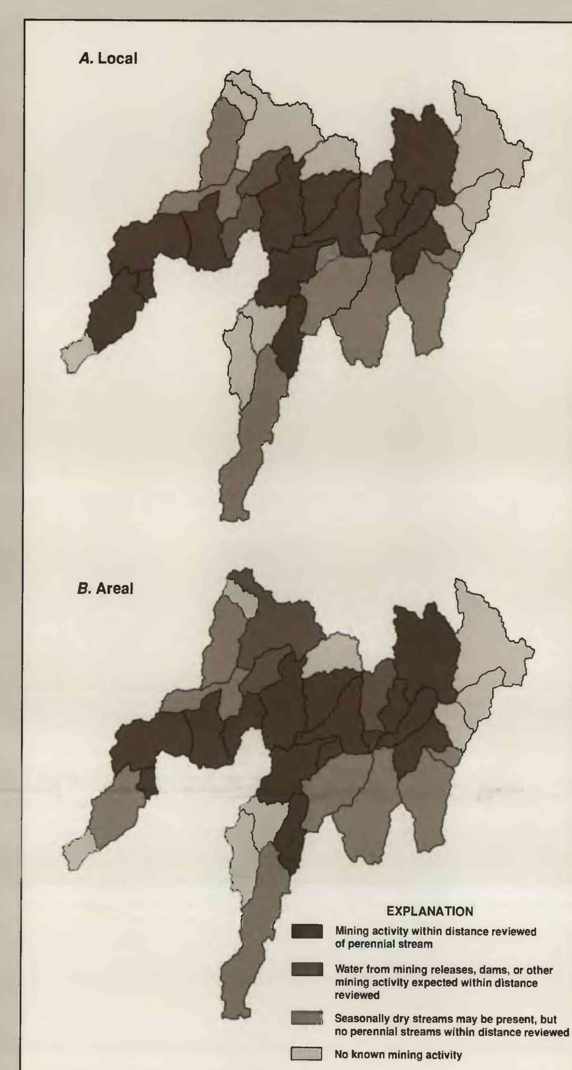


Figure 7. Potential effects on perennial streams within *(A) local* distance (less than 2 miles) and *(B) areal* distance (2-6 miles) of mining activity, by hydrographic area.

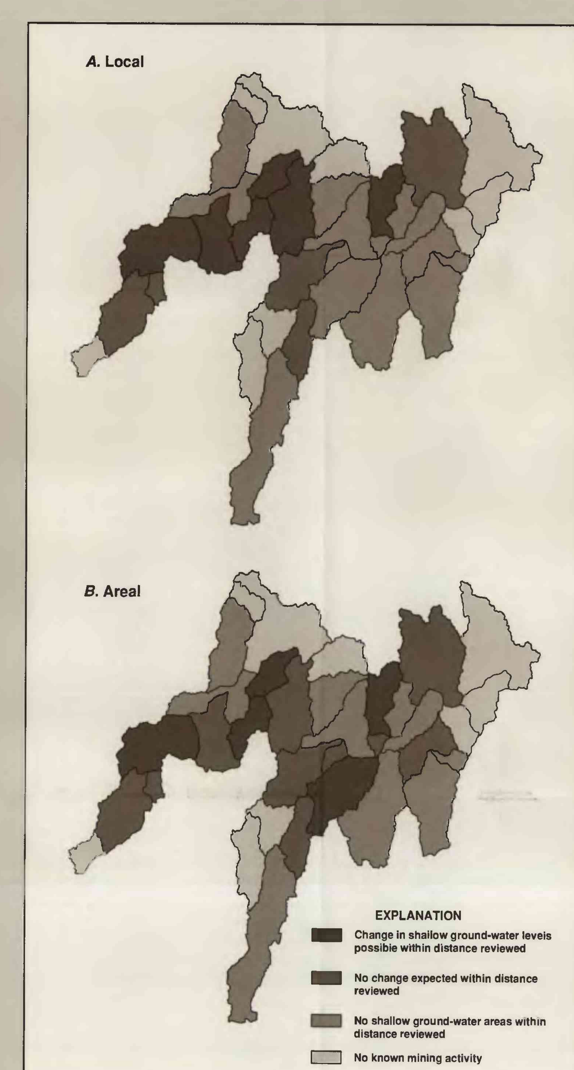


Figure 8. Potential effects on shallow ground-water areas within *(A) local* distance (less than 2 miles) and *(B) areal* distance (2-6 miles) of mining activity, by hydrographic area.

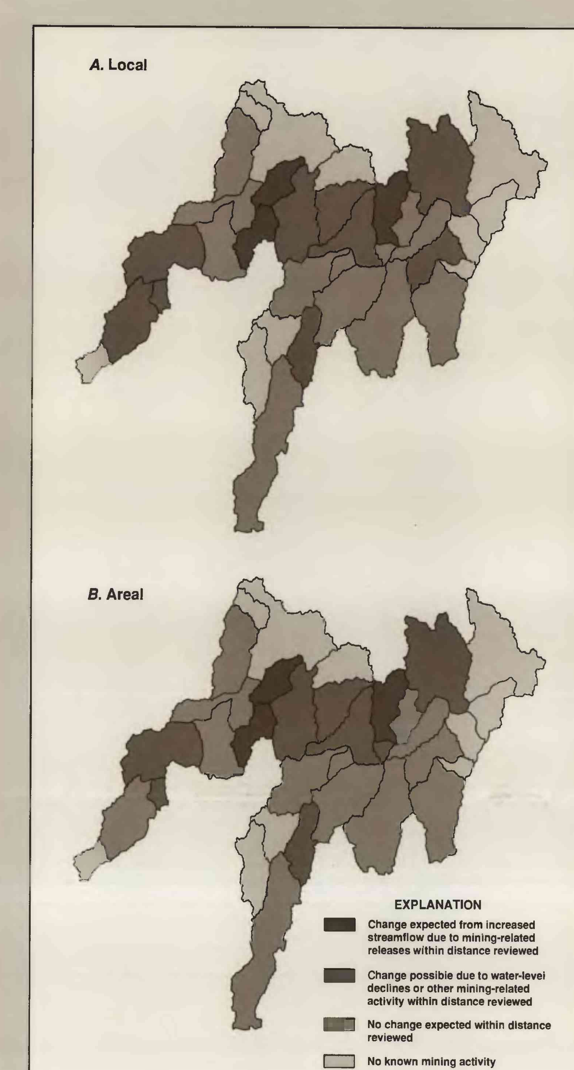


Figure 9. Potential effects on sediment transport within *(A) local* distance (less than 2 miles) and *(B) areal* distance (2-6 miles) of mining activity, by hydrographic area.

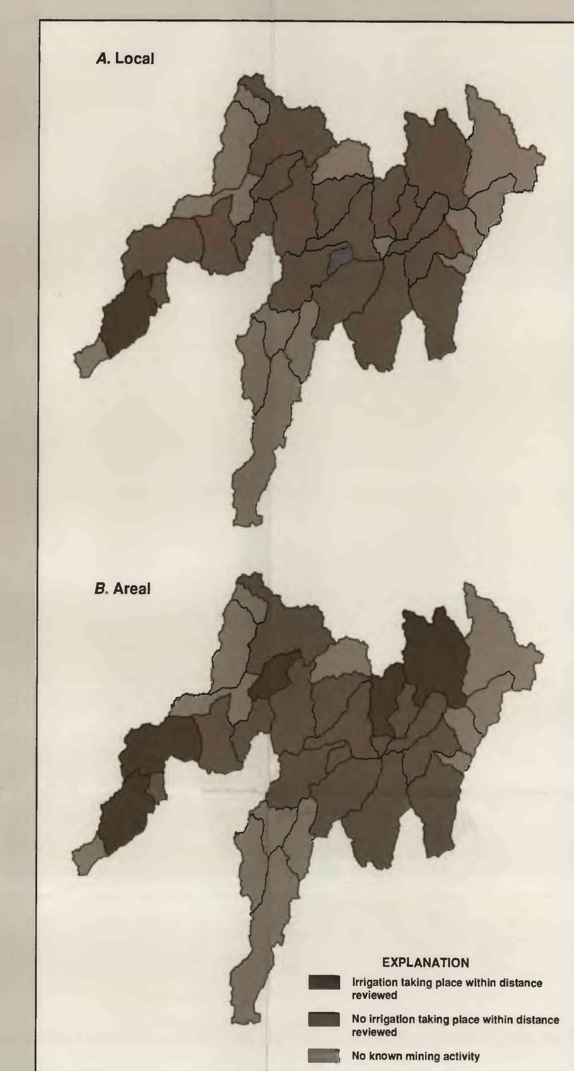


Figure 10. Potential effects on agricultural irrigation within *(A) local* distance (less than 2 miles) and *(B) areal* distance (2-6 miles) of mining activity, by hydrographic area.

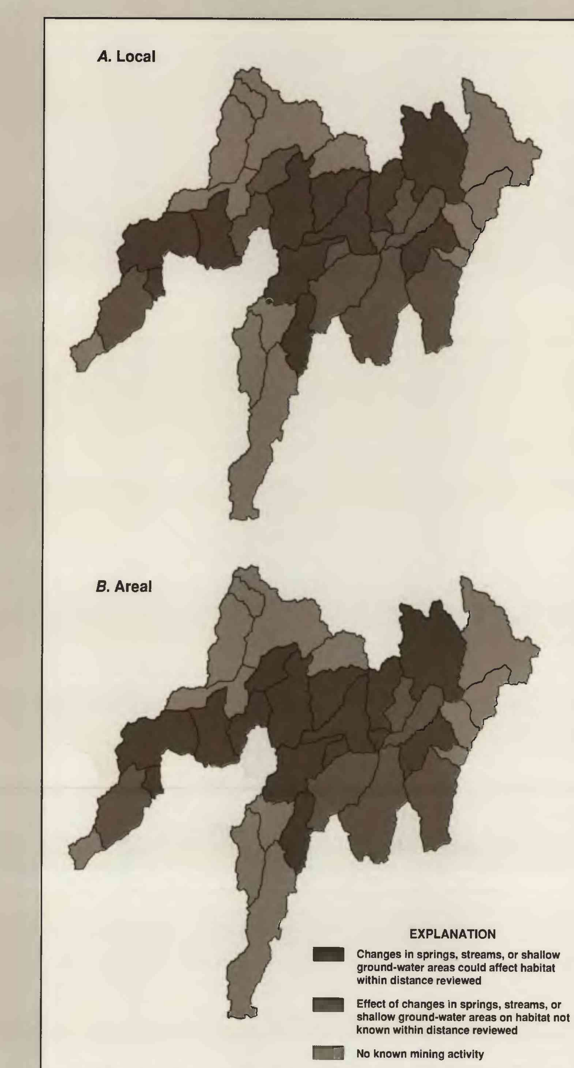
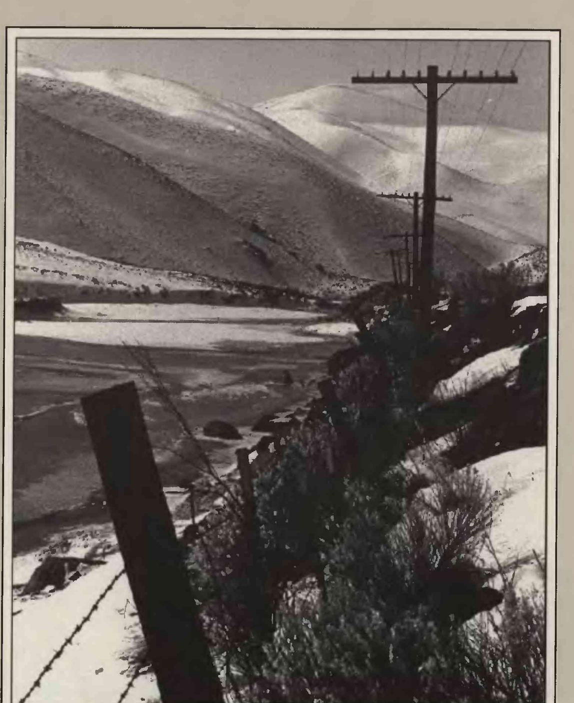


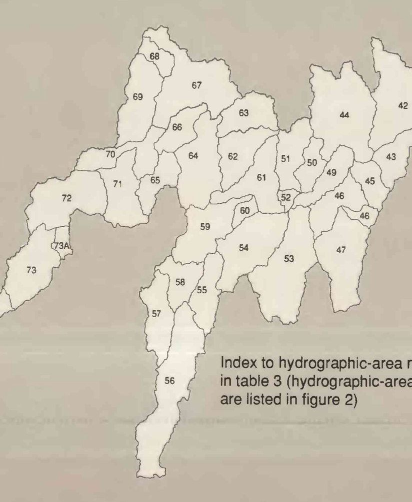
Figure 11. Potential effects on fish and wildlife habitat within *(A) local* distance (less than 2 miles) and *(B) areal* distance (2-6 miles), by hydrographic area.

Table 2. Description of ranking criteria used in table 3 and figures 5-13 for selected characteristics or features

Rank	Description
Ground-water levels (fig. 5):	
1	Potential drawdown may reach maximum of about 100 feet or greater within distance reviewed.
2	Potential drawdown may reach maximum of about 20 feet or greater, but less than about 100 feet, within distance reviewed.
3	Potential drawdown less than about 20 feet within distance reviewed.
4	No known mining activity.
Springs (fig. 6):	
1	Spring within distance reviewed used for public supply.
2	Spring within distance reviewed.
3	No springs within distance reviewed.
4	No known mining activity.
Perennial streams (fig. 7):	
1	Mining activity within distance reviewed of perennial stream.
2	Water from mining releases, dams, or other mining activity expected within distance reviewed.
3	Seasonally dry streams may be present, but no perennial streams within distance reviewed.
4	No known mining activity.
Shallow ground-water areas (fig. 8):	
1	Change in shallow ground-water levels possible within distance reviewed.
2	No change expected within distance reviewed.
3	No shallow ground-water areas within distance reviewed.
4	No known mining activity.
Sediment transport (fig. 9):	
1	Change expected from increased streamflow due to mining-related releases within distance reviewed.
2	Change possible due to water-level declines or other mining-related activity within distance reviewed.
3	No change expected within distance reviewed.
4	No known mining activity.
Agricultural irrigation (fig. 10):	
1	Irrigation taking place within distance reviewed.
2	No irrigation taking place within distance reviewed.
3	No known mining activity.
Fish and wildlife habitat (fig. 11):	
1	Changes in springs, streams, or shallow ground-water areas could affect habitat within distance reviewed.
2	Effect of changes in springs, streams, or shallow ground-water areas on habitat not known within distance reviewed.
3	No known mining activity.
Summary of highest rankings (figs. 12,13):	
A	Hydrographic area has five characteristics at the highest ranking for distance reviewed.
B	Hydrographic area has four characteristics at the highest ranking for distance reviewed.
C	Hydrographic area has three characteristics at the highest ranking for distance reviewed.
D	Hydrographic area has two or fewer characteristics at the highest ranking for distance reviewed.



Humboldt River near Elko, January 1993 Photograph by Nicole A. Jonson



Index to hydrographic-area numbers in table 3 (hydrographic-area names are listed in figure 2)

Table 3. Potential effects of mining, by hydrographic area (HA), as evaluated for each characteristic and distance from mining activity[1]

HA number (index figure above)	Ground-water levels (fig. 5)			Springs (fig. 6)		Perennial streams (fig. 7)		Shallow ground-water areaa (fig. 8)		Sediment transport (fig. 9)		Agricultrual irrigation (fig. 10)		Fish and wildlife habitat (fig. 11)		Summary of rankings (figs. 12,13)	
	Local	Areal	Regional	Local	Areal	Local	Areal	Local	Areal	Local	Areal	Local	Areal	Local	Areal	Local	Areal
42	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	D	D
43	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	D	D
44	1	1	2	2	2	1	1	3	2	2	2	2	1	1	1	C	**B**
45	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	D	D
46	4	4	4	2	2	3	3	3	3	4	4	3	3	3	3	D	D
47	2	3	3	2	2	3	3	3	3	3	3	2	2	2	2	D	D
48	2	3	3	2	2	1	1	3	2	2	3	2	2	1	1	D	D
49	3	3	3	2	2	1	1	3	3	3	3	2	2	2	2	D	D
50	3	2	3	3	3	1	1	3	3	3	3	2	2	2	2	D	D
51	1	2	3	2	2	2	2	1	1	1	1	2	1	1	1	**B**	**B**
52	2	2	3	2	1	3	1	3	3	3	2	3	2	2	1	D	C
53	1	2	3	2	2	3	3	3	3	3	3	2	2	2	2	D	D
54	1	2	3	2	2	3	3	3	2	3	3	2	2	2	2	D	D
55	1	2	3	2	2	1	1	2	2	2	2	3	3	1	1	C	D
56	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	D	D
57	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	D	D
58	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	D	D
59	1	2	3	2	2	1	1	2	2	3	3	2	2	1	1	C	D
60	3	3	3	2	2	3	1	3	2	3	3	2	2	2	1	D	D
61	1	1	1	2	2	1	1	3	3	2	2	2	2	1	1	C	C
62	2	1	2	2	2	1	1	3	3	2	2	2	2	1	1	D	C
63	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	D	D
64	1	2	3	3	2	1	1	1	2	2	2	2	2	1	1	**B**	D
65	1	1	2	3	2	2	1	1	1	1	1	2	2	2	1	C	**A**
66	1	1	2	3	2	2	2	1	1	1	1	2	1	2	1	C	**A**
67	2	3	4	4	4	4	2	4	4	4	4	2	2	3	3	D	D
68	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	D	D
69	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	D	D
70	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	D	D
71	2	3	3	2	2	1	1	1	2	3	3	2	2	1	1	C	D
72	2	2	3	2	2	1	1	1	1	2	2	2	1	1	1	C	**B**
73	2	2	3	3	2	1	3	2	2	2	3	1	1	2	2	D	D
73A	1	3	3	2	2	1	1	2	2	2	2	2	2	1	1	C	D
74	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	D	D

[1] Distance: *local*, within 2 miles of mining activity; *areal*, 2-6 miles from mining activity; *regional*, more than 6 miles from mining actitvity. Rankings defined in table 2.

SUMMARY

The expansion of existing mines and the exploration for new mineral deposits continue throughout the Humboldt River Basin. This study made an initial assessment, on the basis of very limited data, of the generalized extent and magnitude of potential changes on selected hydrologic characteristics and features that could be expected to result from these mining activities. A set of rankings was used to estimate potential effects of mining on seven characteristics or features: ground-water levels, springs, perennial streams, shallow ground-water areas, sediment transport, agricultural irrigation, and fish and wildlife habitat. For some of the characteristics and features reviewed, the data-reporting requirements for current monitoring programs in the basin are not uniform.

The first-order rankings are summarized in the last column of table 3 and shown in figures 12 and 13. The greatest number of first-order rankings (greatest potential for change) in any hydrographic area was five. At the *local* level, two hydrographic areas have four first-order rankings (Maggie Creek Area and Clovers Area) and nine hydrographic areas have three first-order rankings. At the *areal* level, two hydrographic areas have five first-order rankings (Pumpernickel Valley and Kelley Creek Area), three hydrographic areas have four first-order rankings (North Fork Area, Maggie Creek Area, and Imlay Area), and three hydrographic areas have three first-order rankings.

Six hydrographic areas have at least three first-order rankings at both the *local* and *areal* extent: North Fork Area, Maggie Creek Area, Boulder Flat, Pumpernickel Valley, Kelley Creek Area, and Imlay Area. Fourteen hydrographic areas have no first-order rankings at either the *local* or *areal* extent (table 3).

Although regional-scale data in the Humboldt River Basin for the assessment of specific hydrologic effects from mining are limited, this study identified six hydrographic areas with a high potential for change. This study also provides a relative ranking of potential effects, by hydrographic area, that can be used in planning more detailed studies in the basin.

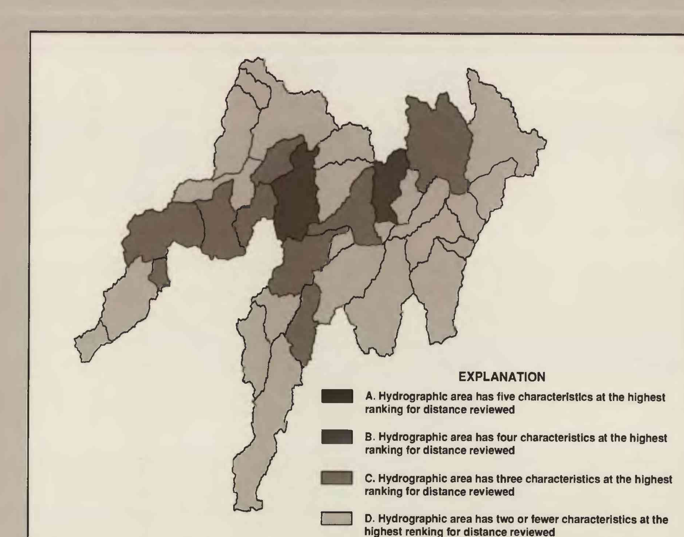


Figure 12. Summary of highest rankings for reviewed characteristics at the *local* distance (less than 2 miles).

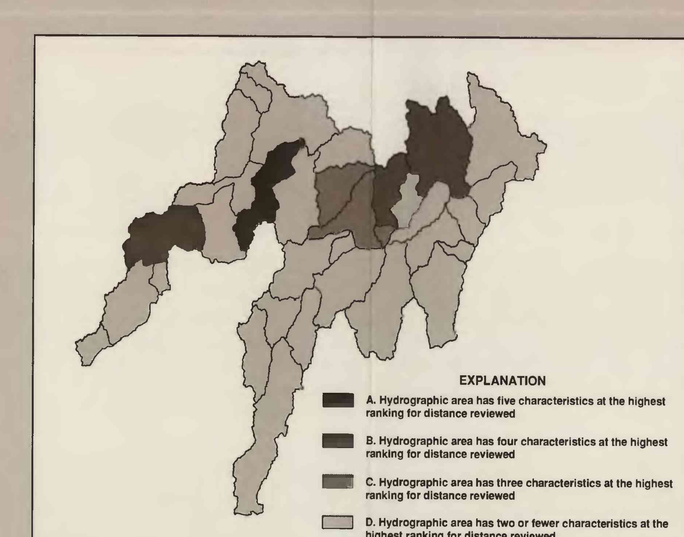


Figure 13. Summary of highest rankings for reviewed characteristics at the *areal* distance (2-6 miles).

REFERENCES CITED

Harrill, J.R., Gates, J.S., and Thomas, J.M., 1988, Major ground-water flow systems in the great basin region of Nevada, Utah, and adjacent states: U.S. Geological Survey Hydrologic Investigations Atlas HA-694-C, 2 sheets, scale 1:1,000,000.

Nevada Bureau of Mines and Geology, 1994, Major Mines of Nevada, 1993: Nevada Bureau of Mines and Geology Special Publication P-5, 28 p.

Nevada Division of Industrial Relations, 1994, Directory of Nevada mine operations active during calendar year 1993: Nevada Division of Industrial Relations, 109 p.

Plume, R.W., and Carlton, S.M., 1988, Hydrogeology of the Great Basin region of Nevada, Utah, and adjacent states: U.S. Geological Survey Hydrologic Investigations Atlas HA-694-A, 1 sheet, scale 1:1,000,000.

Prudic, D.E., Harrill, J.R., and Burbey, T.J., 1993, Conceptual evaluation of regional ground-water flow in the carbonate-rock province of the Great Basin, Nevada, Utah, and adjacent states: U.S. Geological Survey Open-File Report 93-170, 103 p.

Robinson, T.W., 1958, Phreatophytes: U.S. Geological Survey Water-Supply Paper 1423, 84 p.

Rush, R.E., 1968, Index of hydrographic areas in Nevada: Nevada Division of Water Resources, Information Report 6, 38 p.

Scott, B.R., Smales, T.J., Rush, F.E., and Van Denburgh, A.S., 1971, Nevada's water resources: Nevada Division of Water Resources, Water for Nevada Report 3, 87 p.

Seaber, P.R., Kapinos, F.P., and Knapp, G.L., 1987, Hydrologic unit maps: U.S. Geological Survey Water-Supply Paper 2294, 63 p.

Solley, W.B., Pierce, R.R., and Perlman, H.A., 1993, Estimated use of water in the United States in 1990: U.S. Geological Survey Circular 1081, 76 p.

Thomas, J.M., Mason, J.L., and Crabtree, J.D., 1986, Ground-water levels in the Great Basin Region of Nevada, Utah, and adjacent states: U.S. Geological Survey Hydrologic Investigations Atlas HA-694-B, 2 sheets, scale 1:1,000,000.

U.S. Bureau of the Census, 1992, Idaho, Montana, Nevada, Wyoming computer file, *in* 1990 census of population and housing: U.S. Bureau of the Census Summary Tape File CD 90-3A-15 (1 computer laser optical disk, 4-3/4 in.).

U.S. Geological Survey, 1979, Land use and land cover, 1973, Reno, Nevada–California: U.S. Geological Survey Land Use Series Map L-64, scale 1:250,000.

———1983a, Land use and land cover, 1980, Elko, Nevada–Utah: U.S. Geological Survey Open-File Report E5-109-1, scale 1:250,000.

———1983b, Land use and land cover, 1980, Ely, Nevada–Utah: U.S. Geological Survey Open-File Report 83-569-1, scale 1:250,000.

———1983c, Land use and land cover, 1980, Lovelock, Nevada–California: U.S. Geological Survey Open-File Report 83-111-1, scale 1:250,000.

———1983d, Land use and land cover, 1980, Vya, Nevada–Oregon–California: U.S. Geological Survey Open-File Report 83-110-1, scale 1:250,000.

———1983e, Land use and land cover, 1980, Wells, Nevada–Utah–Idaho: U.S. Geological Survey Open-File Report 83-108-1, scale 1:250,000.

———1984a, Land use and land cover, 1983, McDermitt, Nevada–Oregon–Idaho: U.S. Geological Survey Open-File Report 84-047-1, scale 1:250,000.

———1984b, Land use and land cover, 1983, Millett, Nevada: U.S. Geological Survey Open-File Report 83-045-1, scale 1:250,000.

———1984c, Land use and land cover, 1980, 83, Winnemucca, Nevada: U.S. Geological Survey Open-File Report 83-084-1, scale 1:250,000.

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