TASK MEMORANDUM 2-2

ALLOCATION OF POLLUTANT LOADS FOR THE HUMBOLDT AND WALKER RIVERS, NEVADA

FOR

STATE OF NEVADA

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

DIVISION OF ENVIRONMENTAL PROTECTION

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BY

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I. INTRODUCTION

In order to attain the goal of fishable/swimmable water as mandated by Public Law 92-500, the Nevada Division of Environmental Protection has set water quality standards on the Humboldt and Walker Rivers. The next step is to ensure these standards are met in the future by setting limits on pollutant loads entering these rivers. These wasteload limits--or wasteload allocations--should include, where possible, all point and nonpoint sources of pollution.

The purpose of Task Memorandum 2-1 (TM2-1g, Reference 1) on allowable daily loads was to determine how much more pollutants could be safely added to the river and not violate the present standards and/or how much a given pollutant must be reduced to meet these standards.

This task memorandum describes how the information in TM 2-1, additional model runs, levels of point source treatment, and nonpoint source controls were analyzed to determine recommended wasteload allocations on the Humboldt and Walker Rivers.

II. NONPOINT SOURCES

IIA. Natural and Agricultural Loads

The Nevada Division of Environmental Protection (NDEP) has suggested use of EPA's allocation of wasteload reduction by the equal relative reduction approach. This requires a comparison of existing instream loads to the adjacent land use pattern in each reach. This cannot be accomplished since:

1. Information on the area of irrigated land, type of crop grown, and appropriate quality of irrigation return flow are not available.

2. Consideration of multiple irrigation reuse of water would require extensive analysis of existing irrigation systems.

3. Many of the systems contributing pollutants to the rivers use sources away from the main rivers. These sources include hundreds of small streams and wells where data are unavailable or inadequate.

4. Headwater water quality data are inadequate for estimation of natural nonpoint source pollution from the North Fork, South Fork, Marys, and other major flow contributors to the 7Q2.

The abatement efficiency of best management practices for various categories of agricultural land use vary widely. Factors such as distance from the river, distance from flowing streams, ground water depths, and ground water flow rates all influence the movement of pollutants to the rivers. Our opinion is that irrigated pasture or cropland located in the flood plains of both rivers are the most important pollutant sources, with most pollutant pathways by shallow ground-water flow to the rivers. Best management practices should emphasize control of salt leaching and capture and evaporation of any irrigation return flow which is too salty for crop use.

Until information on the location, area, and efficiency of best management practices is available, NDEP has recommended that a 20-percent reduction over 30 years of combined man-induced and natural nonpoint source pollutants is a workable decision rule. Best management practices for certain categories of agricultural land and types of nonpoint source pollutants can attain an effectiveness of 75 to 95 percent. Table 1 shows Humboldt River reach allowable loads for present nonpoint sources, with no point sources. NO_3-N exceeds standards in Reaches 28 to 30, and TDS exceeds standards in Reaches 24 to 31. A reduction in nonpoint sources of 20 percent (Table 2) shows that NO_3-N still exceeds standards for Reaches 28 to 30. Figure 1 and Figure 2 show the locations of reaches on the Humboldt and Walker Rivers, respectively.

Table 3 shows Walker River allowable loads by reach for present nonpoint sources (no point sources exist). TDS violations exist in Reaches 5 to 7 and 13. A 20-percent reduction (Table 4) in nonpoint sources is not sufficient to meet TDS standards in these reaches. In terms of concentrations, these differences between standard and simulated are 1 to 7 percent, within the accuracy of the measurement.

IIB. Urban Stormwater Pollution Loads

The average annual maximum 1-hour storm rainfall was chosen to determine the influence of stormwater runoff from urban areas. One hour is the typical length of thunderstorm events which occur in Nevada in the summer. Reference 2 indicates that the rainfall intensity of this event is approximately .27 inch/hr for northcentral Nevada. Reference 3, page 201 reports that a total rainfall of .27 inch will remove 70 percent of road surface particulates.

It was assumed that pollutant buildup on impervious surfaces occurs for an average of 15 days before removal by street sweeping, traffic wakes, or wind. Table 5 shows pollution buildup rates for various land uses. The unit of kg/ha/day is approximately the same as pounds/acre/day. These data are a compilation and average of land surface pollutant buildup estimates from many places in the U.S., including Denver, Seattle, San Francisco, Chicago, Boise, and Knoxville. Principal sources of these data are References 4, 5, and 6. These data did not show enough regional variation to justify adjustments for Nevada conditions. The low intensity of .27 inch/hour will restrict nearly all runoff to impervious surfaces.

Urban land use areas for the Humboldt River basin was calculated from planimetering 1976 aerial photographs of Elko, Carlin, Winnemucca, and Lovelock. Urban areas in the Walker River basin are either too small to generate significant urban runoff or, in the case of Yerington, runoff is intercepted by irrigators. Figures 1 and 2 show locations of these urban areas in the Humboldt and Walker River basins. Areas of industrial, commercial, multiple-family residential, and single-family residential are shown in Table 6. This table also shows 1-hour flow and weighted pollutant constituent concentrations for the storm event.

These flows and concentrations were input to the water quality model, which was run dynamically. Figures 3A-3F, 4A-4F, 5A-5F, and 6A-6F show the water quality of this urban stormwater runoff slug load as it flows downstream from each urban area. Note that concentrations shown on these graphs only last 1 hour at any given point. Single value standards are shown as bars at the quality control points. Elko stormwater runoff from the maximum annual 1-hour storm violates the single value standard for BOD, PO_4, and NO_3 all the way to Rye Patch Reservoir. Storage in Rye Patch Reservoir will dilute this slug flow of pollutants to undetectable levels. The model probably overestimates the concentrations below Palisade since the model is underestimating longitudinal dispersion in these analyses.

Urban runoff from Carlin (Figures 4A-4F) has much less influence on river water quality than Elko. Dissolved oxygen levels remain high although the BOD standard is exceeded down to Beowawe. The 1-hour slug load of PO_4-P generated by this event exceeds the standard all the way to Rye Patch Reservoir. NO_3-N and TDS are within the standards.

Urban runoff from Winnemucca (Figures 5A-5F) causes 1-hour violations of the standards for BOD, NO_3-N and PO_4-P from Winnemucca downstream to Rye Patch Reservoir.

Urban runoff from Lovelock (Figures 6A-6F) causes 1-hour violations of the standards for BOD, NO_3-N, and PO_4-P from Lovelock to the Humboldt Sink.

There is extensive literature on best management practices for control of urban stormwater runoff. Reference 7 gives an initial screening of alternative control practices. It is not possible to recommend control practices specifically for Elko, Carlin, Winnemmucca, and Lovelock without field surveys. However, many practices have been generally accepted as feasible for most urban areas. These include: air pollution control, land use control, retention and detention sedimentation basins, more frequent and efficient street sweeping, and waste oil recycling.

It has been found possible to reduce erosion and sedimentation from areas undergoing construction to acceptable levels by suitable control practices.

Wasteloads generated by stormwater runoff from existing urban areas can be reduced by 25 to 30 percent. However, a 30-percent reduction in BOD, NO_3-N, and PO_4-P in stormwater runoff for the annual maximum 1-hour event will not meet the single value standards below Elko, Winnemucca, and Lovelock.

III. POINT SOURCES

From the nonpoint analysis described above and the work in TM 2-1, it has been shown that the Humboldt and Walker Rivers violate water quality standards of NO_3 and TDS even with 20-percent reduction of nonpoint loads and no point sources on either river. As mentioned in TM 2-1, present point sources are not discharging directly into the Humboldt River in the summer season. Instead, they are being diverted directly to cropland and pasture. However, these discharges have been reported at times to bypass directly to the river. For future wasteload allocations, each point source that could reasonably discharge into the Humboldt River was assumed to do so. Consequently, any source added to the river in the future will increase the frequency of violations in the river.

To analyze the reductions needed for the pont sources, each point on the river was reviewed in detail (Reference 8). Each plant had a discharge standard that was based on a criteria that the 30-day average BOD and suspended solids be less than or equal to 30 mg/l, while the 7-day average be less than or equal to 45 mg/l. Some permits contained total phosphorus standards less than 1 mg/l and TDS standards of 500 ppm or less. For future conditions the study recommended alternative types of treatment with some type of lagoon system followed by land disposal or evaporation-percolation ponds as a cost effective alternative.

The projected effluent quantity and quality for various alternatives is shown in Table 7. Winnemucca was not shown because it does not now have an NPDES permit and was assumed not to discharge to the river. The Nevada Barth Iron Mine is currently meeting the limitations of the waste discharge permit which, for the projected flow rate from the mine, will produce negligible effects on the river. The nutrient values in Table 7 were estimated from future population projections and the types of treatment processes involved.

To test the impacts on the Humboldt River at various treatment levels for Wells, Elko, Carlin, and Lovelock, model runs were made on the following levels with and without 20-percent reduction in nonpoint source loads:

- 30 mg/l BOD and 30 mg/l suspended solids
- 45 mg/l BOD and 45 mg/l suspended solids
- 60 mg/l BOD and 60 mg/l suspended solids
- Land application-overland flow
- Land application-evaporation/infiltration-percolation basin (zero discharge)

The allowable loads for each reach for each alternative are shown in Tables 8 through 18. Again, negative values shown in the allowable load column mean that the pollution load must be further reduced by the amount to achieve the standard.

It can be seen in Table 13 that increasing the discharge to 30/30 causes violation of the PO_4 and NO_3 standard even with the 20-percent reduction of nonpoint sources. Land application with the 20-percent reduction (Table 16) shows little violation of standards, except nitrate between Rye Patch and Lovelock.

IV. RECOMMENDED WASTELOAD ALLOCATIONS

IVA. Nonpoint Sources

Ideally, nonpoint source wasteload allocations should be made by the detailed procedure outlined by EPA (Reference 9) and summarized by Ekechukwu (Reference 10). However, as mentioned earlier, the present data are insufficient to determine the effectiveness by reach of nonpoint water quality control best management practices. An analysis by NDEP indicated that present trends and recommended water quality control best management practices for agriculture will reduce the future nonpoint source loads by 20 percent in ~~30~~ 20 years.

Therefore, it is recommended that these best managment practices be applied in the Humboldt and Walker River basins through the Division of Environmental Protection to attempt to achieve this 20-percent reduction in nonpoint source loads.

Best management practice should also be instituted in urban areas such as Elko, Carlin, Winnemucca, and Lovelock. Only measures should be put into use that have shown to be cost effective in other urban areas in the United States. At best, reasonable control measures for these cities will reduce the urban pollutant load by 25 to 30 percent over 10 years.

IVB. Point Sources

Using the proportional reduction decision rule theory for the point sources of Wells, Elko, and Carlin with 20-percent reduction on the nonpoint sources, generated three basic alternatives that will meet proposed water quality standards. Wasteload allocation was not performed for Lovelock since the receiving water standard is Class D.

1. 30 mg/l BOD and 30 mg/l suspended solids with equal percent reductions in NO_3 and PO_4

2. Land Application--overland flow

3. Land Application--evaporation/infiltration percolation basin (zero discharge)

If the land is available and suitable, Alternatives 2 and 3 are far less expensive than Alternative 1.

In the event Alternatives 2 and 3 are found to be undesirable, 30/30 should be considered. Using an equal percentage reduction decision rule, all forms of nitrogen and PO_4 were reduced on all four plants by 20, 40, 60, 80, and 90 percent until the water quality standards were met. Water quality violations occurred in most reaches for NO_3 and PO_4 until all nutrients were reduced by 90 percent at all the plants (see Table 18). The corresponding wasteload allocation for 30/30 and 90-percent nutrient reduction should be:

Wells: Effluent Flow 0.53 cfs

BOD_5^{20}	30 ppm	85 lbs/day
TSS	30 ppm	85 lbs/day
TDS	800 ppm	2,268 lbs/day
NH_3-N	1 ppm	3 lbs/day
NO_3-N	2 ppm	6 lbs/day
TOT-N	3 ppm	9 lbs/day
P	.8 ppm	2 lbs/day

Elko: Effluent Flow 4.95 cfs

BOD_5^{20}	30 ppm	801 lbs/day
TSS	30 ppm	801 lbs/day
TDS	800 ppm	21,350 lbs/day
NH_3-N	1 ppm	27 lbs/day
NO_3-N	2 ppm	53 lbs/day
TOT-N	3 ppm	80 lbs/day
P	.8 ppm	21 lbs/day

Carlin: Effluent Flow 0.42 cfs

BOD_5^{20}	30 ppm	68 lbs/day
TSS	30 ppm	68 lbs/day
TDS	800 ppm	1,801 lbs/day
NH_3-N	1 ppm	2 lbs/day
NO_3-N	2 ppm	5 lbs/day
TOT-N	3 ppm	7 lbs/day
P	.8 ppm	2 lbs/day

Table 18 shows the results of this load allocation on the river.

If Alternative 2 is feasible, the wasteload allocation should follow that described in Table 7 for land application. These loads are summarized below:

Wells: Effluent Flow .15 cfs

BOD_5^{20}	5 ppm	4. lbs/day
TSS	5 ppm	4. lbs/day
TDS	800 ppm	667. lbs/day
NH_3-N	.5 ppm	.4 lbs day
NO_3-N	2.5 ppm	2. lbs/day
TOT-N	3 ppm	3. lbs/day
P	5 ppm	4. lbs/day

Elko: Effluent Flow 1.49 cfs

BOD_5^{20}	5 ppm	40. lbs/day
TSS	5 ppm	40. lbs/day
TDS	800 ppm	6,405. lbs/day
NH_3-N	.5 ppm	4. lbs/day
NO_3-N	2.5 ppm	20. lbs/day
TOT-N	3 ppm	24. lbs/day
P	5 ppm	40. lbs/day

Carlin: Effluent Flow 0.12 cfs

BOD_5^{20}	5 ppm	3. lbs/day
TSS	5 ppm	3. lbs/day
TDS	800 ppm	534. lbs/day
NH_3-N	0.5 ppm	0.3 lbs/day
NO_3-N	2.5 ppm	2. lbs/day
TOT-N	3 ppm	2. lbs/day
P	5 ppm	3. lbs/day

Results of this load allocation are shown in Table 16. In the lower reaches of the river (28 to 30) a 0.25 mg/l NO_3 standard is recommended.

Alternative 3, no discharge standard, results are shown in Table 17.

Of the three alternative load allocations above, Alternative 2 appears to be the most cost effective.

V. SUGGESTIONS FOR FUTURE WATER QUALITY MONITORING

The most serious data deficiency was measurements of the quality of surface and subsurface irrigation return flows. Several synoptic surveys of the water quality of river flow and all inflows should be made from the headwaters to terminous of the Humboldt and Walker Rivers during July and August. Time periods should be chosen so that measurement and analysis occur at flow conditions which range between 7Q2 and 7Q10 and include flow, temperature, DO, BOD_5, BOD_u, SS, TDS, NO_3-N, NH_4-N, PO_4-P, and chlorophyll A.

The existing DEP program should be expanded with additional monitoring points at:

- The Humboldt River just above Wells's STP discharge point.

- The Humboldt River just above Lovelock's STP discharge point.

- Headwaters of Marys, North Fork Humboldt, Lamoille Creek, and South Fork Humboldt.

- West Walker River outflow from Topaz Lake.

These measurements can be restricted to the June to September period.

A continuous sampling station should be set up just downstream of Elko during June to September. Continuous recording of temperature and DO would be valuable for model refinement. Automatic samples should be taken at 15-minute intervals whenever precipitation occurs. Constituents analyzed should include BOD_5, BOD_u, COD, SS, NH_4-N, NO_3-N, PO_4-P, TDS, fecal coliforms, fecal streptococci, iron, and lead. This information is essential for the evaluation of requirements for urban runoff management.

REFERENCES

1. CH2M HILL. *Task B--Allowable Daily Loads for the Walker and Humboldt Rivers.* Task Memorandum 2-1. For State of Nevada Division of Environmental Protection. December 1977.

2. Hershfield, David M. *Rainfall Frequency Atlas of the United States.* Technical Paper 40. National Weather Service, U.S. Department of Commerce, Washington, D.C. 1960.

3. McElroy, A. D. et al. *Loading Functions for Assessment of Water Pollution from Nonpoint Sources.* EPA-600/2-76-151, May 1976. Washington, D.C.

4. Athayde, Dennis N. and Andrew Waldo. *The Urban Stormwater Presentation,* 208 Seminars Spring 1977. Water Planning Division, EPA, Washington, D.C.

5. Beason, Roger. *Urban Hydrology, A Systems Study in Knoxville, Tennessee.* Tennessee Valley Authority, Division of Water Management, Knoxville, Tennessee. June 1976.

6. Droste, Ronald L. and James P. Hartt. "Quality and Variation of Pollutant Loads in Urban Stormwater Runoff" *Canadian Journal of Civil Engineering.* Vol. 2, 1975. p. 418-429.

7. CH2M HILL. *Draft Interim Reports on Feasible Methods to Control Pollution from Urban Stormwater Runoff for Nondesignated 208 Study Areas In Illinois.* Submitted to State of Illinois, Environmental Protection Agency, January 1978.

8. STR, *TASK C - Describe Control Measures Needed for the Present and Anticipated Municipal and Industrial Sewage Facilities (Draft).* Task Memorandum 3-1. For State of Nevada, Division of Environmental Protection, November 1977.

9. EPA, *Areawide Assessment Procedures Manual, Volume I, II, and III,* EPA-600/9-76-014, July 1976.

10. Ekechukwu, Geoffrey, *Allocation of Wasteload Reductions--Summary of EPA-DEP Decision Rules,* Nevada Division of EPA Memorandum, November 1977.

TABLES

Table 1

Humboldt River Allowable Loads
Present Nonpoint Sources-No Point Sources
Existing Standards

	DO		BOD_{ult}			PO_4			NO_3			TDS		
Reach	Standard (mg/l)	Model Value (mg/l)	Standard (mg/l) ($4xBOD_5$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.33xPO_4-PO_4$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.23xNO_3-NO_3$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l)	Model Value (mg/l)	Allowable Load (lb/day)
1	7.0	8.7	12.0	8.3	40	.11	.05	1	.23	.20	0	320	300	216
2	7.0	8.5	12.0	7.1	53	.11	.05	1	.23	.21	0	320	300	216
3	7.0	8.4	12.0	3.9	89	.11	.05	1	.23	.23	0	320	300	216
4	7.0	8.2	12.0	8.6	384	.11	.06	6	.23	.16	8	320	237	9,412
5	7.0	8.6	12.0	8.9	1,624	.11	.07	21	.23	.16	37	320	281	20,428
6*	7.0	8.4	12.0	8.1	2,508	.11	.07	26	.23	.16	45	320	279	26,347
7	7.0	8.3	12.0	7.4	2,682	.13	.07	34	.23	.17	35	350	300	28,620
8	7.0	8.3	12.0	7.1	2,832	.13	.07	34	.23	.17	35	350	309	23,247
9	7.0	8.1	12.0	5.1	8,232	.13	.07	71	.23	.16	84	350	265	100,521
10	7.0	8.1	12.0	5.0	8,239	.13	.07	70	.23	.17	71	350	273	89,813
11	7.0	8.0	12.0	4.8	8,633	.13	.07	71	.23	.17	72	350	274	90,288
12*	7.0	8.0	12.0	4.6	9,154	.13	.07	74	.23	.17	74	350	281	84,580
13	7.0	8.0	12.0	4.4	9,523	.13	.07	75	.23	.17	75	425	282	176,834
14	7.0	8.1	12.0	4.1	9,899	.13	.07	75	.23	.17	75	425	282	176,834
15	7.0	8.0	12.0	3.5	10,651	.13	.07	75	.23	.17	75	425	282	176,834
16	7.0	8.0	12.0	4.0	8,208	.13	.08	51	.23	.20	31	425	335	91,368
17*	7.0	8.0	12.0	3.7	8,516	.13	.08	51	.23	.20	30	425	335	91,368
18	7.0	7.7	12.0	5.6	8,986	.17	.09	111	.23	.21	28	500	368	183,902
19	7.0	7.8	12.0	4.8	10,109	.17	.09	111	.23	.20	42	500	368	183,902
20*	7.0	7.8	12.0	5.6	9,677	.17	.10	105	.23	.22	15	500	477	34,528
21	7.0	7.8	12.0	4.7	11,038	.17	.10	105	.23	.21	30	505	477	42,034
22	7.0	7.8	12.0	4.1	11,945	.17	.10	105	.23	.21	30	505	477	42,034
23	7.0	7.8	12.0	3.6	12,701	.17	.10	105	.23	.21	30	505	477	42,034
24	7.0	7.8	12.0	4.5	12,133	.17	.11	96	.23	.22	16	505	541	-57,737
25	7.0	7.8	12.0	4.0	12,920	.17	.11	96	.23	.22	16	505	541	-57,737
26	7.0	7.9	12.0	3.3	14,051	.17	.11	96	.23	.21	32	505	541	-57,737
27*	7.0	7.9	12.0	2.6	15,181	.17	.11	96	.23	.21	32	505	541	-57,737
28	7.0	7.9	12.0	2.4	12,706	.23	.11	159	.16	.22	-93	600	585	19,845
29*	7.0	7.2	12.0	3.0	21,238	.23	.11	283	.16	.23	-213	600	578	51,916
30	7.0	7.6	12.0	2.7	19,536	.23	.12	231	.16	.25	-190	600	647	-98,728
31	5.0	7.9	None	2.4	N.A.	.33	.12	441	None	.25	N.A.	500	647	-308,788
32	3.0	8.0	None	2.3	N.A.	None	.12	N.A.	None	.26	N.A.	None	666	N.A.
33	3.0	8.1	None	2.1	N.A.	None	.12	N.A.	None	.25	N.A.	None	666	N.A.

*Water Quality Control Point

Humboldt River Allowable Loads
20% Reduction of Nonpoint-No Point Sources
Existing Standards

	DO		BOD_{ult}			PO_4			NO_3			TDS		
Reach	Standard (mg/l)	Model Value (mg/l)	Standard (mg/l) ($4\times BOD_5$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.33\times PO_4-PO_4$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.23\times NO_3-NO_3$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l)	Model Value (mg/l)	Allowable Load (lb/day)
1	7.0	8.7	12.0	8.3	40	.11	.05	1	.23	.20	0	320	300	216
2	7.0	8.5	12.0	7.1	53	.11	.05	1	.23	.21	0	320	300	216
3	7.0	8.5	12.0	3.9	87	.11	.05	1	.23	.23	0	320	300	216
4	7.0	8.3	12.0	7.0	567	.11	.05	7	.23	.13	11	320	195	14,175
5	7.0	8.6	12.0	7.1	2,567	.11	.05	31	.23	.13	52	320	226	49,237
6*	7.0	8.4	12.0	6.5	3,534	.11	.05	39	.23	.13	64	320	224	61,690
7	7.0	8.3	12.0	6.0	3,434	.13	.06	40	.23	.14	52	350	241	62,392
8	7.0	8.3	12.0	5.7	3,572	.13	.06	40	.23	.14	51	350	248	57,834
9	7.0	8.2	12.0	4.1	9,343	.13	.05	95	.23	.13	118	350	213	162,016
10	7.0	8.2	12.0	4.0	9,331	.13	.05	93	.23	.13	117	350	219	152,798
11	7.0	8.1	12.0	3.8	9,742	.13	.05	95	.23	.13	119	350	219	155,628
12*	7.0	8.1	12.0	3.7	10,174	.13	.05	98	.23	.13	123	350	225	153,225
13	7.0	8.1	12.0	3.5	10,511	.13	.05	99	.23	.13	124	425	226	246,083
14	7.0	8.2	12.0	3.2	10,882	.13	.05	99	.23	.13	124	425	226	246,083
15	7.0	8.1	12.0	2.8	11,377	.13	.05	99	.23	.13	124	425	226	246,053
16	7.0	8.0	12.0	3.2	8,934	.13	.06	71	.23	.16	71	425	269	158,371
17*	7.0	8.0	12.0	3.0	9,137	.13	.06	71	.23	.16	71	425	269	158,371
18	7.0	7.8	12.0	4.5	10,449	.17	.07	153	.23	.17	84	500	295	285,606
19	7.0	7.8	12.0	3.8	11,424	.17	.07	137	.23	.16	98	500	295	280,071
20*	7.0	7.9	12.0	4.5	11,259	.17	.08	135	.23	.17	90	500	382	177,142
21	7.0	7.9	12.0	3.8	12,310	.17	.08	135	.23	.17	90	505	382	184,648
22	7.0	7.9	12.0	3.2	13,211	.17	.08	135	.23	.17	90	505	382	184,648
23	7.0	7.9	12.0	2.9	13,661	.17	.08	135	.23	.17	90	505	382	184,648
24	7.0	7.8	12.0	3.6	13,472	.17	.09	128	.23	.18	80	505	433	115,474
25	7.0	7.9	12.0	3.2	14,113	.17	.09	128	.23	.18	80	505	433	115.474
26	7.0	7.9	12.0	2.6	15,076	.17	.09	128	.23	.17	96	505	433	115,474
27*	7.0	7.9	12.0	2.0	16,038	.17	.09	128	.23	.17	96	505	433	115,474
28	7.0	7.9	12.0	1.9	13,362	.23	.09	185	.16	.18	-13	600	468	174,636
29*	7.0	7.2	12.0	2.4	22,654	.23	.09	330	.16	.19	-71	600	463	323,293
30	7.0	7.7	12.0	2.2	20,586	.23	.10	273	.16	.20	-84	600	518	172,249
31	5.0	7.9	None	1.9	N.A.	.33	.10	483	None	.20	N.A.	500	518	-37,811
32	3.0	8.0	None	1.8	N.A.	None	.10	N.A.	None	.21	N.A.	None	533	N.A.
33	3.0	8.1	None	1.7	N.A.	None	.10	N.A.	None	.20	N.A.	None	533	N.A.

*Water Quality Control Point

Walker River Allowable Loads
Present Nonpoint Sources
Existing Standards

	DO		BOD_{ult}			PO_4-P			NO_3-N			TDS		
Reach	Standard (mg/l)	Model Value (mg/l)	Standard (mg/l) ($4xBOD_5$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.33xPO_4$-PO4)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.23xNO_3$-NO_3)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l)	Model Value (mg/l)	Allowable Load (lb/day)
1*	7.0	8.7	8.0	4.1	9,603	.07	.05	49	.23	.20	74	100	68	78,797
2*	7.0	8.0	8.0	4.0	8,230	.07	.06	21	.23	.19	82	150	80	144,018
3*	7.0	8.4	12.0	3.7	13,043	.10	.06	63	.51	.20	487	290	80	329,994
4	7.0	8.3	12.0	7.1	6,933	.16	.05	156	.28	.20	113	250	250	0
5	7.0	8.7	12.0	6.5	8,791	.16	.06	160	.28	.20	128	250	261	-17,582
6	7.0	8.5	12.0	6.1	9,431	.16	.06	160	.28	.20	128	250	261	-17,582
7*	7.0	8.3	12.0	6.6	7,494	.16	.07	125	.28	.21	97	250	281	-43,022
8	7.0	8.2	12.0	5.6	13,271	.26	.08	373	.41	.27	290	360	168	398,131
9	7.0	7.9	12.0	5.3	13,893	.26	.08	373	.41	.27	290	360	168	398,131
10*	7.0	7.4	12.0	9.3	1,531	.26	.15	62	.41	.24	96	360	328	18,144
11	5.0	7.4	None	8.7	N.A.	.33	.16	93	None	.25	N.A.	500	341	86,719
12	5.0	7.4	None	8.4	N.A.	.33	.16	37	None	.23	N.A.	500	341	34,344
13	5.0	7.2	None	11.2	N.A.	.33	.16	27	None	.19	N.A.	500	596	-15,034

*Water Quality Control Point

Walker River Allowable Loads
20% Reduction of Nonpoint Sources
Existing Standards

	DO		BOD$_{ult}$			PO_4-P			NO_3-N			TDS		
Reach	Standard (mg/l)	Model Value (mg/l)	Standard (mg/l) ($4 \times BOD_5$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.33 \times PO_4$-PO_4)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.23 \times NO_3$-NO_3)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l)	Model Value (mg/l)	Allowable Load (lb/day)
1*	7.0	8.7	8.0	4.1	9,602	.07	.05	49	.23	.20	74	100	68	78,784
2*	7.0	8.0	8.0	3.7	8,845	.07	.05	41	.23	.19	82	150	76	152,218
3*	7.0	8.4	12.0	3.5	13,354	.10	.05	79	.51	.19	503	290	76	336,194
4	7.0	8.3	12.0	7.1	6,929	.16	.05	156	.28	.20	113	250	150	0
5	7.0	8.7	12.0	6.4	8,949	.16	.05	176	.28	.20	128	250	253	-4,794
6	7.0	8.5	12.0	6.0	9,568	.16	.05	176	.28	.20	128	250	253	-4,794
7*	7.0	8.3	12.0	6.3	4,834	.16	.06	85	.28	.20	68	250	268	-15,264
8	7.0	8.2	12.0	5.2	14,103	.26	.08	373	.41	.26	311	360	160	414,800
9	7.0	7.9	12.0	4.9	14,725	.26	.08	373	.41	.26	311	360	160	414,800
10*	7.0	7.5	12.0	7.8	2,381	.26	.13	74	.41	.22	108	360	276	47,628
11	5.0	7.5	None	7.2	N.A.	.33	.13	109	None	.23	N.A.	500	286	116,630
12	5.0	7.4	None	7.0	N.A.	.33	.13	43	None	.23	N.A.	500	286	46,224
13	5.0	7.2	None	9.0	N.A.	.33	.13	31	None	.16	N.A.	500	481	2,983

*Water Quality Control Point

Table 5

URBAN LAND USE POLLUTANT LOADINGS

Land Use	Effective Impervious %	Biochemical Oxygen Demand (BOD_5) Impervious	Biochemical Oxygen Demand (BOD_5) Pervious	Ammonia Nitrogen (NH_3-N) Impervious	Ammonia Nitrogen (NH_3-N) Pervious	Nitrate Nitrogen (NO_3-N) Impervious	Nitrate Nitrogen (NO_3-N) Pervious	Dissolved Inorganic Phosphorus (PO_4-P) Impervious	Dissolved Inorganic Phosphorus (PO_4-P) Pervious	Total Dissolved Solids (TDS) Impervious	Total Dissolved Solids (TDS) Pervious
		KG/HA/DAY		KG/HA/DAY		KG/HA/DAY		KG/HA/DAY		KG/HA/DAY	
Industrial	70	.60	.10	.01	.001	.02	.06	.03	.02	1.5	15
Commercial Shopping Centers, Central Business Districts	90	.30	.10	.01	.001	.013	.04	.05	.01	1.2	10
Multiple-Family Residential Apartments, Trailer Parks	45	.25	.20	.03	.005	.01	.03	.01	.01	1.0	10
Single-Family Residential 3-5 U/Acre, Fully Storm and Sanitary Sewered, Schools	20	.20	.20	.02	.005	.007	.02	.005	.01	.8	8
Urban Undeveloped Vacant Fields Surrounded by Urbanization	5	.10	.10	.01	.001	.005	.01	.005	.001	.5	5
Irrigated Pasture Two to Five Animals/Acre	2	.10	.20	.01	.01	.01	.01	.002	.001	.5	5

Table 6
Water Quality of Stormwater Runoff During
Annual Average Maximum 1-Hour Event

City	Land Use	Area Acres	Flow CFS	BOD_5 mg/l	NH_3-N mg/l	NO_3-N mg/l	PO_4-P mg/l	TDS mg/l
Elko	Industrial	292	55.7	103.6	1.7	3.5	5.2	259
	Commercial	88	21.5	51.8	1.7	2.3	8.6	207
	MF Residential	76	9.3	43.2	5.2	1.7	1.7	173
	SF Residential	577	31.5	34.5	3.5	1.2	0.9	138
	ALL	1,033	118.0	70.9	2.5	2.5	4.4	210
Carlin	Industrial	42	8.0	103.6	1.7	3.5	5.2	259
	Commercial	8	1.9	51.8	1.7	2.3	8.6	207
	MF Residential	35	4.2	43.2	5.2	1.7	1.7	173
	SF Residential	83	4.5	34.5	3.5	1.2	0.9	138
	ALL	168	18.6	67.9	2.9	2.4	3.7	205
Winnemucca	Industrial	154	29.4	103.6	1.7	3.5	5.2	259
	Commercial	45	11.0	51.8	1.7	2.3	8.6	207
	MF Residential	32	3.9	43.2	5.2	1.7	1.7	173
	SF Residential	428	23.4	34.5	3.5	1.2	0.9	138
	ALL	659	67.7	67.8	2.5	2.4	4.1	204
Lovelock	Industrial	195	37.2	103.6	1.7	3.5	5.2	259
	Commercial	35	8.6	51.8	1.7	2.3	8.6	207
	MF Residential	24	2.9	43.2	5.2	1.7	1.7	173
	SF Residential	288	15.7	34.5	3.5	1.2	0.9	138
	ALL	542	64.4	77.0	2.3	2.7	4.5	219

Table 7
Projected Effluent Characteristics for Municipal Discharges for Year 2000 Using Different Treatment Strategies

			Wells	Elko	Carlin	Lovelock
INFLUENT FLOW (YR 2000, CFS)			0.53	4.95	0.42	0.84
Treatment to 60/60						
1.	Effluent Flow (CFS)		0.53	4.95	0.42	0.84
2.	BOD_5^{20} (lb/D)	(60 ppm)	172	1,604	136	272
3.	TSS (lb/D)	(60 ppm)	172	1,604	136	272
4.	TDS (lb/D)	(800 ppm)	2,268	21,350	1,801	3,603
5.	NH_3-N (lb/D)	(10 ppm)	28	267	23	45
6.	NO_3-N (lb/D)	(20 ppm)	57	534	45	90
7.	TOT-N (lb/D)	(30 ppm)	85	801	68	135
8.	P (lb/D)	(8 ppm)	23	214	18	36
Treatment to 45/45						
1.	Effluent Flow (CFS)		0.53	4.95	0.42	0.84
2.	BOD_5^{20} (lb/D)	(45 ppm)	129	1,203	103	204
3.	TSS (lb/D)	(45 ppm)	129	1,203	103	204
4.	TDS (lb/D)	(800 ppm)	2,268	21,350	1,801	3,603
5.	NH_3-N (lb/D)	(10 ppm)	28	267	23	45
6.	NO_3-N (lb/D)	(20 ppm)	57	534	45	90
7.	TOT-N (lb/D)	(30 ppm)	85	801	68	135
8.	P (lb/D)	(8 ppm)	23	214	18	36
Secondary Treatment Aerated Lagoons and Polishing Ponds						
1.	Effluent Flow (CFS)		0.53	4.95	0.42	0.84
2.	BOD_5^{20} (lb/D)	(30 ppm)	85	801	68	135
3.	TSS (lb/D)	(30 ppm)	85	801	68	135
4.	TDS (lb/D)	(800 ppm)	2,268	21,350	1,801	3,603
5.	NH_3-N (lb/D)	(20 ppm)	28	267	23	45
6.	NO_3-N (lb/D)	(20 ppm)	57	534	45	90
7.	TOT-N (lb/D)	(30 ppm)	85	801	68	135
8.	P (lb/D)	(8 ppm)	23	214	18	36
Land Application - Overland Flow						
1.	Effluent Flow (CFS)		0.15	1.49	0.12	0.25
2.	BOD_5^{20} (lb/D)	(5 ppm)	4	40	3	7
3.	TSS (lb/D)	(5 ppm)	4	40	3	7
4.	TDS (lb/D)	(800 ppm)	667	6,405	534	1,068
5.	NH_3-N (lb/D)	(0.5 ppm)	0.4	4	0.3	1
6.	NO_3-N (lb/D)	(2.5 ppm)	2	20	2	3
7.	TOT-N (lb/D)	(3 ppm)	3	24	2	4
8.	P (lb/D)	(5 ppm)	4	40	3	7
Land Application - Evaporation/Infiltration Percolation Basin						
	Effluent Flow		0	0	0	0
2.	BOD/TSS/TDS/N/P		0	0	0	0

Humboldt River Allowable Loads
Present Nonpoint-30/30 For STP
Existing Standards

	DO		BOD ult			PO_4			NO_3			TDS		
Reach	Standard (mg/l)	Model Value (mg/l)	Standard (mg/l) (4xEOD5)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) (.33xPO4-PO4)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) (.23xNO3-NO3)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l)	Model Value (mg/l)	Allowable Load (lb/day)
1	7.0	8.7	12.0	8.3	40	.11	.05	1	.23	.20	0	320	300	216
2	7.0	8.4	12.0	28.9	-274	.11	1.69	-26	.23	4.29	-66	320	403	-1,345
3	7.0	8.3	12.0	17.7	-92	.11	1.69	-26	.23	4.68	-72	320	403	-1,345
4	7.0	8.1	12.0	9.9	249	.11	.25	-17	.23	.70	-56	320	250	8,316
5	7.0	8.6	12.0	9.1	1,535	.11	.11	0	.23	.28	-26	320	284	19,051
6*	7.0	8.4	12.0	8.2	2,462	.11	.10	6	.23	.26	-19	320	281	25,272
7	7.0	8.3	12.0	12.8	-480	.13	.46	-198	.23	1.14	-545	350	324	15,584
8	7.0	8.2	12.0	12.1	-59	.13	.46	-196	.23	1.15	-546	350	333	10,096
9	7.0	8.0	12.0	7.4	5,564	.13	.26	-157	.23	.65	-508	350	278	87,091
10	7.0	8.0	12.0	7.4	5,490	.13	.27	-167	.23	.68	-537	350	287	75,184
11	7.0	7.9	12.0	7.0	6,075	.13	.27	-170	.23	.67	-535	350	287	76,545
12*	7.0	7.9	12.0	6.7	6,640	.13	.26	-163	.23	.66	-539	350	293	71,410
13	7.0	7.9	12.0	6.3	7,233	.13	.26	-165	.23	.66	-546	425	295	164,970
14	7.0	8.0	12.0	5.9	7,741	.13	.26	-165	.23	.67	-558	425	295	164,970
15	7.0	7.9	12.0	5.1	8,756	.13	.26	-165	.23	.67	-558	425	295	164,970
16	7.0	7.9	12.0	5.7	6,566	.13	.30	-177	.23	.77	-563	425	348	80,249
17*	7.0	7.8	12.0	5.2	7,087	.13	.30	-177	.23	.77	-563	425	348	80,249
18	7.0	7.6	12.0	6.6	7,669	.17	.25	-114	.23	.63	-568	500	376	176,105
19	7.0	7.7	12.0	5.6	9,089	.17	.25	-114	.23	.62	-554	500	376	176,105
20*	7.0	7.7	12.0	6.3	8,711	.17	.24	-107	.23	.58	-535	500	483	25,979
21	7.0	7.7	12.0	5.3	10,239	.17	.24	-107	.23	.58	-535	505	483	33,620
22	7.0	7.7	12.0	4.5	11,462	.17	.24	-107	.23	.57	-520	505	483	33,620
23	7.0	7.8	12.0	4.0	12,226	.17	.24	-107	.23	.57	-520	505	483	33,620
24	7.0	7.7	12.0	4.8	11,742	.17	.23	-98	.23	.54	-506	505	545	-65,232
25	7.0	7.8	12.0	4.3	12,557	.17	.23	-98	.23	.53	-489	505	545	-65,232
26	7.0	7.9	12.0	3.6	13,699	.17	.23	-98	.23	.52	-473	505	545	-65,232
27*	7.0	7.8	12.0	2.8	15,003	.17	.23	-98	.23	.51	-457	505	545	-65,232
28	7.0	7.8	12.0	2.5	12,825	.23	.24	-14	.16	.54	-459	600	588	16,200
29*	7.0	7.2	12.0	3.1	21,243	.23	.18	119	.16	.41	-597	600	580	47,736
30	7.0	7.6	12.0	2.8	19,574	.23	.20	64	.16	.44	-596	600	648	-102,125
31	5.0	7.9	None	2.5	N.A.	.33	.20	277	None	.44	N.A.	500	648	-314,885
32	3.0	8.0	None	2.4	N.A.	None		N.A.	None	.45		None	666	N.A.
33	3.0	8.1	None	3.3	N.A.	None		N.A.	None	.62		None	668	N.A.

*Water Quality Control Point

Humboldt River Allowable Loads
Present Nonpoint-45/45 For STP
Existing Standards

	DO		BOD_{ult}			PO_4			NO_3			TDS		
Reach	Standard (mg/l)	Model Value (mg/l)	Standard (mg/l) ($4xBOD_5$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.33xPO_4-PO_4$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.23xNO_3-NO_3$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l)	Model Value (mg/l)	Allowable Load (lb/day)
1	7.0	8.7	12.0	8.3	40	.11	.05	1	.23	.20	0	320	300	216
2	7.0	8.4	12.0	40.4	-460	.11	1.69	-26	.23	4.29	-66	320	403	-1,345
3	7.0	8.3	12.0	24.8	-207	.11	1.69	-26	.23	4.67	-72	320	403	-1,345
4	7.0	8.1	12.0	10.6	166	.11	.25	-17	.23	.70	-56	320	250	8,316
5	7.0	8.6	12.0	9.2	1,482	.11	.11	0	.23	.28	-26	320	284	19,051
6*	7.0	8.4	12.0	8.3	2,398	.11	.10	6	.23	.26	-19	320	281	25,272
7	7.0	6.3	12.0	15.6	-2,158	.13	.46	-198	.23	1.14	-545	350	324	15,584
8	7.0	8.2	12.0	14.8	-1,663	.13	.46	-196	.23	1.15	-546	350	333	10,098
9	7.0	7.9	12.0	8.7	3,992	.13	.26	-157	.23	.64	-496	350	278	87,091
10	7.0	7.9	12.0	8.6	4,058	.13	.27	-167	.23	.68	-537	350	287	75,184
11	7.0	7.8	12.0	8.2	4,617	.13	.27	-170	.23	.67	-535	350	287	76,545
12*	7.0	7.8	12.0	7.8	5,262	.13	.26	-163	.23	.66	-539	350	293	71,410
13	7.0	7.9	12.0	7.3	5,964	.13	.26	-165	.23	.66	-546	425	295	164,970
14	7.0	8.0	12.0	6.8	6,599	.13	.26	-165	.23	.66	-546	425	295	164,970
15	7.0	7.8	12.0	5.9	7,741	.13	.26	-165	.23	.67	-558	425	295	164,970
16	7.0	7.8	12.0	6.5	5,732	.13	.26	-165	.23	.77	-563	425	348	80,249
17*	7.0	7.8	12.0	6.0	6,253	.13	.30	-177	.23	.77	-563	425	348	80,249
18	7.0	7.6	12.0	7.1	6,959	.17	.25	-114	.23	.63	-568	500	376	176,105
19	7.0	7.7	12.0	6.1	8,379	.17	.25	-114	.23	.62	-554	500	376	176,105
20*	7.0	7.7	12.0	6.6	8,252	.17	.24	-107	.23	.58	-535	500	483	25,979
21	7.0	7.7	12.0	5.5	9,933	.17	.24	-107	.23	.57	-520	505	483	25,979
22	7.0	7.7	12.0	4.8	11,003	.17	.24	-107	.23	.57	-520	505	483	25,979
23	7.0	7.7	12.0	4.2	11,920	.17	.24	-107	.23	.57	-520	505	483	25,979
24	7.0	7.7	12.0	5.0	11,416	.17	.23	-98	.23	.53	-489	505	545	-65,232
25	7.0	7.8	12.0	4.5	12,231	.17	.23	-98	.23	.53	-489	505	545	-65,232
26	7.0	7.9	12.0	3.7	13,536	.17	.23	-98	.23	.52	-473	505	545	-65,232
27*	7.0	7.8	12.0	2.9	14,840	.17	.23	-98	.23	.51	-457	505	545	-65,232
28	7.0	7.8	12.0	2.6	12,690	.23	.24	-14	.16	.53	-446	600	588	16,200
29*	7.0	7.2	12.0	3.2	21,004	.23	.18	119	.16	.41	-597	600	580	47,736
30	7.0	7.6	12.0	2.9	19,361	.23	.20	64	.16	.44	-596	600	648	-102,125
31	5.0	7.9	None	2.5	N.A.	.33	.20	277	None	.44	N.A.	500	648	-314,885
32	3.0	8.0	None	2.4	N.A.	None	.21	N.A.	None	.45	N.A.	None	666	N.A.
33	3.0	8.1	None	3.9	N.A.	None	.28	N.A.	None	.62	N.A.	None	668	N.A.

*Water Quality Control Point

Humboldt River Allowable Loads
Present Nonpoint-60/60 For STP

Existing Standards

	DO		BOD$_{ult}$			PO$_4$			NO$_3$			TDS		
Reach	Standard (mg/l)	Model Value (mg/l)	Standard (mg/l) (4xBOD$_5$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) (.33xPO$_4$-PO$_4$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) (.23xNO$_3$-NO$_3$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l)	Model Value (mg/l)	Allowable Load (lb/day)
1	7.0	8.7	12.0	8.3	40	.11	.05	1	.23	.20	0	320	300	216
2	7.0	8.4	12.0	51.9	-646	.11	1.69	-26	.23	4.29	-66	320	403	-1,345
3	7.0	8.2	12.0	31.9	-322	.11	1.69	-26	.23	4.67	-72	320	403	-1,345
4	7.0	8.1	12.0	11.3	83	.11	.25	-17	.23	.69	-55	320	250	8,316
5	7.0	8.6	12.0	9.3	1,429	.11	.11	0	.23	.28	-26	320	284	19,051
6*	7.0	8.4	12.0	8.3	2,398	.11	.10	6	.23	.26	-19	320	281	25,272
7	7.0	8.3	12.0	18.4	-3,836	.13	.46	-198	.23	1.14	-545	350	324	15,584
8	7.0	8.1	12.0	17.5	-3,267	.13	.46	-196	.23	1.15	-546	350	333	10,098
9	7.0	7.9	12.0	9.9	2,540	.13	.26	-157	.23	.64	-496	350	278	87,091
10	7.0	7.8	12.0	9.8	2,625	.13	.27	-167	.23	.68	-537	350	287	75,184
11	7.0	7.8	12.0	9.4	3,259	.13	.27	-170	.23	.67	-535	350	287	76,545
12*	7.0	7.7	12.0	8.9	3,884	.13	.26	-163	.23	.66	-539	350	293	71,410
13	7.0	7.8	12.0	8.3	4,695	.13	.26	-165	.23	.66	-546	425	295	164,970
14	7.0	7.9	12.0	7.7	5,457	.13	.26	-165	.23	.66	-546	425	295	164,970
15	7.0	7.7	12.0	6.7	6,726	.13	.26	-165	.23	.67	-558	425	295	164,970
16	7.0	7.8	12.0	7.3	4,898	.13	.30	-177	.23	.76	-552	425	348	80,249
17*	7.0	7.7	12.0	6.8	5,419	.13	.30	-177	.23	.77	-563	425	348	80,249
18	7.0	7.6	12.0	7.6	6,249	.17	.25	-114	.23	.62	-554	500	376	176,105
19	7.0	7.7	12.0	6.5	7,811	.17	.25	-114	.23	.62	-554	500	376	176,105
20*	7.0	7.7	12.0	6.9	7,794	.17	.24	-107	.23	.58	-535	500	483	25,979
21	7.0	7.7	12.0	5.8	9,475	.17	.24	-107	.23	.57	-520	505	483	33,620
22	7.0	7.7	12.0	5.0	10,697	.17	.24	-107	.23	.57	-520	505	483	33,620
23	7.0	7.7	12.0	4.5	11,462	.17	.24	-107	.23	.56	-504	505	483	33,620
24	7.0	7.7	12.0	5.2	11,089	.17	.23	-98	.23	.53	-489	505	545	-65,232
25	7.0	7.7	12.0	4.6	12,068	.17	.23	-98	.23	.53	-489	505	545	-65,232
26	7.0	7.8	12.0	3.8	13,373	.17	.23	-98	.23	.52	-473	505	545	-65,232
27*	7.0	7.8	12.0	3.0	14,677	.17	.23	-98	.23	.51	-457	505	545	-65,232
28	7.0	7.8	12.0	2.7	12,555	.23	.24	-14	.16	.53	-446	600	588	16,200
29*	7.0	7.1	12.0	3.2	21,004	.23	.18	119	.16	.41	-597	600	580	47,736
30	7.0	7.6	12.0	2.9	19,361	.23	.20	64	.16	.44	-596	600	648	-102,125
31	5.0	7.9	None	2.6	N.A.	.33	.20	277	None	.44	N.A.	500	648	-314,885
32	3.0	8.0	None	2.4	N.A.	None		N.A.	None	.45	N.A.	None	666	N.A.
33	3.0	8.1	None	4.5	N.A.	None		N.A.	None	.62	N.A.	None	668	N.A.

*Water Quality Control Point

Humboldt River Allowable Loads
Present Nonpoint-Land Application For STP
Existing Standards

	DO		BOD_{ult}			PO_4			NO_3			TDS		
Reach	Standard (mg/l)	Model Value (mg/l)	Standard (mg/l) ($4xBOD_5$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.33xPO_4-PO_4$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.23xNO_3-NO_3$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l)	Model Value (mg/l)	Allowable Load (lb/day)
1	7.0	8.7	12.0	8.3	40	.11	.05	1	.23	.20	0	320	300	216
2	7.0	8.5	12.0	7.7	46	.11	.09	0	.23	.31	-1	320	324	-43
3	7.0	8.5	12.0	4.3	83	.11	.09	0	.23	.34	-1	320	324	-43
4	7.0	8.2	12.0	8.6	386	.11	.06	5	.23	.17	7	320	239	9,185
5	7.0	8.6	12.0	8.9	1,624	.11	.07	22	.23	.16	37	320	281	20,428
6*	7.0	8.4	12.0	8.1	2,506	.11	.07	28	.23	.16	45	320	279	26,347
7	7.0	8.3	12.0	7.6	2,542	.13	.08	29	.23	.19	23	350	305	26,001
8	7.0	8.3	12.0	7.2	2,748	.13	.08	29	.23	.20	17	350	314	20,606
9	7.0	8.1	12.0	5.2	8,078	.13	.07	71	.23	.17	71	350	268	97,416
10	7.0	8.1	12.0	5.1	8,085	.13	.07	70	.23	.18	59	350	276	86,713
11	7.0	8.1	12.0	4.9	8,473	.13	.07	70	.23	.18	62	350	276	88,312
12*	7.0	8.0	12.0	4.7	8,988	.13	.07	73	.23	.18	62	350	283	82,490
13	7.0	8.1	12.0	4.4	9,439	.13	.07	73	.23	.18	62	425	285	173,880
14	7.0	8.1	12.0	4.1	9,812	.13	.07	73	.23	.18	62	425	285	173,880
15	7.0	8.0	12.0	3.6	10,433	.13	.07	73	.23	.18	51	425	285	173,880
16	7.0	8.0	12.0	4.1	8,063	.13	.08	47	.23	.21	20	425	338	88,792
17*	7.0	8.0	12.0	3.7	8,471	.13	.08	47	.23	.21	28	425	338	88,792
18	7.0	7.7	12.0	5.7	8,811	.17	.09	112	.23	.21	28	500	370	181,818
19	7.0	7.8	12.0	4.8	10,070	.17	.09	112	.23	.21	30	500	370	181,818
20*	7.0	7.8	12.0	5.7	9,492	.17	.10	105	.23	.22	15	500	478	33,145
21	7.0	7.8	12.0	4.7	10,998	.17	.10	105	.23	.22	15	505	478	40,678
22	7.0	7.8	12.0	4.1	11,902	.17	.10	105	.23	.22	15	505	478	40,678
23	7.0	7.8	12.0	3.6	12,655	.17	.10	105	.23	.22	16	505	478	40,678
24	7.0	7.8	12.0	4.5	12,069	.17	.11	97	.23	.23	0	505	542	-59,540
25	7.0	7.8	12.0	4.0	12,874	.17	.11	97	.23	.22	16	505	542	-59,540
26	7.0	7.9	12.0	3.3	14,000	.17	.11	97	.23	.22	16	505	542	-59,540
27*	7.0	7.9	12.0	2.6	15,126	.17	.11	97	.23	.22	13	505	542	-59,540
28	7.0	7.9	12.0	2.4	12,753	.23	.12	146	.16	.23	-166	600	586	18,598
29*	7.0	7.2	12.0	3.0	21,287	.23	.11	284	.16	.24	-168	600	579	49,669
30	7.0	7.6	12.0	2.7	19,586	.23	.12	232	.16	.26	-211	600	647	-98,982
31	5.0	7.9	None	2.4	N.A.	.33	.12	442	None	.25	N.A.	500	647	-309,582
32	3.0	8.0	None	2.3	N.A.	None	.13	N.A.	None	.26	N.A.	None	666	N.A.
33	3.0	8.1	None	2.2	N.A.	None	.13	N.A.	None	.26	N.A.	None	666	N.A.

*Water Quality Control Point

Humboldt River Allowable Loads
Present Nonpoint-Zero Discharge For STP
Existing Standards

	DO		BOD_{ult}			PO_4			NO_3			TDS		
Reach	Standard (mg/l)	Model Value (mg/l)	Standard (mg/l) (4xBOD_5)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) (.33xPO_4-PO_4)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) (.23xNO_3-NO_3)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l)	Model Value (mg/l)	Allowable Load (lb/day)
1	7.0	8.7	12.0	8.3	40	.11	.05	1	.23	.20	0	320	300	216
2	7.0	8.5	12.0	7.1	53	.11	.05	1	.23	.21	0	320	300	216
3	7.0	8.4	12.0	3.9	89	.11	.05	1	.23	.23	0	320	300	216
4	7.0	8.2	12.0	8.6	384	.11	.06	6	.23	.16	8	320	237	9,412
5	7.0	8.6	12.0	8.9	1,624	.11	.07	21	.23	.16	37	320	281	20,428
6*	7.0	8.4	12.0	8.1	2,508	.11	.07	26	.23	.16	45	320	279	26,347
7	7.0	8.3	12.0	7.4	2,682	.13	.07	34	.23	.17	35	350	300	28,620
8	7.0	8.3	12.0	7.1	2,832	.13	.07	34	.23	.17	35	350	309	23,247
9	7.0	8.1	12.0	5.1	8,232	.13	.07	71	.23	.16	84	350	265	100,521
10	7.0	8.1	12.0	5.0	8,239	.13	.07	70	.23	.17	71	350	273	89,813
11	7.0	8.0	12.0	4.8	8,633	.13	.07	71	.23	.17	72	350	274	90,288
12*	7.0	8.0	12.0	4.6	9,154	.13	.07	74	.23	.17	74	350	281	64,580
13	7.0	8.0	12.0	4.4	9,523	.13	.07	75	.23	.17	75	425	282	176,834
14	7.0	8.1	12.0	4.1	9,899	.13	.07	75	.23	.17	75	425	282	176,834
15	7.0	8.0	12.0	3.5	10,651	.13	.07	75	.23	.17	75	425	282	176,834
16	7.0	8.0	12.0	4.0	8,208	.13	.08	51	.23	.20	31	425	335	91,388
17*	7.0	8.0	12.0	3.7	8,516	.13	.08	51	.23	.20	30	425	335	91,368
18	7.0	7.7	12.0	5.6	8,986	.17	.09	111	.23	.21	28	500	368	183,902
19	7.0	7.8	12.0	4.8	10,109	.17	.09	111	.23	.20	42	500	368	183,902
20*	7.0	7.8	12.0	5.6	9,677	.17	.10	105	.23	.22	15	500	477	34,828
21	7.0	7.8	12.0	4.7	11,038	.17	.10	105	.23	.21	30	505	477	42,034
22	7.0	7.8	12.0	4.1	11,945	.17	.10	105	.23	.21	30	505	477	42,034
23	7.0	7.8	12.0	3.6	12,701	.17	.10	105	.23	.21	30	505	477	42,034
24	7.0	7.8	12.0	4.5	12,133	.17	.11	96	.23	.22	16	505	541	-57,737
25	7.0	7.8	12.0	4.0	12,920	.17	.11	96	.23	.22	16	505	541	-57,737
26	7.0	7.9	12.0	3.3	14,051	.17	.11	96	.23	.21	32	505	541	-57,737
27*	7.0	7.9	12.0	2.6	15,181	.17	.11	96	.23	.21	32	505	541	-57,737
28	7.0	7.9	12.0	2.4	12,706	.23	.11	159	.16	.22	-93	600	585	19,845
29*	7.0	7.2	12.0	3.0	21,238	.23	.11	283	.16	.23	-213	600	578	51,916
30	7.0	7.6	12.0	2.7	19,536	.23	.12	231	.16	.25	-190	600	647	-98,728
31	5.0	7.9	None	2.4	N.A.	.33	.12	441	None	.25	N.A.	500	647	-308,768
32	3.0	8.0	None	2.3	N.A.	None	.12	N.A.	None	.26	N.A.	None	666	N.A.
33	3.0	8.1	None	2.1	N.A.	None	.12	N.A.	None	.25	N.A.	None	666	N.A.

*Water Quality Control Point

Humboldt River Allowable Loads
20% Reduction of Nonpoint-30/30 For STP
Existing Standards

	DO		BOD_{ult}			PO_4			NO_3			TDS		
Reach	Standard (mg/l)	Model Value (mg/l)	Standard (mg/l) (4xBOD_5)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) (.33xPO_4-PO_4)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) (.23xNO_3-NO_3)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l)	Model Value (mg/l)	Allowable Load (lb/day)
1	7.0	8.7	12.0	8.3	40	.11	.05	1	.23	.20	0	320	300	216
2	7.0	8.5	12.0	28	-259	.11	1.62	-24	.23	4.13	-63	320	397	-1,247
3	7.0	8.3	12.0	17.2	-84	.11	1.62	-24	.23	4.50	-69	320	397	-1,247
4	7.0	8.2	12.0	8.2	451	.11	.23	-14	.23	.65	-50	320	209	13,187
5	7.0	8.6	12.0	7.3	2,487	.11	.10	5	.23	.24	-5	320	229	48,157
6*	7.0	8.4	12.0	6.6	3,499	.11	.09	13	.23	.22	6	320	226	60,912
7	7.0	8.3	12.0	11.1	539	.13	.43	-180	.23	1.07	-503	350	267	49,750
8	7.0	8.2	12.0	10.6	832	.13	.43	-178	.23	1.08	-505	350	274	45,144
9	7.0	8.0	12.0	6.3	6,895	.13	.24	-133	.23	.59	-435	350	226	149,990
10	7.0	8.0	12.0	6.3	6,802	.13	.25	-143	.23	.63	-477	350	233	139,628
11	7.0	8.0	12.0	6.0	7,290	.13	.25	-146	.23	.62	-474	350	233	142,155
12*	7.0	7.9	12.0	5.7	7,893	.13	.24	-138	.23	.61	-476	350	238	140,314
13	7.0	8.0	12.0	5.4	8,375	.13	.24	-140	.23	.61	-482	425	239	236,034
14	7.0	8.0	12.0	5.0	8,883	.13	.24	-140	.23	.61	-482	425	239	236,034
15	7.0	7.9	12.0	4.3	9,771	.13	.24	-140	.23	.62	-495	425	239	236,034
16	7.0	7.9	12.0	4.8	7,504	.13	.27	-146	.23	.71	-500	425	282	149,035
17*	7.0	7.9	12.0	4.4	7,921	.13	.27	-146	.23	.71	-500	425	282	149,035
18	7.0	7.7	12.0	5.4	9,373	.17	.22	-71	.23	.57	-483	500	304	278,359
19	7.0	7.8	12.0	4.6	10,509	.17	.22	-71	.23	.57	-483	500	304	278,359
20*	7.0	7.8	12.0	5.1	10,545	.17	.21	-61	.23	.53	-458	500	389	169,630
21	7.0	7.8	12.0	4.3	11,767	.17	.21	-61	.23	.52	-443	505	389	177,271
22	7.0	7.8	12.0	3.7	12,684	.17	.21	-61	.23	.52	-443	505	389	177,271
23	7.0	7.8	12.0	3.3	13,295	.17	.21	-61	.23	.51	-428	505	389	177,271
24	7.0	7.8	12.0	3.9	13,209	.17	.20	-49	.23	.48	-408	505	438	109,264
25	7.0	7.8	12.0	3.5	13,862	.17	.20	-49	.23	.48	-408	505	438	109,264
26	7.0	7.9	12.0	2.9	14,840	.17	.20	-49	.23	.47	-391	505	438	109,264
27*	7.0	7.9	12.0	2.3	15,819	.17	.20	-49	.23	.46	-375	505	438	109,264
28	7.0	7.9	12.0	2.1	13,365	.23	.22	14	.16	.48	-378	600	473	171,450
29*	7.0	7.2	12.0	2.5	22,675	.23	.16	167	.16	.36	-477	600	465	322,218
30	7.0	7.7	12.0	2.3	20,638	.23	.18	106	.16	.39	-489	600	520	170,208
31	5.0	7.9	None	2.0	N.A.	.33	.18	319	None	.38	N.A.	500	520	-42,552
32	3.0	8.0	None	1.9	N.A.	None	.18	N.A.	None	.39	N.A.	None	535	N.A.
33	3.0	8.1	None	2.9	N.A.	None	.25	N.A.	None	.56	N.A.	None	537	N.A.

*Water Quality Control Point

Humboldt River Allowable Loads
20% Reduction of Nonpoint-45/45 For STP
Existing Standards

	DO		BOD_{ult}			PO_4			NO_3			TDS		
Reach	Standard (mg/l)	Model Value (mg/l)	Standard (mg/l) ($4xBOD_5$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.33xPO_4-PO_4$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.23xNO_3-NO_3$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l)	Model Value (mg/l)	Allowable Load (lb/day)
1	7.0	8.7	12.0	8.3	40	.11	.05	1	.23	.20	0	320	300	216
2	7.0	8.4	12.0	39.0	-437	.11	1.62	-24	.23	4.12	-63	320	387	-1,247
3	7.0	8.3	12.0	24.0	-194	.11	1.62	-24	.23	4.49	-69	320	397	-1,247
4	7.0	8.2	12.0	8.9	368	.11	.23	-14	.23	.65	-50	320	209	13,187
5	7.0	8.6	12.0	7.4	2,434	.11	.10	5	.23	.24	-5	320	229	48,157
6*	7.0	8.4	12.0	6.7	3,434	.11	.09	13	.23	.22	6	320	226	60,912
7	7.0	8.3	12.0	13.9	-1,139	.13	.43	-180	.23	1.07	-503	350	267	49,750
8	7.0	8.2	12.0	13.1	-653	.13	.43	-178	.23	1.08	-505	350	274	45,144
9	7.0	8.0	12.0	7.5	5,443	.13	.24	-133	.23	.59	-435	350	226	149,990
10	7.0	8.0	12.0	7.5	5,370	.13	.25	-143	.23	.63	-477	350	233	139,628
11	7.0	7.9	12.0	7.1	5,954	.13	.25	-146	.23	.62	-474	350	233	142,155
12*	7.0	7.9	12.0	6.8	6,515	.13	.24	-138	.23	.61	-476	350	238	140,314
13	7.0	7.9	12.0	6.3	7,233	.13	.24	-140	.23	.61	-482	425	239	236,034
14	7.0	8.0	12.0	5.9	7,741	.13	.24	-140	.23	.61	-482	425	239	236,034
15	7.0	7.9	12.0	5.1	8,756	.13	.24	-140	.23	.62	-495	425	239	236,034
16	7.0	7.9	12.0	5.6	6,670	.13	.27	-146	.23	.71	-500	425	282	149,035
17*	7.0	7.8	12.0	5.2	7,087	.13	.27	-146	.23	.71	-500	425	282	149,035
18	7.0	7.6	12.0	5.9	8,663	.17	.22	-71	.23	.57	-483	500	304	278,359
19	7.0	7.7	12.0	5.1	9,799	.17	.22	-71	.23	.57	-483	500	304	278,359
20*	7.0	7.8	12.0	5.4	10,086	.17	.21	-61	.23	.52	-443	500	389	169,630
21	7.0	7.8	12.0	4.6	11,309	.17	.21	-61	.23	.52	-443	505	389	177,271
22	7.0	7.8	12.0	3.9	12,378	.17	.21	-61	.23	.52	-443	505	389	177,271
23	7.0	7.8	12.0	3.5	12,990	.17	.21	-49	.23	.51	-428	505	389	177,271
24	7.0	7.8	12.0	4.1	12,883	.17	.20	-49	.23	.48	-408	505	438	109,264
25	7.0	7.8	12.0	3.7	13,536	.17	.20	-49	.23	.48	-408	505	438	109,264
26	7.0	7.9	12.0	3.0	14,677	.17	.20	-49	.23	.47	-391	505	438	109,264
27*	7.0	7.9	12.0	2.3	15,819	.17	.20	-49	.23	.46	-375	505	438	109,264
28	7.0	7.9	12.0	2.1	13,365	.23	.22	14	.16	.48	-378	600	473	171,450
29*	7.0	7.2	12.0	2.5	22,675	.23	.16	167	.16	.36	-477	600	465	322,218
30	7.0	7.7	12.0	2.3	20,638	.23	.18	106	.16	.39	-489	600	520	170,208
31	5.0	7.9	None	2.1	N.A.	.33	.18	319	None	.38	N.A.	500	520	-42,552
32	3.0	8.0	None	1.9	N.A.	None		N.A.	None	.39	N.A.	None	535	N.A.
33	3.0	8.1	None	3.4	N.A.	None		N.A.	None	.56	N.A.	None	537	N.A.

*Water Quality Control Point

Humboldt River Allowable Loads
20% Reduction of Nonpoint-60/60 For STP
Existing Standards

	DO		BOD_{ult}			PO_4			NO_3			TDS		
Reach	Standard (mg/l)	Model Value (mg/l)	Standard (mg/l) ($4xBOD_5$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.33xPO_4-PO_4$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.23xNO_3-NO_3$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l)	Model Value (mg/l)	Allowable Load (lb/day)
1	7.0	8.7	12.0	8.3	40	.11	.05	1	.23	.20	0	320	300	216
2	7.0	8.4	12.0	50.1	-617	.11	1.62	-24	.23	4.12	-63	320	397	-1,247
3	7.0	8.2	12.0	30.7	-303	.11	1.62	-24	.23	4.49	-69	320	397	-1,247
4	7.0	8.1	12.0	9.6	285	.11	.23	-14	.23	.65	-50	320	209	13,187
5	7.0	8.6	12.0	7.5	2,381	.11	.10	5	.23	.24	-5	320	229	48,157
6*	7.0	8.4	12.0	6.7	3,434	.11	.09	13	.23	.22	6	320	226	60,912
7	7.0	8.3	12.0	16.6	-2,757	.13	.43	-180	.23	1.07	-503	350	267	49,750
8	7.0	8.1	12.0	15.7	-2,198	.13	.43	-178	.23	1.08	-505	350	274	45,144
9	7.0	7.9	12.0	8.7	3,992	.13	.24	-133	.23	.59	-435	350	226	149,990
10	7.0	7.9	12.0	8.7	3,938	.13	.25	-143	.23	.63	-477	350	233	139,628
11	7.0	7.8	12.0	8.2	4,617	.13	.25	-146	.23	.62	-474	350	233	142,155
12*	7.0	7.8	12.0	7.8	5,262	.13	.24	-138	.23	.61	-476	350	238	140,314
13	7.0	7.9	12.0	7.3	5,964	.13	.24	-140	.23	.61	-482	425	239	236,034
14	7.0	8.0	12.0	6.8	6,599	.13	.24	-140	.23	.61	-482	425	239	236,034
15	7.0	7.8	12.0	5.9	7,741	.13	.24	-140	.23	.62	-495	425	239	236,034
16	7.0	7.8	12.0	6.4	5,836	.13	.27	-146	.23	.70	-490	425	282	149,035
17*	7.0	7.8	12.0	5.9	6,357	.13	.27	-146	.23	.71	-500	425	282	149,035
18	7.0	7.6	12.0	6.4	7,953	.17	.22	-71	.23	.57	-483	500	304	278,359
19	7.0	7.7	12.0	5.5	9,231	.17	.22	-71	.23	.57	-483	500	304	278,359
20*	7.0	7.8	12.0	5.8	9,475	.17	.21	-61	.23	.52	-443	500	389	169,630
21	7.0	7.8	12.0	4.8	11,003	.17	.21	-61	.23	.52	-443	505	389	169,630
22	7.0	7.8	12.0	4.2	11,920	.17	.21	-61	.23	.52	-443	505	389	169,630
23	7.0	7.8	12.0	3.7	12,684	.17	.21	-61	.23	.51	-428	505	389	169,630
24	7.0	7.8	12.0	4.3	13,536	.17	.20	-49	.23	.48	-408	505	438	109,264
25	7.0	7.8	12.0	3.8	13,373	.17	.20	-49	.23	.48	-408	505	438	109,264
26	7.0	7.9	12.0	3.1	14,514	.17	.20	-49	.23	.47	-391	505	438	109,264
27*	7.0	7.9	12.0	2.4	15,656	.17	.20	-49	.23	.46	-375	505	438	109,264
28	7.0	7.9	12.0	2.2	13,230	.23	.22	14	.16	.48	-378	600	473	171,450
29*	7.0	7.2	12.0	2.6	22,436	.23	.16	167	.16	.36	-477	600	465	322,218
30	7.0	7.7	12.0	2.3	20,638	.23	.18	106	.16	.39	-489	600	520	170,208
31	5.0	7.9	None	2.1	N.A.	.33	.18	319	None	.38	N.A.	500	520	-42,552
32	3.0	8.0	None	2.0	N.A.	None	.18	N.A.	None	.39	N.A.	None	535	N.A.
33	3.0	8.1	None	4.0	N.A.	None	.25	N.A.	None	.56	N.A.	None	537	N.A.

*Water Quality Control Point

Humboldt River Allowable Loads
20% Reduction of Nonpoint-Land Application For STP
Existing Standards

	DO		BOD$_{ult}$			PO_4			NO_3			TDS		
Reach	Standard (mg/l)	Model Value (mg/l)	Standard (mg/l) (4xBOD_5)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) (.33xPO_4-PO_4)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) (.23xNO_3-NO_3)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l)	Model Value (mg/l)	Allowable Load (lb/day)
1	7.0	8.7	12.0	8.3	40	.11	.05	1	.23	.20	0	320	300	216
2	7.0	8.5	12.0	7.9	44	.11	.10	0	.23	.36	-1	320	333	-140
3	7.0	8.5	12.0	4.5	81	.11	.10	0	.23	.38	-2	320	333	-140
4	7.0	8.3	12.0	7.0	567	.11	.05	7	.23	.15	9	320	199	13,721
5	7.0	8.6	12.0	7.2	2,514	.11	.06	26	.23	.13	52	320	227	48,713
6*	7.0	8.4	12.0	6.5	3,534	.11	.05	39	.23	.13	64	320	225	61,047
7	7.0	8.3	12.0	6.2	3,351	.13	.07	35	.23	.17	35	350	249	58,358
8	7.0	8.3	12.0	5.9	3,492	.13	.07	34	.23	.17	34	350	256	53,806
9	7.0	8.2	12.0	4.2	9,266	.13	.06	83	.23	.15	95	350	217	158,004
10	7.0	8.2	12.0	4.1	9,257	.13	.06	82	.23	.15	94	350	224	147,647
11	7.0	8.1	12.0	3.9	9,667	.13	.06	84	.23	.15	95	350	224	150,368
12*	7.0	8.1	12.0	3.8	10,096	.13	.06	86	.23	.15	98	350	229	148,975
13	7.0	8.1	12.0	3.6	10,478	.13	.06	87	.23	.15	100	425	230	243,243
14	7.0	8.2	12.0	3.3	10,852	.13	.06	87	.23	.15	100	425	230	243,243
15	7.0	8.1	12.0	2.9	11,351	.13	.06	87	.23	.15	100	425	230	243,243
16	7.0	8.0	12.0	3.3	8,879	.13	.07	61	.23	.18	51	425	273	155,131
17*	7.0	8.0	12.0	3.0	8,879	.13	.07	61	.23	.18	51	425	273	155,131
18	7.0	7.8	12.0	4.5	10,490	.17	.08	126	.23	.18	70	500	298	282,517
19	7.0	7.8	12.0	3.9	11,329	.17	.08	126	.23	.18	70	500	298	282,517
20*	7.0	7.9	12.0	4.5	11,300	.17	.08	136	.23	.19	60	500	384	174,766
21	7.0	7.9	12.0	3.8	12,354	.17	.08	136	.23	.18	75	505	384	182,299
22	7.0	7.9	12.0	3.3	13,107	.17	.08	136	.23	.18	75	505	384	182,299
23	7.0	7.9	12.0	2.9	13,710	.17	.08	136	.23	.18	75	505	384	182,299
24	7.0	7.8	12.0	3.6	13,517	.17	.09	129	.23	.19	64	505	435	112,644
25	7.0	7.9	12.0	3.2	14,161	.17	.09	129	.23	.18	80	505	435	112,644
26	7.0	7.9	12.0	2.7	14,966	.17	.09	129	.23	.18	80	505	435	112,644
27*	7.0	7.9	12.0	2.1	15,931	.17	.09	129	.23	.18	80	505	435	112,644
28	7.0	7.9	12.0	1.9	13,417	.23	.10	173	.16	.19	-13	600	470	172,692
29*	7.0	7.2	12.0	2.4	22,706	.23	.09	331	.16	.19	-71	600	464	321,667
30	7.0	7.7	12.0	2.2	20,639	.23	.10	274	.16	.21	-105	600	518	172,692
31	5.0	7.9	None	2.0	N.A.	.33	.10	274	None	.21	N.A.	500	518	-37,908
32	3.0	8.0	None	1.8	N.A.	None	.10	N.A.	None	.21	N.A.	None	533	N.A.
33	3.0	8.1	None	1.8	N.A.	None	.10	N.A.	None	.22	N.A.	None	534	N.A.

*Water Quality Control Point

Humboldt River Allowable Loads
20% Reduction of Nonpoint-Zero Discharge For STP
Existing Standards

	DO		BOD_{ult}			PO_4			NO_3			TDS		
Reach	Standard (mg/l)	Model Value (mg/l)	Standard (mg/l) ($4xBOD_5$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.33xPO_4-PO_4$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.23xNO_3-NO_3$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l)	Model Value (mg/l)	Allowable Load (lb/day)
1	7.0	8.7	12.0	8.3	40	.11	.05	1	.23	.20	0	320	300	216
2	7.0	8.5	12.0	7.1	53	.11	.05	1	.23	.21	0	320	300	216
3	7.0	8.5	12.0	3.9	87	.11	.05	1	.23	.23	0	320	300	216
4	7.0	8.3	12.0	7.0	567	.11	.05	7	.23	.13	11	320	195	14,175
5	7.0	8.6	12.0	7.1	2,567	.11	.05	31	.23	.13	52	320	226	49,237
6*	7.0	8.4	12.0	6.5	3,534	.11	.05	39	.23	.13	64	320	224	61,690
7	7.0	8.3	12.0	6.0	3,434	.13	.06	40	.23	.14	52	350	241	62,392
8	7.0	8.3	12.0	5.7	3,572	.13	.06	40	.23	.14	51	350	248	57,834
9	7.0	8.2	12.0	4.1	9,343	.13	.05	95	.23	.13	118	350	213	162,016
10	7.0	8.2	12.0	4.0	9,331	.13	.05	93	.23	.13	117	350	219	152,798
11	7.0	8.1	12.0	3.8	9,742	.13	.05	95	.23	.13	119	350	219	155,628
12*	7.0	8.1	12.0	3.7	10,174	.13	.05	98	.23	.13	123	350	225	153,225
13	7.0	8.1	12.0	3.5	10,511	.13	.05	99	.23	.13	124	425	226	246,083
14	7.0	8.2	12.0	3.2	10,882	.13	.05	99	.23	.13	124	425	226	246,083
15	7.0	8.1	12.0	2.8	11,377	.13	.05	99	.23	.13	124	425	226	246,083
16	7.0	8.0	12.0	3.2	8,934	.13	.06	71	.23	.16	71	425	269	158,371
17*	7.0	8.0	12.0	3.0	9,137	.13	.06	71	.23	.16	71	425	269	158,371
18	7.0	7.8	12.0	4.5	10,449	.17	.07	153	.23	.17	84	500	295	285,606
19	7.0	7.8	12.0	3.8	11,424	.17	.07	137	.23	.16	98	500	295	280,071
20*	7.0	7.9	12.0	4.5	11,259	.17	.08	135	.23	.17	90	500	382	177,142
21	7.0	7.9	12.0	3.8	12,310	.17	.08	135	.23	.17	90	505	382	184,648
22	7.0	7.9	12.0	3.2	13,211	.17	.08	135	.23	.17	90	505	382	184,648
23	7.0	7.9	12.0	2.9	13,661	.17	.08	135	.23	.17	90	505	382	184,648
24	7.0	7.8	12.0	3.6	13,472	.17	.09	128	.23	.18	80	505	433	115,474
25	7.0	7.9	12.0	3.2	14,113	.17	.09	128	.23	.18	80	505	433	115,474
26	7.0	7.9	12.0	2.6	15,076	.17	.09	128	.23	.17	96	505	433	115,474
27*	7.0	7.9	12.0	2.0	16,038	.17	.09	128	.23	.17	96	505	433	115,474
28	7.0	7.9	12.0	1.9	13,362	.23	.09	185	.16	.18	13	600	468	174,636
29*	7.0	7.2	12.0	2.4	22,654	.23	.09	330	.16	.19	-71	600	463	323,293
30	7.0	7.7	12.0	2.2	20,586	.23	.10	273	.16	.20	-84	600	518	172,249
31	5.0	7.9	None	1.9	N.A.	.33	.10	483	None	.20	N.A.	500	518	-37,811
32	3.0	8.0	None	1.8	N.A.	None	.10	N.A.	None	.21	N.A.	None	533	N.A.
33	3.0	8.1	None	1.7	N.A.	None	.10	N.A.	None	.20	N.A.	None	533	N.A.

*Water Quality Control Point

Table 18
Humboldt River Allowable Loads
20% Reduction of Nonpoint-30/30, 90% Reduction of Nutrients
Existing Standards

	DO		BOD_{ult}			PO_4			NO_3			TDS		
Reach	Standard (mg/l)	Model Value (mg/l)	Standard (mg/l) ($4xBOD_5$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.33xPO_4-PO_4$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.23xNO_3-NO_3$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l)	Model Value (mg/l)	Allowable Load (lb/day)
1	7.0	8.7	12.0	8.3	40	.11	.05	1	.23	.20	0	320	300	216
2	7.0	8.5	12.0	28.0	-259	.11	.21	-2	.23	.58	-6	320	397	-1,247
3	7.0	8.4	12.0	17.2	-84	.11	.21	-2	.23	.63	-6	320	397	-1,247
4	7.0	8.2	12.0	8.2	451	.11	.07	5	.23	.18	6	320	209	13,187
5	7.0	8.6	12.0	7.3	2,487	.11	.06	26	.23	.14	48	320	229	49,157
6*	7.0	8.4	12.0	6.6	3,499	.11	.06	32	.23	.14	58	320	226	60,912
7	7.0	8.3	12.0	11.1	539	.13	.09	24	.23	.23	0	350	267	49,750
8	7.0	8.2	12.0	10.6	832	.13	.09	24	.23	.23	0	350	274	45,144
9	7.0	8.3	12.0	6.3	6,695	.13	.07	73	.23	.18	60	350	226	149,380
10	7.0	8.3	12.0	6.4	6,683	.13	.07	72	.23	.18	60	350	234	133,434
11	7.0	8.2	12.0	6.1	7,169	.13	.07	73	.23	.18	61	350	234	140,940
12*	7.0	8.2	12.0	5.8	7,767	.13	.07	75	.23	.18	63	350	239	139,001
13	7.0	8.2	12.0	5.4	8,375	.13	.07	76	.23	.18	63	425	239	230,034
14	7.0	8.2	12.0	5.1	8,756	.13	.07	76	.23	.18	63	425	239	231,334
15	7.0	8.1	12.0	4.4	9,644	.13	.07	76	.23	.19	51	425	239	230,034
16	7.0	8.1	12.0	4.8	7,504	.13	.09	42	.23	.21	21	425	283	147,932
17*	7.0	8.1	12.0	4.5	7,817	.13	.09	42	.23	.21	21	425	283	147,932
18	7.0	7.9	12.0	5.5	9,231	.17	.09	114	.23	.21	28	500	304	278,359
19	7.0	7.9	12.0	4.7	10,367	.17	.09	114	.23	.20	43	500	304	278,359
20*	7.0	8.0	12.0	5.1	10,545	.17	.09	122	.23	.21	31	500	389	169,630
21	7.0	7.9	12.0	4.3	11,767	.17	.09	122	.23	.21	31	505	389	177,271
22	7.0	7.8	12.0	3.7	12,684	.17	.09	122	.23	.21	31	505	389	177,271
23	7.0	7.8	12.0	3.3	13,295	.17	.09	122	.23	.21	31	505	389	177,271
24	7.0	7.7	12.0	3.9	13,209	.17	.10	114	.23	.21	33	505	438	109,264
25	7.0	7.8	12.0	3.5	13,862	.17	.10	114	.23	.21	33	505	438	109,264
26	7.0	8.0	12.0	2.9	14,840	.17	.10	114	.23	.20	49	505	438	109,264
27*	7.0	8.0	12.0	2.3	15,819	.17	.10	114	.23	.20	49	505	438	109,264
28	7.0	8.0	12.0	-2.1	13,365	.23	.10	176	.16	.21	-68	600	473	171,450
29*	7.0	7.3	12.0	2.5	22,675	.23	.09	334	.16	.21	-119	600	466	319,831
30	7.0	7.7	12.0	2.3	20,638	.23	.10	277	.16	.22	-128	600	520	170,238
31	5.0	7.9	None	2.0	N.A.	.33	.10	489	None	.22	N.A.	500	520	-42,552
32	3.0	8.0	None	1.9	N.A.	None	.11	N.A.	None	.22	N.A.	None	535	N.A.
33	3.0	8.0	None	2.9	N.A.	None	.11	N.A.	None	.24	N.A.	None	537	N.A.

*Water Quality Control Point

FIGURES

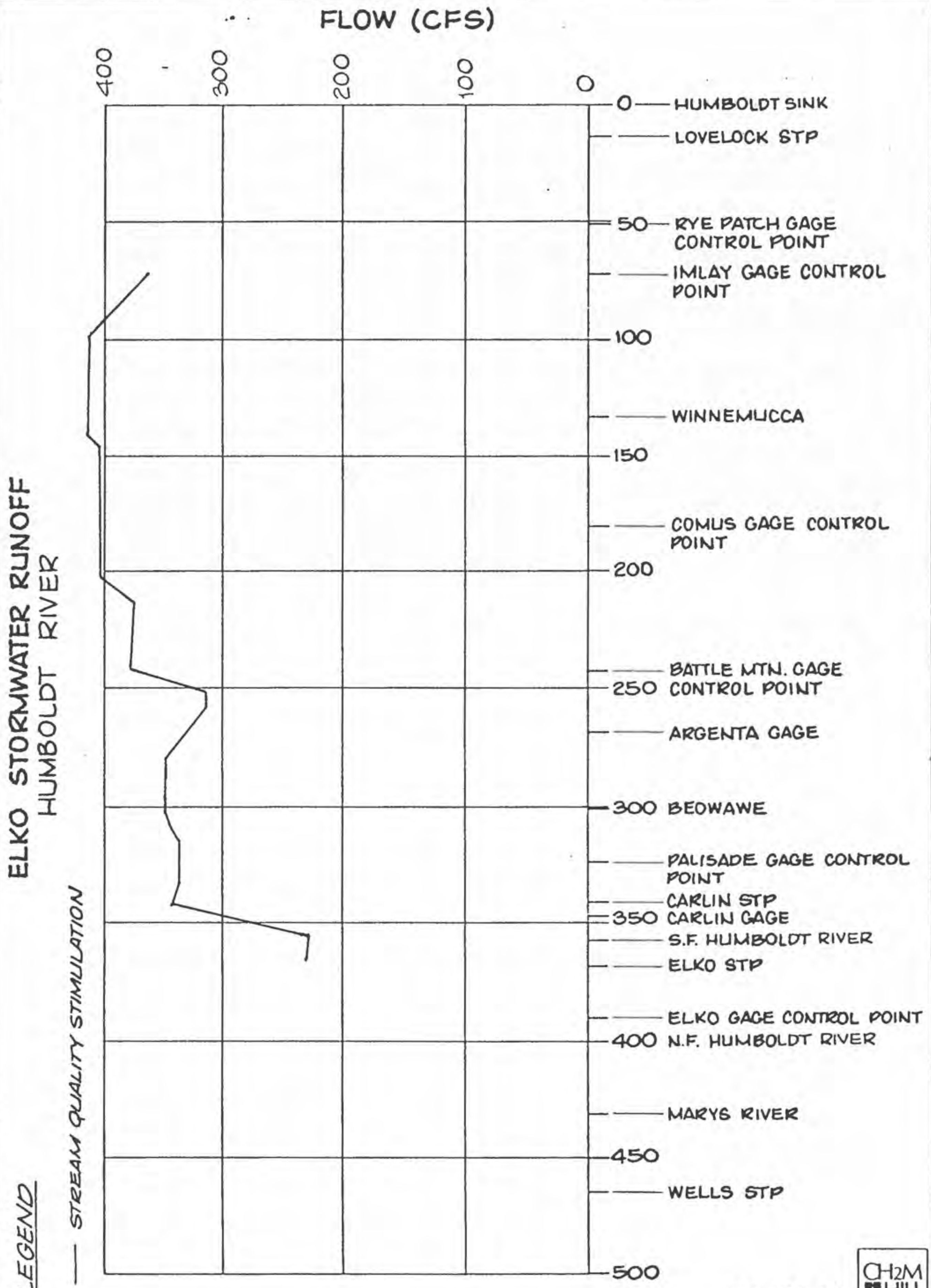


FIGURE 3A

CH2M HILL

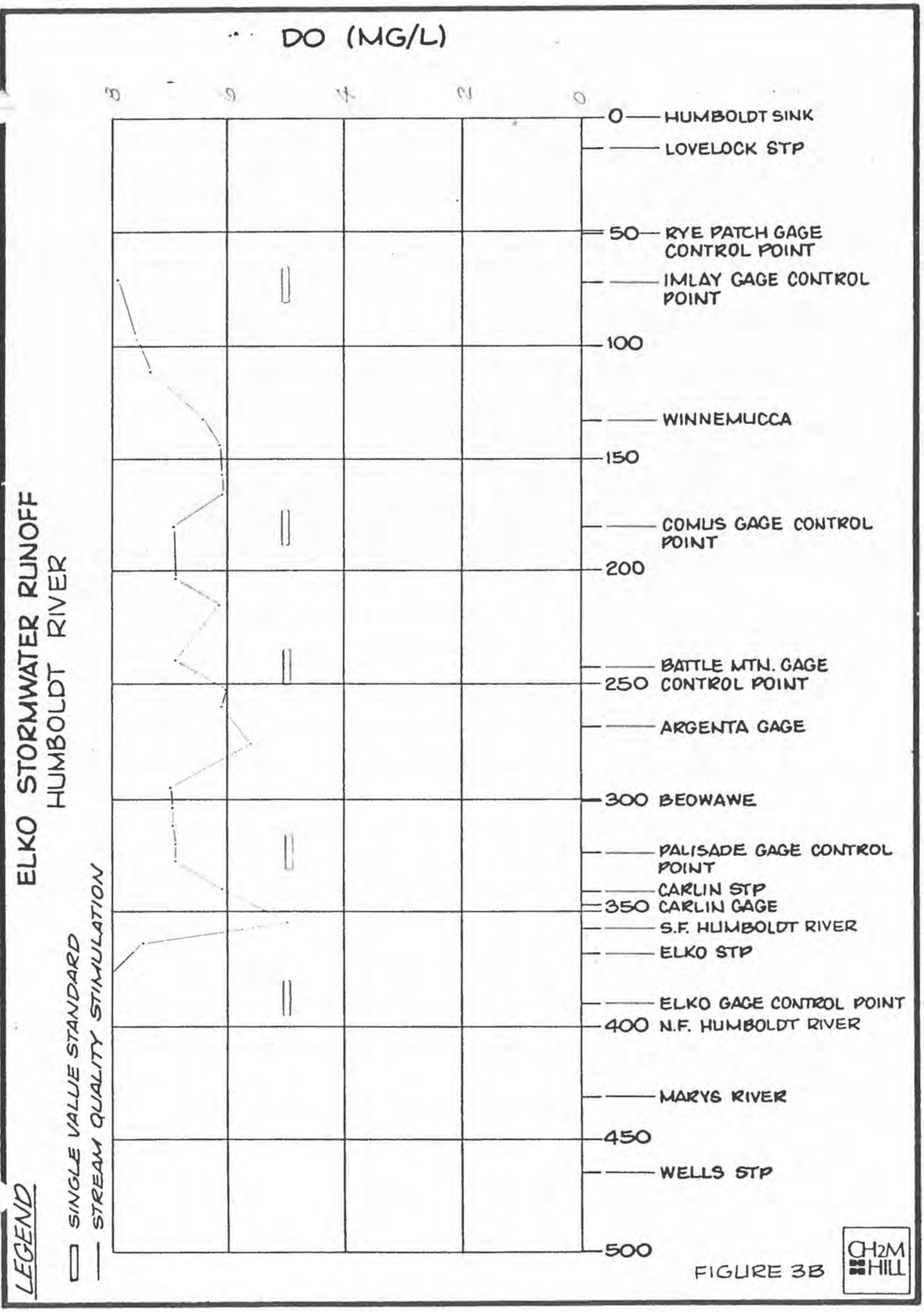

DO (MG/L)
8
6
4
2
0
0 HUMBOLDT SINK
LOVELOCK STP
50 RYE PATCH GAGE CONTROL POINT
IMLAY GAGE CONTROL POINT
100
WINNEMUCCA
150
COMUS GAGE CONTROL POINT
200
BATTLE MTN. GAGE CONTROL POINT
250
ARGENTA GAGE
300 BEOWAWE
PALISADE GAGE CONTROL POINT
CARLIN STP
350 CARLIN GAGE
S.F. HUMBOLDT RIVER
ELKO STP
ELKO GAGE CONTROL POINT
400 N.F. HUMBOLDT RIVER
MARYS RIVER
450
WELLS STP
500
ELKO STORMWATER RUNOFF
HUMBOLDT RIVER
LEGEND
SINGLE VALUE STANDARD
STREAM QUALITY STIMULATION
CH2M HILL

FIGURE 3B

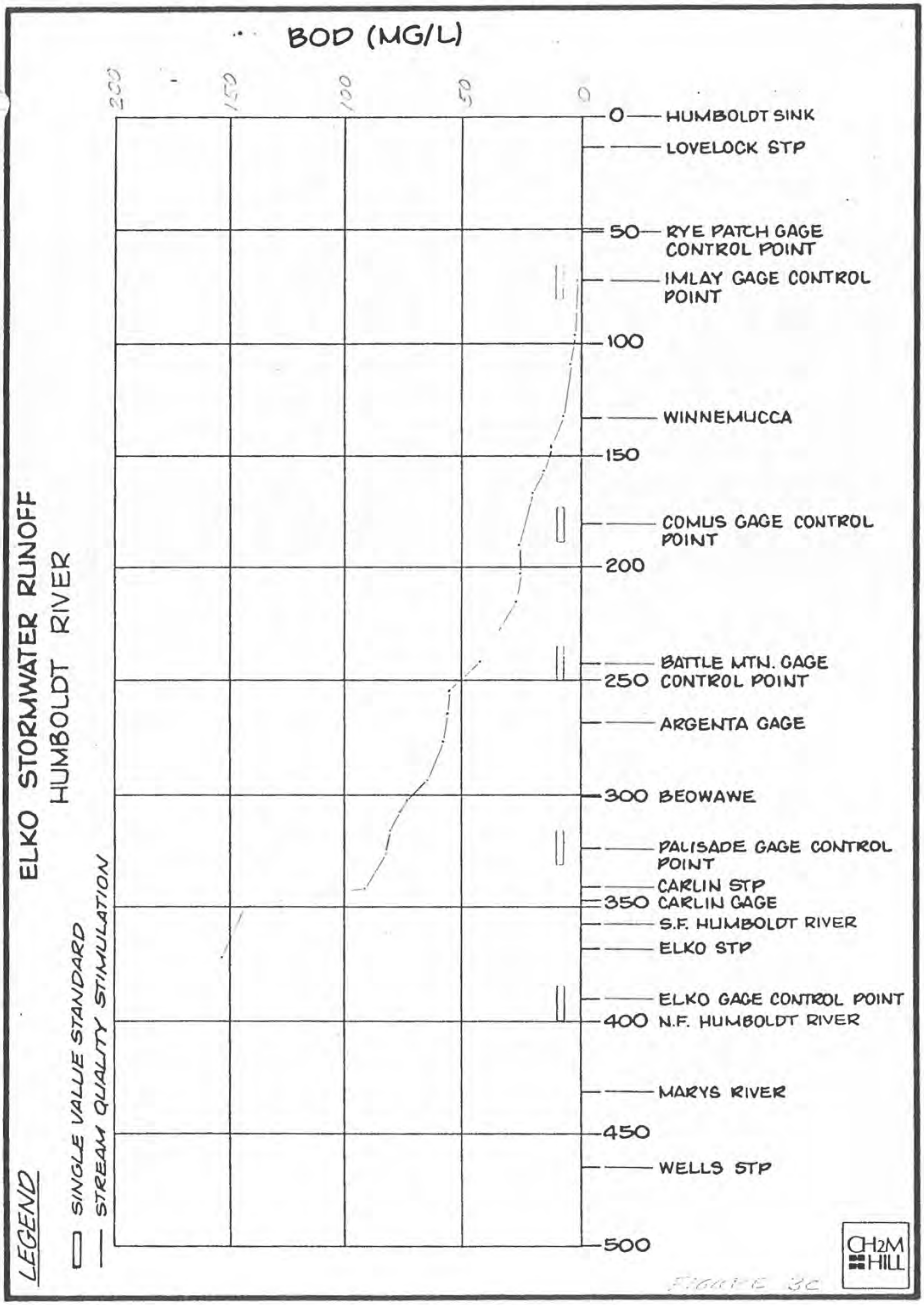
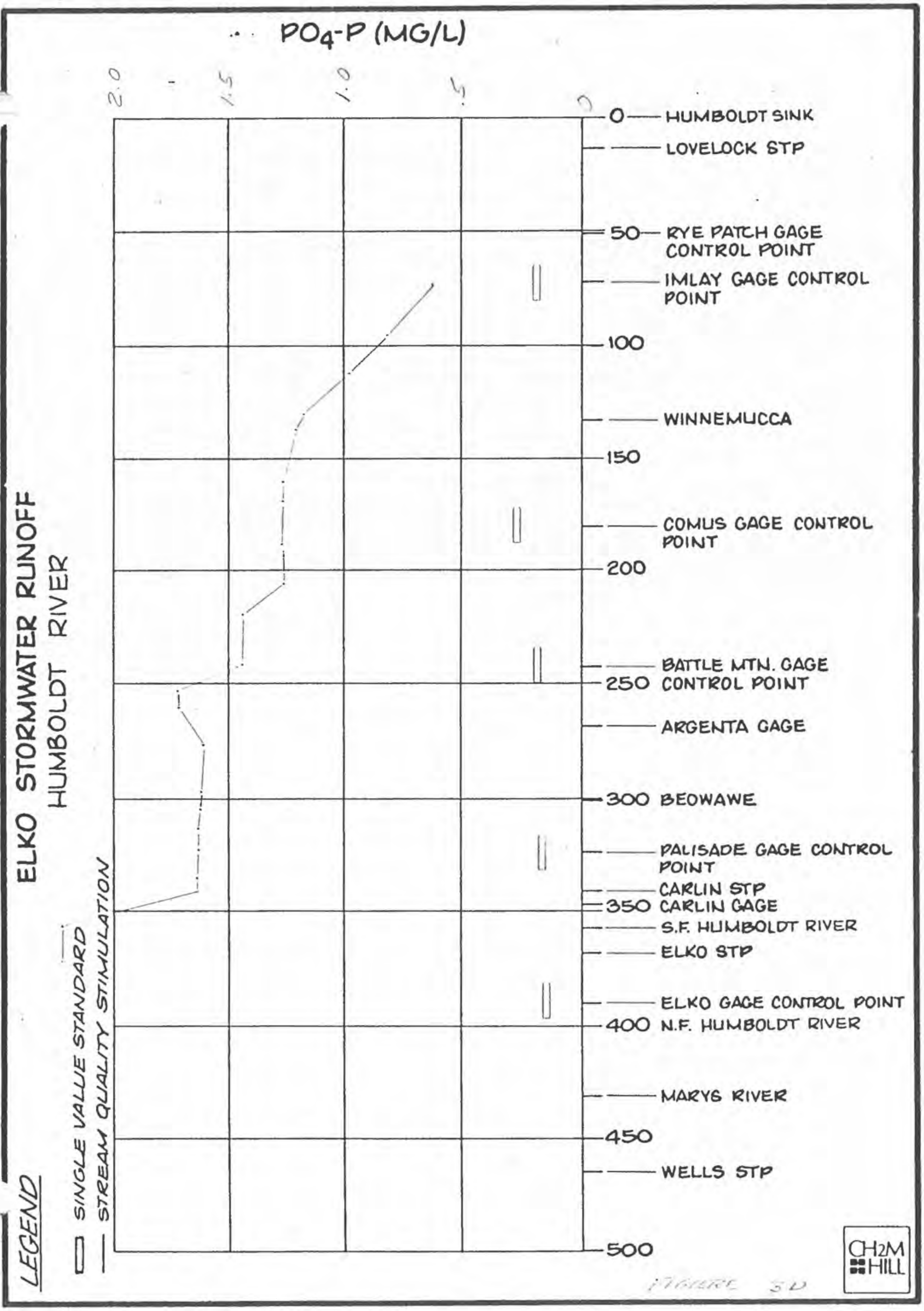

ELKO STORMWATER RUNOFF
HUMBOLDT RIVER
BOD (MG/L)
200
150
100
50
0
0
50
100
150
200
250
300
350
400
450
500
HUMBOLDT SINK
LOVELOCK STP
RYE PATCH GAGE CONTROL POINT
IMLAY GAGE CONTROL POINT
WINNEMUCCA
COMUS GAGE CONTROL POINT
BATTLE MTN. GAGE CONTROL POINT
ARGENTA GAGE
BEOWAWE
PALISADE GAGE CONTROL POINT
CARLIN STP
CARLIN GAGE
S.F. HUMBOLDT RIVER
ELKO STP
ELKO GAGE CONTROL POINT
N.F. HUMBOLDT RIVER
MARYS RIVER
WELLS STP
LEGEND
SINGLE VALUE STANDARD
STREAM QUALITY STIMULATION
CH2M HILL

FIGURE 3C


ELKO STORMWATER RUNOFF
HUMBOLDT RIVER
PO4-P (MG/L)
2.0
1.5
1.0
.5
0
LEGEND
SINGLE VALUE STANDARD
STREAM QUALITY STIMULATION
0 HUMBOLDT SINK
LOVELOCK STP
50 RYE PATCH GAGE CONTROL POINT
IMLAY GAGE CONTROL POINT
100
WINNEMUCCA
150
COMUS GAGE CONTROL POINT
200
BATTLE MTN. GAGE CONTROL POINT
250
ARGENTA GAGE
300 BEOWAWE
PALISADE GAGE CONTROL POINT
CARLIN STP
350 CARLIN GAGE
S.F. HUMBOLDT RIVER
ELKO STP
ELKO GAGE CONTROL POINT
400 N.F. HUMBOLDT RIVER
MARYS RIVER
450
WELLS STP
500
CH2M HILL
FIGURE 5D

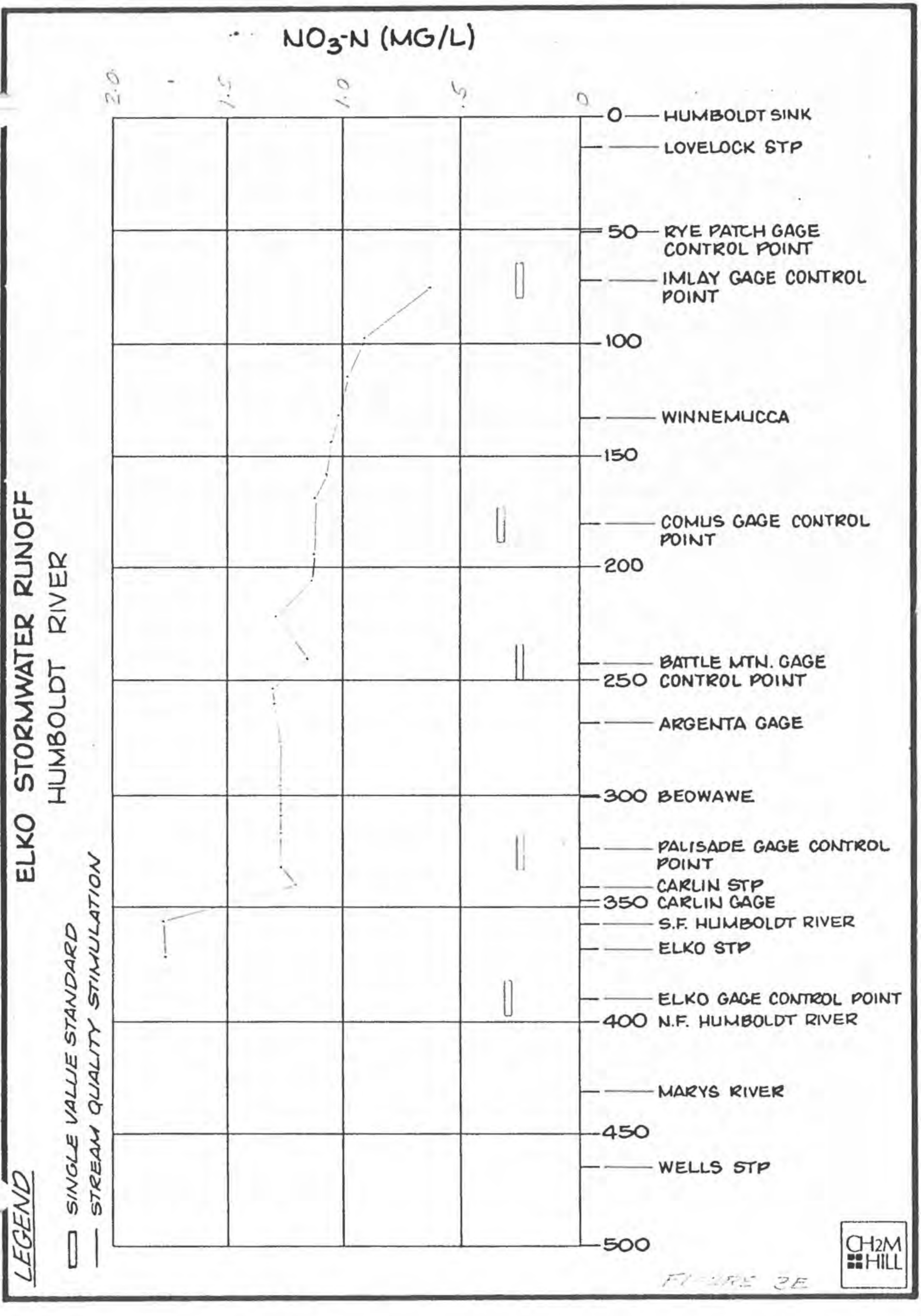
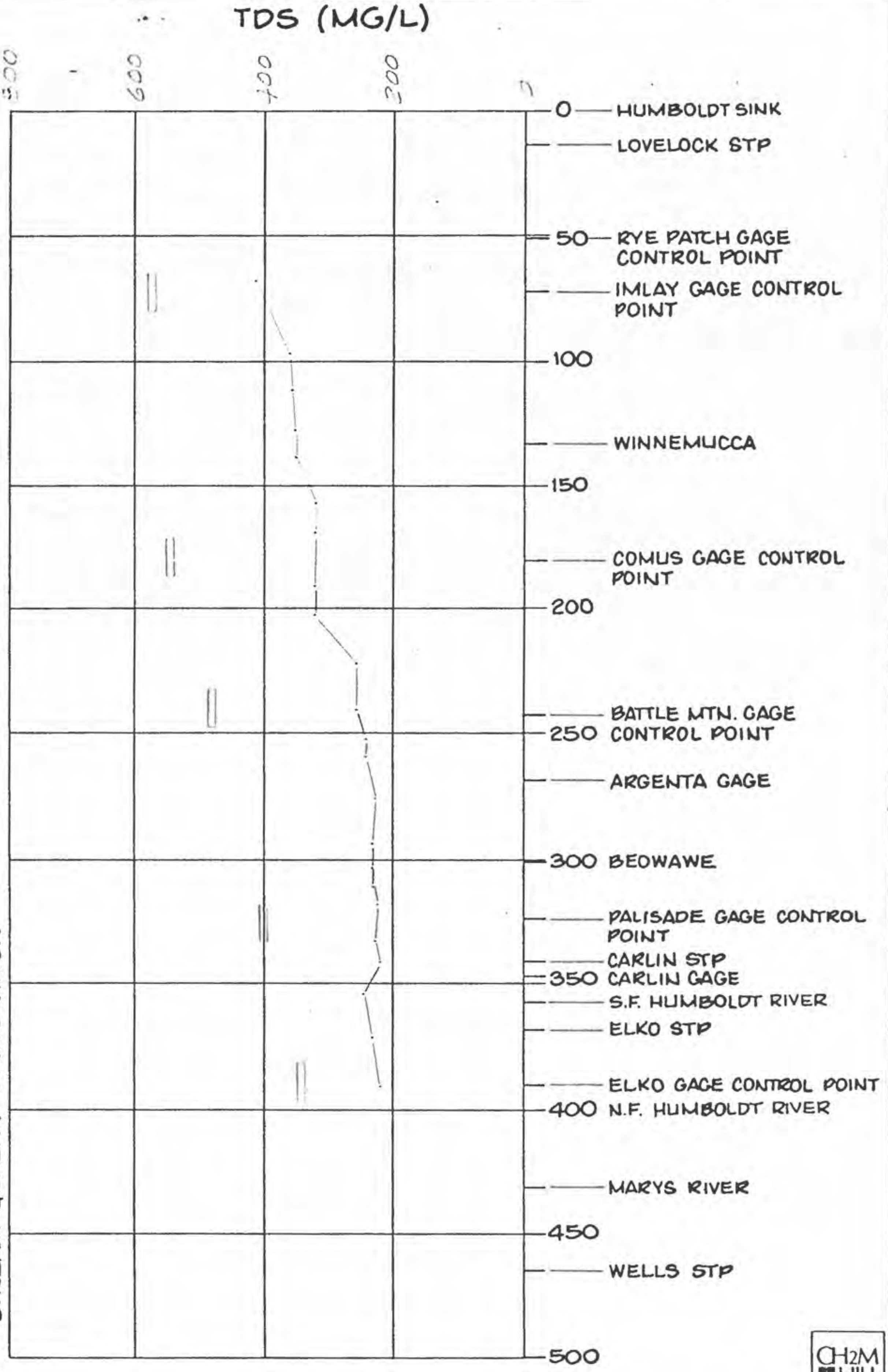

NO3-N (MG/L)
2.0
1.5
1.0
.5
0
0 HUMBOLDT SINK
LOVELOCK STP
50 RYE PATCH GAGE CONTROL POINT
IMLAY GAGE CONTROL POINT
100
WINNEMUCCA
150
COMUS GAGE CONTROL POINT
200
BATTLE MTN. GAGE CONTROL POINT
250
ARGENTA GAGE
300 BEOWAWE
PALISADE GAGE CONTROL POINT
CARLIN STP
350 CARLIN GAGE
S.F. HUMBOLDT RIVER
ELKO STP
ELKO GAGE CONTROL POINT
400 N.F. HUMBOLDT RIVER
MARYS RIVER
450
WELLS STP
500
ELKO STORMWATER RUNOFF
HUMBOLDT RIVER
LEGEND
SINGLE VALUE STANDARD
STREAM QUALITY STIMULATION
CH2M HILL

FIGURE 3E

ELKO STORMWATER RUNOFF
HUMBOLDT RIVER



LEGEND

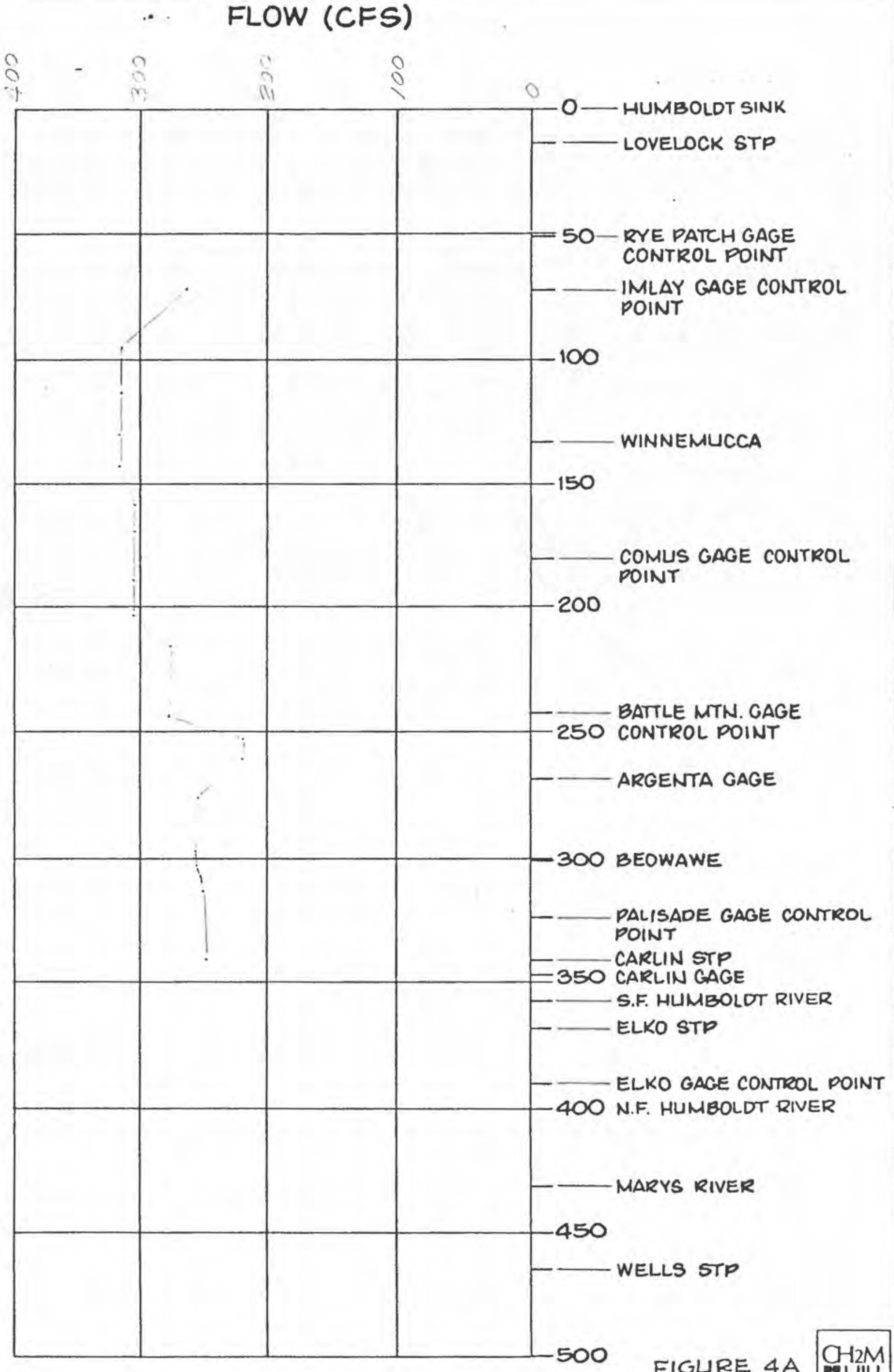
▭ *SINGLE VALUE STANDARD*

— *STREAM QUALITY STIMULATION*

CH2M HILL

FIGURE 3F

CARLIN STORMWATER RUNOFF
HUMBOLDT RIVER



LEGEND
— STREAM QUALITY STIMULATION

FIGURE 4A

CH2M HILL

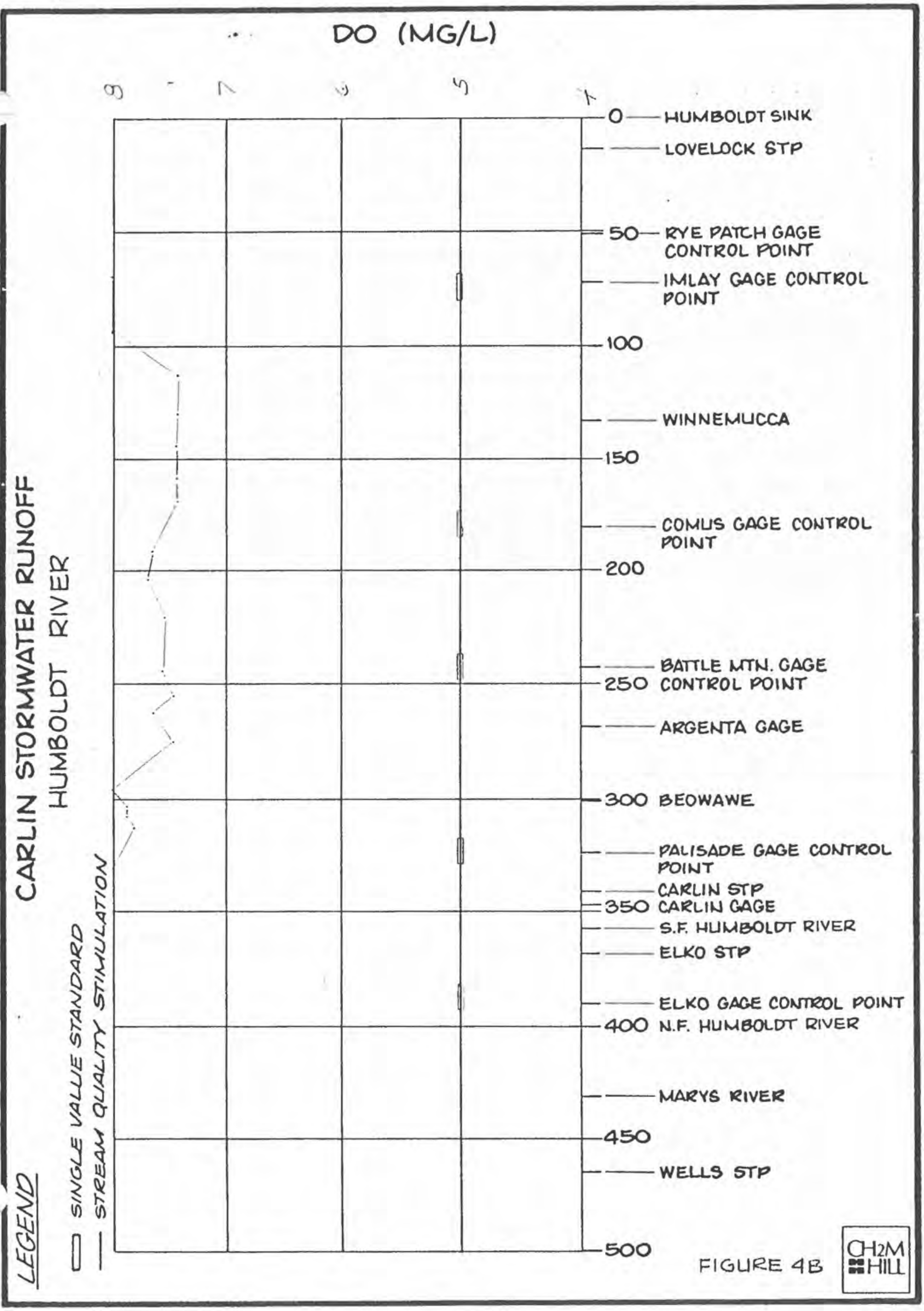

DO (MG/L)
8
7
6
5
4
0
50
100
150
200
250
300
350
400
450
500
HUMBOLDT SINK
LOVELOCK STP
RYE PATCH GAGE CONTROL POINT
IMLAY GAGE CONTROL POINT
WINNEMUCCA
COMUS GAGE CONTROL POINT
BATTLE MTN. GAGE CONTROL POINT
ARGENTA GAGE
BEOWAWE
PALISADE GAGE CONTROL POINT
CARLIN STP
CARLIN GAGE
S.F. HUMBOLDT RIVER
ELKO STP
ELKO GAGE CONTROL POINT
N.F. HUMBOLDT RIVER
MARYS RIVER
WELLS STP
CARLIN STORMWATER RUNOFF
HUMBOLDT RIVER
LEGEND
SINGLE VALUE STANDARD
STREAM QUALITY STIMULATION
CH2M HILL

FIGURE 4B

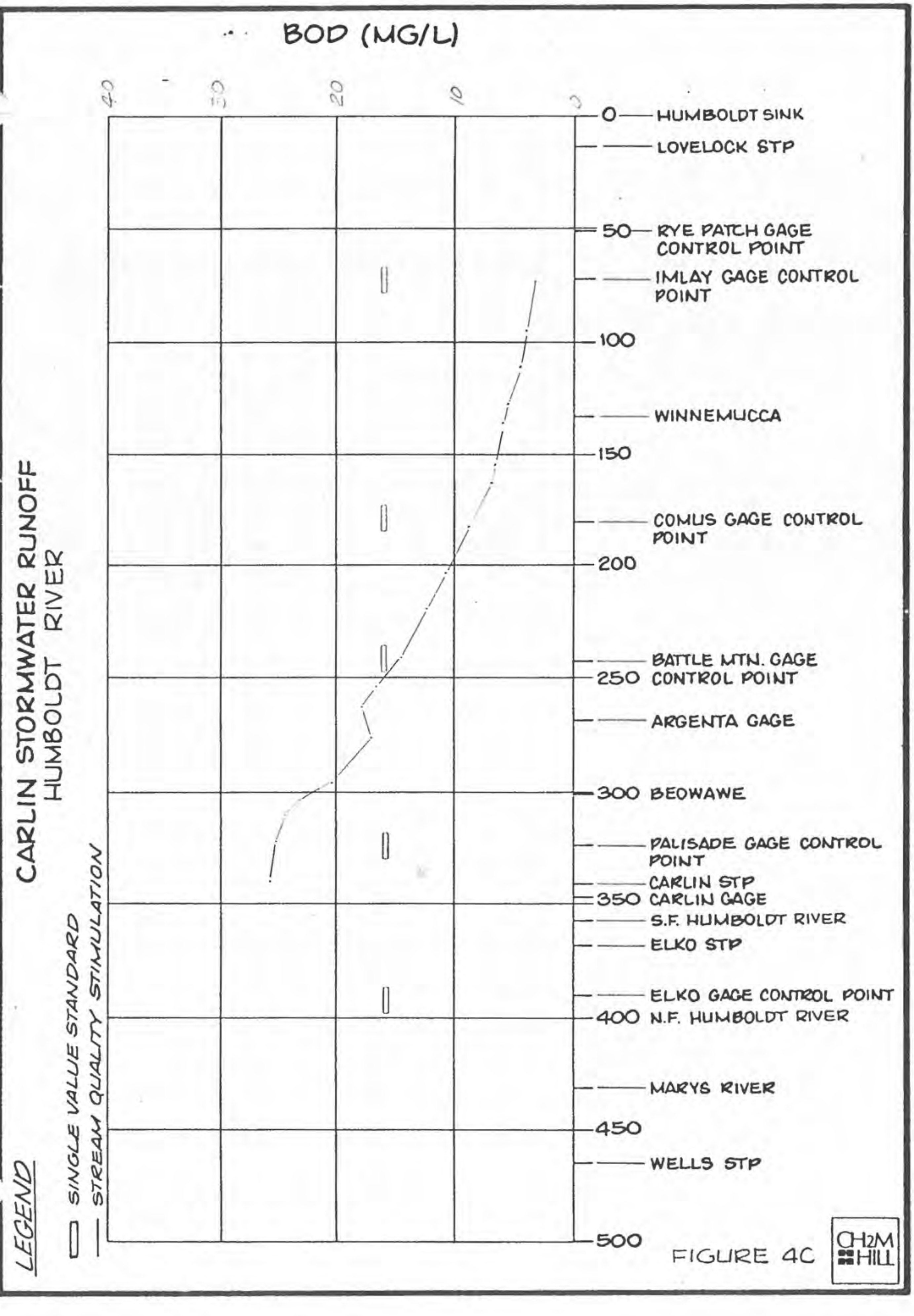
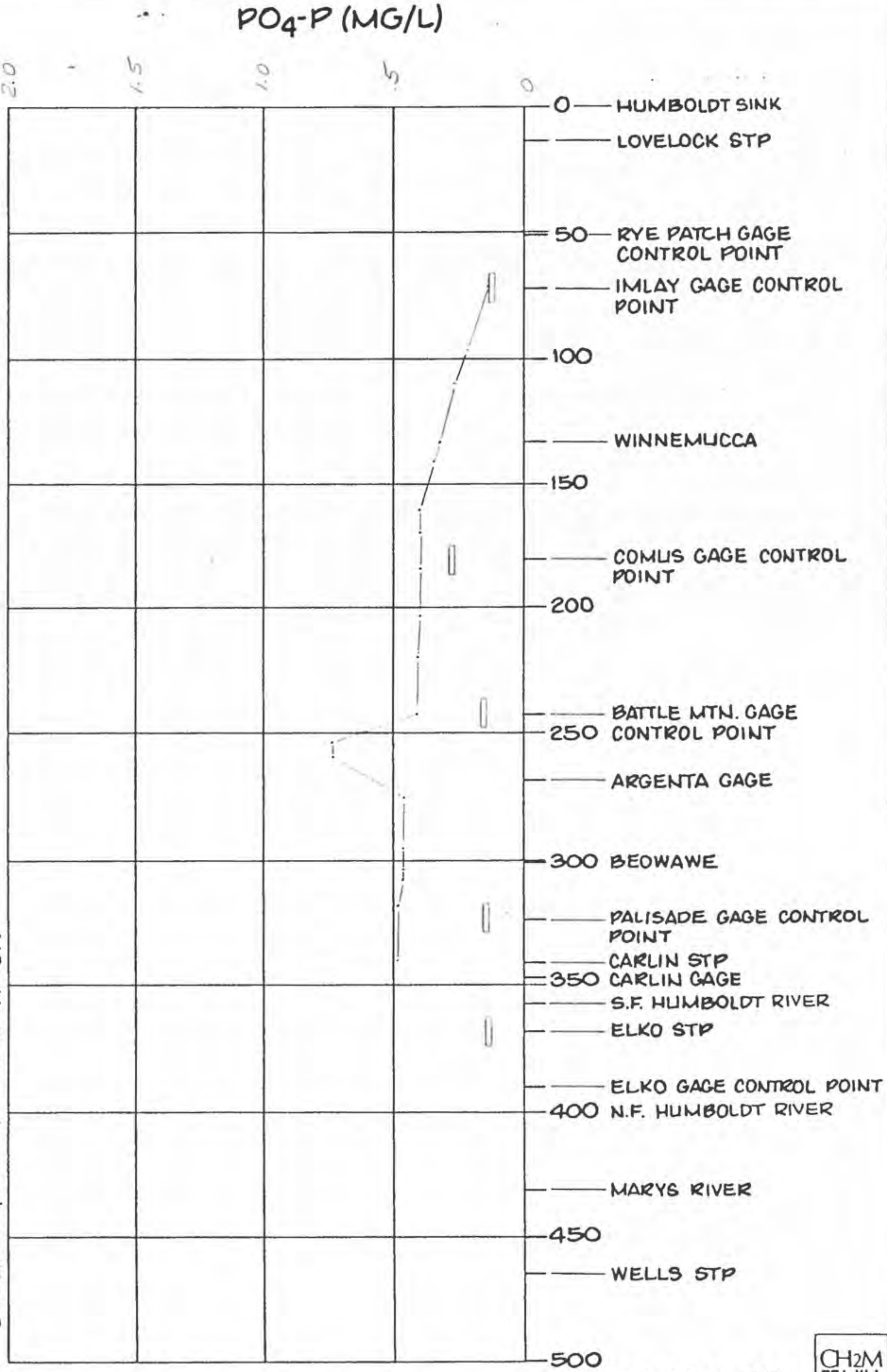


FIGURE 4C

CH2M HILL

CARLIN STORMWATER RUNOFF
HUMBOLDT RIVER



LEGEND

▯ SINGLE VALUE STANDARD

— STREAM QUALITY STIMULATION

FIGURE 4D

CH2M HILL

CARLIN STORMWATER RUNOFF
HUMBOLDT RIVER

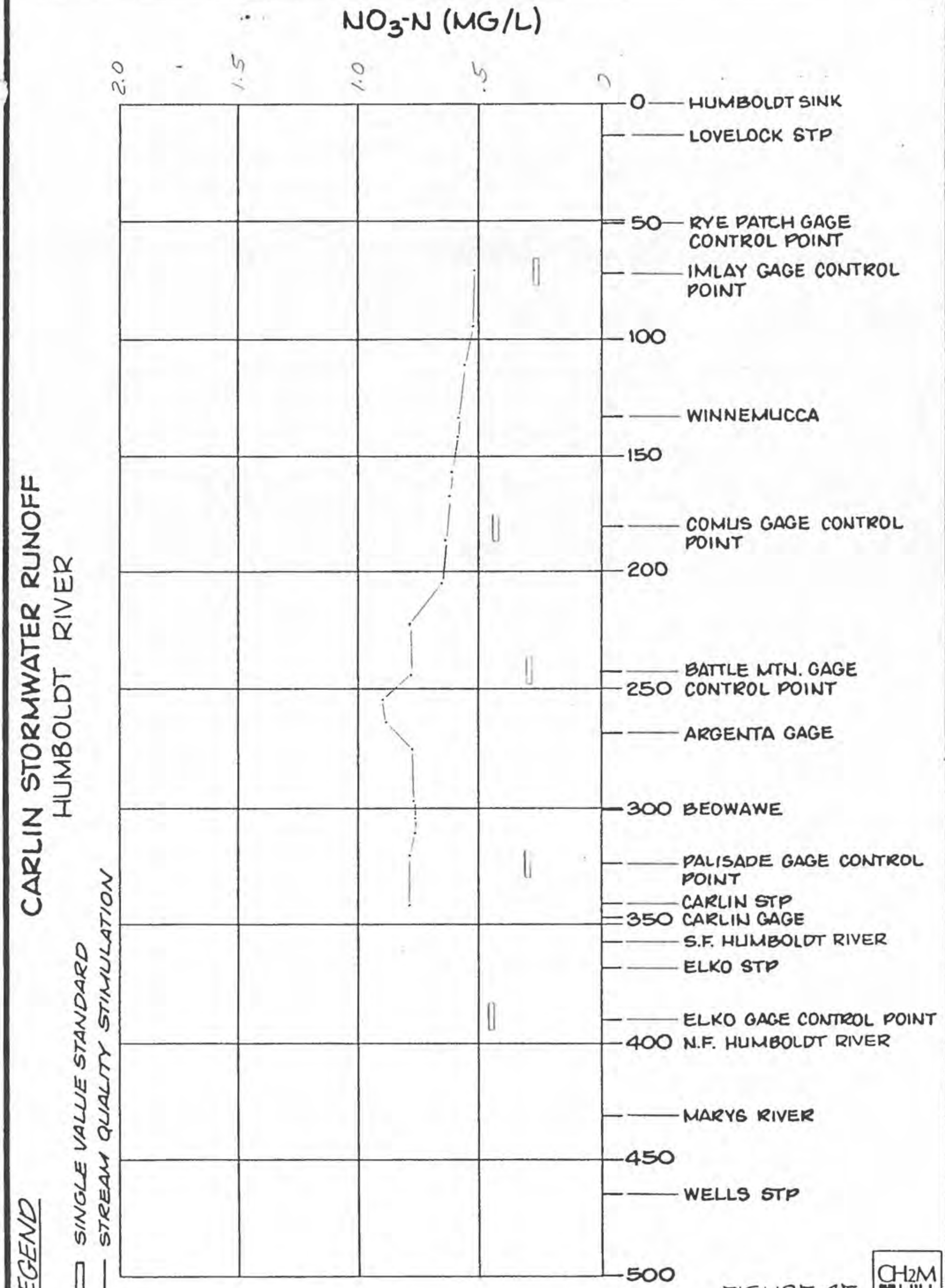
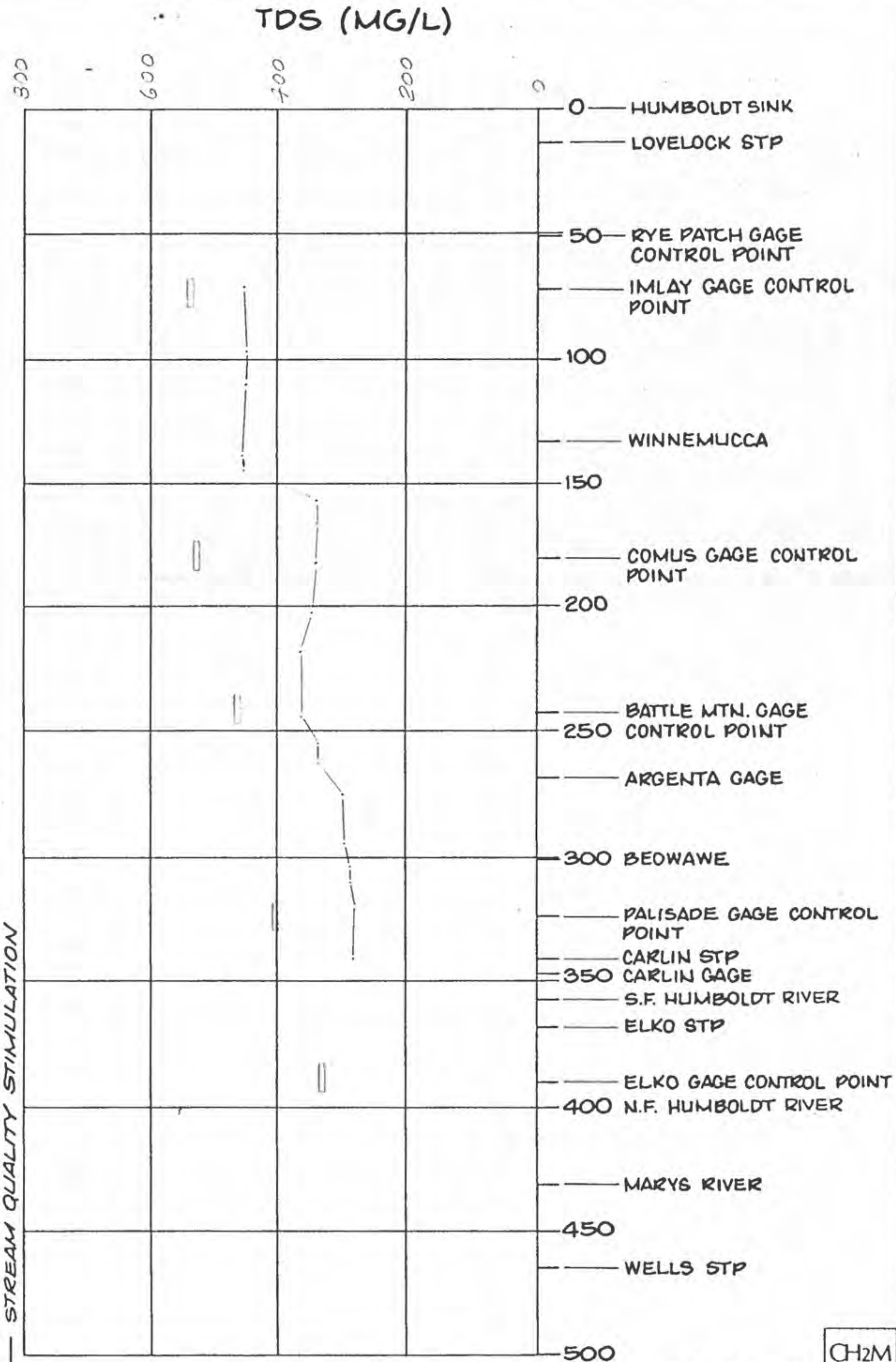


FIGURE 4E

CARLIN STORMWATER RUNOFF
HUMBOLDT RIVER



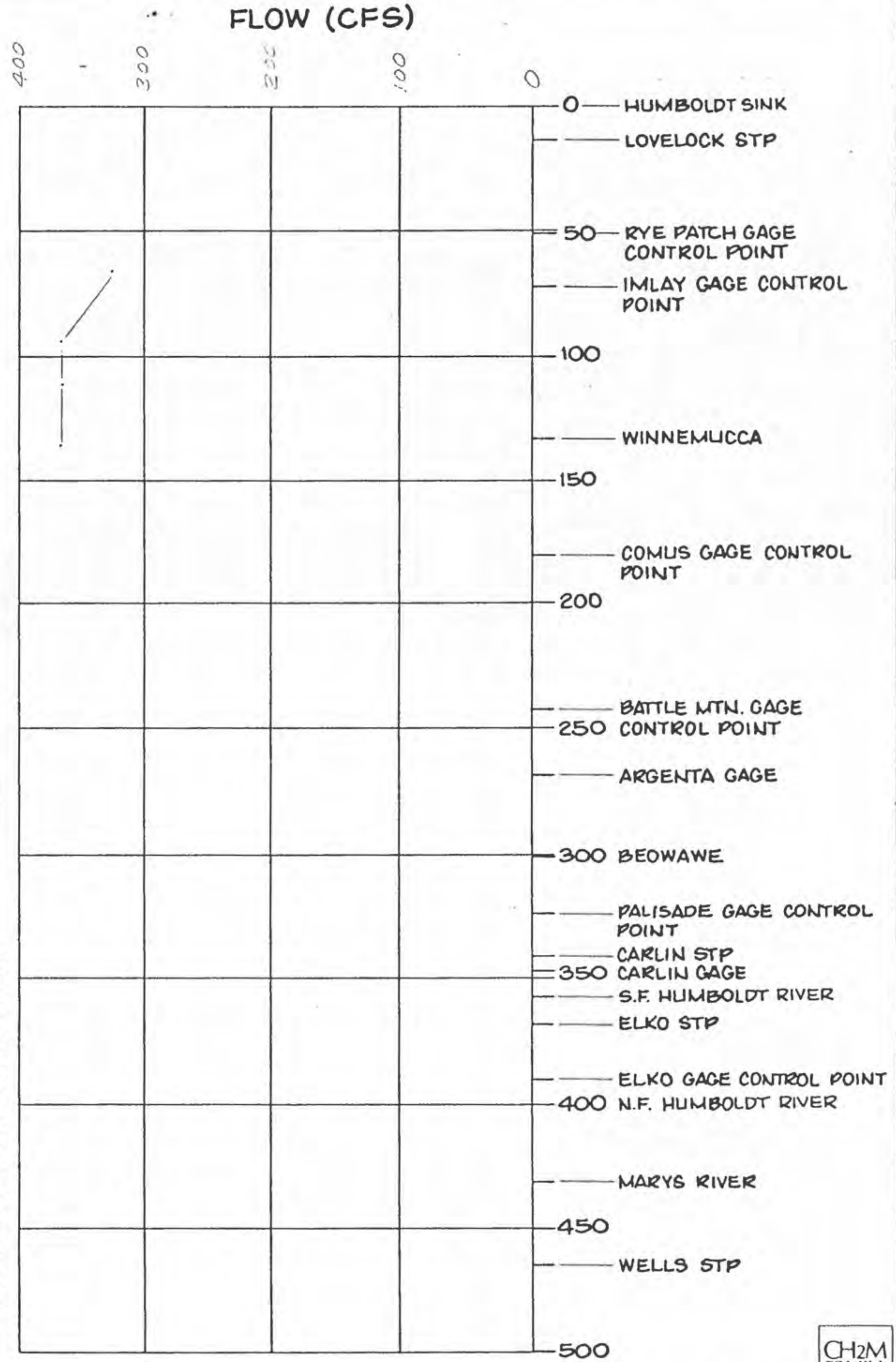
LEGEND

▯ SINGLE VALUE STANDARD

— STREAM QUALITY STIMULATION

FIGURE 4F

WINNEMUCCA STORMWATER RUNOFF
HUMBOLDT RIVER

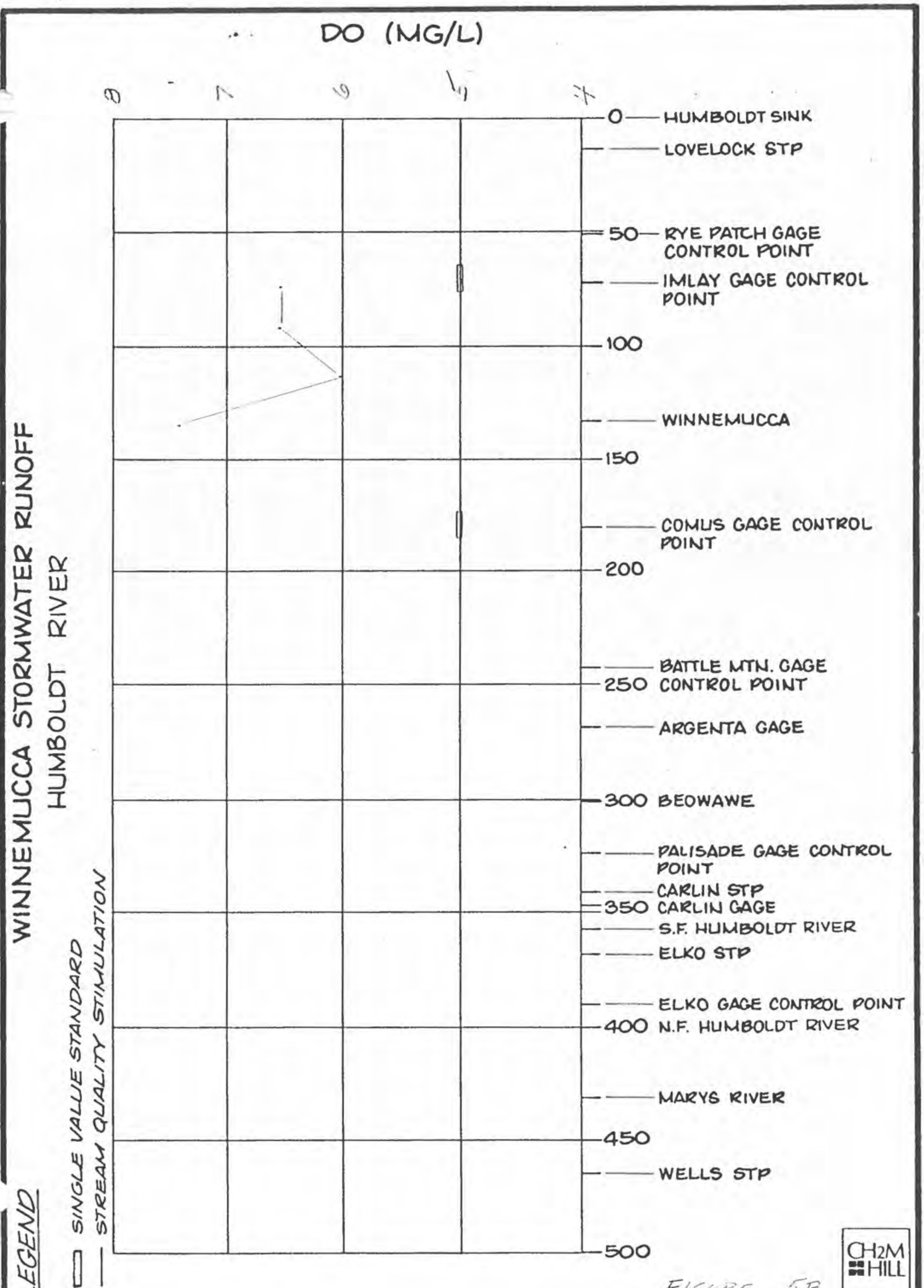


LEGEND

— STREAM QUALITY STIMULATION

CH2M HILL

FIGURE 5A


DO (MG/L)
8
7
6
5
4
0 HUMBOLDT SINK
LOVELOCK STP
50 RYE PATCH GAGE CONTROL POINT
IMLAY GAGE CONTROL POINT
100
WINNEMUCCA
150
COMUS GAGE CONTROL POINT
200
BATTLE MTN. GAGE CONTROL POINT
250
ARGENTA GAGE
300 BEOWAWE
PALISADE GAGE CONTROL POINT
CARLIN STP
350 CARLIN GAGE
S.F. HUMBOLDT RIVER
ELKO STP
ELKO GAGE CONTROL POINT
400 N.F. HUMBOLDT RIVER
MARYS RIVER
450
WELLS STP
500
WINNEMUCCA STORMWATER RUNOFF
HUMBOLDT RIVER
LEGEND
SINGLE VALUE STANDARD
STREAM QUALITY STIMULATION
CH2M HILL
FIGURE 5B

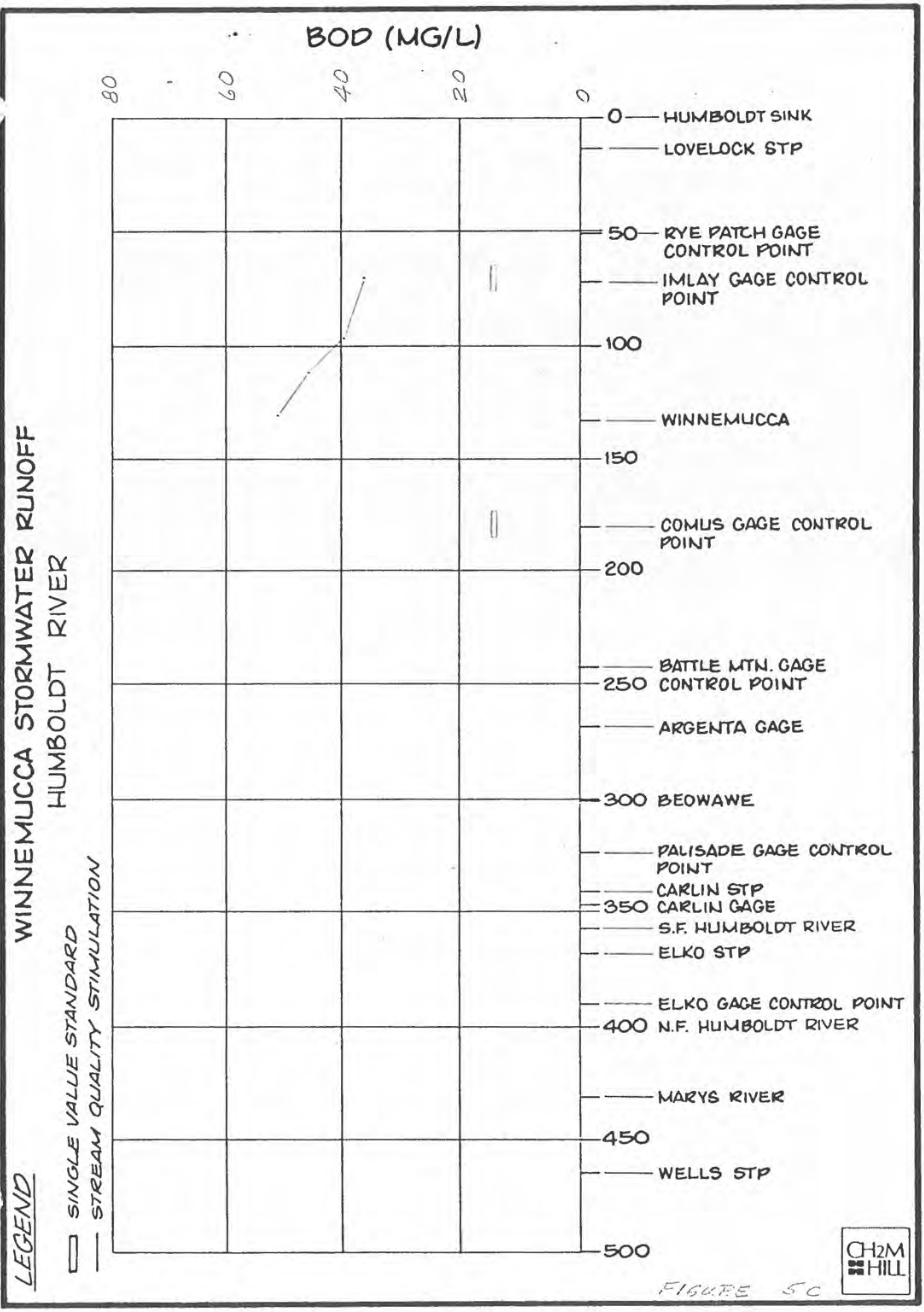
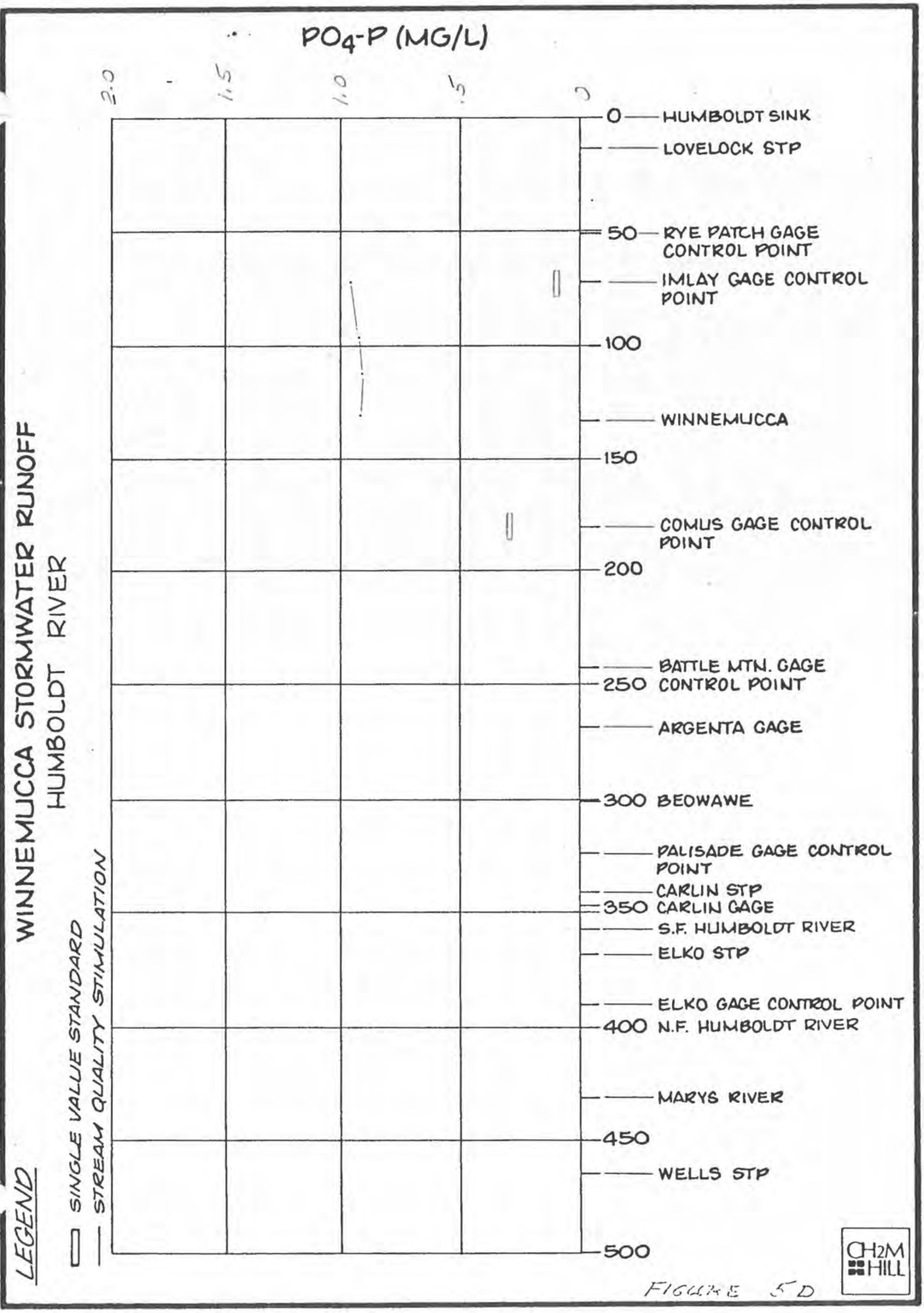

WINNEMUCCA STORMWATER RUNOFF
HUMBOLDT RIVER
BOD (MG/L)
80
60
40
20
0
0 HUMBOLDT SINK
LOVELOCK STP
50 RYE PATCH GAGE CONTROL POINT
IMLAY GAGE CONTROL POINT
100
WINNEMUCCA
150
COMUS GAGE CONTROL POINT
200
BATTLE MTN. GAGE CONTROL POINT
250
ARGENTA GAGE
300 BEOWAWE
PALISADE GAGE CONTROL POINT
CARLIN STP
350 CARLIN GAGE
S.F. HUMBOLDT RIVER
ELKO STP
ELKO GAGE CONTROL POINT
400 N.F. HUMBOLDT RIVER
MARYS RIVER
450
WELLS STP
500
LEGEND
SINGLE VALUE STANDARD
STREAM QUALITY STIMULATION
CH2M HILL

FIGURE 5C



WINNEMUCCA STORMWATER RUNOFF
HUMBOLDT RIVER
PO4-P (MG/L)
2.0
1.5
1.0
.5
0
0 HUMBOLDT SINK
LOVELOCK STP
50 RYE PATCH GAGE CONTROL POINT
IMLAY GAGE CONTROL POINT
100
WINNEMUCCA
150
COMUS GAGE CONTROL POINT
200
BATTLE MTN. GAGE CONTROL POINT
250
ARGENTA GAGE
300 BEOWAWE
PALISADE GAGE CONTROL POINT
CARLIN STP
350 CARLIN GAGE
S.F. HUMBOLDT RIVER
ELKO STP
ELKO GAGE CONTROL POINT
400 N.F. HUMBOLDT RIVER
MARYS RIVER
450
WELLS STP
500
LEGEND
SINGLE VALUE STANDARD
STREAM QUALITY STIMULATION
CH2M HILL

FIGURE 5D

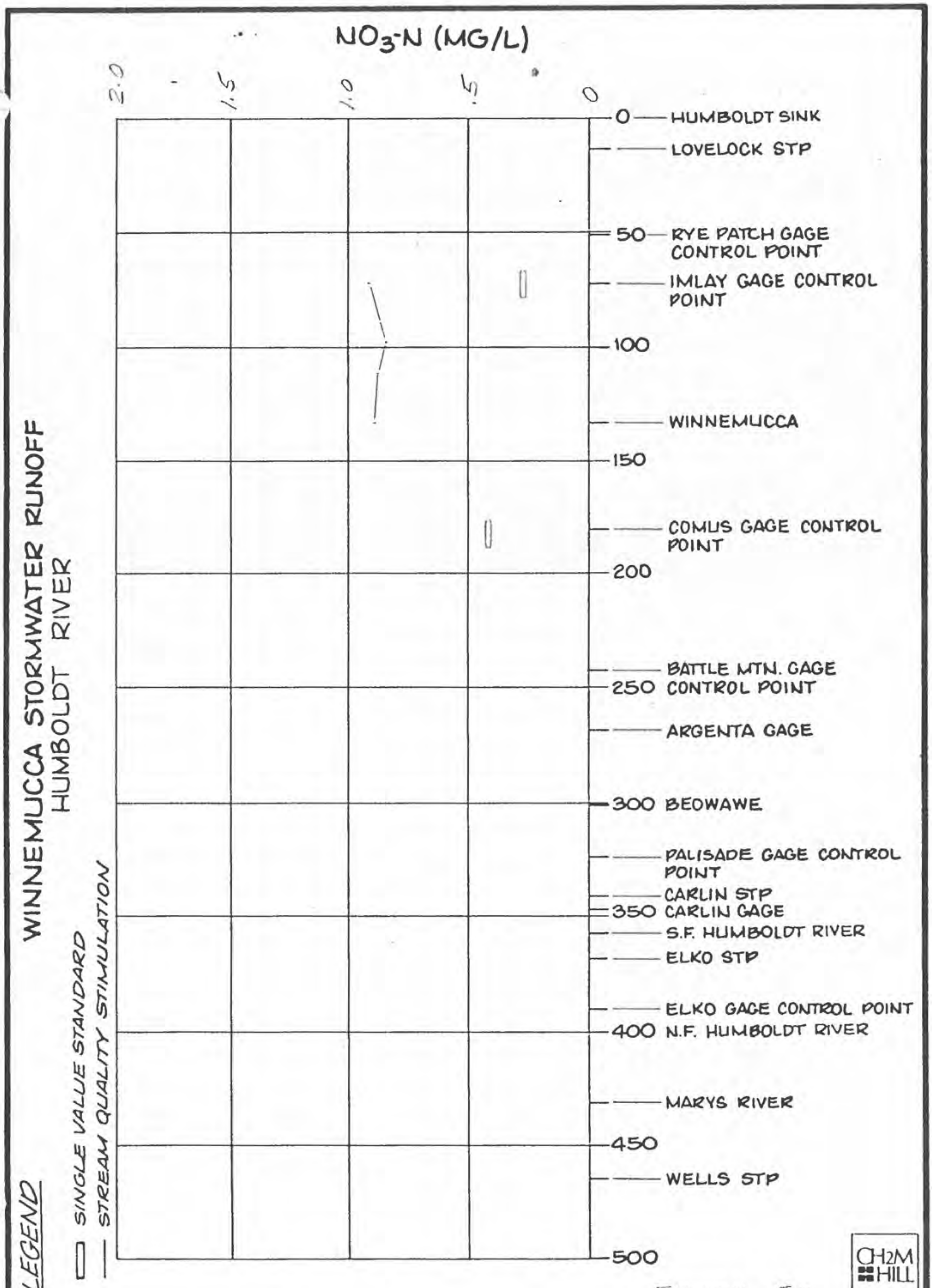
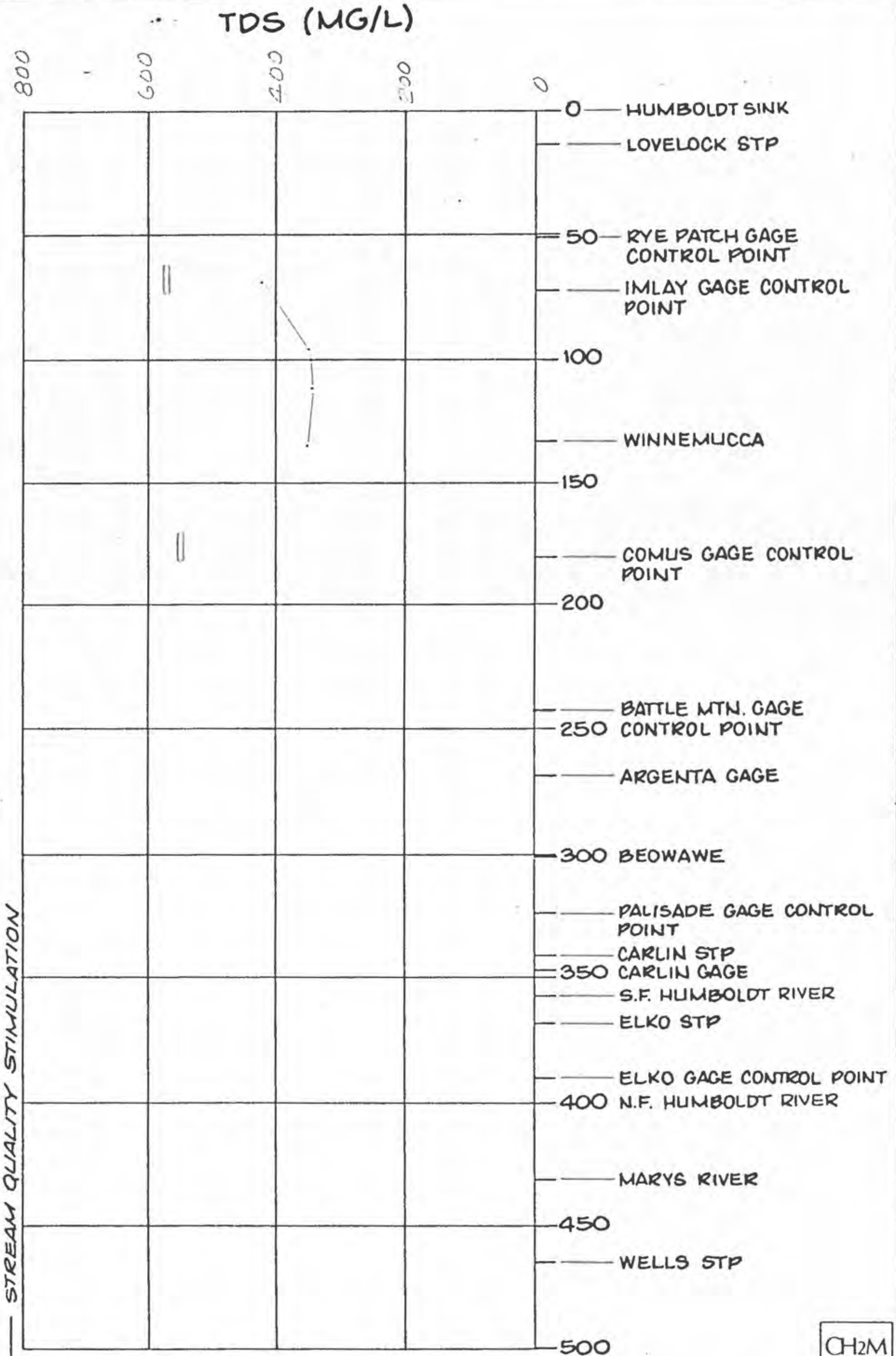

WINNEMUCCA STORMWATER RUNOFF
HUMBOLDT RIVER
NO3-N (MG/L)
2.0
1.5
1.0
.5
0
0 HUMBOLDT SINK
LOVELOCK STP
50 RYE PATCH GAGE CONTROL POINT
IMLAY GAGE CONTROL POINT
100
WINNEMUCCA
150
COMUS GAGE CONTROL POINT
200
BATTLE MTN. GAGE CONTROL POINT
250
ARGENTA GAGE
300 BEOWAWE
PALISADE GAGE CONTROL POINT
CARLIN STP
350 CARLIN GAGE
S.F. HUMBOLDT RIVER
ELKO STP
ELKO GAGE CONTROL POINT
400 N.F. HUMBOLDT RIVER
MARYS RIVER
450
WELLS STP
500
LEGEND
SINGLE VALUE STANDARD
STREAM QUALITY STIMULATION
CH2M HILL

FIGURE 5E

WINNEMUCCA STORMWATER RUNOFF
HUMBOLDT RIVER



LEGEND

▯ SINGLE VALUE STANDARD

— STREAM QUALITY STIMULATION

FIGURE 5F

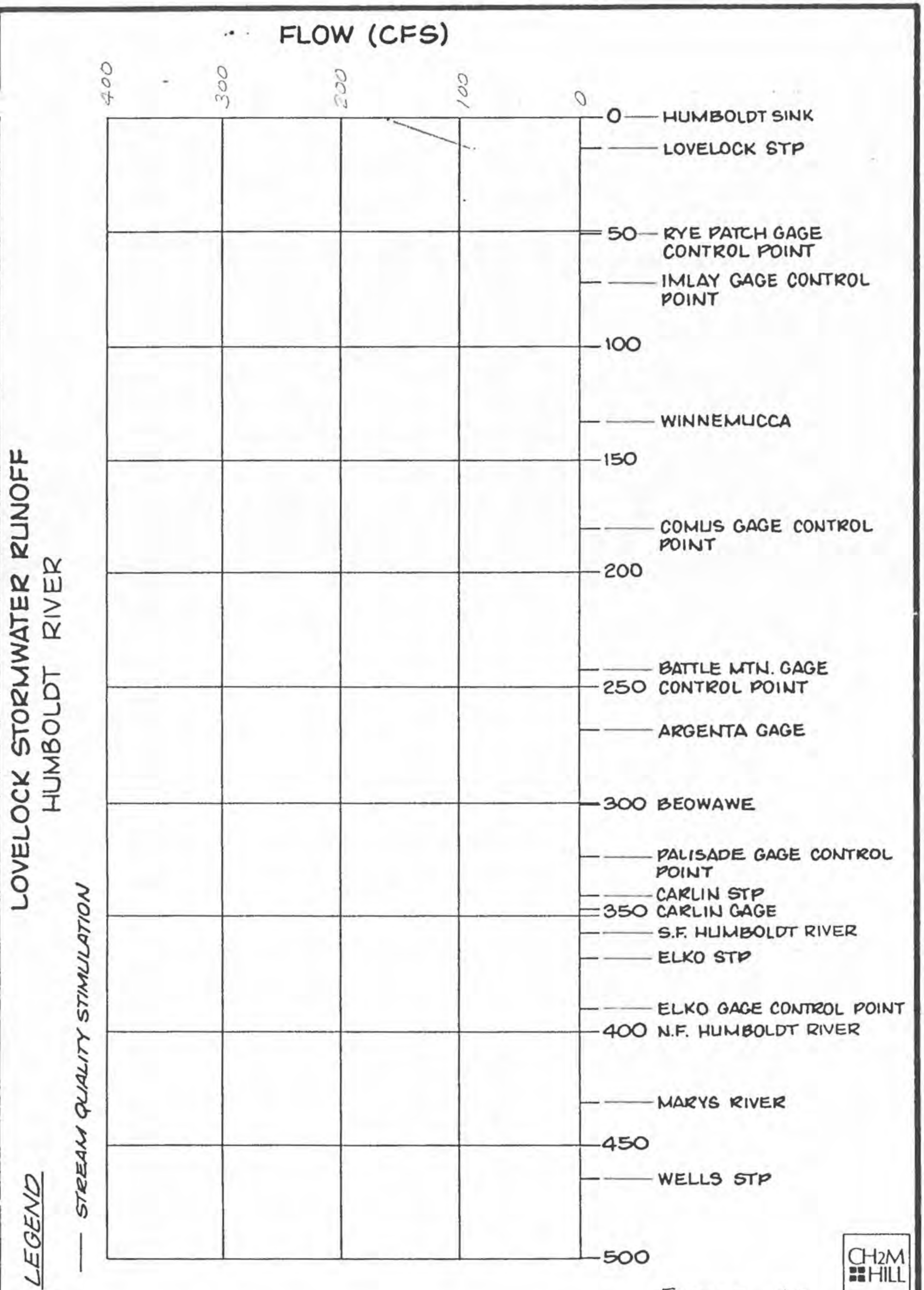
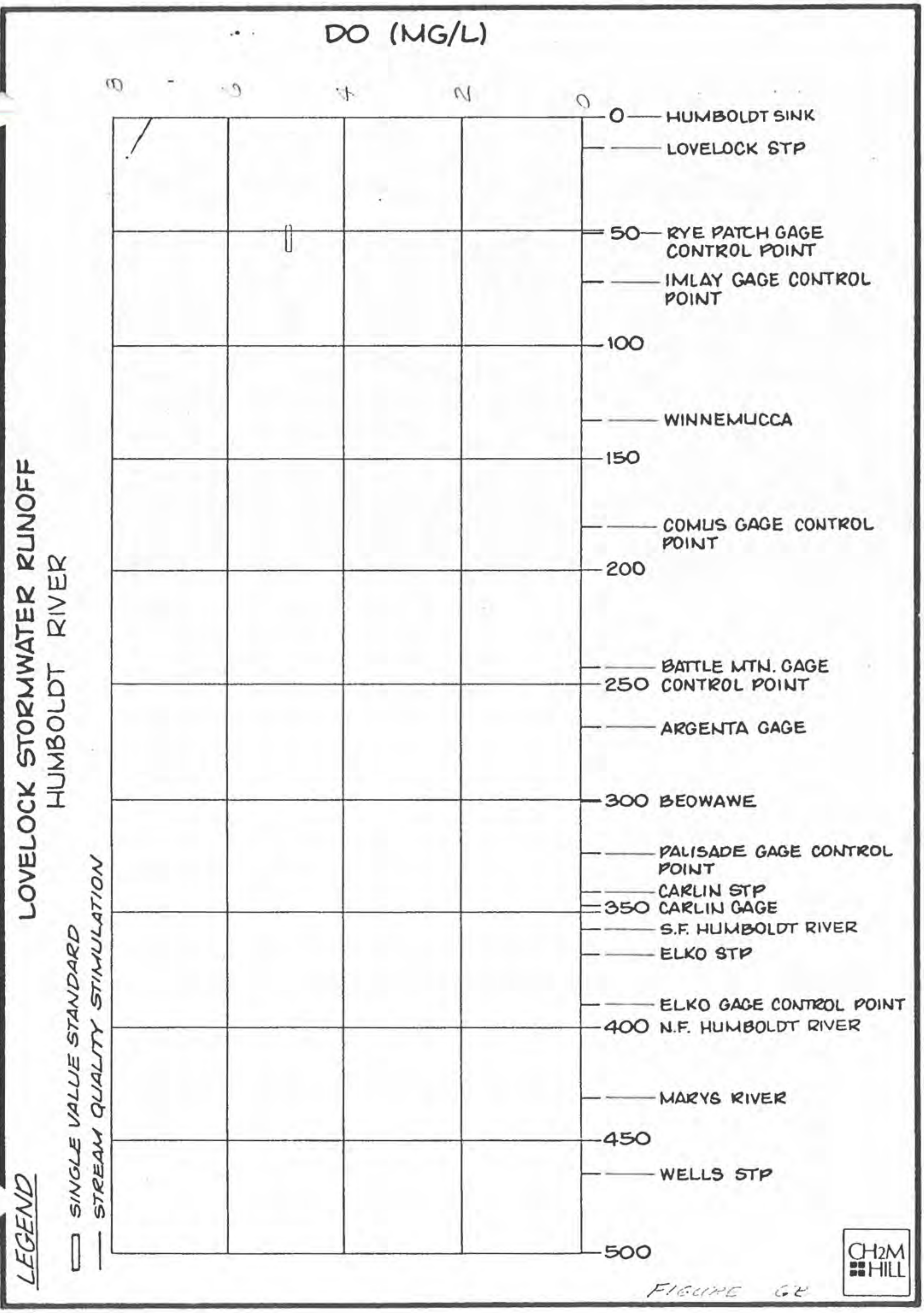
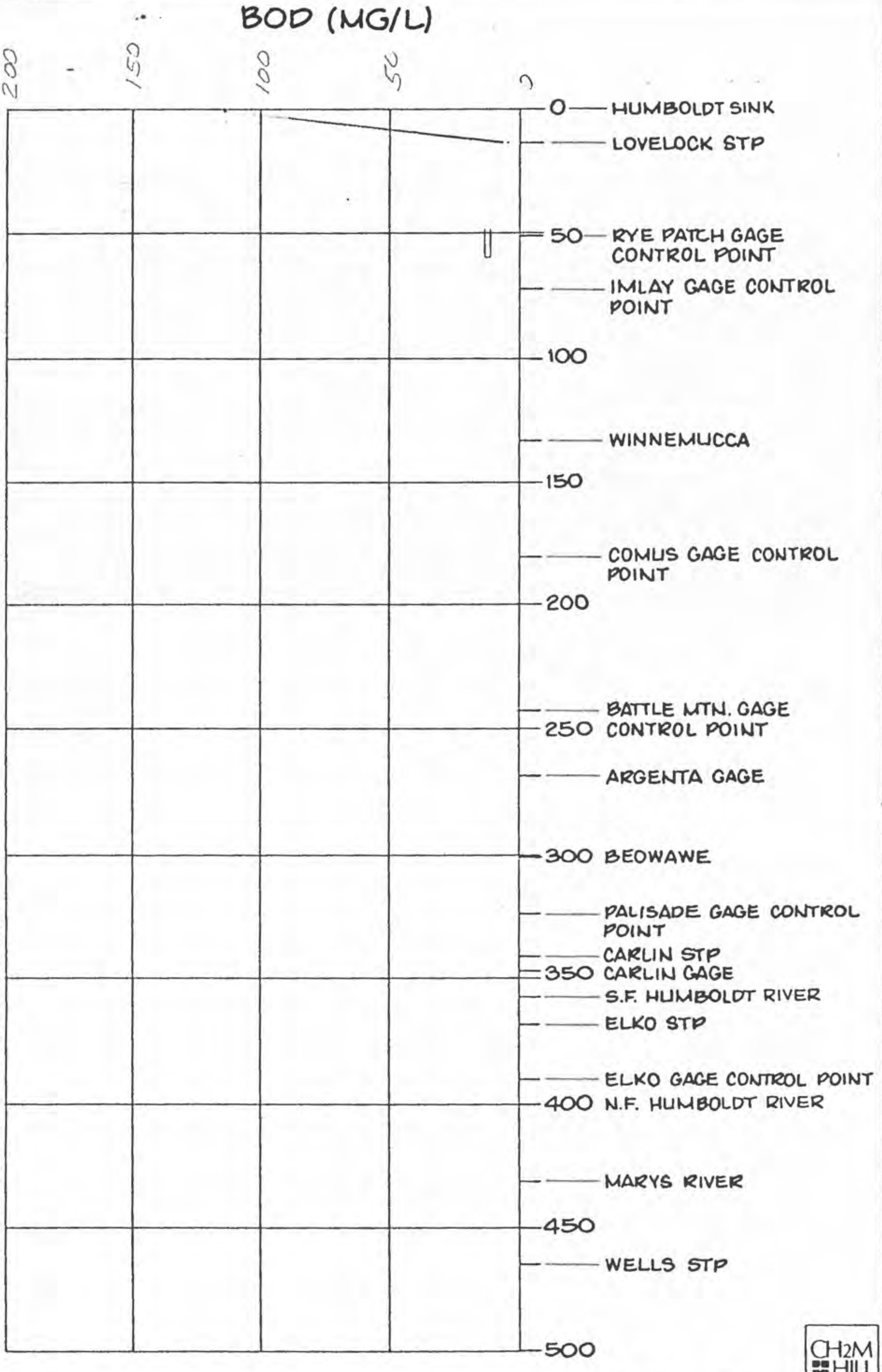

LOVELOCK STORMWATER RUNOFF
HUMBOLDT RIVER
LEGEND
— STREAM QUALITY STIMULATION
FLOW (CFS)
400
300
200
100
0
0 HUMBOLDT SINK
LOVELOCK STP
50 RYE PATCH GAGE CONTROL POINT
IMLAY GAGE CONTROL POINT
100
WINNEMUCCA
150
COMUS GAGE CONTROL POINT
200
BATTLE MTN. GAGE CONTROL POINT
250
ARGENTA GAGE
300 BEOWAWE
PALISADE GAGE CONTROL POINT
CARLIN STP
350 CARLIN GAGE
S.F. HUMBOLDT RIVER
ELKO STP
ELKO GAGE CONTROL POINT
400 N.F. HUMBOLDT RIVER
MARYS RIVER
450
WELLS STP
500
CH2M HILL

FIGURE 6A


DO (MG/L)
0
2
4
6
8
0 HUMBOLDT SINK
LOVELOCK STP
50 RYE PATCH GAGE CONTROL POINT
IMLAY GAGE CONTROL POINT
100
WINNEMUCCA
150
COMUS GAGE CONTROL POINT
200
BATTLE MTN. GAGE CONTROL POINT
250
ARGENTA GAGE
300 BEOWAWE
PALISADE GAGE CONTROL POINT
CARLIN STP
350 CARLIN GAGE
S.F. HUMBOLDT RIVER
ELKO STP
ELKO GAGE CONTROL POINT
400 N.F. HUMBOLDT RIVER
MARYS RIVER
450
WELLS STP
500
LOVELOCK STORMWATER RUNOFF
HUMBOLDT RIVER
LEGEND
SINGLE VALUE STANDARD
STREAM QUALITY STIMULATION
CH2M HILL
FIGURE 6B

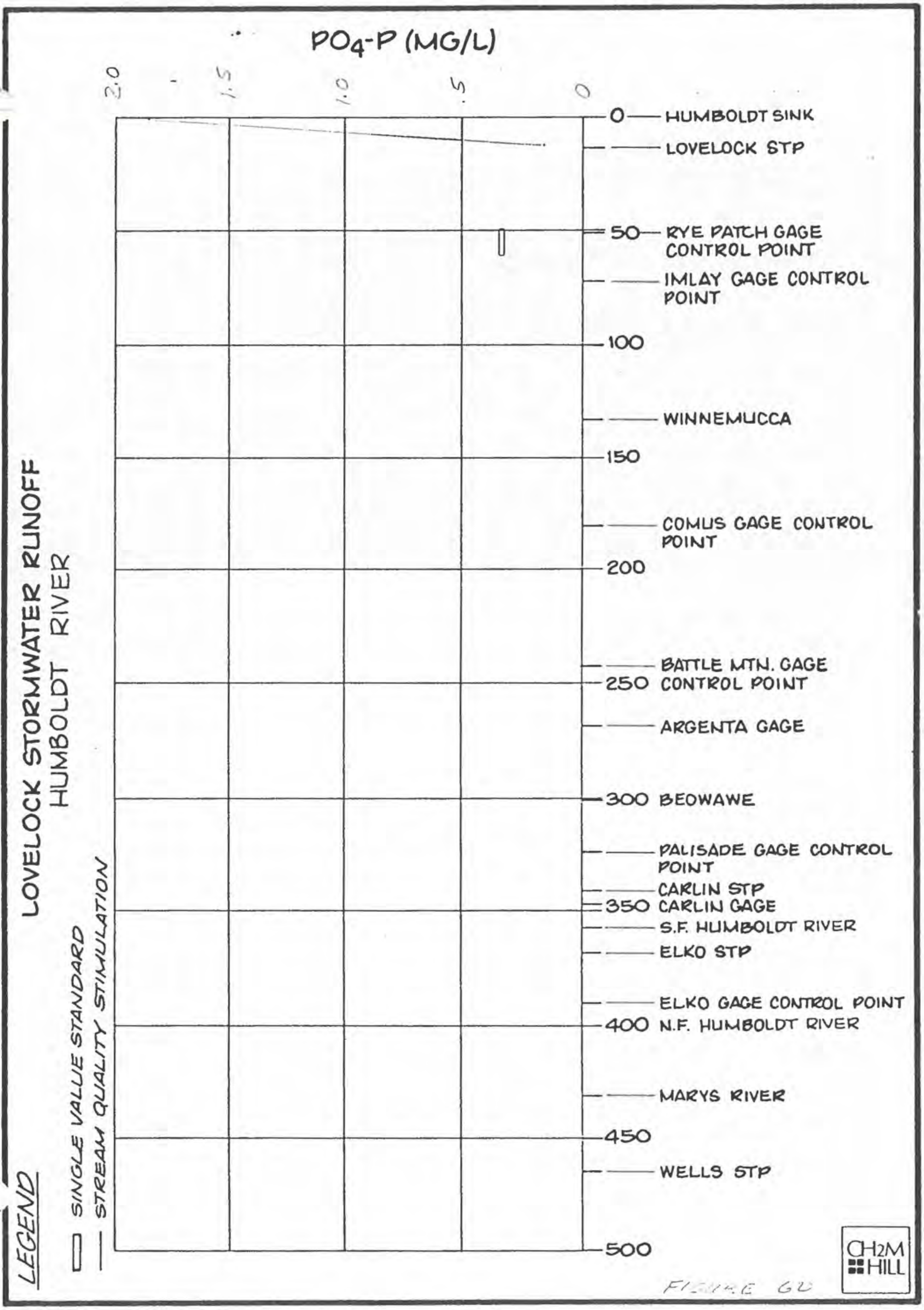
LOVELOCK STORMWATER RUNOFF
HUMBOLDT RIVER



LEGEND
▭ SINGLE VALUE STANDARD
— STREAM QUALITY STIMULATION

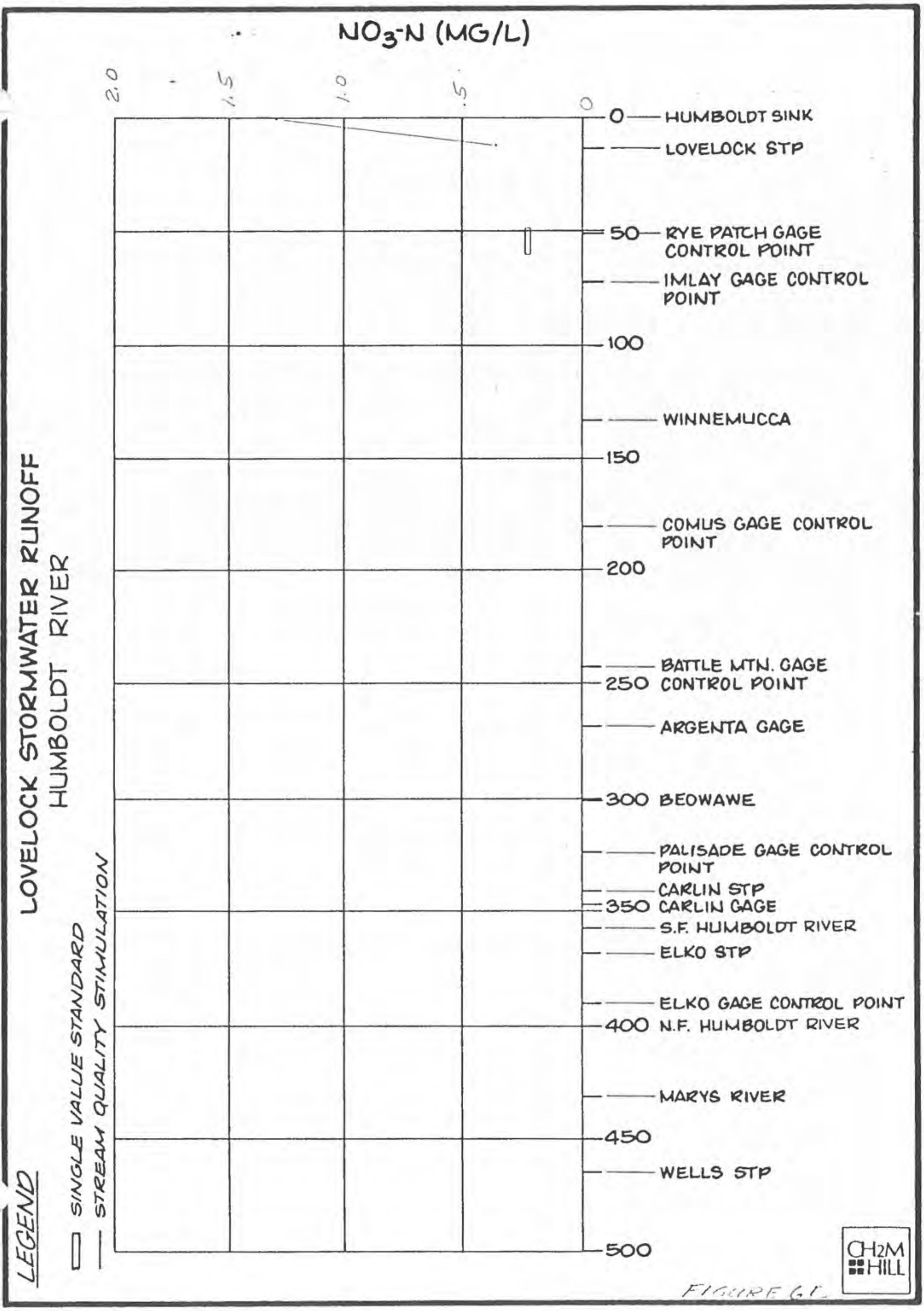
CH2M HILL

FIGURE 6C



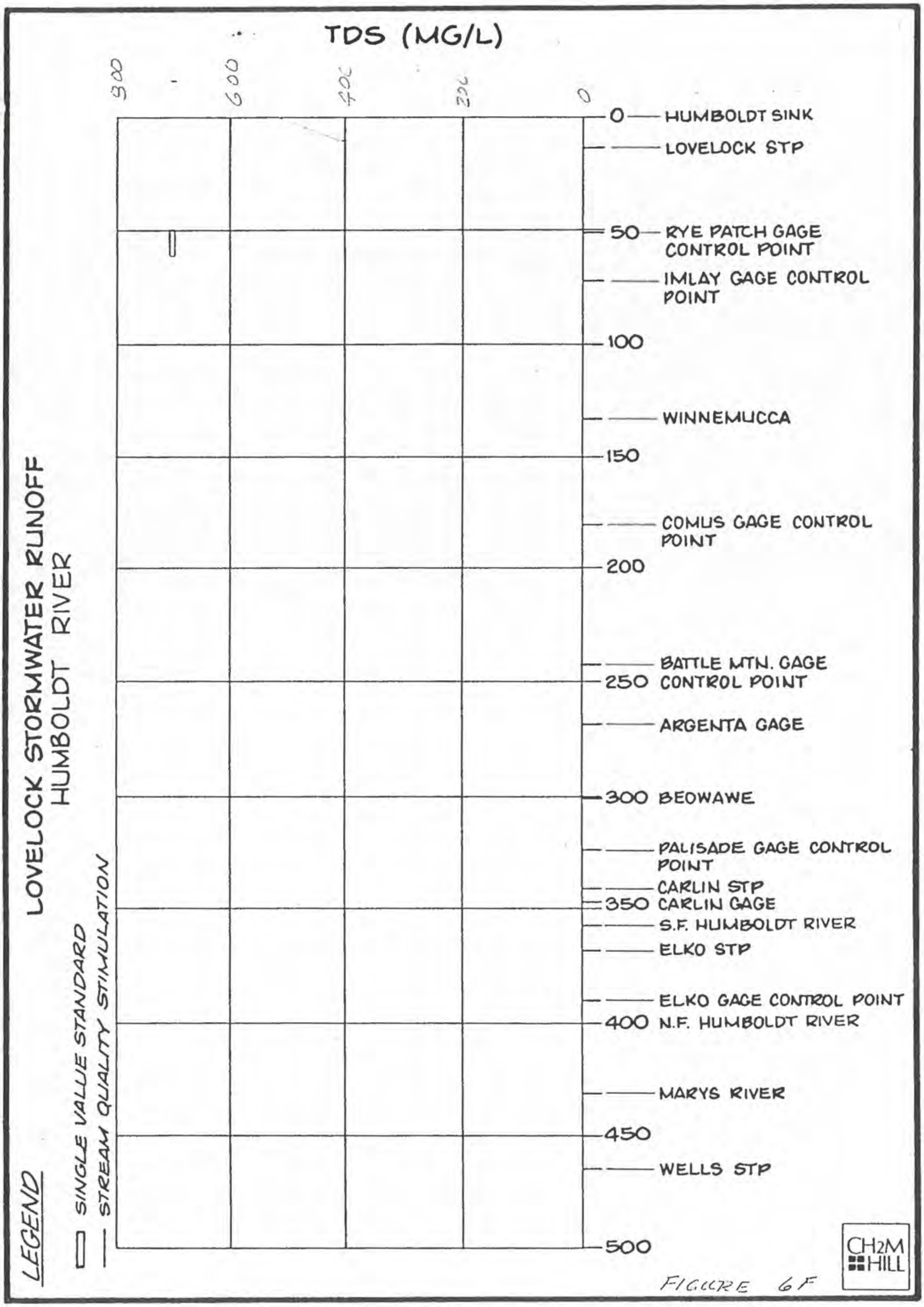
LOVELOCK STORMWATER RUNOFF
HUMBOLDT RIVER
PO_4-P (MG/L)
2.0
1.5
1.0
.5
0
0 HUMBOLDT SINK
LOVELOCK STP
50 RYE PATCH GAGE CONTROL POINT
IMLAY GAGE CONTROL POINT
100
WINNEMUCCA
150
COMUS GAGE CONTROL POINT
200
BATTLE MTN. GAGE CONTROL POINT
250
ARGENTA GAGE
300 BEOWAWE
PALISADE GAGE CONTROL POINT
CARLIN STP
350 CARLIN GAGE
S.F. HUMBOLDT RIVER
ELKO STP
ELKO GAGE CONTROL POINT
400 N.F. HUMBOLDT RIVER
MARYS RIVER
450
WELLS STP
500
LEGEND
SINGLE VALUE STANDARD
STREAM QUALITY STIMULATION
CH2M HILL

FIGURE 62



NO3-N (MG/L)
2.0
1.5
1.0
.5
0
0 — HUMBOLDT SINK
LOVELOCK STP
50 — RYE PATCH GAGE CONTROL POINT
IMLAY GAGE CONTROL POINT
100
WINNEMUCCA
150
COMUS GAGE CONTROL POINT
200
BATTLE MTN. GAGE CONTROL POINT
250
ARGENTA GAGE
300 BEOWAWE
PALISADE GAGE CONTROL POINT
CARLIN STP
350 CARLIN GAGE
S.F. HUMBOLDT RIVER
ELKO STP
ELKO GAGE CONTROL POINT
400 N.F. HUMBOLDT RIVER
MARYS RIVER
450
WELLS STP
500
LOVELOCK STORMWATER RUNOFF
HUMBOLDT RIVER
LEGEND
SINGLE VALUE STANDARD
STREAM QUALITY STIMULATION
CH2M HILL

FIGURE 6.[illegible]



TDS (MG/L)
800
600
400
200
0
0 — HUMBOLDT SINK
LOVELOCK STP
50 — RYE PATCH GAGE CONTROL POINT
IMLAY GAGE CONTROL POINT
100
WINNEMUCCA
150
COMUS GAGE CONTROL POINT
200
BATTLE MTN. GAGE CONTROL POINT
250
ARGENTA GAGE
300 BEOWAWE
PALISADE GAGE CONTROL POINT
CARLIN STP
350 CARLIN GAGE
S.F. HUMBOLDT RIVER
ELKO STP
ELKO GAGE CONTROL POINT
400 N.F. HUMBOLDT RIVER
MARYS RIVER
450
WELLS STP
500
LOVELOCK STORMWATER RUNOFF
HUMBOLDT RIVER
LEGEND
SINGLE VALUE STANDARD
STREAM QUALITY STIMULATION
CH2M HILL

FIGURE 6F

TABLES

NEVADA NON-DESIGNATED 208

TASK ORDER NO. 3:

TASK D - CONTROL MEASURES

FINAL REPORT

March 20, 1978

Prepared By

STEVENS, THOMPSON & RUNYAN, INC.

NEVADA NON-DESIGNATED 208

TASK ORDER NO. 3:

TASK D - CONTROL MEASURES

FINAL REPORT

January 16, 1978

MARCH 20, 1978

Prepared By

STEVENS, THOMPSON & RUNYAN, INC.

INTRODUCTION

Municipal wastewater treatment facilities at Caliente, Carlin, Elko, Ely, Lovelock, Owyhee, Wells, and Winnemucca, and the industrial wastewater treatment facilities at the Barth Iron Mine, Spring Creek Fish Hatchery, and the Gallagher Fish Hatchery have been studied to determine the control facilities necessary to satisfy PL-92-500. Each site was visited and the existing local situation discussed with responsible officials. NPDES waste discharge permits and monitoring data were examined for each source. All facilities other than those at Owyhee and the Barth Iron Mine should be upgraded in order to meet existing and future requirements.

Treatment alternatives for upgrading existing facilities were developed and evaluated. The cost and anticipated performance of each alternative are presented, together with costs for upgrading each facility. The costs, based on a 20-year planning period, consider future treatment requirements and the cost-effectiveness of the alternatives.

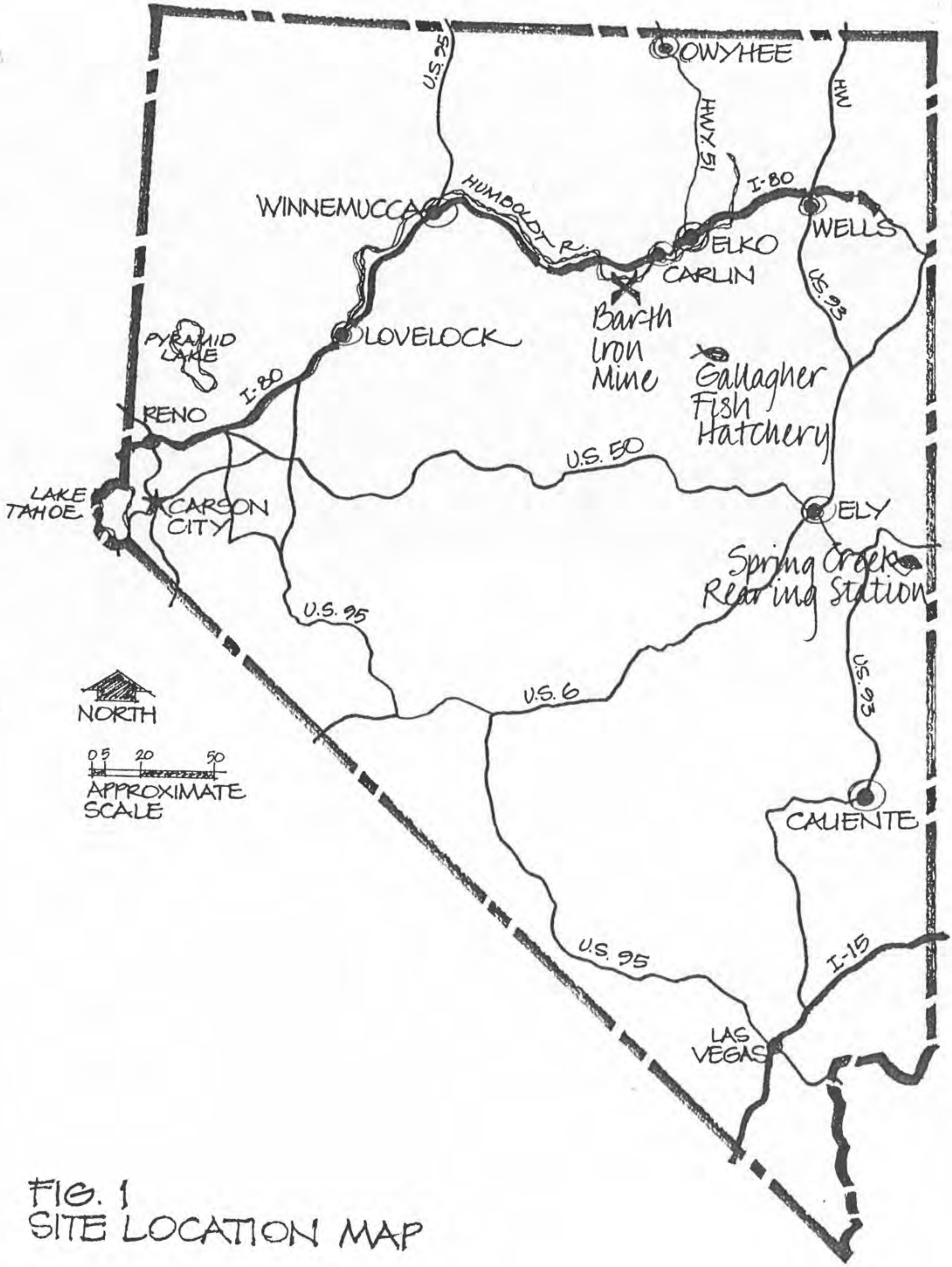


FIG. 1
SITE LOCATION MAP

CHAPTER I

EXISTING CONDITIONS

As part of the Nevada Non-Designated Area 208 Study, existing wastewater treatment conditions have been reviewed for eight municipal dischargers and three industrial dischargers:

<u>Municipal</u>

Carlin
Elko
Lovelock
Wells
Winnemucca
Owyhee
Ely
Caliente

<u>Industrial</u>

Barth Iron Mine
Gallagher Fish Hatchery
Spring Creek Rearing Station

The characteristics of the municipalities studied are similar. All of the municipalities currently provide wastewater collection for the entire community. (No attempt was made to determine the condition of the sewers or to quantify infiltration/inflow problems.) All of the communities serve relatively small populations, all have land readily available for expansion of existing treatment facilities, and most facilities are staffed on a part-time basis by personnel who are not trained specifically in the areas of wastewater treatment. In addition, the sampling procedures used rely almost exclusively on monthly grab samples and instantaneous flow measurements.

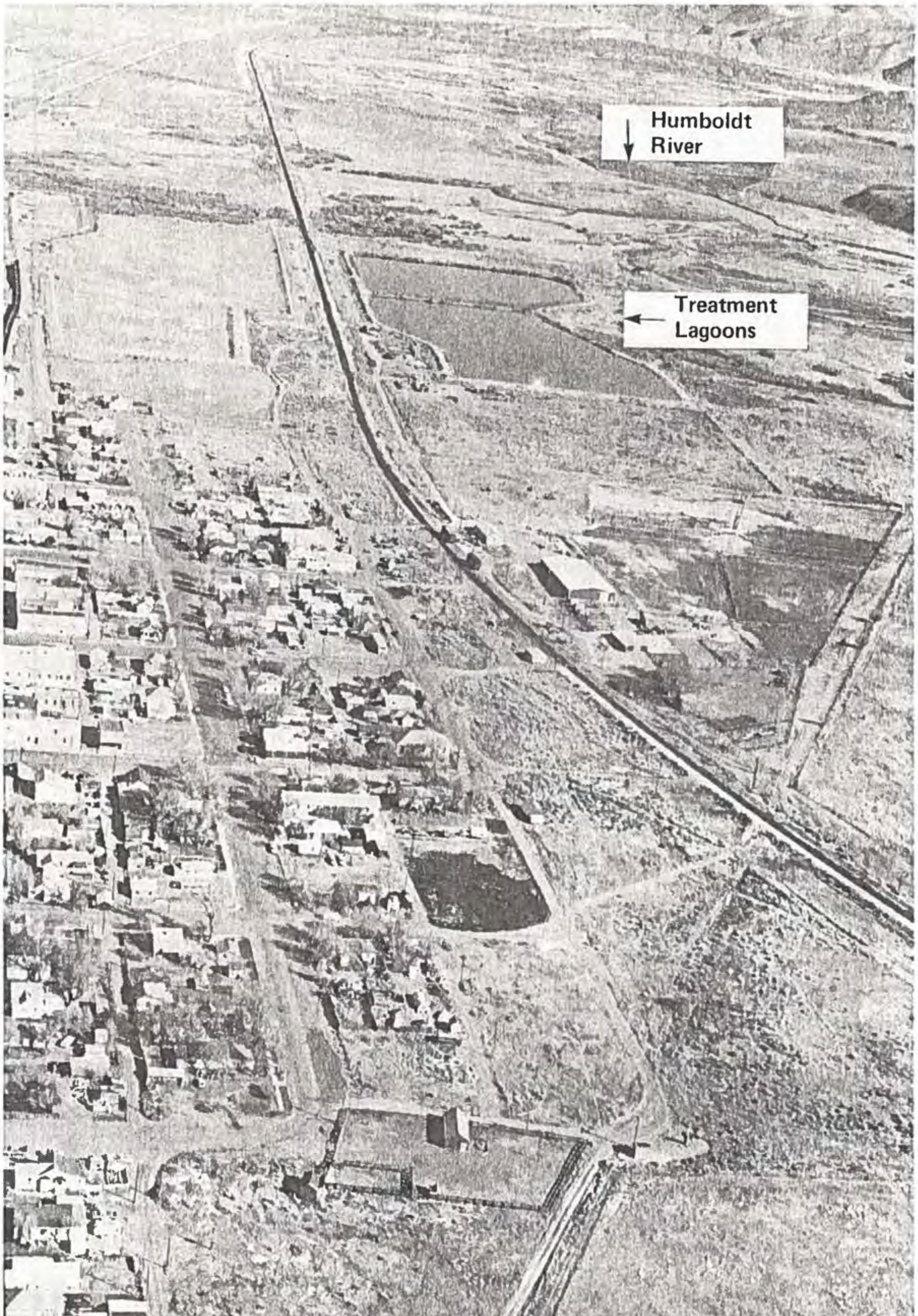
The climate of the region may be described as arid with an annual rainfall of approximately 8 inches per year and a Class A pan evaporation of approximately 64 inches per year. The maximum annual average temperature is about 68 degrees, while the annual average minimum temperature is about 35 degrees. Approximately 78 percent of the annual evaporation occurs in the period from May through October.

A discussion of the wastewater characteristics, discharge permit, and treatment system for each municipal and industrial discharge follows. Existing effluent characteristics are summarized in Table 3 at the end of this chapter.

CARLIN

Wastewater Characteristics

Data on wastewater characteristics for Carlin, Nevada have been obtained from monthly NPDES monitoring data sheets. The data indicate an average flow of 0.16 mgd, which is equivalent to 107 gpcd. The influent BOD averaged 66 ppm, which is equivalent to 88 lbs/day or 0.06 lbs/capita/day, while the effluent averaged 5 ppm. During the same period, the influent suspended solids averaged 27 ppm, which is equivalent to 36 lbs/day or 0.02 lbs/capita/day, while the effluent suspended solids averaged 4 ppm. The per capita BOD and suspended solids loading both appear to be substantially lower than would normally be expected. However, at this point in time we have no evidence to indicate that this data is invalid. Over the nine-month period from which the data was obtained, the percent BOD and suspended solids removal met permit conditions on the average. However, during the



CARLIN, NEVADA

first quarter of 1977, neither the BOD nor suspended solids removal met the effluent criteria of 85 percent removal.

Waste Discharge Permit

The City's waste discharge permit requires that after June 30, 1977, the treatment facility be in compliance with secondary treatment requirements. In addition, the permit also requires that effluent phosphates be less than 1 mgd and total dissolved solids less than 500 ppm. Mass discharge rates based on the stipulated concentrations, combined with a flow of 0.5 mgd, further limits the BOD and TSS to 125 lbs/day for a 30-day average. A fecal coliform limit of 200 organisms per 100 mls for a 30-day average is also required.

Treatment System

The existing treatment plant consists of raw sewage pumping, coarse screening, facultative lagoons, and discharge to the Humboldt River. The raw sewage pumping consists of two pumps, each rated at 350 gpm at 37 feet. The pumping capacity appears marginally adequate to handle peak flows with one pump out of service. The lagoon system consists of two lagoons in series with a side water depth of four to five feet. The lagoons have a total area of 16.6 acres. The lagoons appear to be in sound condition with riprap on all slopes and bentonite sealing of the bottom. No separate solids handling is provided and no effluent chlorination exists. The effluent flow is measured on an instantaneous basis through a rectangular weir.

ELKO

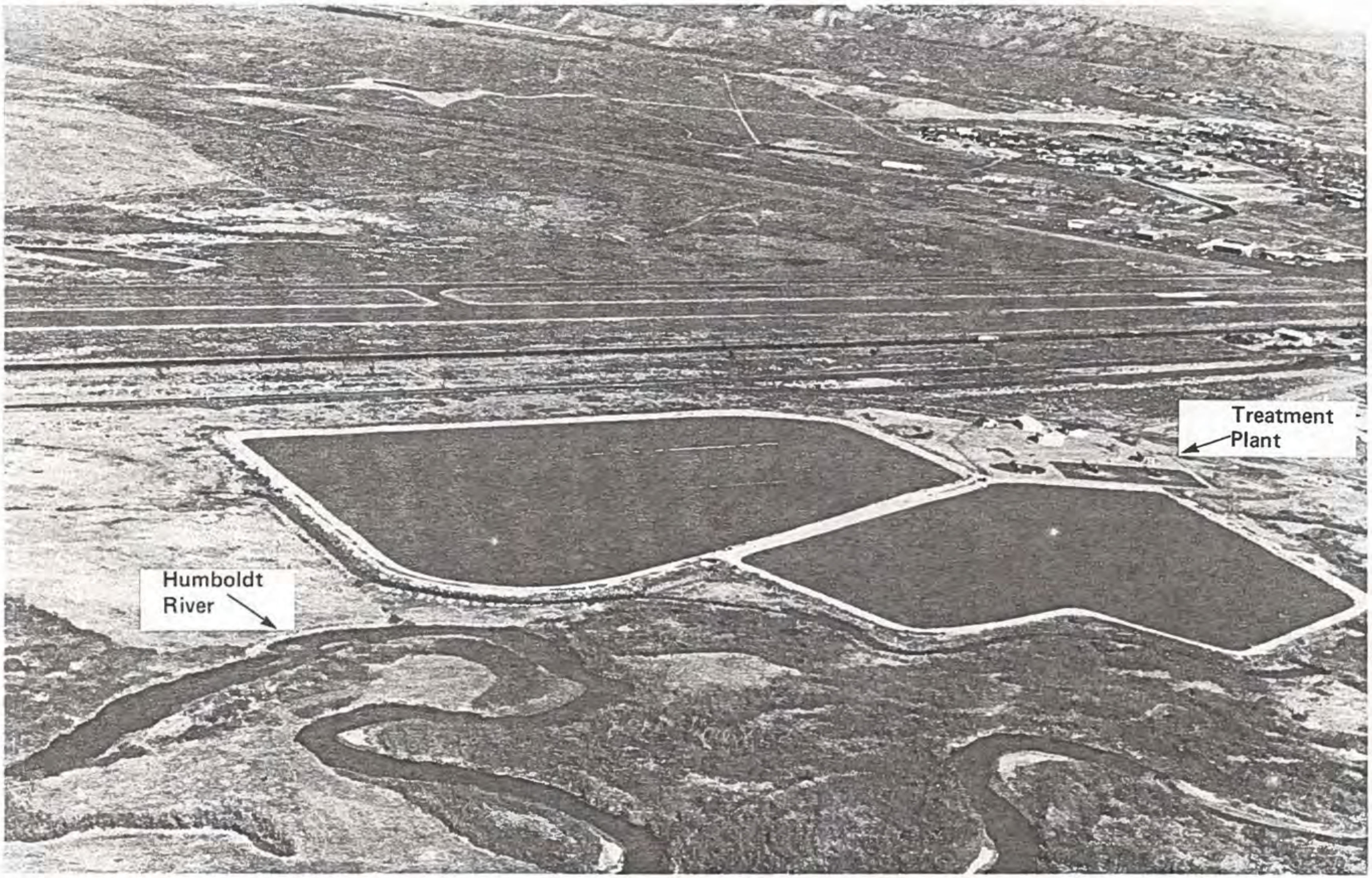
Wastewater Characteristics

Wastewater data for Elko have been obtained from EPA reports on operation and maintenance during 1974 and early 1975. The annual average flow is reported to be 1.52 mgd, while the average summer flow is 1.56 mgd, and the maximum winter flow is 2.86 mgd on an average day basis. The influent BOD and suspended solids average approximately 135 ppm, or 1,711 lbs/day, or 0.19 lbs/capita/day. The effluent BOD averaged 16 ppm in 1974, but increased to 43 ppm in 1975. The effluent suspended solids averaged 57 ppm in 1974, but was reduced to 24 ppm in 1975. The high effluent suspended solids in 1974 occurred in the months of April through September. It is thought that the high effluent solids were the direct result of algal blooms in the polishing ponds. Effluent fecal coliforms average about 736 per hundred mils.

Waste Discharge Permit

The discharge permit for the City of Elko requires that after April 1977 the plant meet secondary standards for BOD and suspended solids. The permit also limits phosphates to 1 mg/L and total dissolved solids (TDS) to 500 mg/L or less. The TDS limit may be exceedingly stringent since the TDS in the potable water supply is about 400 mg/L. A limit of 200 organisms per 100 mils for fecal coliforms is also given. The effluent discharge is further limited to an average of 550 lbs/day each for BOD and suspended solids, over a 30-day period based on a design capacity of 2.8 mgd.

The monitoring data appear to be reliable. Samples are taken weekly and are based on composite sampling methodology.



ELKO, NEVADA

Treatment System

The existing treatment plant began operation in 1971 and has an average design flow of 2.8 mgd. The system is a modified activated sludge concept followed by polishing ponds and discharge to the Humboldt River. The raw wastewater enters the plant by gravity and is lifted by two variable-speed and one constant-speed pump, each rated at 1,000 gpm. No grit removal is provided. The raw sewage then goes through a 3-inch bar screen, followed by a comminutor and Parshall flume. The raw sewage is then pumped directly into an aerated basin with a volume of 1.1 mg. Aeration is provided by two 50 hp turbines. At times there is a problem maintaining adequate DO within the basin. The plant flow then goes to a single secondary clarifier with 7-foot sidewater depth and 75-foot diameter. The overflow rate of the clarifier is 634 gpd/sq. ft. based on the design flow. Two sludge return pumps recirculate the clarifier underflow back to the aeration basin. Each pump is rated at 750 gpm. Waste sludge is pumped directly into Pond No. 1 where it is allowed to settle and digest. The clarifier effluent enters Pond No. 1 and then Pond No. 2. Both ponds were baffled to prevent short circuiting. However, it now appears that one pond is no longer baffled. The total pond volume is estimated to be 39 mg, with a surface area of 24 acres and a depth of approximately five feet.

The plant also has the capability to recirculate effluent using two 900 gpm pumps. No chlorine facilities have been provided. A stand-by generator has been purchased, but was not installed as of 1975. A good laboratory has been provided at the plant and is used by the staff.

LOVELOCK

Wastewater Characteristics

Data on effluent wastewater characteristics for Lovelock were obtained from the EPA monitoring reports for the period of January 1976 through April 1977. During this time, the flow averaged 0.23 mgd; the peak flow was 0.33 mgd averaged over the period July through October 1976. The raw BOD and suspended solids averaged approximately 165 ppm, which is equivalent to 318 lbs/day or 0.18 lbs/capita/day. This data is based on grab samples. The data shows that no substantial reduction in the raw BOD or suspended solids are affected by treatment. The Facilities Plan written by William F. Pillsbury, Inc., Consulting Civil Engineers, and published in December 1974 indicates that the existing treatment system has not been in operation since 1969.(1)

Waste Discharge Permit

The waste discharge permit requires secondary treatment be provided by July 1, 1977. The permit also requires fecal coliforms to be less than 200 organisms per 100 ml. In addition, the discharge permit limits the 30-day average mass discharge rate to 125 lbs/day each of BOD and suspended solids based on a design capacity of 0.5 mgd.

LOVELOCK, NEVADA

Treatment System

The existing facility includes a manual bar screen, pumping station, Imhoff tank, and outfall sewer which drains into the Toulon sink via the Lovelock Drain. No information regarding the design parameters is available at this time. However, the facility plan indicates that the plant would not be capable of meeting current effluent criteria under any conditions and is not now in operation. The City does have a compliance schedule which requires compliance by October 1, 1978.

WELLS

Wastewater Characteristics

Wastewater characteristics data for Wells were obtained from NPDES reporting logs for the period October 1975 through March 1976. During this time the flow averaged 0.21 mgd and was virtually constant. The influent BOD averaged 88 ppm, while the effluent averaged 29 ppm. The influent suspended solids averaged 119 ppm, while the effluent averaged 53 ppm. On a mass basis, the influent BOD was 154 lbs/day or 0.12 lbs/capita/day, while the suspended solids was equivalent to 209 lbs/day or 0.16 lbs/capita/day. The average flow is equivalent to 165 gpcd.

Waste Discharge Permit

The waste discharge permit requires that the plant comply with secondary treatment standards by July 1, 1977. In addition, the permit further limits the 30-day average for total phosphates to 1 mg/L and total dissolved solids to 500 ppm, while the fecal coliform limit is set at 200 organisms per 100 ml.

WELLS, NEVADA

Treatment System

The existing treatment system in Wells has a design capacity of 0.25 mgd and consists of a comminutor with a bypass bar screen being provided, followed by a Parshall flume and an aerated lagoon and a facultative pond. The wastewater is stored in the lagoon and disposed of by land treatment using overland flow. During periods when discharge to surface waters is required, the effluent would be discharged to the East Fork of the Humboldt River. A 201 Facilities Plan is currently underway and is being performed by Pillsbury Engineers. A visit to the site indicated that more detail for operation and maintenance of the plant would greatly improve performance. The site visit also indicated a bad algae problem. A flume is provided for flow measurement, however, the recorder does not work at this time. The State of Nevada has issued a compliance schedule which sets a date of January 1, 1980, for meeting effluent standards.

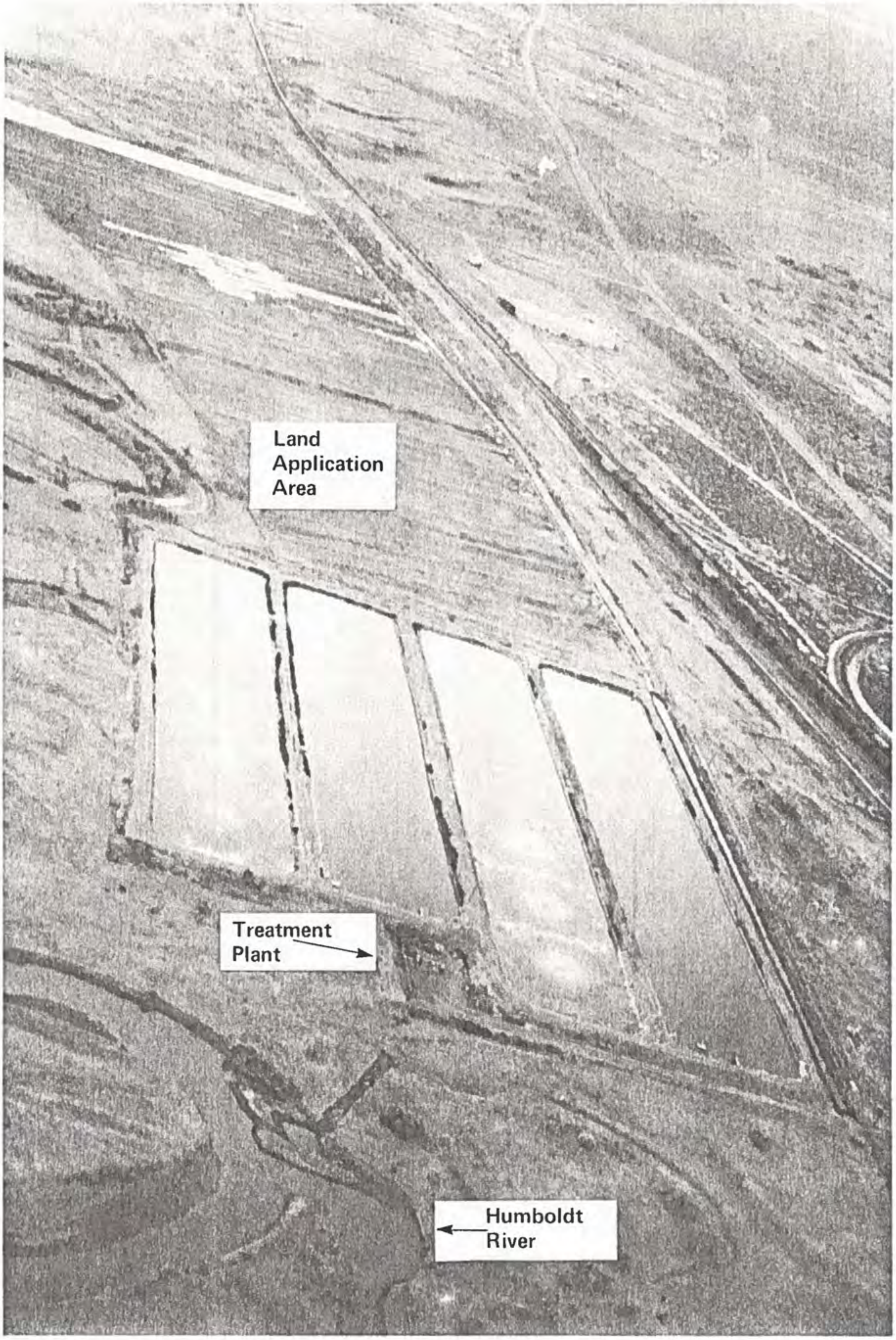
WINNEMUCCA

Wastewater Characteristics

Limited data are currently available regarding the wastewater characteristics. The average annual flow is reported to be 0.75 mgd, while the peak dry weather flow is 0.75 mgd and the wet weather peak is reported to be 2.25 mgd. The annual average BOD of raw sewage is reported to be approximately 160 ppm. No data are available for raw suspended solids.

Waste Discharge Permit

The City of Winnemucca currently does not have a NPDES waste discharge permit. This is a result of the claim of a no-discharge system. However,



WINNEMUCCA, NEVADA

this is currently being disputed due to the fact that much of the wastewater applied to the land short circuits and enters directly into the Humboldt River. The State of Nevada is considering issuing an NPDES permit.

Treatment System

The existing treatment system is comprised of a barminutor, followed by raw sewage pumping, two aerated ponds, and two facultative ponds. The ponds may be operated either in parallel or in series. Each aerated pond has two mechanical aerators.

OWYHEE

Wastewater Characteristics

Limited wastewater data are available for this source, which is under the control of the Bureau of Indian Affairs. The data indicated an average effluent flow for December 1975 through August 1976 of 0.038 mgd. The effluent flow ranges from 0.23 mgd to 0.49 mgd. During a similar period, the effluent BOD averaged 25 ppm, while the suspended solids averaged 44 ppm. The high summer suspended solids indicates the presence of algae.

Waste Discharge Permit

The waste discharge permit requires that construction plans and specifications for facilities to assure compliance with the effluent limitations be completed by April 1, 1977. These modifications have been constructed and are now in operation. The effluent limitations require secondary treatment. Mass discharge rates are given based on a design capacity of 0.2 mgd. The facility is not now discharging to surface waters.

Treatment System

The treatment system consists of an influent pumping station followed by a 20,000 square foot aerated lagoon using one surface aerator, which is then followed by five facultative lagoons having a total area of 73,000 square feet. No staff is available for operating and maintaining the treatment system on a regular basis.

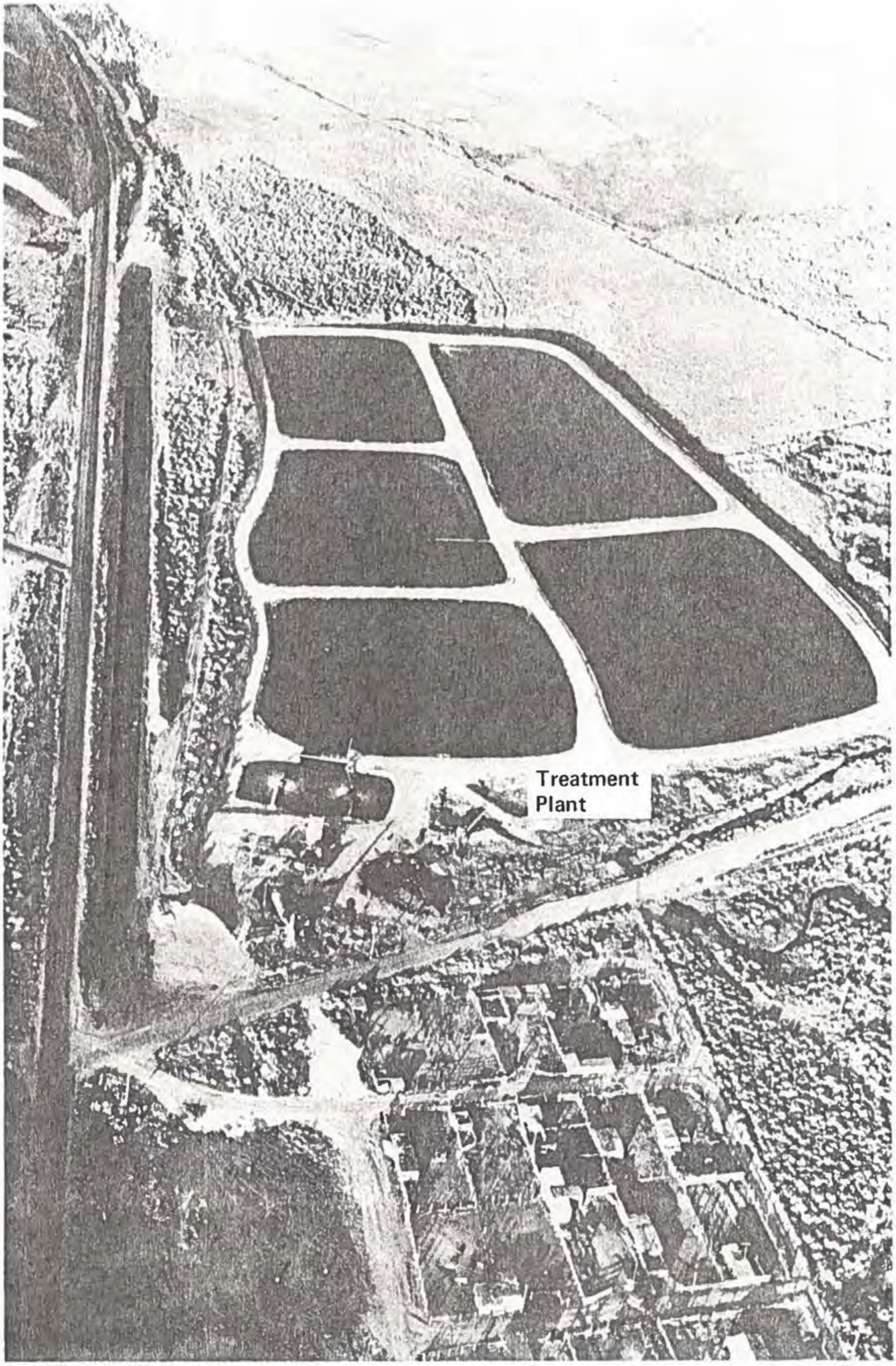
ELY

Wastewater Characteristics

Information regarding the wastewater characteristics for Ely was obtained from the October 1976 EPA Report on operation and maintenance of the Ely wastewater treatment plant. This report covers the period from November 1975 through October 28, 1976. The average flow during this period is reported to be 1.2 mgd with an equal peak dry and wet weather flow rate. The raw BOD and suspended solids for the period were reported to average 107 mg/L each, which is equivalent to 1,071 lbs/day or 0.15 lbs/capita/day. The effluent suspended solids for the period was 24 ppm, while the effluent BOD was 20 ppm.

Waste Discharge Permit

At the present time, Ely is not under an NPDES permit, but a state permit for secondary treatment will be issued in the near future.



ELY, NEVADA

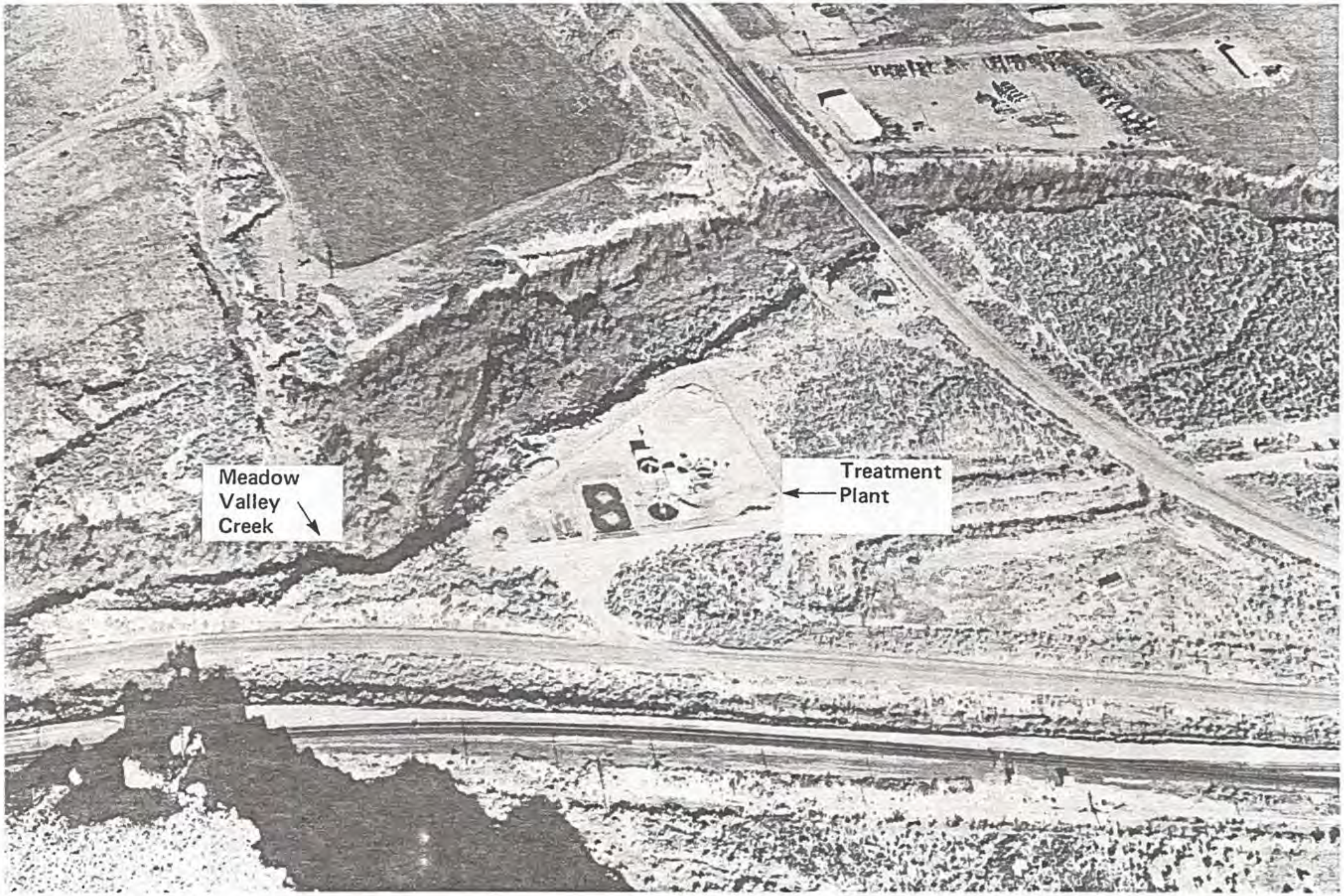
Treatment System

Wastewater enters the Ely treatment plant by gravity. The inffluent sewage goes through a comminutor and flume at the inlet structure and then flows into an aerated lagoon which has two surface aerators. The flow then goes into a secondary clarifier and then through a series of five facultative ponds. The water surface of the aerated lagoon, clarifier, and facultative ponds is at the same approximate elevation for each. The plant was designed for an average daily flow of 1.8 mgd. No scum or grease removal is provided in the clarifier and it is thought that this creates some inefficiency and difficulty in operation. The plant is staffed five days per week on a part-time basis by an operator that has not received formal training in the operation of wastewater treatment plants.

CALIENTE

Wastewater Characteristics

Data on wastewater charateristics for Caliente have been obtained from the November 1976 NPDES Monitoring Report on operation and maintenance of the wastewater treatment plant; data cover the period July 1976 through September 1976. The average daily flow during this period was 0.25 mgd. The influent BOD averaged 77 ppm, while the effluent averaged 22 ppm. The influent suspended solids averaged 58 ppm, while the effluent averaged 35 ppm. The BOD loading was 160 lbs/day or 0.16 lbs/capita/day, while the raw suspended solids was 121 lbs/day or 0.12 lbs/capita/day during the recording period.



CALIENTE, NEVADA

Waste Discharge Permit

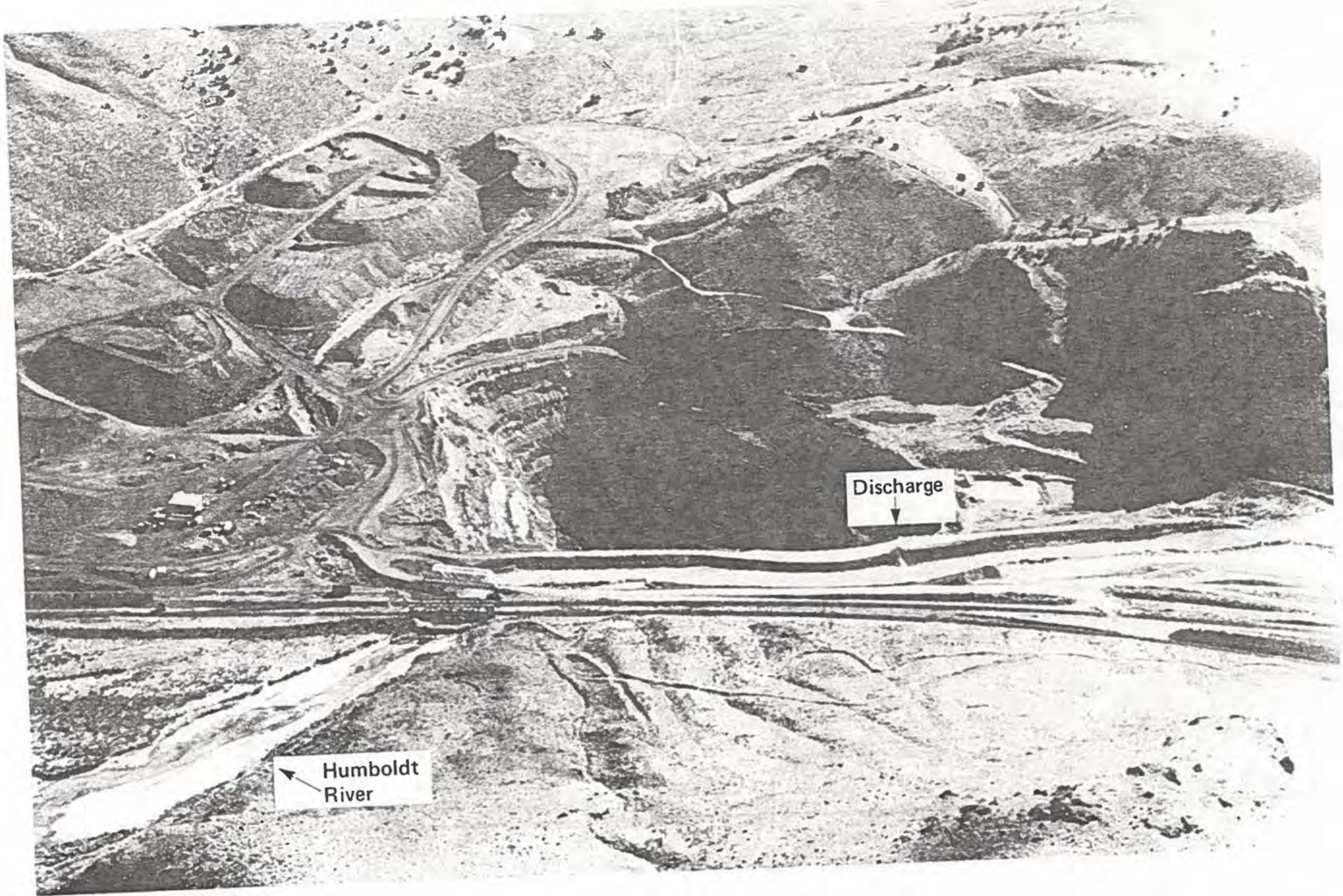
The waste discharge permit was issued February 25, 1974, by EPA, and requires that secondary treatment standards be met. A fecal coliform level to be less than or equal to 200 organisms per 100 ml on a 30-day average is also required. The permit further limits the discharge of BOD and suspended solids on a mass dishcarge basis of 100 lbs/day based on a design flow rate of 0.4 mgd over a 30-day period.

Treatment System

The existing plant began operation in January 1974. The plant is an extended aeration system having an average design flow of 0.4 mgd. The plant includes grit removal, comminution or screening, flow measurement by a 6-inch Parshall flume, raw sewage pumping, aeration; followed by clarification, chlorination, and final screening of effluent. Sludge is recycled to the influent pump station from the secondary clarifier. Waste sludge is removed from the second clarifier and the chlorine contact chamber and is pumped to a digester and then to a sludge drying bed.

NEVADA BARTH IRON MINE

The Barth Iron Mine is an open pit operation. At this time it is anticipated that production from this mine will cease about 1982. The wastewater from this mine consists of groundwater seepage and overland flow which collects in the central sedimentation pit.



BARTH IRON MINE
EUREKA COUNTY, NEVADA

Wastewater Characteristics

Data were obtained from the NPDES discharge monitoring report which covered the year 1977, January to April. During this period the average discharge flow was 0.64 mgd, while the average suspended solids was 5 ppm and the total dissolved solids was 395 ppm and the pH was 8.0. The solids concentrations are based on 8-hour composite samples. Concentrations of cadmium, chromium, lead, manganese, and mercury are all well within the acceptable limits.

Waste Discharge Permit

The waste discharge permit stipulates that suspended solids shall be less than 20 mg/L on a daily average or 30 mg/L on a daily maximum basis. The permit further limits total dissolved solids to a daily maximum of 500 ppm and the daily flow to 0.87 mgd. Limits are also established for cadmium, chromium, lead, manganese, and mercury. All of the latter limits are well above the current discharge levels.

Treatment System

The treatment system consists of a sedimentation pit and two variable-speed pumps, each rated at 400 gpm. The pumps operate 24 hours per day. The detention time in the sedimentation pit is approximately one hour.

GALLAGHER FISH HATCHERY

The primary function of this hatchery is the hatching, nursing, and rearing of native fish. The facility includes 60 175-gallon hatching troughs which are used on an intermittent basis. When in operation, these troughs

GALLAGHER FISH HATCHERY
RUBY VALLEY, ELKO COMPANY, NEVADA

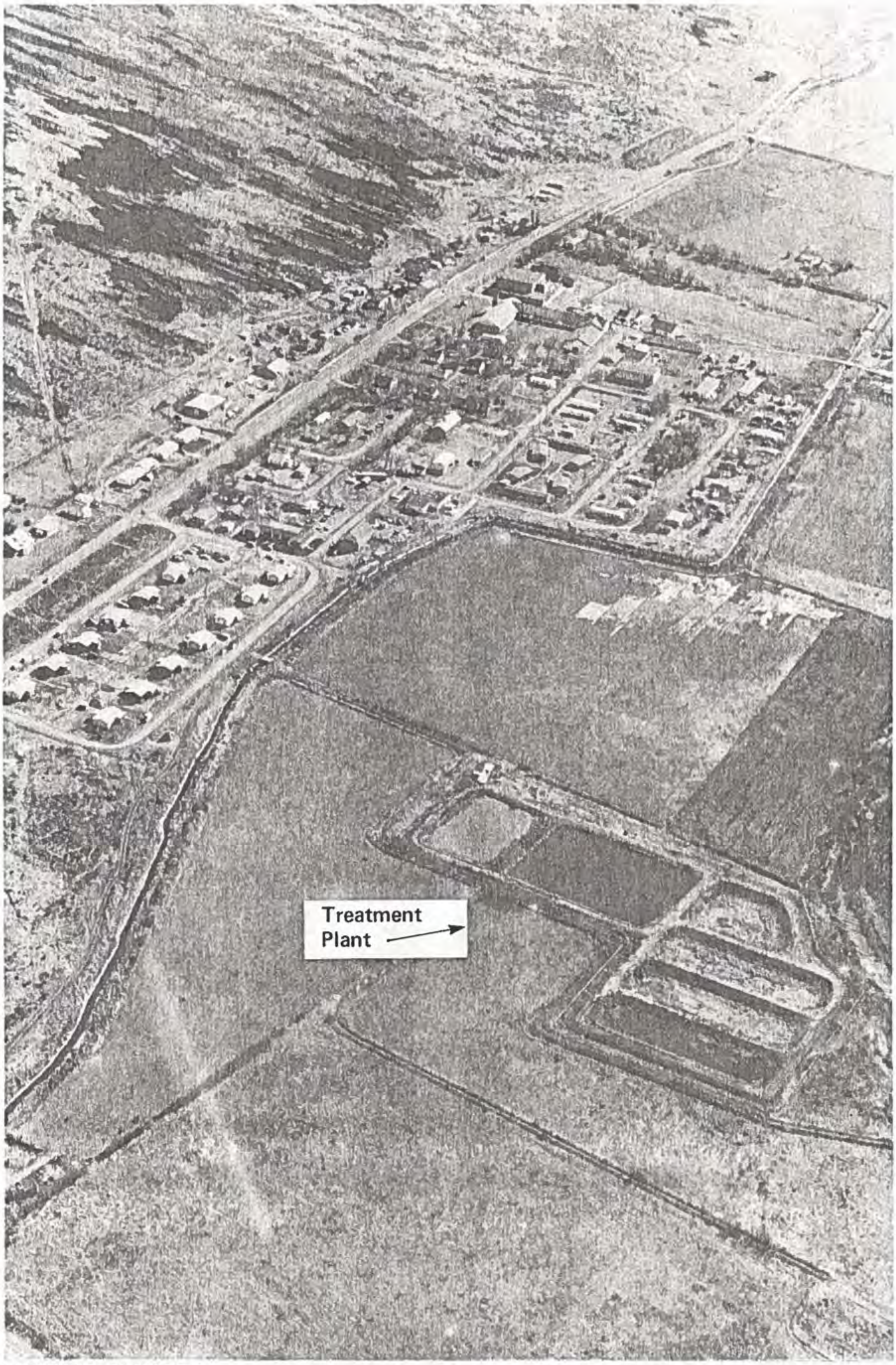
are cleaned daily and have a net discharge of 200 gallons per trough. The discharge duration is 10 minutes per trough. Twenty-four 2,500-gallon nursery ponds are used almost continuously. These ponds are cleaned twice monthly and have a total net discharge, per pond, of 6,000 gallons during cleaning. The duration of this discharge is 20 minutes per pond. The rearing ponds include 26 medium-size ponds of 12,000 gallons each. At pond cleaning, which occurs once per month, the net discharge per pond is 18,000 gallons. The duration of the discharge is 30 minutes per pond. In addition, 20 large rearing ponds of 19,000 gallons each are also in use. At cleaning, the large ponds discharge 25,000 gallons net. These ponds are cleaned once per month and have an average duration of discharge of 30 minutes per pond.

The operation relys on water from three springs totaling approximately 12 cfs for flow-through water. This flow-through represents a continuous 24-hour per day discharge. The facility has the capability to recycle a portion of the flow-through, but is not currently doing so.

The pond cleaning discharge is routed into one discharge system, while the effluent resulting from trough cleaning is routed into another discharge. Cleaning operations occur more frequently in warm weather and also when heavy fish loads and/or heavy feeding occur.

Wastewater Characteristics and Waste Discharge Permit Conditions

The hatchery has two discharge points. Discharge No. 1 is the flow-through discharge, while Discharge No. 2 is used only for pond cleaning. Each discharge point has different wastewater characteristics and permit conditions as summarized in Table 1.



OWYHEE, NEVADA

Table 1
SUMMARY OF PERMIT AND ACTUAL DISCHARGE CONDITIONS FOR GALLAGHER FISH HATCHERY (RUBY MARSH)

	(Permit) Actual Conditions			
	Average Day		Maximum Day	
	ppm	lb/D	ppm	lb/D
A. Flow-Through Discharge			(7.8 mgd)3.2 mgd	
1. Suspended Solids	(10)3.3	(650)89	(15)6	(976)160
2. Total Phosphates	(0.2)0.35	(13)8	(0.3)0.4	(20)10.6
3. Total Dissolved Solids	(340)	(22,000)	(500)	(32,400)
4. Un-ionized Ammonia	(0.02)	(1.3)	(0.03)	(2.0)
5. Settleable Solids	(0.1 ml/L)	-	(0.2 ml/L)	-
B. Pond Cleaning			(0.91 mgd)0.4 mgd	
1. Suspended Solids	(10)117	(76)390	(15)227	(114)757
2. Total Phosphates	(0.2)2.0	(1.5)6.8	(0.3)4.5	(2.3)15
3. Total Dissolved Solids	(340)	(2,580)	(500)	(3,795)
4. Un-ionized Ammonia	(0.02)	(0.15)	(0.03)	(0.23)
5. Settleable Solids	(0.1 ml/L)	-	(0.2 ml/L)	-

Wastewater Treatment

Wastewater from the Hatchery currently receives no treatment and is discharged directly into Ruby Marsh. The facility has a compliance schedule for upgrading treatment by December 31, 1978. The water quality in the Marsh now appears to be relatively good, according to data obtained by the Nevada Department of Environmental Protection.

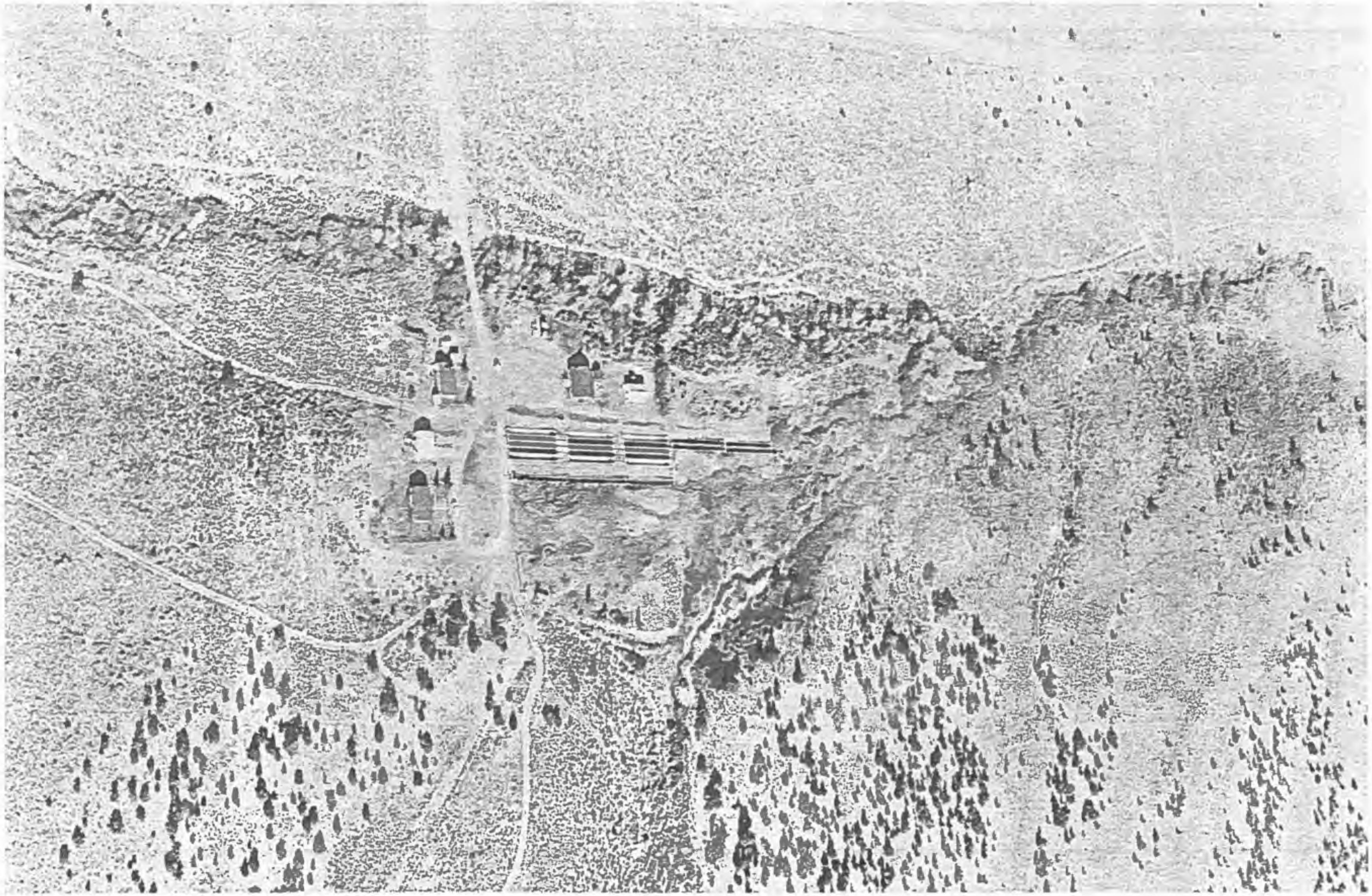
SPRING CREEK REARING STATION

The Spring Creek Rearing Station obtains its water directly from Spring Creek and Snake Creek. The volume of combined average water usage is approximately 2 cfs. The hatchery contains 19 concrete ponds, each of which has a net volume of 9,600 gallons. The rearing station has no hatchery troughs. The total net discharge per pond during cleaning is approximately 12,000 gallons. Each pond is cleaned twice per month and the duration of the discharge is 30 minutes per pond. The flow-through water is discharged from one point, while there are four discharge points used during pond cleaning. All flow is discharged directly into Snake Creek.

The Nevada Department of Fish and Game indicates that the raw water has a very high phosphate concentration. The waste discharge permit does not now appear to recognize this fact as no appropriate consideration is indicated as evidenced by very restrictive standards.

Wastewater Characteristics and Waste Discharge Permit Conditions

The wastewater discharge permit for the Spring Creek rearing station requires that the limitations outlined below be achieved by July 1, 1977. At this point, the required treatment is not being provided. The discharge data are as recorded for the year 1975. The permit and actual conditions are summarized in Table 2.



SPRING CREEK REARING STATION
SNAKE VALLEY, WHITE PINE COMPANY, NEVADA

Table 2
SUMMARY OF PERMIT AND ACTUAL DISCHARGE CONDITIONS FOR SPRING CREEK REARING STATION

	(Permit) Actual Conditions			
	Average Day		Maximum Day	
	ppm	lb/D	ppm	lb/D
A. Flow-Through Discharge			(2.3 mgd)1.3 mgd	
1. Total Phosphates(PO_4)	(0.03)0.34	(0.6)3.7	(0.04)1.76	(0.8)19
2. BOD	(4)4.3	(77)46	(5)21	(96)228
3. Total Dissolved Solids	(100)	(1,918)	(125)	(2,398)
4. Suspended Solids	(10)23	(192)249	(15)168	(288)1,821
5. Un-ionized Ammonia	(0.02)	(0.4)	(0.03)	(0.6)
6. Settleable Solids	(0.1 ml/L)	0.4 ml/L	(0.2 ml/L)	3 ml/L
7. Nitrate (NO_3)	(0.7)1.8	(13)20	(1)2.3	(19)25
B. Pond Cleaning			(0.5 mgd)0.5 mgd	
1. Total Phosphates	(0.03)8.0	(0.13)33	(0.04)15.6	(0.17)65
2. BOD	(4)100	(17)417	(5)144	(21)600
3. Total Dissolved Solids	(100)	(417)	(125)	(521)
4. Suspended Solids	(10)595	(42)2,481	(15)950	(63)3,962
5. Un-ionized Ammonia	(0.02)	(0.08)	(0.03)	(0.13)
6. Settleable Solids	(0.1 ml/L)	7.9 ml/L	(0.2 ml/L)	11 ml/L
7. Nitrate	(0.7)1.5	(2.9)6.3	(1)1.9	(4.2)7.9

Treatment System

Wastewater from the Spring Creek Rearing Station currently receives no treatment prior to discharge into Snake Creek. The State of Nevada has issued a compliance schedule which requires that effluent standards be met by December 31, 1978.

SUMMARY OF EXISTING CONDITIONS

Existing effluent characteristics of the eight municipal sources and three industrial sources in the study area are summarized in Table 3. It can be seen that the municipal facilities are not meeting secondary treatment criteria for BOD and TSS of 30 ppm and a minimum of 85 percent removal for each based on a 30-day average, or 45 ppm based on a 7-day average. This is the minimum standard which currently applies to all municipal facilities. Of the three industrial sources, only the Barth Iron Mine is currently in compliance with the waste discharge permit. Therefore, it is concluded that all of the remaining industrial and municipal facilities must be upgraded to comply with the required discharge conditions.

Copies of the monitoring and permit information supplied by the Nevada Division of Environmental Protection are included in Appendix B.

Table 3

SUMMARY OF EFFLUENT CHARACTERISTICS

	Effluent Characteristics (Average Day)			
	BOD (ppm)	TSS (ppm)	Fecal Coliform #/100 ml	Flow (mgd)
Municipalities				
Carlin[c]	5	4[a]	-[e]	0.16
Elko[c]	43[b]	24[b]	736	1.52
Lovelock	165	165	-[e]	0.23
Wells[c]	29[a]	53[a]	-[e]	0.21
Winnemucca	-[e]	-[e]	-[e]	0.75
Owyhee	25	44	>5,000	0.04
Ely	20	24	-[e]	1.20
Caliente	22	35	-[e]	0.25
Industries				
Barth Iron	-[e]	5	-[e]	0.64
Spring Creek	31[d]	182[d]	-[e]	1.8[d]
Gallagher	-[e]	16[d]	-[e]	3.6[d]

a Reduction in concentration less than 85 percent.

b 1975 data; 1974 data indicates BOD of 16 ppm and TSS of 57.

c Permit also limits total phosphates to 1 ppm as PO_4 and total dissolved solids to 500 ppm.

d Based on combined flow-through and pond cleaning discharge.

e No data available

CHAPTER II

TREATMENT ALTERNATIVES FOR UPGRADING FACILITIES

With the many options available for upgrading wastewater treatment facilities, a method for screening the alternatives is desirable. In this study the treatment alternatives to be evaluated (individual unit treatment, wastewater stabilization, ponds, compact conventional systems,, and upgrading existing lagoons) are screened primarily using two criteria:

1. The ability to meet the required effluent limitations.

2. The total cost including operation, maintenance, and capital.

Capital costs have been obtained almost exclusively from published reports. In some cases, experience has been used to modify these costs. The costs are based largely on national studies and represent a generalized approach to specific systems. The costs are useful in making relative judgements such as judging the cost effectiveness of specific treatment concepts; however, the absolute magnitude of these estimates may be found to be considerably different from those developed during 201 Facility Planning or estimates prepared as part of detailed designs. Theoretically, the costs presented in 208 studies should be accurate within ± 30-50 percent. Experience has shown that national cost curves which represent the best available data for planning purposes, may be more than 100 percent different from actual bid costs.

Capital costs have been updated to an Engineering News Record cost index of 2,800. Labor costs are based on a labor rate of $10.00/manhour including fringe benefits. Power costs are based on $0.03/kilowatt-hour, and chlorine costs are based on $0.25/lb. Capital costs have been amortized over a period of 20 years with a discount rate of 6-3/8 percent. The costs given as total annual costs include both the amortized capital cost and the estimated costs associated with operation and maintenance of the facilities. Appendix A contains information relative to facilities cost estimates.

INDIVIDUAL UNIT TREATMENT

It is common practice to provide centralized treatment of wastewater. In the case of municipalities, this demands that a collection system be installed to convey the wastewater to a central treatment facility. Otis has estimated that roughly 72 percent of the cost of collection and treatment is associated with the collection system.(2) Therefore, it may be appropriate to consider individual treatment systems, rather than centralized facilities.

As it applies to this study, it would not be possible to reduce costs associated with collection in a significant manner due to the fact that all of the communities currently have existing collection systems serving the entire communities' population. However, it may be reasonable to still provide individual rather than centralized treatment. The individual treatment units would discharge into the existing sewer system, which would convey the combined sewage to a common discharge point. It has been assumed that the effluent characteristics as required by the waste discharge permit now in effect would not be altered.

The onsite treatment system required to meet the effluent requirements would include a septic tank, a recirculating sand filter, and chlorination. Otis estimates the cost for this system to be $2,700 for installation costs, plus $100/yr for operation and maintenance.(2) The equivalent annual cost would then be $350/yr. Assuming a household with three people and discharging 300 gpd, the cost of this system would be $3,200/mg treated based on the equivalent annual cost. This cost far exceeds other alternatives and will not be considered further.

WASTEWATER STABILIZATION PONDS

Facultative Ponds

Facultative ponds utilize an aerobic surface layer and an anaerobic bottom layer to effect treatment of wastewater. Algae are relied upon exclusively to transfer oxygen into the lagoon. The fact that algae are used as an integral part of this treatment system tends to make the effectiveness of the system somewhat limited in terms of reliably meeting the discharge permit. However, the system is one associated with very low costs. It has been shown that similar systems that are well designed and carefully operated can meet the effluent criteria the majority of the time. It has been shown that a minimum of three cells are required to effect the solids removal required. Some systems have used in excess of seven cells to effect the desired treatment.(3, 4)

Metcalf and Eddy recommend a BOD loading of between 15 and 50 lbs/acre/day. They also recommend a detention time of between 7 and 20 days and a depth between 3 and 6 feet.(5) Other sources indicate that a detention time up to 120 days may be desirable. For the purpose of cost estimation, it has been assumed that a BOD loading of 30 lbs/acre/day will be acceptable. In addition, a lagoon depth of 5 feet, a per capita BOD contribution of 0.17 lb/D, and a per capita flow of 100 gal/D have been assumed. This requires a surface area of 57 acres per mgd in total, and yields a detention time of 70 days. The total annual cost for 1 mgd capacity is estimated to be $70,000/mgd. The cost does not include lining of the lagoon, but does include effluent chlorination with a dosage of 8 ppm at average flow.

In sizing the facultative lagoon, evaporation, percolation, and rainfall have been neglected; of these factors, percolation is by far the most important. Recent changes in EPA regulations will relax the secondary standards for ponds treating a flow of 2 mgd or less. The new standards would not change requirements for BOD removal, but may relax suspended solids requirements to 60-90 mg/L depending on local conditions and water quality.

Aerated Lagoons

Aerated lagoons differ from facultative ponds in that they rely primarily on mechanical aeration devices, rather than algae, for transferring oxygen into the pond. This system tends to trade the high effluent solids content due to algae for high operation and maintenance costs associated with the surface aerators provided. Experience has shown that aerated lagoons followed by polishing ponds can be an effective means of providing treatment.

For this study, it has been assumed that an aerated lagoon with seven days detention time and mechanical surface aerators is provided. In addition, three polishing ponds, each with one day's retention and effluent chlorination, are provided. The total annual cost, which includes amoritization, operation and maintenance, is estimated to be $55,000/mgd for a 1.0 mgd facility. The total system would require 3.7 acres/mgd.(6)

COMPACT CONVENTIONAL SYSTEMS

The systems described previously require large land areas. Conventional compact systems can be obtained in package or custom-built designs. These systems rely primarily on suspended growth treatment as opposed to fixed growth systems. The suspended growth concept requires intensive operator attention and skill, as compared to the lagoon systems previously described. The lagoon system does not require the operational attendance; however, the capital cost can be greater. Benjes has summarized the costs which might be anticipated using these small package or custom-built systems. The costs range from a low of $83,000 for a 0.1 mgd system to $315,000 for a 1.0 mgd system.(7) While these systems can treat and produce a high quality effluent reliably, the unit cost (#/mgd) is much greater than that associated with lagoons. Since none of the communities involved are limited for space, it is thought that the lagoon-type system provides advantages which far outweigh the increased reliability which may be obtained from more standard treatment systems. Therefore, these small compact systems will not be considered further.

UPGRADING OF EXISTING LAGOONS

Land Application

Land application systems have been demonstrated to work reliably without providing pretreatment to remove solids. However, it has also been shown that the removal of settleable solids will improve the long-term performance of evaporation-percolation systems. The State of Nevada has no requirements for pretreatment. For the purposes of this study, it has been assumed that existing facilities will be retained in their present state, unless they are hydraulically inadequate, and will be utilized to provide pretreatment.

Overland Flow

The effluent from lagoons may be polished by applying a thin layer directly onto land; the land slope should be about 2 percent. The method of application normally includes either fixed or center-pivot sprinklers, surface flooding using border strips, or ridge and furrow. Storage capacity is required for those times when the weather is not suitable for applying to the land due to excessive rain or due to freezing conditions. For comparison purposes, it has been assumed that a ten-week storage is required, that the application rate is four inches per week, and that application using border strips is provided. The land area required would be 110 acres/mgd capacity. The total annual cost is estimated to be $94,000 for a 1.0 mgd plant. The cost includes chlorination of the discharge which was assumed to be 25 percent of the flow applied.(6)

Zero Discharge Ponds

Ponds can be designed to completely retain the wastewater discharged into them, thus eliminating discharge to surface waters. The wastewater is disposed of through evaporation, infiltration, transpiration, and percolation. Off-setting these losses is the annual precipitation. For the study area, the annual lake evaporation is estimated to be 42 inches per year, while the precipitation was estimated to be 8 inches per year. Transpiration is assumed to be negligible. Percolation is difficult to estimate without performing tests on the actual soils involved. In addition, the percolation will change during construction due to compaction and during the life of the facility due to settling of solids and bacterial growth which will tend to plug the soil pores.

Clark and Viessman state that a percolation rate of one inch per hour is the minimum required for any type of soil absorption system as related to septic tanks; this is equivalent to 0.6 gal/sq.ft./day or 26,000 gal/acre/day. A percolation rate of 0.5 inches/hr would allow for tight soils due to compaction or plugging. Using these assumptions, the combined loss of water is estimated to be 120 mg/acre/yr or 85 in/wk. Approximately 99 percent of this loss is through percolation and, therefore, the importance of accurately, or more importantly, reasonably estimating percolation rate can be seen.

EPA indicates that in order to allow for resting periods and decreasing soil permeability, a loading rate of 4 to 12 inches per week (60-20 acre/mgd) should be used for low rate systems, while a loading rate of 5 to 8 feet per week (3-6 acre/mgd) should be allowed for high rate systems.(8)

In addition, allowance should be included for storage during periods when climatic conditions such as very low temperatures or high ground water render the facilities inoperable. This system has a direct advantage over other systems due to the fact that no effluent is discharged to surface waters. Thus, the need for chemical treatment such as chlorination is eliminated unless bacterial or viral contamination of the groundwater becomes evident. Nitrate-nitrite levels in the groundwater may also become a significant problem which would prevent the use of infiltration-percolation ponds.

The total annual cost including amortization, operation, and maintenance is estimated to be $32,000 for a capacity of 1 mgd. The cost includes five weeks of storage capacity and is based on an application rate of 12 in/wk, which requires approximately 25 acre/mgd of capacity, including storage.(6) No costs for effluent polishing have been included.

Since zero discharge lagoons rely predominantly on percolation to dispose of the influent wastewater, the impact on the area's groundwater can be significant. This is particularly important in areas where the community might obtain their drinking water from wells which tap the groundwater in the vicinity. In addition, the effect on groundwater may be important as it relates to the recharge of rivers which may flow nearby. It is interesting to note that the estimated cost for zero discharge lagoons is one-half that estimated for a flow-through facultative lagoon. This is due to a decrease in land area required by relying on percolation through the soil to dispose of the wastewater.

Intermittent Sand Filters

Middlebrooks has indicated that direct filtration of aerated lagoon effluent followed by facultative polishing ponds may prove to be effective for suspended solids removal.(9) He reported that the effluent suspended solids can be reduced to 10-15 ppm throughout the year. The equivalent annual cost estimated by Middlebrooks for a 0.3 mgd facility was $145,000/mgd. This cost is substantially higher than that for overland flow.

Chemical Precipitation

In some facilities, suspended solids are removed by precipitation using lime for coagulation. This system has an attendant benefit in that phosphorus is also removed. Pound and Crites show that the cost of two-stage lime coagulation and filtration is approximately twice the cost of overland flow.(10) They also show that the effluent quality from the two systems is approximately the same.

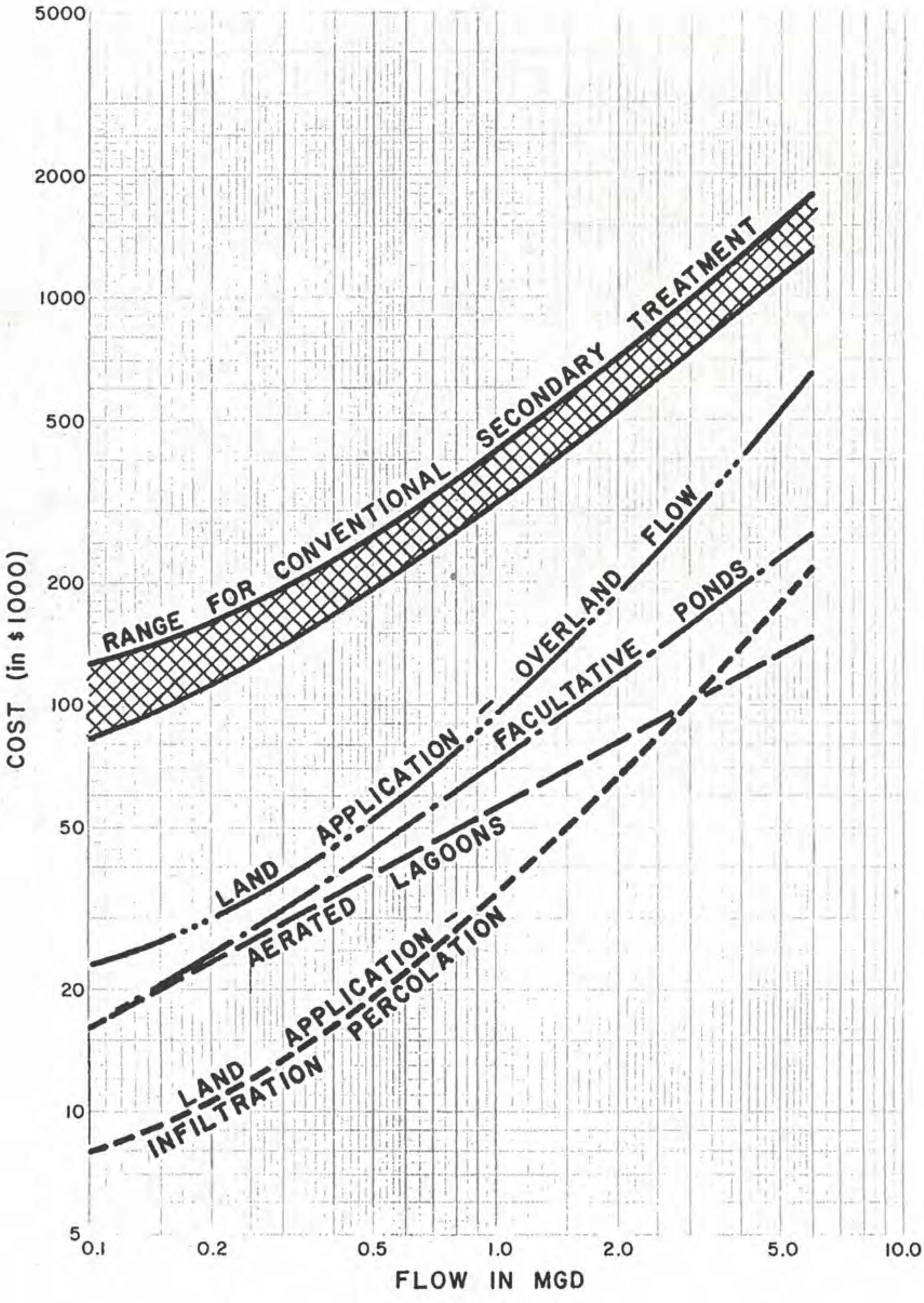
Middlebrooks indicates that batch feeding of liquid alum to storage lagoons which are designed for intermittent discharge is effective for removing both suspended solids and phosphate.(11) The liquid alum is applied from a motor boat traversing back and forth across the lagoon selected for discharge. The alum cost based on a dosage of 150 mg/L and a cost of $200 per ton is about $250 mg treated. Labor requirements are about 2 manhours per acre.

No Action

Regulations published in the October 7, 1977, Federal Register indicate that secondary standards for wastewater treatment ponds with design capacities less than 2.0 mgd will be relaxed by EPA. The full impact of this change is not known at this time since the effluent criteria have not been firmly established. However, it appears that requirements of 85 percent removal or 30 mg/L BOD will be retained while suspended solids limits will be increased to allow between 60 and 90 mg/L. In establishing the allowable standard, the assimilative capacity of the receiving stream must be considered. Since this alternative has the least economic impact on the region, it should be given due consideration by the regulatory agencies. Present indications from the State of Nevada are that water quality will not allow a decrease in the standards. Therefore, this alternative will not be considered further.

Non-Viable Alternatives

There are several systems which could theoretically be utilized but are not considered practical at this time. The concept of regionalization is not feasible due to the high cost associated with collecting and transporting the small wastewater flows over very long distances. Sophisticated technology such as reverse osmosis, physical-chemical, electrodialysis, distillation, adsorption, and ion exchange are not applicable due to high initial cost and demands for very specialized operation and maintenance. Similarly, reuse of effluents for supplementing potable water supplies is not economically feasible.



TOTAL EQUIVALENT ANNUAL COSTS

FIGURE 2.

SUMMARY OF COSTS

The costs for the systems described are summarized in Table 4 and illustrated in Figure 2. Additional documentation is included in Appendix A.

Table 4
SUMMARY OF EQUIVALENT TOTAL ANNUAL COST $10^3$$

	Plant Capacity		
	0.1 mgd	0.5 mgd	1.0 mgd
Conventional Secondary	83	199	315
Aerated Lagoons	16	37	55
Facultative Ponds	16	45	70
Land Application - Overland Flow	23	51	94
Land Application - Infiltration	8	19	32

ANTICIPATED PERFORMANCE

The effluent characteristics from conventional treatment systems are summarized in Table 5. These characteristics are based on "typical" influent quality and operating conditions. It can be seen that BOD and suspended solids limits can be met with all systems unless the influent concentration is low and the 85 percent removal requirement controls. None of the systems described, except for infiltration-percolation systems, are capable of meeting nutrient standards; however, it is possible to collect and reapply the effluent from overland flow systems to achieve zero discharge.

Table 5
SUMMARY OF ANTICIPATED EFFLUENT CHARACTERISTICS FROM SELECTED TREATMENT SYSTEMS

		Stabilization Ponds		Land Application	
	Conventional Secondary	Aerated Lagoon	Facilitative Ponds	Overland Flow	Infiltration-Percolation
Effluent Flow As % Influent	100	100	100	25	0
BOD, mg/L	20	30	30	5	0
TSS, mg/L	20	30	60	5	0
TDS, mg/L	800	800	800	800	0
NH_3-N, mg/L	10	10	10	0.5	0
NO_3-N, mg/L	20	20	20	2.5	0
TOT-N, mg/L	30	30	30	3	0
PO_4-P, mg/L	8	8	8	5	0

CHAPTER III

SELECTED ALTERNATIVES FOR UPGRADING

MUNICIPALITIES

Most of the facilities being studied are in need of upgrading. The physical methods of upgrading were described in the previous chapter. Infiltration-percolation basins are the only option for meeting all effluent criteria including nutrients as required by existing permits. Furthermore, infiltration-percolation basins appear to offer the most cost effective solution for upgrading existing facilities to meet the existing permit conditions.

Future goals established in the Federal Water Pollution Control Act Amendments of 1972, PL 92-500, have the objective of "restoring and maintaining the physical, chemical, and biological integrity of the nation's waters." The use of infiltration-percolation basins insures compliance with the 1983 goals as a result of eliminating discharge to surface waters. Therefore, the need to provide additional facilities to meet future goals established in PL 92-500 will be eliminated by the installation of zero discharge facilities at this time. This does not preclude the need for additional expansion which may be required due to increased hydraulic loading.

Comparison of 208 and 201 Plans

In the case of Elko, Wells, Ely, and Lovelock, detailed 201 facilities plans are now published or will be in the near future. Facilities plans consider the situation existing in each community in detail. In contrast, 208 plans approach local problems from a less detailed and more conceptual position. Consequently, the conclusions and cost estimates developed during the course of the 208 and 201 planning efforts may be substantially different. In this 208 study, the conceptual approach to each treatment system's needs are in reasonable agreement with those proposed in the facilities plans. However, in some cases the costs are substantially different. Conceptually, both levels of planning agree that land application is the best solution; how-ever, substantial difference in opinion exists as to the basic elements which will be required to provide land application. The most notable differences lie in pretreatment requirements, land area requirements and in the length of required storage period. This 208 study assumes that 5 weeks of storage is adequate for infiltration-percolation systems and that pretreat-ment is not required by the State of Nevada. It has also been assumed that soil conditions, which are site specific, are suitable for infiltration-percolation ponds.

Operation and Maintenance

One practice which should be incorporated into all facilities as standard procedure is the establishment of routine operation and maintenance proce-dures. Staff should be trained to operate the specific processes being utilized and should be assigned to the facility on a regular, daily basis. In some instances, part-time attendance may be adequate. The establishment of preventive maintenance programs will increase the longevity of the system and will help alleviate crisis situations which may result from equipment failure. Training of the operators will give them the tool of understanding which can be used to approach the operational problems from a rational basis rather than relying on myths or guesswork.

The importance of having a well-trained staff cannot be overstated. At a minimum, it can safely be assumed that top quality operation will lead to the best quality effluent attainable from the treatment facilities. In some cases, the improvement in effluent quality may be so substantial as to alleviate the need for plant upgrading by tacking on additional treatment systems which will require even more operator attention to all phases of the system.

Basis of Design

The existing and projected wastewater flows are given in Table 6. The design flow for the existing facilities are also given. Projected flows were furnished by the State of Nevada. It can be seen that the projected flows for the year 2000 are not greatly different from either present design flows or projected 1980 or 1990 flows. At a minimum, facilities should not be constructed for less than a 10-year planning period; however, economic considerations favor a 20-year planning period for wastewater treatment facilities due to economies of scale. Therefore, the facilities size and costs are based on a 20-year planning period and flows projected for the year 2000.

Table 6
EXISTING AND PROJECTED WASTEWATER FLOWS

	Existing Design, Influent Flow (mgd)	Projected Influent Flow (mgd) 1980	1990	2000	% CH (1990-2000)
Municipalities					
Carlin	0.50	0.16	0.22	0.27	+23
Elko	2.20	1.70	2.3	3.20	+39
Lovelock	0.10	0.46	0.51	0.54	+ 6
Wells	0.25	0.23	0.28	0.34	+21
Winnemucca	1.50	0.75	-	-	-
Owyhee	0.40	0	40.05	0	+20
Ely	3.00	1.20	1.25	1.30	+ 4
Caliente	0.40	0.28	0.32	0.32	+ 7
Industries					
Barth Iron	-	0.64		0.64	-
Spring Creek	-	1.3[a]+0.5[b]		-	-
Gallagher	-	7.8[a]+0.91[b]		-	-

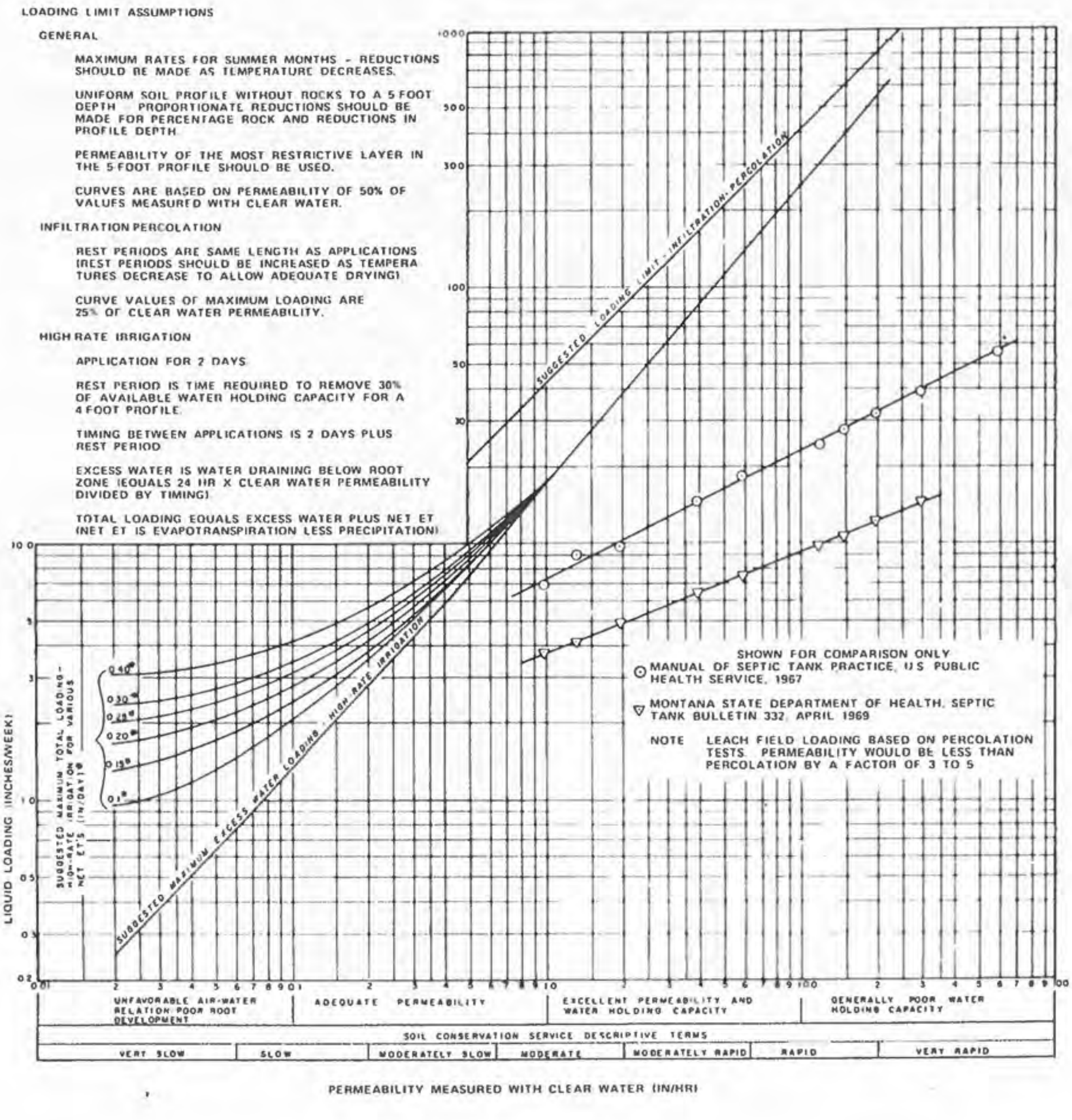
a Flow-through discharge
b Pond cleaning

Soil Permeability

Soil permeability is a critical paramater for sizing infiltration-percolation basins. Limited data is currently available for soil permeability in the vicinity of the communities being studied. The data indicates soils which have slow to moderate permeabilities predominate. The data are summarized below:

Ely	0.2 to 0.6 in/hr
Wells	0.65 to 10 in/hr
Elko	0.1 to 1.0 in/hr
Carlin	0.06 to 2.0 in/hr
Lovelock	0.2 to 0.8 in/hr

Figure 3 shows that for soils characterized as having slow to moderate permeabilities, a liquid loading rate of 3 to 80 inches per week should be used. Costs presented previously were based on a loading rate of 12 inches



SUGGESTED MAXIMUM LOADING RATE VERSUS MEASURED PERMEABILITY FOR HIGH-RATE IRRIGATION AND INFILTRATION-PERCOLATION per week which is the suggested loading rate for soils having a permeability of about 0.25 inches per hour. The soils data indiates that this is a reasonable assumption for the purpose of this study.

ENVIRONMENTAL ASPECTS

Land application using either overland flow or infiltration-percolation systems will probably have the least environmental impact of any of the available alternatives. The amount of energy required for constructing and operating the system will be less than that for other systems. The amount of solid waste generated will be minimal since most of the BOD which could be converted to waste solids will be applied to the land and no chemical sludges will be generated from chemical precipitation.

The general surface water quality will be improved slightly since no discharge is made directly to the surface water. This will also mean that no chemical treatment for disinfection is required. This insures that no chlorinated hydrocarbons will be formed. However, the fact that the effluent does reach the groundwater may create some problems in terms of meeting future drinking water standards, especially for nitrates.

Relatively large land areas are required for permanent commitment to wastewater treatment. This should not be a problem since land is not now nor is it expected to be a scarce resource in the near future.

The application of the wastewater directly to the land without spraying will minimize any introduction of viruses via aerosols into the air. Odors will not present a significant air quality problem.

Since the land treatment sites will be somewhat removed from the immediate area of the communities involved, impacts such as noise, dust, and traffic congestion which result from construction activities will be minimized.

Following is a discussion of the methods and costs of upgrading facilities for each municipal discharger.

Carlin

The existing treatment plant has ample reserve capacity to handle projected flows. However, due to the low influent BOD and TSS concentrations, it is unlikely the required 85 percent reductions in BOD and TSS can be realized. If the state and EPA can not be convinced to waive this requirement, the most cost-effective upgrading system would be to add a seven acre evaporation-percolation lagoon. This would eliminate all discharge to surface waters and would preclude the need for adding disinfection. The modifications are estimated to cost $100,000 for initial capital cost plus an additional $500 for annual operation and maintenance.

Prior to beginning design of any new facilities, the State of Nevada should strongly encourage the EPA to rescind the requirement for 85 percent BOD and TSS removal, at least for the immediate future. The cost for upgrading the facility does not appear to be soundly justified at this time in light of the water quality modeling, which indicates no significant affect on the surface water quality as a result of the continued discharge with existing BOD and TSS concentrations and mass discharge rates. Precedent has been established by EPA when it relaxed standards for TSS discharges from lagoons with a capacity of 2 mgd or less. At a minimum it would appear to be more appropriate to approach the upgrading "problem" from an operation viewpoint before finalizing on capital facilities for upgrading.

Elko

The Elko plant appears to be in need of a major upgrading. The existing raw sewage pumping capacity must be expanded to handle a peak flow of about 7,000 gpm as compared to the existing 2,200 gpm capacity with one pump out of service. Additional aeration capacity will be required. The existing secondary clarifier has a sidewater depth of only seven feet as opposed to 12 feet normally used with activated sludge plants. In addition, EPA reliability criteria require two units. Effluent chlorination will also be required. Disposal of waste solids is now a significant problem. Current practice is to waste solids into the No. 1 facultative pond. It is recommended that separate digestion and thickening be provided. The estimated cost for the aforementioned modifications is $2.6 million. The annual O&M cost is estimated to be $170,000 per year.

A second alternative would be to rely on the existing system with minor modifications including the facultative lagoons and effluent disposal via an evaporation-percolation system. Modification of the raw sewage pumping would be required. The evaporation-percolation lagoon would require 80 acres. The capital cost is estimated to be $750,000, while the annual operation and maintenance cost for the lagoons is $37,000. The O&M cost of the existing secondary system is now about $170,000 per year. This option would be the most cost effective.

A third alternative, as recommended in the facilities plan prepared by Chilton Engineering, is to upgrade the entire existing secondary system and then apply the effluent to the land with provision to irrigate the City golf course in addition. The estimated cost presented in the facilities plan for construction of this alternative is $2.04 million. During discussions with the City's engineers, it was indicated that they determined that infiltration-percolation ponds were not cost effective. Information regarding this was to be furnished for inclusion in this report but had not been received prior to completing this report.

Lovelock

Currently, Lovelock is discharging raw sewage. One cost-effective alternative for Lovelock appears to be facultative lagoons followed by evaporation-percolation ponds. The design flow is projected to be 0.54 mgd. A facultative lagoon system of 31 acres would be required with an additional 14 acres for the evaporation-percolation pond. However, the facility plan indicates that the soil is of low permeability and, therefore, the assumption of zero discharge needs to be carefully checked. The estimated capital cost is $530,000, while the annual operation and maintenance cost is estimated to be about $16,000.

A second alternative would be to utilize overland flow rather than the evaporation-percolation pond for effluent disposal. Approximately 60 acres would be required in addition to the 31-acre lagoon. The capital cost is estimated to be $780,000, while the operating and maintenance cost is estimated to be $32,000.

A third alternative, as recommended in the Facilities Plan, is to provide treatment using aerated lagoons followed by land disposal. Using the cost curves developed for this study, the capital cost for this alternative is estimated to be $570,000, while the annual operation and maintenance cost is estimated to be $41,000.

By the estimating procedure and assumptions used, Alternative 1 would be the most cost effective. Alternative 2 has a greater equivalent annual cost than Alternative 3; however, inflation as it relates to power costs is not included in Alternative 3, which is more energy intensive than Alternative 2.

The alternatives and cost estimates presented above are moot at this time since Alternative 3 is now under construction. The facility being constructed includes two 2.24 million gallon aerated lagoons with two 15 hp surface aerators in each followed by two 2.24 million gallon clarification lagoons with provision for effluent chlorination and discharge to surface waters when land disposal is not feasible. The bid for construction was $267,796. Under normal conditions, effluent will be disposed of by land treatment. A 20-year lease is now being negotiated with a nearby farmer who will bear all costs for the land disposal system. The total project actual construction cost, including engineering and contingencies, is now expected to be $368,775. Because the City is not going to bear the construction, operation, or maintenance costs associated with the land disposal portion of the system, the selected alternative appears to be more cost effective than the alternatives presented above.

Wells

The existing system must be expanded and upgraded to meet projected load requirements and to satisfy permit conditions. The most cost-effective solutions appear to be overland flow and evaporation-percolation ponds. Both systems should be capable of meeting the permit conditions, although the effluent from the overland flow alternative will be marginal for phosphate levels.

An evaporation-percolation pond would require about nine acres and cost about $110,000 to construct. The annual operation and maintenance cost would be about $4,500. Overland flow would cost about $280,000 to construct and $15,000 per year to operate.

A facilities plan is currently being developed for Wells by Pillsbury Engineers. At this time, it appears that the recommended plan will include modifications to the existing lagoons, a storage basin with 4 to 5 months capacity and effluent disposal by a land application (overland flow) system. The construction cost for this system is estimated to be about $400,000.

During discussions with the Pillsbury people, they indicated that they do not believe that evaporation-percolation ponds are cost effective and that they may not even be feasible due to soil conditions. They had agreed to study this matter further and to furnish specific information for inclusion in this report; however, the information was not received in time to include it herein.

Winnemucca

The major problem in evidence with the Winnnemucca system appears to be infiltration/inflow (I/I) in the sewer system. A sewer system evaluation survey will be performed when funding becomes available. In March 1972, the I/I flow was estimated to be 0.8 mgd, while the domestic sewage flow was estimated to be 0.89 mgd. The current wet weather flow is reported to be 2.25 mgd.

The City currently has a contract with a local rancher for disposal of the treated effluent via overland flow. As is characteristic with overland flow, roughly 25-30 percent of the effluent runs off the land and enters the nearby water course. Treatment alternatives include collection and disinfection of the runoff or providing an evaporation-percolation pond.

The cost of collection and disinfection is estimated to be $198,000. The associated operation and maintenance cost is projected to be about $16,000 per year.

Construction of an evaporation-percolation pond would require approximately 19 acres and would cost about $200,000. The increased operation and maintenance cost would be about $8,000 per year.

Owyhee

The Owyhee system has been expanded and put in service in July of 1977. The design flow is 0.4 mgd, which is much greater than the population projections require. The Bureau of Indian Affairs indicates that the major flow originates from a newly constructed hospital and that the domestic flow will not increase significantly during the next decade or two.

The design of the evaporation-percolation ponds appears to be adequate for future conditions. The system will not discharge to any surface waters.

Ely

The hydraulic design capacity of the existing plant appears to be more than adequate to treat projected flows. Upgrading the plant using evaporation-percolation basins is estimated to cost $300,000 for construction and add $12,000 to the annual O&M cost.

The Facilities Plan indicates that the only feasible alternatives for upgrading the Ely plant are conversion to an activated sludge system and land application using irrigation and evaportion-percolation ponds. The report shows that land disposal is more cost effective than conversion to activated sludge. The facilities plan gives an estimated cost for land for land disposal, including chlorination, is estimated to be $265,000 for construction and $26,000 annually for operation and maintenance.

Caliente

The Caliente plant has adequate capacity to treat the projected flows. Increased attention to operation and maintenance will improve performance significantly, however, the low influent BOD and TSS concentrations make the 85 percent removal efficiency requirement difficult to meet, even with constant operator attention.

Upgrading by addition of an evaporation-percolation pond would insure compliance with the waste discharge permit. Approximately 8 acres would be required. The estimated capital cost is $110,000, while the increased operation and maintenance cost would be about $4,500 per year.

Recent records indicate continued improvements in effluent quality through improved operation techniques. All interested parties should be convinced that continued improvements in operation will not bring this facility into substantial compliance with permit conditions before the construction of capital facilities is contemplated further.

INDUSTRIAL SOURCES

Barth Iron Mine

The discharge from the Barth Iron Mine is currently meeting, and is expected to continue meeting, the limitations set forth in the waste discharge permit. Therefore, no upgrading or modifications are required at this time.

Fish Hatcheries

Technology

EPA has tentatively determined that the 1977 and 1983 requirements for effluent quality will be the same (12). The EPA draft development document recommended vacuum cleaning of culturing units with sedimentation of the cleaning flow and sludge removal or equivalent technology. The data shows that simple settling or aeration followed by settling will not allow meeting nutrient linits as defined in the existing permits. The EPA document does not consider nutrient removal to be included in 1983 goals for "best available technology economically achievable."

Gallagher Fish Hatchery

The flow-through discharge is violating only the phosphate concentration, but not the total mass discharge rate, standard. The pond cleaning discharge violates both suspended solids and phosphate concentration and mass discharge rate standards. Suspended solids can easily be reduced in the pond cleaning water by providing a sedimentation basin. The cost of a simple sedimentation pond is estimated to be $20,000, while a conventional clarifier is estimated to cost $125,000.

If phosphates are to be removed from both flow-through and pond cleaning water, the pond volume should be increased. Liquid alum at a dosage of about 150 mg/L could be metered into the pond influent. To precipitate phosphate, the larger pond is estimated to cost $28,000. In addition, chemical storage and metering would be required. The estimated cost for chemical storage, metering, and mixing is estimated to be $90,000, giving a total capital cost of $118,000. The annual chemical cost based on an alum usage of 150 ppm and a unit cost of $125 per ton is $220,000. Phosphate levels in the incoming water are greater than the permit limit. Therefore, the limit appears unreasonable and the cost unwarrented, as far as the hatchery is concerned. It would appear to be appropriate to alter the permit requirement to reflect the influent level.

Spring Creek Hatchery

Data indicate that the flow-through discharge barely violates permit conditions for BOD and TSS, but substantially violates phosphate and nitrate limits based on average day conditions; all maximum day conditions are violated. In addition, all average and maximum day conditions are violated for the pond cleaning discharge. Therefore, it appears that the two discharges should be combined and pumped to a sedimentation basin where alum could be added to precipitate phosphate, suspended solids, and associated BOD. The entire flow would then be denitrified.

The estimated cost for removing BOD and TSS, using simple sedimentation ponds including raw wastewater pumping, is $100,000. The addition of a chemical feed system for liquid alum to remove phosphates would add about $90,000 in capital cost, and $50,000 per year for alum.

Reduction of nitrate levels to those permitted will also prove to be difficult and costly. Sedimentation is only partially effective in removing nitrates, indicating predominance of soluble forms. The most practical means of providing denitrification is by using a suspended growth plug flow reactor. This mode of operation requires anaerobic conditions. In addition, a carbon source, usually methanol, is required. A clarifier and sludge recycle pumping is also required. The estimated construction cost, including the sedimentation ponds and alum system, is $600,000, while the estimated annual operation and maintenance cost if $65,000.

SUMMARY

The capital, operation and maintenance, and equivalent annual costs associated with upgrading the wastewater treatment facilities are summarized in Table 7. In order to evaluate the economic impact on the communities, the assessed valuation and tax rate required to repay the annual costs are also presented in Table 7.

Table 7
SUMMARY OF COSTS

Location	Land Area (AC)	Capital Cost(c) Total	Capital Cost(c) City Share(a)	O&M(c) Cost	Annual Cost(b,c) Total	Annual Cost(b,c) City Share	Assessed(c) Valuation	City Annual (MILS)
Carlin	7	100	25	0.5	10	3	3,625	8.3
Elko	80	750	188	37	113	54	45,233	11.9
Lovelock	45	530	133	16	64	28	4,692	6.0
Wells	9	110	28	4.5	14	7	4,956	14.1
Winnemucca	19	200	50	8	26	13	15,142	8.6
Owyhee	-	-	-	-	-	-	-	-
Ely	35	265	66	26	50	32	14,825	21.6
Caliente	8	110	28	4.5	14	7	1,363	51.4
Barth Iron	-	-	-	-	-	-	-	-
Spring Creek	-	600	-	65	-	-	-	-
Gallagher	-	118	-	220	-	-	-	-

(a) Assumes 75 percent EPA grant
(b) Capital cost amortized over a period of 20 years at a discount rate of 6-3/8 percent. (CRF=.09166)
(c) Thousand dollars

REFERENCES

(1) William F. Pillsbury, Inc., Consulting Engineers, "Lovelock Wastewater Treatment Facility, City of Lovelock, Nevada," December 1974.

(2) Otis, R. J.; et al, "On-Site Disposal of Small Wastewater Flows," EPA Technology Transfer Design Seminar for Small Wastewater Treatment Systems, 1977.

(3) EPA, "Wastewater Treatment Ponds," EPA-430/9-74-011, March 1974.

(4) Middlebrooks, E. J.; Reynolds, J. H.; Middlebrooks, C. H., "Performance and Upgrading of Wastewater Stabilization Ponds," EPA Technology Transfer Design Seminar for Small Wastewater Treatment Systems, 1977.

(5) Metcalf and Eddy, Wastewater Engineering, McGraw-Hill, 1972.

(6) EPA, "Costs of Wastewater Treatment by Land Application," EPA-430/9-75-003, June 1975.

(7) Benjes, H. H., "Small Community Wastewater Treatment Facilities - Biological Treatment Systems." Prepared for EPA Technology Transfer National Seminar on Small Wastewater Treatment Systems.

(8) EPA, "Land Treatment of Municipal Wastewater Effluents - Design Factors 1 and 2," January 1976.

(9) Marshall, G. R.; Middlebrooks, E. J., "Intermittant Sand Filtration to Upgrade Existing Wastewater Treatment Facilities," Utah State University Water Research Lab, February 1974.

(10) EPA, "Cost Effective Comparison of Land Application and Advanced Waste Treatment," EPA-430/9-75-016, November 1975.

(11) Middlebrooks, E. J.; et al, "Evaluation of Techniques for Algae Removal from Wastewater Stabilization Ponds," Utah State University Water Research Lab, January 1974.

(12) EPA; "Draft Development Document for Guidelines and Standards of Performance for the Fish Hatcheries and Farm Point Source Category," EPA, Washington, D.C., February 1977.

BIBLIOGRAPHY

Benjes, H.H., "Small Community Wastewater Treatment Facilities - Biological Treatment Systems". Prepared for EPA Technology Transfer National Seminar on Small Wastewater Treatment Systems.

Black and Veatch, "Estimating Costs and Manpower Requirements for Conventional Wastewater Treatment Facilities," EPA 17090 DAN 10/71.

Chilton Engineering, "City of Ely, Nevada, Sewage Treatment Plant and Collection System Draft Facilities Plan," August 26, 1977.

Chilton Engineering, "Sewage Treatment Facilities Plan for Elko, Nevada," November 1977.

Clark, J.W.; Viessman, W., Water Supply and Pollution Control, International Textbook Co., 1965.

EPA, "Alternative Waste Management Techniques for Best Practicable Waste Treatment," EPA-430/9-75-013, October 1975.

EPA, "Cost Effective Comparison of Land Application and Advanced Waste Treatment," EPA-430/9-75-016, November 1975.

EPA, "Costs of Wastewater Treatment by Land Application," EPA-430/9-75-003, June 1975.

EPA, "Draft Development Document for Recommended Effluent Limitations Guidelines and Standards of Performance for the Fish Hatcheries and Farms Point Source Category," EPA, Washington, D.C., February 1977.

EPA, "Disinfection of Wastewater," EPA-430/9-75-012, March 1975.

EPA, "Disinfection of Wastewater," EPA-430/9-75-012, March 1975.

EPA, "Land Treatment of Municipal Wastewater Effluents - Design Factors 1 and 2," January 1976.

EPA, "Physical-Chemical Nitrogen Removal," EPA-625/4-74-008, July 1974.

EPA, "Upgrading Lagoons," January 1974.

EPA, "Wastewater Treatment Ponds," EPA-430/9-74-011, March 1974.

Lewis, R.F.; Smith, J.M., "Upgrading Existing Lagoons," National Environmental Research Center, Cincinatti, Ohio, 1973.

Marshall, G.R.; Middlebrooks, E.J., "Intermittant Sand Filtration to Upgrade Existing Wastewater Treatment Facilities," Utah State University Water Research Lab, February 1974.

Metcalf and Eddy, Wastewater Engineering, McGraw Hill, 1972.

Middlebrooks, E.J.; et al, "Evaluation of Techniques for Algae Removal from Wastewater Stabilization Ponds," Utah State University Water Research Lab, January 1974.

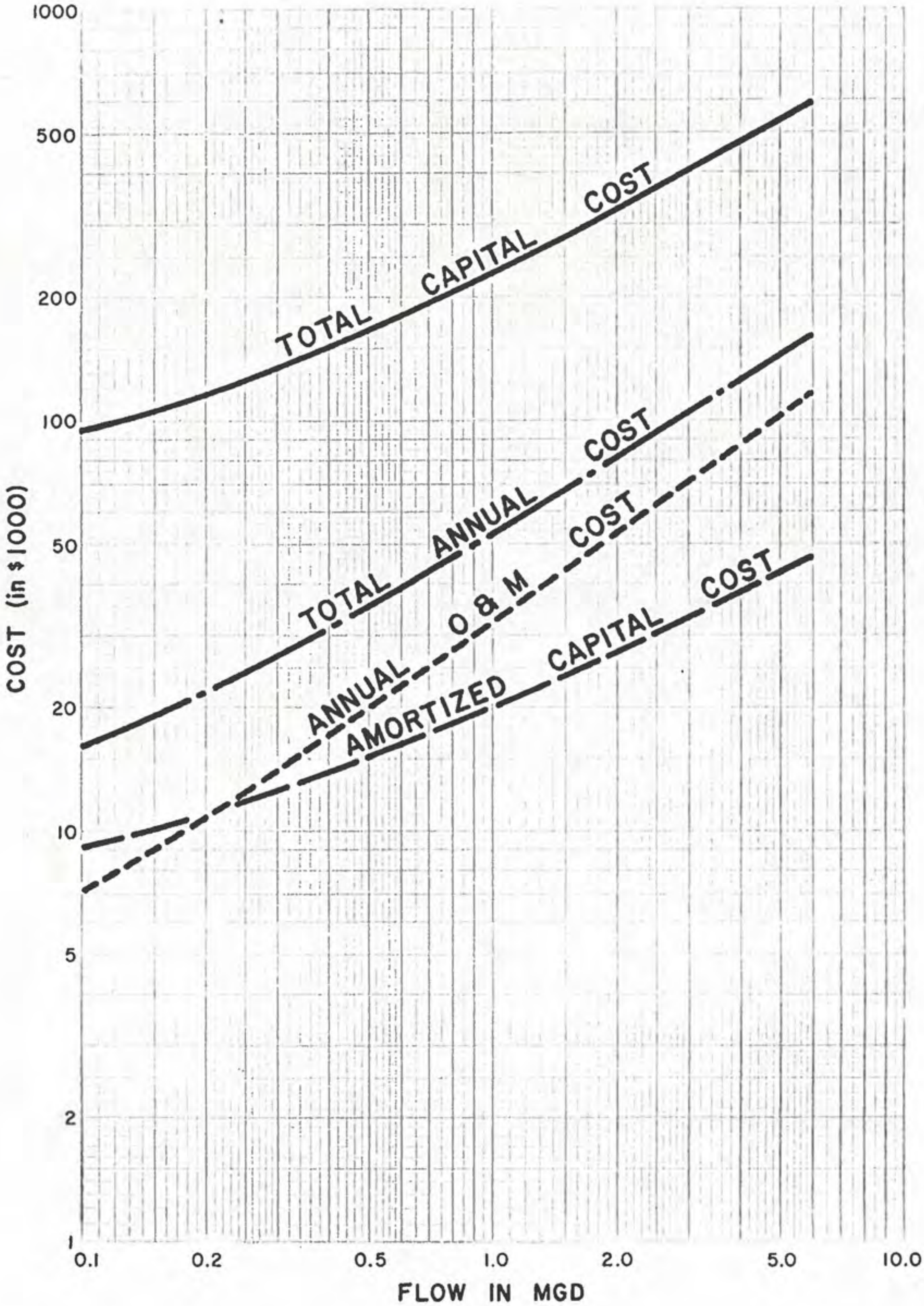
Middlebrooks, E.J.; Reynolds, J.H.; Middlebrooks, C.H., "Performance and Upgrading of Wastewater Stabilization Ponds," EPA Technology Transfer Design Seminar for Small Wastewater Treatment Systems, 1977.

Otis, R.J.; et al, "On-site Disposal of Small Wastewater Flows," EPA Technology Transfer Design Seminar for Small Wastewater Treatment Systems, 1977.

USDA Soil Conservation Service, "Soil Survey: Lovelock Area Nevada," June 1965.

William F. Pillsbury, Inc., Consulting Engineers, "Lovelock Wastewater Treatment Facility, City of Lovelock, Nevada," December 1974.

APPENDIX A



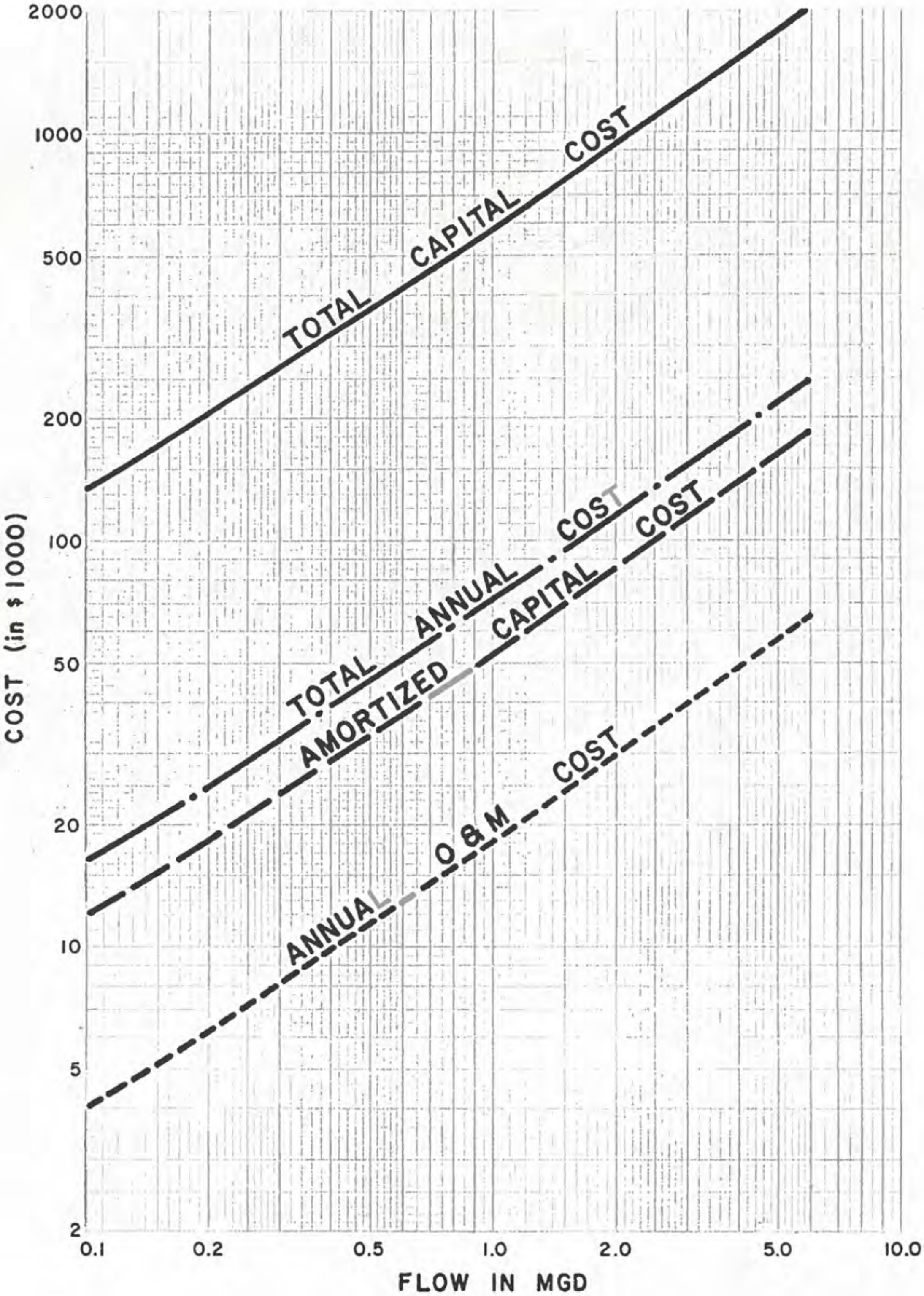
AERATED LAGOONS

AERATED LAGOONS
(ENR 2800)

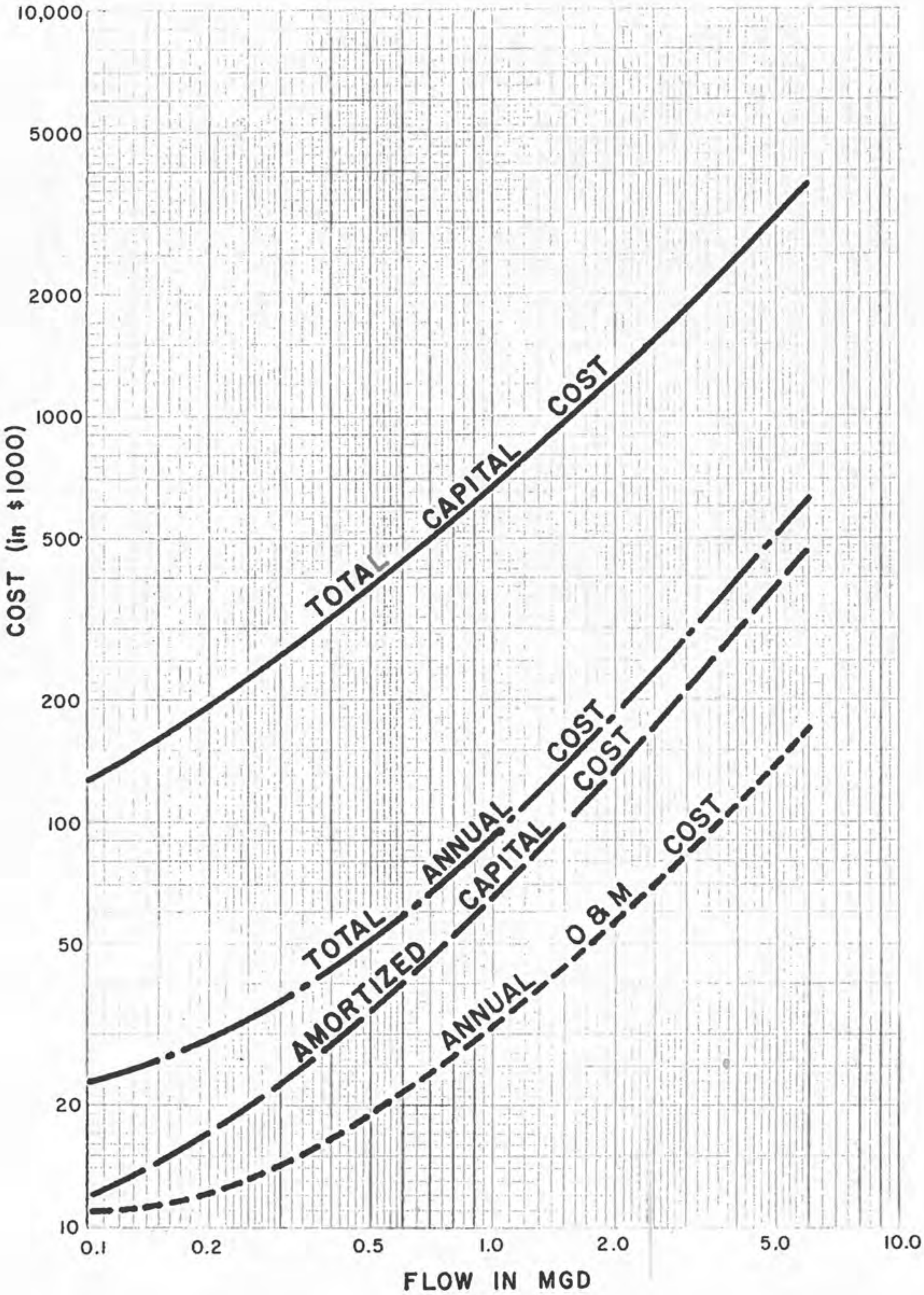
	Treatment Capacity (mgd)		
	0.1	0.5	1.0
Construction Cost (Thousand $)			
Aerated Lagoons (7-day Detention)	50	80	110
Polishing Ponds	10	25	35
Chlorine System	30	55	70
Chlorine Basin	15	27	45
Total Capital	105	187	260
Total Annual	9	17	23
Annual Operation and Maintenance (Thousand $)			
Lagoons	4	10	17
Chlorine	3	10	15
Total	7	20	32
TOTAL ANNUAL COST	16	37	55

FACULTATIVE PONDS
(ENR 2800)

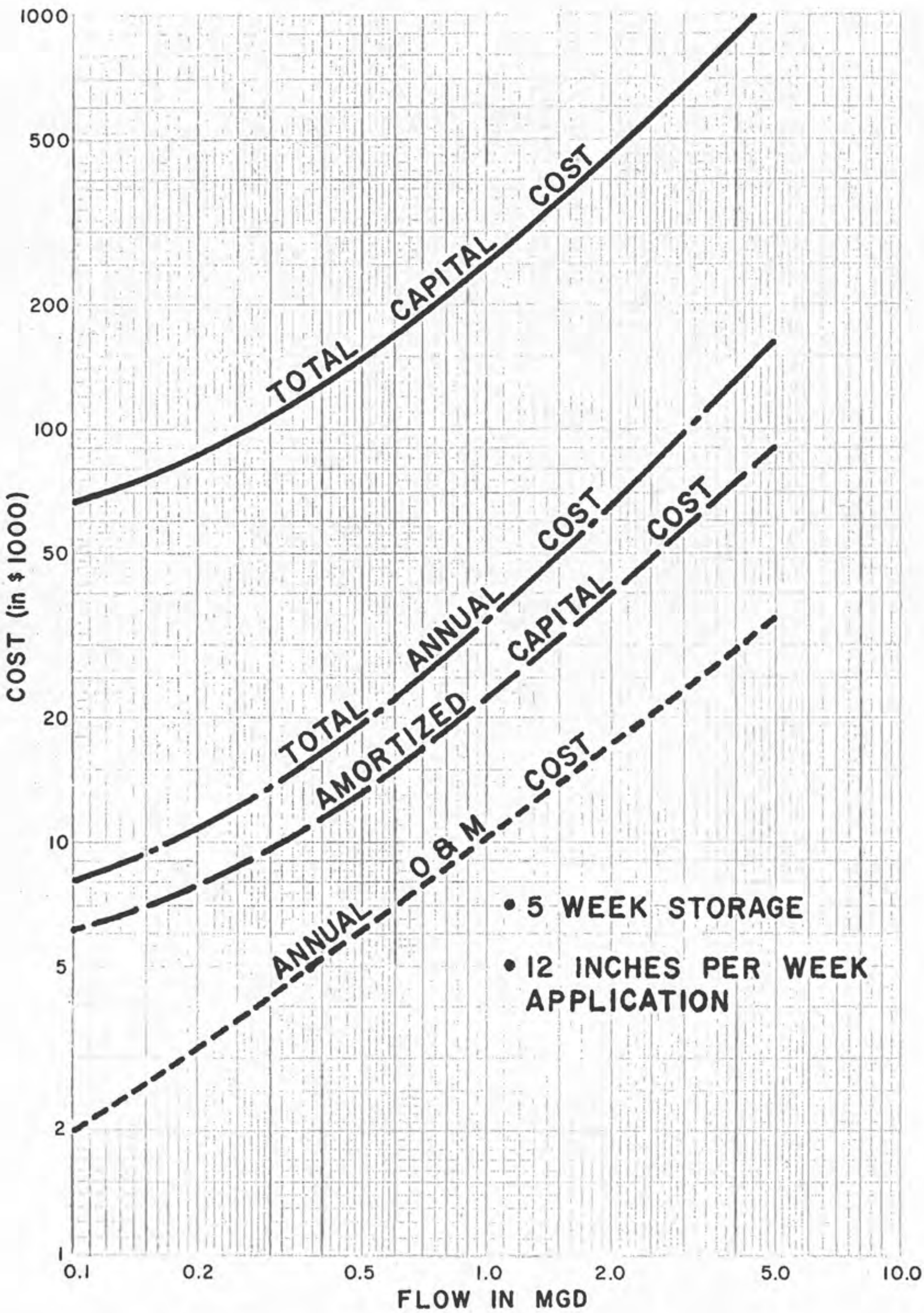
	Treatment Capacity (mgd) 0.1	0.5	1.0
Construction Cost (Thousand $)			
Basins (70-day Detention, 57 ac/mgd)	60	190	290
Land ($2,000/ac)	11	57	114
Roads and Fencing	15	40	58
Chlorination	30	55	70
Chlorine Contact Basin	15	27	45
Total	131	369	577
Total Annual	12	33	52
Annual Operation and Maintenance (Thousand $)			
Basins	1	2	3
Chlorination	3	10	15
Total	4	12	18
TOTAL ANNUAL COST	16	45	70



FACULTATIVE PONDS



LAND APPLICATION
OVERLAND FLOW



LAND APPLICATION
INFILTRATION PERCOLATION

LAND APPLICATION - OVERLAND FLOW
(ENR 2800)

	Treatment Capacity (mgd) 0.1	0.5	1.0
Construction Cost (Thousand $)			
Storage (10 weeks/year)	54	100	190
Site Clearing (110 ac/mgd)	-	1	1
Field Preparation (110 ac/mgd)	15	47	90
Border Strips	9	20	35
Runoff Collection (Gravity Pipe)	12	62	120
Chlorination (0.25 Flow Applied)	20	30	40
Land ($2,000/ac)	22	110	220
Total Construction	132	370	696
Ammortized Construction	12	33	63
Annual Operation and Maintenance (Thousand $)			
Storage	1	2	3
Border Strips	10	16	28
Chlorination (0.25 Flow Applied)	1	2	4
Total	12	20	35
TOTAL ANNUAL COST	24	53	98

LAND APPLICATION - INFILTRATION BASINS
(ENR 2800)

	Treatment Capacity (mgd)		
	0.1	0.5	1.0
Construction Cost (Thousand $)			
Storage (5 weeks/year)	38	60	110
Infiltration Basins (25 ac/mgd)	19	60	100
Land ($2,000/ac)	5	26	50
Roads and Fencing	9	24	37
Total	71	170	297
Total Annual	7	16	27
Annual Operation and Maintenance (Thousand $)			
Basins	2	6	10
Total	2	6	10
TOTAL ANNUAL COST	9	22	37

TASK MEMORANDUM 2-1

TASK B - ALLOWABLE DAILY LOADS FOR THE WALKER AND HUMBOLDT RIVERS

FOR
STATE OF NEVADA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
DIVISION OF ENVIRONMENTAL PROTECTION

BY
CH2M HILL, REDDING, CALIFORNIA

PROJECT MANAGER	DR. RONALD F. OTT
WATER QUALITY MODELER	DR. NOEL J. WILLIAMS
HYDROLOGIST	DR. JACK H. HUMPHREY

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I. INTRODUCTION

The purpose of this task memorandum is to present the allowable daily pollutant loads for the Walker and Humboldt Rivers. An allowable daily load is that amount or mass of any given pollutant that can be added at a point in the stream and not cause the stream to violate water quality standards. This mass may be associated with a point or nonpoint source.

To compute the allowable loads for each river, a hydrologic and water quality data base was constructed, models were applied to convert mass loads into instream concentrations; nonpoint sources, and boundary flows, and quantity were estimated; and a allowable load procedure was established.

This memorandum describes the data base, models, model runs, allowable daily loads, and a model sensitivity analysis on the impacts of various load amounts.

II. MODEL DATA BASE

The model data base is the most important element of the study in that it describes all the sources and sinks of pollutants in the study area. If the basic data does not describe the actual flows and pollutant loading entering and leaving the river systems, a model does nothing more than produce erroneous instream data that will lead to faulty planning decisions. Each one of the elements of the data bases for the Walker and Humboldt River systems are discussed below.

II.A. RIVER REACHES

For study purposes, each river was divided into study reaches. The selection of these reaches was described in detail in TM 1-1 (Reference 1). For modeling purposes, these reaches were further divided into smaller reaches which had the same physical, chemical, and biological characteristics and, therefore, would have a unique set of model parameters.

For computational purposes, the model reaches were even further broken down into 1-mile segments. The relationship between the model reaches and the original study reaches for both rivers are shown in Tables 1 and 2. The actual locations of the model reaches and segments are shown on Figures 1 and 2.

To measure the river miles on the Humboldt and Walker Rivers, a Keuffel and Essen map measurer with a .25-inch wheel was used to follow the river channel on USGS maps as closely as possible. On the Humboldt River, 7-1/2-minute series maps were used above Elko and 15-minute series maps downstream to the Humboldt Sink. Fifteen-minute series maps were available on the Walker River. A subjective multiplier was used to account for river sinuosity, which could not be followed by the wheel. This factor varied from 1.0 to 3.0 on extremely winding sections of the Humboldt River. The model calculated a flow time of 3 weeks from Wells to Rye Patch Reservoir. Observed flow times from Marys River and North Fork Humboldt gauges to Rye Patch Reservoir (for example, the flood event of February 1962) are 20 to 25 days. For this agreement to occur, the measured river miles must be approximately correct, at least for near bank-full conditions. Observed velocities taken during CH2M HILL's July 1977 survey also agree with model simulations.

II.B. PHYSICAL DESCRIPTION

The physical description of each river as described in the model is shown in Tables 3 and 4. The description of the physical system for the Humboldt and Walker Rivers was based on USGS topographic maps, aerial photography, surveyed cross sections, and field notes. Cross section data at 5-mile intervals were available on the Humboldt River from the U.S. Army Corps of Engineers (Reference 2). Cross sections at USGS gauging sites on both rivers were provided by the USGS Carson City Office. In Tables 3 and 4, columns of width, depth, and area refer to the 7-Q-2 flow itself (described below), not the capacity of the channel.

II.C. BOUNDARIES AND NONPOINT SOURCES

Reliable flow on the Humboldt River occurs from three sources: early spring snowmelt from middle elevations (5000 to 7000 feet) above Palisade and mountain ranges below Palisade (March to April); high elevation snowmelt from the Ruby, Tuscarora, and Jarbidge mountain ranges (April to June); and releases from flood runoff stored in Rye Patch (from winter rain and spring snowmelt flood years). Sporadic sources of flow are summer thunderstorm runoff and rain-on-frozen ground or snow, winter and spring floods from low elevations.

As a result of these surface runoff patterns and irrigation practices, flows in the winter are extremely low or dry with ice cover. Spring flows are high and good quality. Fall flows are extremely low or dry. Only in the <u>irrigation season</u> (May through August) are surface waters available for recreational use and water quality conditions poor enough to affect these uses, (i.e., fishable, swimmable: 1985 goals). The worst water quality conditions occur in July and August when water temperatures are the highest, dissolved oxygen (DO) is low, aquatic plants have reached their maximum growth, and irrigation return flows have reached their maximum extent.

Daily flow records of all the USGS stations were analyzed statistically by the USGS (in Sacramento) for low flow-probability-duration statistics. Daily flows at selected stations are shown on plots for the Humboldt River during low flow years of 1961, 1966, and 1976 (Figures 3, 4, 5). The 7-day, 10-year low flow (7-Q-10) and the 7-day, 2-year low flow (7-Q-2) were analyzed by monthly and annual statistics. The 7-Q-10 statistics were zero or near zero annually and for all months except May, June, and July. Of irrigation season months, July has more consistent flows and the poorer water quality conditions similar to August. For modeling purposes, the flow probability (7-Q-2), representative of the normal irrigation season was used, since the

7-Q-10 flow is discontinuous (completely diverted at various locations and then replenished by ground-water inflow).

The Walker River flow regime is somewhat different than the Humboldt River. Much heavier precipitation occurs in the Sierra Nevada headwaters. The river channel has greater slopes and much shorter flow times. Both evaporation and channel seepage losses are much lower in the Walker system. However, critical water quality conditions still occur in July due to the simultaneous occurrence of high water temperatures, greatest biological activity, relatively low flows, and greatest surface and ground-water irrigation return flows.

USGS statistical analysis of daily flow records were used to determine 7-Q-10 and 7-Q-2. Daily flow plots for the Walker River during the low flow years of 1961, 1966, and 1976 are shown on Figures 6, 7, and 8. The 7-Q-2 for July was selected for modeling to allow direct comparisons with Humboldt River simulations.

II.C.1 FLOW ANALYSIS

Due to statistical inconsistencies in the records, flows at Palisade on the Humboldt, and Wabuska on the Walker, were used as controls. These inconsistencies in statistical flow, as compared to observed flows during any given year, are caused by different lengths of records, different time periods of records, different diversion practices over time, different reservoir release practices over time, and time of travel distortions (3 to 4 weeks on Humboldt and approximately 3 days on Walker). In most cases, only minor adjustments to the statistical flows were required to provide physically consistent flows from the headwaters to the terminus of the rivers.

The rivers were divided into reaches based on requirements for waste load allocation modeling and the availability of water quantity and quality data. Where possible, reach boundaries were set to coincide with monitoring sites. Since only rough interpolations of flow and water quality parameters were possible between sites, inflow and outflow was balanced between reach boundaries. Inflows come from surface water tributaries, ground water, and irrigation return flow. Outflows consisted of irrigation diversion, channel seepage, channel evaporation, and phreatophyte evapotranspiration (ET). In some reaches, reservoir storage and/or releases caused discontinuities in the river flow patterns (at Rye Patch, Topaz, and Weber Reservoirs).

Flow records were available for most tributaries in the Humboldt River Basin (North Fork Humboldt, Marys River, South Fork Humboldt, Maggie Creek, Susie Creek, Pine Creek, Rock Creek, Reese River, and Little Humboldt River). Estimates were required of flow contributions, based on basin characteristics, for Lamoille Creek, Star Creek, and other small tributaries in Reach 1. All other surface water inflows are intercepted by irrigation works or are too small to influence flow balancing calculations. It was also necessary to estimate local inflows on the West Walker (Reach 4). Releases for Lake Topaz were estimated from daily storage data. Other local inflows on the Walker River appeared to be negligible during July or intercepted by irrigators.

Phreatophyte-evapotranspiration (ET) was determined by using measurements in the Carson Basin, Fallon, and Winnemucca areas. An ET rate of approximately 2 inches per week in July was selected as representative. Actual losses due to ET in a reach were calculated using measured stream flow velocities, water surface width, reach length, and width of bank phreatophyte zones.

Diversions during the 50-percent flow probability (7-Q-2) were based on adjudicated water rights. Diversions during 7-Q-10 were based on flow balancing considerations and water right priorities. Irrigation returns were estimated from literature values and water quality data. An irrigation return of 40 percent of diversions was initially assumed for 7-Q-2 and 60 percent for 7-Q-10. A higher percent of irrigation return occurs during 7-Q-10 due to slow ground-water return from higher irrigation during preceding weeks. These initially assumed percentages had to be lowered in some reaches due to multiple reuse of irrigation return flow. Surface return flow quality was based on research in the Carson River Basin and California Central Valley. Subsurface water quality inflow was estimated from shallow well data in the vicinity of the rivers. This well data was obtained from USGS and Nevada State Division of Public Health Records.

II.C.2 WATER QUALITY ANALYSIS

All available water quality for temperature, dissolved oxygen (DO), biological oxygen demand (BOD), ammonia-nitrogen (NH3-N), nitrate-nitrogen (NO3-N), orthophosphate phosphorus (PO4-P), total dissolved solids (TDS), and total suspended solids (TSS) were plotted versus corresponding flow data. Due to the limited number of observations and random deviations from natural causes and measurement errors, all data from May, June, July, August, and September were grouped. A linear regression of TSS on turbidity was partially successful in providing additional TSS values. TSS measurements were limited and only available at two USGS stations

(Wabuska and Palisade), the Department of Environmental Quality Stations (Humboldt 1975-76), and from CH2M HILL's 1977 grab samples. These plots were used to determine the values of water quality parameters for the 7-Q-10 and 7-Q-2 at the reach boundaries. Where sufficient data existed, the values of water quality parameters were selected to represent July conditions. TDS was estimated for all inflows and outflows so that conservation of mass was maintained. The same mass conservation of TSS was not attempted since little consistent data were available and TSS can exhibit nonconservative behavior.

Values of water quality parameters were estimated at most reach boundaries even where data were deficient or nonexistent so that they were consistent with more reliable upstream and downstream stations. Table 5 summarizes the analysis of flow and water quality on Humboldt River basin and Table 6 of the Walker River basin.

II.D. METEOROLOGICAL

Meteorological data, at 3-hour intervals, were required for water temperature simulation. Air temperature, relative humidity, barometric pressure, cloudiness, and windspeed data were available in Reference 3. Data input to the model were based on mean monthly July conditions for first class weather stations at Elko, Battle Mountain, Winnemucca, Lovelock, and Reno. Atmospheric pressure was estimated from elevation and the standard atmosphere elevation-pressure relationships. Solar radiation data were taken from mean monthly values in Reference 4. Table 7 shows sample meteorological input to the temperature simulation model.

II.E. POINT SOURCES

Pollutant load concentrations for the model data base are shown in Tables 8 and 9. Point source concentrations were derived from National Pollutant Discharge Elimination system discharge permits and discharge monitoring reports, operation and maintenance waste treatment plant reports, and field sampling by CH2M HILL as outlined in TM 1-1 (Reference 1). Additional sampling of the plant effluents was conducted in October 1977. The values represented in Tables 8 and 9 reflect the present day load concentrations into the river system.

III. MODEL DESCRIPTION

The water quality model used on both the Humboldt River and the Walker River is RIVQUAL. RIVQUAL is CH2M HILL's modification of QUAL-III which was obtained by CH2M HILL from the Wisconsin Department of Natural Resources. QUAL-III is the result of many changes made by the Wisconsin Department of Natural Resources to QUAL-II, which they received from Water Resources Engineers, Inc. in 1973 (Ref 5). QUAL-II was developed by Water Resources Engineers under contract from USEPA. CH2M HILL modifications have been mainly improvements in the BOD and algae simulation routines in the model.

III.A. ADVECTION AND DIFFUSION OF FLUID MASSES

The RIVQUAL Model solves the advection dispersion mass transport equation for each water quality constituent being modeled. This equation considers the effects of advection, dispersion, individual constituent changes, and all sources or sinks for each constituent.

The Advection Dispersion Mass Transport Equation is written:

$$A_x dx \frac{\delta c}{\delta t} = \frac{\delta (A_x D_x \frac{c}{x})}{\delta_x} dx - \frac{\delta (A_x uc)}{\delta_x} dx + (A_x dx) \frac{dc}{dt} + S \qquad (1)$$

where:

c = concentration (mg/l)

x = distance (L)

t = time (T)

A_x = cross sectional area (L^2)

D_x = dispersion coefficient (L^2/t)

u = velocity (L/T)

S = source or sink (mg/l - L^3/T)

$\frac{dc}{dt}$ = physical, chemical, or biological reactions

III.B. TEMPERATURE SIMULATION

Temperature simulation is accomplished in the model by the heat budget approach that is described in the following equation and in greater detail by the Texas Water Board (Ref 6).

$$H_N = H_{SN} + H_{AN} - (H_b + H_c + H_e) \qquad (2)$$

where:

H_N = Net energy flux passing the air-water interface

H_{SN} = Net short-wave solar radiation flux passing through the interface after losses due to absorption and scattering in the atmosphere and by reflection at the interface.

H_{AN} = Net long-wave atmospheric radiation flux passing through the interface after reflection.

H_b = Outgoing long-wave back radiation flux.

H_c = Convective energy flux passing back and forth between the interface and the atmosphere.

H_e = Energy loss by evaporation.

This energy balance is performed for each time step for each reach of the model.

The inputs require detailed description of the cross section for each reach and the following meteorological data.

- Air Temperature
- Humidity
- Solar Radiation
- Wind Speed
- Atmospheric Pressure

Heat fluxes such as long-wave atmospheric radiation, water surface back radiation, evaporation, and convection are all calculated by the model from this data.

III.C. WATER QUALITY SIMULATION

The general forms of the equations for water quality are termed mass balance equations. They assist the modeler in the mathematical description of quality parameters which are occurring in the aquatic system. The ecosystem may be thought of as a series of fully mixed stream segments. This series of segments is integrated throughout the length of the stream by the advection and diffusion of fluid masses.

The mathematical descriptions are developed with certain coefficients which describe certain rates and levels. These coefficients are evaluated and defined by the calibration and verification process. Theoretical, laboratory, and field experiments are useful in defining basic coefficient ranges.

Any quantity routed through the model can do any of the following things:

1. Continue into the next stream reach with no change.

2. Be lost to the system due to any removal mechanism such as withdrawal or decay.

3. Enter the system from any waste input or tributary.

4. Be transformed into another substance by biological or chemical reactions.

The basic structure of the model used for Nevada 208 is shown in Figure 9. This flow diagram shows all the possible pathways of interaction and feedback in the model.

III.C.1. ALGAE

The differential equation that controls the growth and respiration of algae is:

$$\frac{d\ Algae}{dt} = Algae\ (G-R-D) \qquad (3)$$

where:

Algae = Algae concentration (mg/l)

G = Growth rate (Day^{-1})

R = Respiration rate (Day^{-1})

D = Death rate (day^{-1})

and,

$$G = GROMAX \cdot \theta^{TEMP-20} \cdot \frac{P}{CKP+P} \cdot$$

$$\frac{NH3+NO3}{CKN+NH3+NO3} \cdot \sigma_o \qquad (4)$$

where:

GROMAX = Maximum Growth Rate (Day^{-1})

θ = Temperature Correction Coefficient

P = Phosporous Concentration (mg/l)

CKP = P Half Saturation Constant (mg/l)

NH3 = Ammonia Concentration (mg/l)

NO3 = Nitrate Concentration (mg/l)

CKN = Nitrogen Half Saturation Constant (mg/l)

σ_o = Light Factor

and,

$$\sigma_o = \frac{e}{EXCOEF.DEPTH} (e^{-\sigma_1} - e^{-\sigma_2}) \qquad (5)$$

where:

EXCOEF = Extinction Coefficient (ft^{-1})

DEPTH = Depth (ft)

$$\sigma_1 = \frac{I_o}{CKL} e - EXCOEF \cdot DEPTH \qquad (6)$$

$$\sigma_2 = \frac{I_O}{CKL} \qquad (7)$$

I_o = Surface Light Intensity (Langleys)

CKL = Optimum Light Intensity (Langleys)

and,

$$R = RESPRT \cdot \theta^{TEMP-20} \qquad (8)$$

where:

R = Temperature corrected respiration rate (day^{-1})

RESPRT = Algae respiration rate (day^{-1})

θ = Temperature correction coefficient

Growth of algae is controlled by light, nitrogen, phosphorus, and temperature. Respiration is controlled by temperature and the death rate is constant. Nitrogen compounds are transformed by nitrification and algal uptake and release. There is also a possibility of nitrogen release during the decay of dead organic material. The equations that describe the nitrogen cycle follow:

III.C.2. AMMONIA

$$\frac{dNH3}{dt} = RNBOD \cdot K1 \cdot BOD - CKNH3 \cdot NH3 \cdot$$

$$ALPHA1 \left(\frac{NH3}{NH3+NO3} \right) (G - R) \cdot Algae$$

$$+ S_2 \qquad (9)$$

where:

RNBOD = mg N Released/mg BOD Consumed

K1 = BOD Delay Rate (Day^{-1})

CKNH3 = Nitrification Rate (Day^{-1})

ALPHA1 = mg N/mg Algae

III.C.3. NITRITE

$$\frac{dNO2}{dt} = CKNH3 \cdot NH3 - CKNO2 \cdot NO2 \qquad (10)$$

NO2 = Nitrite Concentration (mg/l)

CKNO2 = Nitrification Rate (Day^{-1})

III.C.4. NITRATE

$$\frac{dNO3}{dt} = CKNO_2 \cdot NO_2 -$$

$$ALPHAI \left(\frac{NO3}{NH3+NO3} \right) \cdot G \cdot Algae \qquad (11)$$

Phosphorus concentration is controlled by uptake and release by algae and possible release during the decay of dead organic material. The equation describing phosphorus is:

III.C.5. PHOSPHOROUS

$$\frac{dP}{dt} = RPBOD \cdot K1 \cdot BOD -$$

$$ALPHA2 \cdot (G-R) \cdot Algae \qquad (12)$$

where:

RPBOD = mg P/mg BOD Consumed

ALPHA2 = mg P/mg Algae

carbonaceous BOD increases with the death of algae and undergoes temperature-dependent decay. Carbonaceous BOD is described by the following equation.

III.C.6. CARBONACEOUS BOD

$$\frac{dBOD}{dt} = D \cdot Algae \cdot ALPHA3 - K1 \cdot BOD \qquad (13)$$

where:

ALPHA3 = mg OXYGEN/mg ALGAE

BOD = ULTIMATE BOD (mg/l)

Oxygen concentration depends on algal growth and respiration, BOD decay, and reaeration. The equation for the oxygen budget is:

$$\frac{dO}{dt} = K2\ (DOSAT-O) + (ALPHA3 \cdot G - ALPHA4 \cdot R) \cdot ALGAE - K1 \cdot BOD - ALPHA5 \cdot CKNH3 \cdot NH3 - ALPHA6 \cdot CKNO2 \cdot NO2 \qquad (14)$$

where:

O = Oxygen Concentration (mg/l)

ALPHA5 = mg O/mg N, NH3

ALPHA6 = mg O/mg N, NO2

IV. MODEL RUNS

Once the model was set up and the data base defined, various runs were made to test the model's ability to reproduce water quality observed in the rivers. The procedures used to adjust the model are described below.

IV.A. WATER TEMPERATURE

Dynamic simulation of water temperatures was performed for a 10-day period that represented fair, hot weather in July and August. For these runs the diurnal swings in water temperature were similar to those observed in the past. This run produced mean daily temperatures at the 7-Q-2 flow that were consistent with those shown in Table 5. These temperatures were then input in all steady-state runs using the 7-Q-2 flow.

IV.B. PARAMETER ESTIMATION

In order to apply RIVQUAL to the Humboldt and Walker rivers it is necessary to estimate the values of the parameters used in the construction of the model (Table 10). Literature values are used for most of these parameters (Ref 5). Three parameters were estimated specifically for the Humboldt and Walker Rivers.

The oxygen reaeration rate constant depends on the physical properties of the stream. The coefficient of reaeration has been calculated by both theoretical and empirical techniques by several investigators. Most of these are summarized in Ref 7 and Ref 8. Churchill's equation has been chosen for use in the Humboldt and Walker Rivers because it applies to the range of depths and velocities found in the rivers and it is the most conservative (it gives the lowest reaeration rates) of the possible choices.

The BOD decay rate was estimated from an actual measurement made in the Humboldt River at Lovelock.

The light extinction coefficient was estimated from observation of river transparency made on the field trip.

IV.C. ALGAE RUN

A 10-day dynamic run was made to simulate algae and its effects on the streams. Diurnal variation in temperature was simulated at the same time. Algae concentrations as high as 20 mg/l chlorophyll a produced no significant diurnal swing in dissolved oxygen concentration. It is apparent, then, that steady state runs are sufficient to describe water quality in the Humboldt and Walker Rivers. This lack of diurnal swing was expected because observed diurnal changes in the Humboldt River are very low and the lower reaches of the rivers are very turbid, thus blocking out the light required for algae growth.

IV.D. HUMBOLDT RIVER WITHOUT STP'S

A model run was made for existing conditions on the Humboldt River. The results are shown on Figures 10A through G. Nonpoint source waste loads were added to the river according to Table 8. No point sources were included for two reasons:

1. Under 7-Q-2 flow conditions, wastes from the STP's are not discharged into the river.

2. These runs were used to calculate allowable daily loads.

IV.E. WALKER RIVER

Figures 11A through G show the results of the model run for the Walker River. Nonpoint source waste loads were added to the river according to Table 9. No point sources were included because there are none on the river.

IV.F. HUMBOLDT WITH STP'S

Figures 12A through G show the results of the model run for both nonpoint sources and point sources on the Humboldt River. Waste characteristics for each of the point sources are shown in Table 11. The results show the minimal effect of the STP's on water quality in the river. Only Wells STP shows significant influences on the river since it is input to the headwater of the river which has very low flow in the 7-Q-2.

IV.G. SENSITIVITY

A sensitivity analysis was performed on both the Humboldt and Walker Rivers. The lack of effect of the point sources on water quality in the Humboldt River indicates that the nonpoint sources are critical in the control of water quality. It is expected that, in the future, best management practices will decrease these nonpoint source pollutants by about 20 percent. For the sensitivity analysis, therefore, a reduction and increase of nonpoint pollutants of 20 percent was run. The dashed lines on Figures 11C through 11G and 12C through 12G show the effect of these changes.

V. ALLOWABLE DAILY LOADS

The results of the model runs for the Humboldt River with no point sources and the Walker River were used to calculate allowable daily loads for each of the STP's (Wells, Elko, Carlin, Lovelock) and all other reaches of the rivers. The following method was used.

Q_r = Flow of river at location of STP (cfs)

C_r = Concentration of pollutant in river at location of STP (mg/l)

Q_w = Flow of effluent from STP (cfs)

C_w = Allowable concentration of waste in effluent from STP (mg/l)

S = Water quality standard concentration at location of STP (mg/l)

L = Allowable daily load (lb/day)

$$C_w = \frac{S(Q_r + Q_w) - Q_r C_r}{Q_w}$$

$$L = 5.4 \times C_w \times Q_w$$

The allowable daily loads at the reaches where the STP's are located are given in Tables 12 through 15. Tables 16 to 19 show the allowable loads by reach in both river systems. If the load is negative it means that the load must be reduced by that amount to meet the water quality standard.

REFERENCES

Ref 1. CH2M HILL, TM1-1. *Task A-Description of Data and Modeling Procedures for Humboldt and Walker Rivers*, July 1977.

Ref 2. U.S. Army Corps of Engineers. *Humboldt River and Tributaries - Nevada.* Design Memorandum No. 1 - Hydrology, Archive Files, Sacramento, September 1975.

Ref 3. Bennett, I. "Monthly Maps of Mean Daily Isolation for the United States." *Solar Engineering* 9:3, 1965.

Ref 4. National Climatic Center, Environmental Data Service, NDAA, Department of Commerce. *Climatological Data for Nevada.* Asheville, North Carolina.

Ref 5. Water Resources Engineers, Inc. *Computer Program Documentation for the Stream Quality Model Qual-II* October 1973.

Ref 6. Texas Water Development Board. *Simulation of Water Quality in Streams and Canals*: Report 128, May 1971.

Ref 7. Covar, A. P. *Selecting the Proper Reaeration Coefficient for use in Water Quality Models.* Environmental Modeling and Simulation Conference, Cincinnati, Ohio, 19-22 April 1976, EPA 600-76-016.

Ref 8. Rathbun, R. E. *Reaeration Coefficients of Streams -State-of-the-Art.* Journal of the Hydraulics Division, ASCE, April 1977. 409-424.

Table 1

REACHES OF THE HUMBOLDT RIVER

Study Reach	Model Reach	River Mile	Location
1	1-6	464	Wells
2	7	371	Elko
3	8-9	360	S. Fork Humboldt
4	10-11	338	Carlin
5	12-17	326	Palisade
6	18-20	241	Battle Mtn.
7	21-24	184	Comus
8	25-28	134	Winnemucca
9	29	74	Imlay Gage
10	30-31	54	Rye Patch
11	32	19	Lovelock
12	33	9	Humboldt Drain

Table 2

REACHES OF THE WALKER RIVER

Study Reach	Model Reach	River Mile	Location
1	1	117	State Line
2	2-3	100	Hoye Canyon
3	8-9	71	Confluence
3A	4-5	67	State Line
3B	6-7	35	Strosnider Ditch
4	10-11	46	Wabuska Gage
5	12	25	Weber Reservoir
6	13	14	Schurz

Table 3

HUMBOLDT RIVER
MODEL PHYSICAL DESCRIPTION

Reach	Location	Flow 7Q2	Lg. (mi)	Slope ft/ft	Manning's N	Width (ft)	Depth (ft)	Area (ft^2)
1(1)	Wells to Bishop Cr.	2	13	.0022	.04	5	0.4	2
2(1)	Bishop Cr. to Marys R.	5	16	.0012	.04	10	0.6	6
3(1)	Marys R. to Rasid	25	13	.00095	.04	20	1.1	22
4(1)	Rasid to Elburz	70	17	.00088	.04	40	1.4	56
5(1)	Elburz to Elko Gage	80	14	.00060	.04	50	1.5	75
6(1)	Elko Gage to Elko	105	20	.00097	.04	90	0.9	81
7(2)	Elko to S.F. Humboldt	104	11	.00086	.03	70	0.8	59
8(3)	S.F. Humboldt to Carlin Gage	218	13	.00085	.035	100	1.2	120
9(3)	Carlin Gage to Carlin	215	9	.00088	.03	110	1.1	121
10(4)	Carlin to Tyrol	220	5	.00064	.03	120	1.2	144
11(4)	Tyrol to Palisade Gage	223	7	.0013	.03	120	1.1	130
12(5)	Palisade Gage to Harney	226	11	.00090	.03	100	1.2	120
13(5)	Harney to Beowawe	210	13	.0013	.03	100	1.0	100
14(5)	Beowawe to Dunphy	200	16	.00060	.04	100	1.7	170
15(5)	Dunphy to Argenta Gage	180	14	.00070	.04	100	1.2	120
16(5)	Argenta Gage to Argenta	185	19	.00048	.04	110	1.3	145
17(5)	Argenta to Battle Mtn.	210	12	.00090	.04	110	1.3	145
18(6)	Battle Mtn. to Mote	225	18	.00047	.04	110	1.8	194
19(6)	Mote to Ellison	200	20	.00046	.04	110	1.7	182
20(6)	Ellison to Comus Gage	250	19	.00048	.04	115	1.8	212
21(7)	Comus Gage to Golconda	275	14	.00027	.04	100	2.5	250
22(7)	Golconda to Eglon	270	11	.00028	.04	100	2.5	250
23(7)	Eglon to Tule	280	14	.00027	.04	80	2.8	224
24(7)	Tule to Winnemucca	290	11	.00026	.04	80	3.2	256
25(8)	Winnemucca to Rose Creek	294	19	.00055	.04	110	2.2	242
26(8)	Rose Creek to Cosgrave	270	17	.00050	.04	130	2.9	372
27(8)	Cosgrave to Mill City	250	14	.00041	.04	140	2.9	412
28(8)	Mill City to Imlay Gage	232	10	.00057	.04	150	1.4	203
29(9)	Imlay Gage to Rye Patch Gage	300	20	.00058	.03	200	2.0	400
30(10)	Rye Patch Gage to Woolsey	392	19	.00069	.035	100	2.0	200
31(10)	Woolsey to Lovelock	200	16	.00047	.035	100	1.6	160
32(11)	Lovelock to Humboldt Gage	70	10	.00087	.035	50	1.1	55
33(12)	Humboldt Gage to Sink	10	9	.00090	.035	20	0.6	12

Table 4

WALKER RIVER
MODEL PHYSICAL DESCRIPTION

Reach	Location	Flow 7Q2	Lg. (mi)	Slope ft/ft	Manning's N	Width (ft)	Depth (ft)	Area (ft^2)
1(1)	West Walker Stateline to Hoye Canyon	456	17	.00078	.035	100	9.5	950
2(2)	Hoye Canyon to Wilson Canyon	381	17	.0035	.04	80	1.6	128
3(2)	Wilson Canyon to Confluence	268	12	.0033	.04	85	1.3	108
4(3A)	East Walker Stateline to Rough Creek	262	13	.0058	.05	55	1.6	88
5(3A)	Rough Creek to Flying M Ranch	260	19	.0071	.045	50	1.5	75
6(3A)	Flying M Ranch to Strosnider Ditch Gage	257	20	.0030	.04	40	2.3	90
7(3B)	Strosnider Ditch Gage to Confluence	116	15	.0017	.04	38	1.6	61
8(3)	Confluence to Yerington	384	11	.00075	.035	70	2.3	160
9(3)	Yerington to Wabuska Gage	200	14	.0015	.035	45	1.8	80
10(4)	Wabuska Gage to Head of Weber Reservoir	105	17	.00072	.035	40	1.6	63
11(4)	Head of Weber Reservoir to Weber Dam	102	4	.00052	.03	30	2.1	63
12(5)	Weber Dam to Schurz	40	11	.0013	.04	30	1.1	32
13(6)	Schurz to Walker Lake	29	14	.0020	.04	20	0.9	18

Table 5

HUMBOLDT RIVER BOUNDARY CONDITIONS AND NONPOINT SOURCE CONCENTRATIONS

Reach Name and Number	Inflow/ Outflow	Flow (CFS)		TDS (mg/l)		TSS (mg/l)		Temp (°C)		DO (mg/l)		BOD (mg/l)		NH3-N (mg/l)		NO3-N (mg/l)		PO4-P (mg/l)	
		7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10
Wells		1.5	.5	300	400					9.0		2.2		.10		0.2		.07	.06
	Return Flow	7.5	3.6	400	400	0.0	0.0			9.0		2.4		.05		0.15		.07	
	North Fork	22.0	3.3	270	350	14.0	14.0	23.0	24.0	8.5	8.5	2.2	2.2	.10	.10	0.2		.06	.05
1	Marys River	19.0	1.3	230	320	15.0	20.0	22.0	23.0	9.2		2.6	2.6	.12		0.2		.06	.05
	Local Inflow	76.0	0.1	293	350	15.0				9.0		2.4		.08		0.2		.07	
	E.T.	6.0	6.0	--	--														
	Diversions	15.0	0.0	350	370														
Elko		105.0	2.8	350	370	28.0	30.0	23.0	23.0	9.0		2.4	2.8	.03	.13	0.2		.07	.04
	Return Flow	1.0	2.0	600	600	0.0				8.5		2.5		.05		.15		.08	
	Local Inflow	0.0	0.0	--	--														
2	E.T.	2.0	1.0	--	--														
	Diversions	0.0	0.0	--	--														
Above South Fork		104.0	3.8	360	400														
	Return Flow	2.0	3.7	500	500	0.0	0.0			7.0		2.0		.05		.20		.07	
	South Fork	114.0	7.0	225	300	25.0	27.0	23.0	25.0	8.0		1.0	2.6	.02		.20		.06	
3	Local Inflow	0.0	0.0	--	--														
	E.T.	5.0	3.0	--	--														
	Diversions	0.0	0.0	--	--														
Carlin		215.0	11.5	300	410	28.0	28.0	22.0	25.0	8.0		1.6	2.4	.05		0.2		.08	.06
	Return Flow	0.0	0.0	--	--														
	Susie Creek	1.0	0.1	290	320					7.0		1.0		.05		.10		.06	
4	Maggie Creek	3.0	0.2	290	320					7.0		1.0		.05		.10		.06	
	Local Inflow	10.0	7.0	350	300					7.0		1.0		.05		.10		.06	
	E.T.	3.0	1.0	--	--														
	Diversions	0.0	0.0	--	--														

Table 5 - [illegible]cinued

Reach Name and Number	Inflow/ Outflow	Flow (CFS)		TDS (mg/l)		TSS (mg/l)		Temp (°C)		DO (mg/l)		BOD (mg/l)		NH3-N (mg/l)		NO3-N (mg/l)		PO4-P (mg/l)	
		7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10
Palisade		226.0	17.8	300	390	30.0	30.0	22.0	25.0	7.8		1.3	3.2	.08		0.5	0.8	.07	.05
	Return Flow	7.5	4.7	440	500					7.0		2.5		.05		.20		.10	
5A	Pine Creek	2.5	0.1	400	600					7.0		2.5		.05		.20		.10	
	E.T.	34.0	20.0	--	--														
	Diversions	15.0	0.0	300	--														
Argenta		185.0	2.6	350	450														
	Return Flow	74.0	26.4	398	650					7.0		2.5		.05		.20		.10	
5B	Rock Creek	6.0	0.0	400	--	100.0				7.0		2.5		.05		.20		.10	
	E.T.	10.0	22.0	--	--														
	Diversions	0.0	0.0	--	--														
Battle Mtn.		225.0	7.0	370	520	100.0	80.0	22.0	24.0			2.3	3.0			1.0	0.9	.10	.04
	Return Flow	66.0	10.4	723	750					6.0		2.5		.05		.20		.10	
6	E.T.	25.0	15.0	--	--														
	Diversions	21.0	0.0	--	--														
Comus		275.0	2.4	480	630	100.0	80.0	22.0	24.0			2.0	3.7			0.4		.07	.05
	Return Flow	54.0	22.0	671	700					6.0		2.5		.05		.20		.10	
7	E.T.	20.0	20.4	--	--														
	Diversions	15.0	0.0	--	--														
Winnemucca		294.0	4.0	565	700														
	Return Flow	5.0	20.0	700	700					6.0		2.5		.05		.20		.10	
8	G.W. Loss	27.0	0.0	600	720														
	E.T.	20.0	11.0	--	--														
	Diversions	10.0	0.0	--	--														

Table 5 - Continued

Reach Name and Number	Inflow/ Outflow	Flow (CFS)		TDS (mg/l)		TSS (mg/l)		Temp (°C)		DO (mg/l)		BOD (mg/l)		NH3-N (mg/l)		NO3-N (mg/l)		PO4-P (mg/l)	
		7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10
Imlay		232.0	13.0	660	750	50.0	100.0	23.0	25.0			2.5	2.8			0.6	0.5	.09	.03
	Return Flow	0.0	0.0	--	--														
9	E.T.	46.0	20.0	--	--														
	G.W. Loss	2.0	0.0	710	--														
	Res. Release	192.0	24.0	710	710			23.0		6.0		2.5		.05		.25		.10	
Rye Patch		392.0	17.0	710	710	35.0	35.0	23.0	25.5							1.2	0.5		
	E.T.	11.0	11.0	--	--														
10	Diversions	292.0	0.0	765	--														
Lovelock (City)		70.0	6.0	785	1,200	35.0								.07		0.6	0.5	.10	.03
	Return Flow	6.0	0.0	1,500	--					6.0		2.5		.05		.25		.10	
11	E.T.	12.0	6.0	--	--														
	Diversions	57.7	0.0	990	--														
Humboldt Drain		6.3	0.0	1,100	--			30.0	30.0				2.5			1.5		.20	

Table 6

WALKER RIVER BOUNDARY CONDITIONS AND NONPOINT SOURCE CONCENTRATIONS

Reach Name and Number	Inflow/ Outflow	Flow (CFS)		TDS (mg/l)		TSS (mg/l)		Temp (°C)		DO (mg/l)		BOD (mg/l)		NH3-N (mg/l)		NO3-N (mg/l)		PO4-P (mg/l)	
		7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10
West Walker at State-line	Total	456	137	68	78	24	12	20	26	8.8	8.2	1.0	1.0	.02	.9	.11	.2	.05	.05
	Coleville	389	55	70	80	25	10	20	26	9.0	8.2	1.0	1.0	<.05	.1	.1	.2	.05	.05
	Lake Topaz	67	82	60	60	20	20	21	25	8.0	8.0	1.0	1.0	<.05	.05	.2	.2	.03	.03
	Return Flow	49	30	157	154					7.0		3.0		.05		.10		.10	
	Local Inflow	0	0																
1	E.T.	1	1																
	Diversions	123	50	70	80														
Hoye Bridge W. Walker		381	116	80	100	30	20	21	27	7.5	8.0	1.5	1.8	<.05	.1	.2	.3	.05	.06
	Return Flow	72	51	336	305					7.0		3.5		.05		.10		.10	
	Local Inflow	0	0																
2	E.T.	5	5																
	Diversions	180	85	80	100														
Above Confluence W. Fork (Hudson)		268	77	150	210	30	40	21	28	8.0	7.9	2.0	2.0	<.05	.12	.2	.3	.05	.06
East Walker Stateline		262	80	250	250	150	100	21	22	8.1	8.1	1.7	1.7	.02	.05	.2	.3	.10	.10
	Return Flow	19	8	347	350					7.5		4.0		.05		.15		.20	
3A	Local Inflow	34	0	350	0	45		75		8.0		1.0		.02	.05	.2		.10	.10
	E.T.	10	10	0	0														
	Diversions	48	0	250	0														

Table 6 - Continued

Reach Name and Number	Inflow/ Outflow	Flow (CFS)		TDS (mg/l)		TSS (mg/l)		Temp (°C)		DO (mg/l)		BOD (mg/l)		NH3-N (mg/l)		NO3-N (mg/l)		PO4-P (mg/l)	
		7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10
Strosnider		257	78	280	290	170	100	22	27	8.0	7.5	2.0	2.0	<.05	<.05	.3	.3	.10	.10
	Return Flow	2	3	250	400					7.5		4.0		.05		.15		.20	
3B	Local Inflow	0	0																
	E.T.	2	2																
	Diversion	141	76	280	290														
E. Walker Above Confluence		116	3	282	400	175	100	25	28	8.0	7.0	2.2	2.2	<.05	<.05	.3	.4	.10	.06
Walker River Below Confluence		384	80	190	217	100	50	24	28	8.0	7.0	2.3	2.1	<.05	.10	.4	.4	.10	.06
	Return Flow	57	87	445	440					7.0		3.0		.10		.20		.20	
4	Local Inflow	0	0																
	E.T.	6	6																
	Diversion	330	145	190	430														
Wabuska (J.J. Ranch)		105	16	340	430	200	200	27.5	29	7.9	7.0	2.4	3.0	.05	.05	.5	.5	.11	.06
	Return Flow	0	0																
5	Local Inflow	0	0																
	E.T.	4	2																
	Diversion	0	0																

Table 6 - Continued

Reach Name and Number	Inflow/ Outflow	Flow (CFS)		TDS (mg/l)		TSS (mg/l)		Temp (°C)		DO (mg/l)		BOD (mg/l)		NH3-N (mg/l)		NO3-N (mg/l)		PO4-P (mg/l)	
		7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10	7Q2	7Q10
Weber Res. Outflow		101	14	353	491	200	200	28	29	7.9	7.0	2.5	3.1	.05	.05	.6	.6	.12	
	Return Flow	20	15	500	700					5.0		3.0		.06		.15		.15	
6	Res. Storage	61	-3	353	353														
	E.T.	1	1																
	Diversion	30	30	353	500														
Schurz		29	1	600	650	210	2	29	29	7.0	7.0	2.5	3.0	.05	.05	.6	.6	.11	.09
	Return Flow	5	0	500															
	E.T.	2	1																
	Diversion	10	0																
Inflow to Walker Lake		22	0	420		200		30		7.0		2.5		.05		.4		.06	.06

Table 7
Sample Meteorological Data for Temperature Simulation
July Conditions, Winnemucca

Time	Solar Radiation (Langleys/hr)	Cloudiness (Tenths)	Air Temperature (°F)	Wet Bulb Temperature (°F)	Barometric Pressure (inches Hg)	Windspeed Knots
0000L-0300L	0.	.3	55.0	43.	25.	4.8
0300L-0600L	0.	.3	51.0	42.	25.	6.0
0600L-0900L	42.7	.3	65.0	45.	25.	8.4
0900L-1200L	74.7	.3	80.0	55.	25.	11.5
1200L-1500L	74.2	.3	90.0	65.	25.	12.0
1500L-1800L	41.5	.3	93.4	66.	25.	9.2
1800L-2100L	0.	.3	75.0	52.	25.	7.5
2100L-2400L	0.	.3	60.0	45.	25.	5.0

Battle Mtn. to Comus	18-20	57								
Return Flow			19-1	66.0	723.	6.0	2.5	.05	.20	.10
ET			19-19	25.0						
Diversions			19-20	21.0						
Comus to Winnemucca	21-24	50								
Return Flow			23-1	54.0	671.	6.0	2.5	.05	.20	.10
ET			23-6	20.0						
Diversions			23-7	15.0						
Winnemucca to Imlay	25-28	60								
Return Flow			27-1	5.0	600.	6.0	2.5	.05	.20	.10
Ground-water Loss			27-2	27.0						
ET			27-3	20.0						
Diversions			27-4	10.0						
Imlay to Rye Patch Gage	29	20								
ET			29-19	46.0						
Groundwater Loss			29-10	2.0						
Reservoir Inflow (release)			29-20	192.0	710.	8.0	2.5	.05	.25	.10
Rye Patch to Lovelock	30-31	35								
ET			31-14	11.0						
Diversions			31-15	292.0						
Lovelock to Humboldt Gage	32-33	19								
Return Flow			33-9	6.0	1500.	6.0	2.5	.05	.25	.10
ET			33-8	12.0						
Lovelock STP			32-1	.36	667.	8.0	165.	40.	0.	7.0

Table 8

HUMBOLDT RIVER
POLLUTANT LOAD CONCENTRATIONS

	Reaches	Miles	Flow Reach Elem.	Flow cfs	TDS mg/l	DO mg/l	BOD mg/l	NH_3-N mg/l	NO_3-N mg/l	PO_4-P mg/l
Wells to Elko	1-6	93								
Headwater Flow			1-1	1.5	300.	9.0	2.2	.10	0.2	.07
Wells STP			1-1	.32	545.	9.0	29.	7.5	4.4	5.3
Return Flow			6-19	7.5	400.	9.0	2.4	.05	.15	.07
Marys River			3-1	19.0	230.	9.2	2.6	.12	0.2	.06
Lamoille Creek			4-13	76.0	293.	9.0	2.4	.08	0.2	.07
ET			6-18	6.0						
Diversions			6-20	15.0						
North Fork			5-3	22.0	270.	8.5	2.2	.10	0.2	.06
Elko to above S. Fork	7	11								
Return Flow			7-11	1.0	600.	8.5	2.5	.05	.15	.08
Elko STP			7-1	2.35	687.	8.5	3.5	7.5	4.4	5.3
ET			7-10	2.0						
Above S. Fork to Carlin	8-9	22								
Return Flow			9-9	2.0	500.	7.0	2.0	.05	0.2	.07
South Fork			8-1	114.0	225.	8.0	1.0	.02	0.2	.06
ET			9-8	5.0						
Carlin to Palisade	10-11	12								
Carlin STP			10-1	.25	823.	8.0	5.0	4.2	.09	.84
Susie Creek			10-1	1.0	290.	7.0	1.0	.05	.10	.06
Maggie Creek			10-2	3.0	290.	7.0	1.0	.05	.10	.06
Local Inflow			11-7	10.0	350	7.0	1.0	.05	.10	.06
ET			11-6	3.0						
Palisade to Argenta Gage	12-15	54								
Return Flow			15-3	7.5	440.	7.0	2.5	.05	.20	.10
Pine Creek			12-1	2.5	400.	7.0	2.5	.05	.20	.10
ET			15-12	34.0						
Diversions			15-14	15.0						
Nevada Barth Discharge			12-5	.41	395.					
Argenta to Battle Mtn.	16-17	21								
Return Flow			17-11	74.0	398.	7.0	2.5	.05	.20	.10
Rock Creek			17-12	6.0	400.	7.0	2.5	.05	.20	.10
ET			17-10	10.0						

ET			7-13	2.						
Confluence to Yerington	8	11								
Diversions										
Return Flow										
ET										
Yerington to Wabuska Gage	9	14								
Diversions			9-2	330.						
Return Flow			9-1	57.	445.	7.0	3.0	.10	.20	.20
ET			9-13	6.						
Wabuska Gage to Head Weber Reservoir	10	17								
Diversions										
Return Flow										
ET			10-17	4.						
Weber Reservoir	11	4								
ET										
Storage Diversion			11-1	61.						
Weber Res. Dam to Schurz	12	11								
Diversions			12-8	30.						
Return Flow			12-7	20.	500.	5.0	3.0	.06	.15	.15
ET			12-10	1.						
Schurz to Walker Lake	13	14								
Diversions			13-3	10.						
Return Flow			13-4	5.						
ET			13-10	2.						

WALKER RIVER
POLLUTANT LOAD CONCENTRATIONS

	Reaches	Miles	Flow: Reach Elem.	Flow: cfs	TDS mg/l	DO mg/l	BOD mg/l	NH_3-N mg/l	NO_3-N mg/l	PO_4-P mg/l
Stateline West Walker to Hoye Canyon	1	17	1-1	456.	68.	8.8	1.0	.02	.11	.05
Headwater			1-1	456.	68.	8.8	1.0	.02	.11	.05
Return Flow			1-10	49.	157.	7.0	3.0	.05	.10	.10
ET			1-17	1.						
Diversions			1-11	123.						
Hoye Canyon to Wilson Canyon	2	17								
Return Flow										
ET										
Diversions			2-5	90.						
Wilson Canyon to Confluence	3	12								
Return Flow			3-7	72.	336.	7.0	3.5	.05	.10	.10
ET			3-11	5.						
Diversions			3-8	90.						
Stateline East Walker to Rough Creek	4	13								
Headwater			4-1	262.	250.	8.1	1.7	.02	.2	.10
Local Inflow			4-7	34.	350.	8.0	1.0	.02	.2	.10
ET										
Rough Creek to Flying M Ranch	5	19								
Diversions										
Return Flow										
ET										
Flying M Ranch to Strosnider Gage	6	20								
Diversions			6-19	48.						
Return Flow			6-18	19.	347.	7.5	4.0	.05	.15	.20
ET			6-20	10.						
Strosnider Gage to Confluence	7	15								
Diversions			7-2	141.						
Return Flow			7-1	2.	250.	7.5	4.0	.05	.15	.20

Table 10

MODEL PARAMETERS

Reaeration (day^{-1})	K_2	*
BOD Decay (day^{-1})	K_1	.06
N/BOD (mg N/mg O)	RNBOD	.047
P/BOD (mg P/mg O)	RPBOD	.0072
$NH_3 \rightarrow NO_2$ (day^{-1})	CKNH3	.18
$NO_2 \rightarrow NO_3$ (day^{-1})	CKNO2	1.0
CHLA/ALGAE (μgChl/mg A)	ALPHAO	50
N/A (mg N/mg A)	ALPHA1	.085
P/A (mg N/mg A)	ALPHA2	.013
O/A GROWTH (mg O/mg A)	ALPHA3	1.8
O/A RESPIRATION (mg O/mg A)	ALPHA4	1.8
O/N, NH_3 (mg O/mg N)	ALPHA5	3.5
O/N, NO_2 (mg O/mg N)	ALPHA6	1.14
GROWTH (day^{-1})	GROMAX	1.0
RESPIRATION (day^{-1})	RESPRT	0.1
EXTINCTION (ft^{-1})	EXCOEF	*
HALFSAT,N mg N	CKN	.30
HALFSAT,P mg P	CKP	.04
LIGHT CONSTANT LANGLEYS	CKL	.13
TEMP CORRECTION	θ	1.024

*VARIABLE BY REACH

Table 11

PRESENT WASTE CHARACTERISTICS

STP	Flow (cfs)	TDS (mg/l)	DO (mg/l)	BOD (mg/l)	NH3-N (mg/l)	NO3-N (mg/l)	P (mg/l)
Wells	.32[1]	545[2]	9.0[4]	29[1]	7.5[5]	4.4[5]	5.3[5]
Elko	2.35[1]	687[3]	8.5[4]	3.5[3]	7.5[6]	4.4[3]	5.3[3]
Carlin	.25[1]	823[3]	8.0[4]	5.0[3]	4.2[6]	.09[3]	.84[3]
Lovelock	.36[1]	667[2]	8.0[4]	165[1]	40[7]	0[4]	7[4]

1. ST&R
2. TM1-1
3. CH2M HILL field trip
4. Estimated
5. NH_3 + organic nitrogen
6. Assumed same as Elko
7. Estimated NH_3 + organic nitrogen

Table 12

ALLOWABLE DAILY LOADS

STP LOCATION: Wells
RIVER FLOW: 2 cfs

Pollutant	Model Concentration (mg/l)	Standard 1 (mg/l)	Standard 2 (mg/l)	Allowable Load 1 (lb/day)	Allowable Load 2 (lb/day)	Present STP Load (lb/day)
TDS	300	500	320	2,160	216	942
BOD_5	2.0	None	3.0	N/A	11	50
NO3-N	.20	None	.23	N/A	.6	8
PO4-P	.05	.33	.11	3.0	.8	9

CONTROL POINT USED: Above Elko
STANDARD 1: Existing-Class C
STANDARD 2: Proposed-Annual Average
LOAD 1: Based on Standard 1
LOAD 2: Based on Standard 2

Table 13

ALLOWABLE DAILY LOADS

STP LOCATION: Elko
RIVER FLOW: 106 cfs

Pollutant	Model Concentration (mg/l)	Standard 1 (mg/l)	Standard 2 (mg/l)	Allowable Load 1 (lb/day)	Allowable Load 2 (lb/day)	Present STP Load (lb/day)
TDS	300	500	320	85,860	28,620	8,718
BOD_5	1.8	None	3.0	N/A	725	44
NO3-N	.17	None	.23	N/A	31	56
PO4-P	.07	.33	.11	149	24	67

CONTROL POINT USED: Above Elko
STANDARD 1: Existing-Class C
STANDARD 2: Proposed-Annual Average
LOAD 1: Based on Standard 1
LOAD 2: Based on Standard 2

Table 14

ALLOWABLE DAILY LOADS

STP LOCATION: Carlin
RIVER FLOW: 216 cfs

Pollutant	Model Concentration (mg/l)	Standard 1 (mg/l)	Standard 2 (mg/l)	Allowable Load 1 (lb/day)	Allowable Load 2 (lb/day)	Present STP Load (lb/day)
TDS	273	500	350	264,773	89,813	1,111
BOD_5	1.2	None	3.0	N/A	2,103	7
NO3-N	.17	None	.23	N/A	59	.1
PO4-P	.07	.33	.13	303	70	1

CONTROL POINT USED: At Palisade Gage
STANDARD 1: Existing-Class C
STANDARD 2: Proposed-Annual Average
LOAD 1: Based on Standard 1
LOAD 2: Based on Standard 2

Table 15

ALLOWABLE DAILY LOADS

STP LOCATION: Lovelock
RIVER FLOW: 89 cfs

Pollutant	Model Concentration (mg/l)	Standard 1 (mg/l)	Standard 2 (mg/l)	Allowable Load 1 (lb/day)	Allowable Load 2 (lb/day)	Present STP Load (lb/day)
TDS	666	500	None	0.0	N/A	1,296
BOD_5	.5	None*	None**	N/A	N/A	321
NO3-N	.25	None	None	N/A	N/A	0
PO4-P	.12	.33	None	101	N/A	14

CONTROL POINT USED: Below Rye Patch
STANDARD 1: Annual Average
STANDARD 2: Single Value
LOAD 1: Based on Standard 1
LOAD 2: Based on Standard 2

*Minimum DO 5.0 mg/l
**Minimum DO 3.0 mg/l

Humboldt River Allowable Loads by Reach
Existing Standards

	DO		BOD_{ult}			PO_4			NO_3			TDS		
Reach	Standard (mg/l)	Model Value (mg/l)	Standard (mg/l) ($4 \times BOD_5$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.33 \times PO_4 - PO_4$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.23 \times NO_3 - NO_3$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l)	Model Value (mg/l)	Allowable Load (lb/day)
1	5.0	8.7	None	8.3	N.A.	.33	.05	3	None	.20	N.A.	500	300	2,160
2	5.0	8.5	None	7.1	N.A.	.33	.05	3	None	.21	N.A.	500	300	2,160
3	5.0	8.4	None	3.9	N.A.	.33	.06	4	None	.23	N.A.	500	300	2,160
4	5.0	8.2	None	3.6	N.A.	.33	.07	29	None	.16	N.A.	500	237	29,824
5	5.0	8.6	None	8.9	N.A.	.33	.07	136	None	.16	N.A.	500	281	114,712
6*	5.0	8.4	None	8.1	N.A.	.33	.07	167	None	.16	N.A.	500	279	142,015
7	5.0	8.3	None	7.4	N.A.	.33	.07	149	None	.17	N.A.	500	300	114,480
8	5.0	8.3	None	7.1	N.A.	.33	.07	147	None	.17	N.A.	500	309	103,297
9	5.0	8.1	None	5.1	N.A.	.33	.07	307	None	.16	N.A.	500	265	277,911
10	5.0	8.1	None	5.0	N.A.	.33	.07	303	None	.17	N.A.	500	273	264,773
11	5.0	8.0	None	4.8	N.A.	.33	.07	309	None	.17	N.A.	500	274	268,483
12*	5.0	8.0	None	4.6	N.A.	.33	.07	319	None	.17	N.A.	500	281	268,450
13	5.0	8.0	None	4.4	N.A.	.33	.07	322	None	.17	N.A.	500	282	269,579
14	5.0	8.1	None	4.1	N.A.	.33	.07	322	None	.17	N.A.	500	282	269,579
15	5.0	8.0	None	3.5	N.A.	.33	.08	309	None	.17	N.A.	500	282	269,579
16	5.0	8.0	None	4.0	N.A.	.33	.08	254	None	.20	N.A.	500	335	167,508
17*	5.0	8.0	None	3.7	N.A.	.33	.09	244	None	.20	N.A.	500	335	167,508
18	5.0	7.7	None	5.6	N.A.	.33	.09	334	None	.21	N.A.	500	368	183,902
19	5.0	7.8	None	4.8	N.A.	.33	.10	320	None	.20	N.A.	500	368	183,902
20*	5.0	7.8	None	5.6	N.A.	.33	.10	345	None	.22	N.A.	500	477	34,528
21	5.0	7.8	None	4.7	N.A.	.33	.10	345	None	.21	N.A.	500	477	34,528
22	5.0	7.8	None	4.1	N.A.	.33	.10	345	None	.21	N.A.	500	477	34,528
23	5.0	7.8	None	3.6	N.A.	.33	.11	330	None	.21	N.A.	500	477	34,528
24	5.0	7.8	None	4.5	N.A.	.33	.11	353	None	.22	N.A.	500	541	-65,756
25	5.0	7.8	None	4.0	N.A.	.33	.11	353	None	.22	N.A.	500	541	-65,756
26	5.0	7.9	None	3.3	N.A.	.33	.11	353	None	.21	N.A.	500	541	-65,756
27*	5.0	7.9	None	2.6	N.A.	.33	.11	353	None	.21	N.A.	500	541	-65,756
28	5.0	7.9	None	2.4	N.A.	.33	.11	291	None	.22	N.A.	500	585	-112,455
29*	5.0	7.2	None	3.0	N.A.	.33	.12	496	None	.23	N.A.	500	578	-184,064
30	5.0	7.6	None	2.7	N.A.	.33	.12	441	None	.25	N.A.	500	647	-308,788
31	5.0	7.9	None	2.4	N.A.	.33	.12	441	None	.25	N.A.	500	647	-308,788
32	5.0	8.0	None	2.3	N.A.	.33	.12	100	None	.26	N.A.	500	666	-78,933
33	5.0	8.1	None	2.1	N.A.	.33	.12	101	None	.25	N.A.	500	666	-79,829

*Water Quality Control Point

Humboldt River Allowable Loads by Reach
Proposed Standards

	DO		BOD_{ult}			PO_4			NO_3			TDS		
Reach	Standard (mg/l)	Model Value (mg/l)	Standard (mg/l) ($4xBOD_5$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.33xPO_4-PO_4$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.23xNO_3-NO_3$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l)	Model Value (mg/l)	Allowable Load (lb/day)
1	7.0	8.7	12.0	8.3	40	.11	.05	1	.23	.20	0	320	300	216
2	7.0	8.5	12.0	7.1	53	.11	.05	1	.23	.21	0	320	300	215
3	7.0	8.4	12.0	3.9	89	.11	.05	1	.23	.23	0	320	300	216
4	7.0	8.2	12.0	8.6	384	.11	.06	6	.23	.16	8	320	237	9,412
5	7.0	8.6	12.0	8.9	1,624	.11	.07	21	.23	.16	37	320	281	20,423
6*	7.0	8.4	12.0	8.1	2,508	.11	.07	26	.23	.16	45	320	279	26,347
7	7.0	8.3	12.0	7.4	2,682	.13	.07	34	.23	.17	35	350	300	28,620
8	7.0	8.3	12.0	7.1	2,832	.13	.07	34	.23	.17	35	350	309	23,247
9	7.0	8.1	12.0	5.1	8,232	.13	.07	71	.23	.16	84	350	265	100,521
10	7.0	8.1	12.0	5.0	8,239	.13	.07	70	.23	.17	71	350	273	89,813
11	7.0	8.0	12.0	4.8	8,633	.13	.07	71	.23	.17	72	350	274	90,258
12*	7.0	8.0	12.0	4.6	9,154	.13	.07	74	.23	.17	74	350	281	84,550
13	7.0	8.0	12.0	4.4	9,523	.13	.07	75	.23	.17	75	425	282	176,834
14	7.0	8.1	12.0	4.1	9,899	.13	.07	75	.23	.17	75	425	282	176,834
15	7.0	8.0	12.0	3.5	10,651	.13	.07	75	.23	.17	75	425	282	176,834
16	7.0	8.0	12.0	4.0	8,208	.13	.08	51	.23	.20	31	425	335	91,368
17*	7.0	8.0	12.0	3.7	8,516	.13	.08	51	.23	.20	30	425	335	91,368
18	7.0	7.7	12.0	5.6	8,986	.17	.09	111	.23	.21	28	500	368	183,902
19	7.0	7.8	12.0	4.8	10,109	.17	.09	111	.23	.20	42	500	368	183,902
20*	7.0	7.8	12.0	5.6	9,677	.17	.10	105	.23	.22	15	500	477	34,523
21	7.0	7.8	12.0	4.7	11,038	.17	.10	105	.23	.21	30	505	477	42,034
22	7.0	7.8	12.0	4.1	11,945	.17	.10	105	.23	.21	30	505	477	42,034
23	7.0	7.8	12.0	3.6	12,701	.17	.10	105	.23	.21	30	505	477	42,034
24	7.0	7.8	12.0	4.5	12,133	.17	.11	96	.23	.22	16	505	541	-57,737
25	7.0	7.8	12.0	4.0	12,920	.17	.11	96	.23	.22	16	505	541	-57,737
26	7.0	7.9	12.0	3.3	14,051	.17	.11	96	.23	.21	32	505	541	-57,737
27*	7.0	7.9	12.0	2.6	15,181	.17	.11	96	.23	.21	32	505	541	-57,737
28	7.0	7.9	12.0	2.4	12,706	.23	.11	159	.16	.22	-93	600	565	19,845
29*	7.0	7.2	12.0	3.0	21,238	.23	.11	283	.16	.23	-213	600	578	51,916
30	7.0	7.6	12.0	2.7	19,536	.23	.12	231	.16	.25	-190	600	647	-98,728
31	5.0	7.9	None	2.4	N.A.	.33	.12	441	None	.25	N.A.	500	647	-309,768
32	3.0	8.0	None	2.3	N.A.	None	.12	N.A.	None	.26	N.A.	None	666	N.A.
33	3.0	8.1	None	2.1	N.A.	None	.12	N.A.	None	.25	N.A.	None	666	N.A.

*Water Quality Control Point

Walker River Allowable Loads by Reach
Existing Standards

	DO		BOD_{ult}			PO_4-P			NO_3-N			TDS		
Reach	Standard (mg/l)	Model Value (mg/l)	Standard (mg/l) ($4xBOD_5$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.33xPO_4$-PO_4)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) ($.23xNO_3$-NO_3)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l)	Model Value (mg/l)	Allowable Load (lb/day)
1*	8.0	8.7	None	4.1	N.A.	.07	.05	49	.46	.20	640	100	68	78,784
2*	8.0	8.0	40.0	4.0	74,052	.07	.06	21	.46	.19	555	125	80	92,565
3*	8.0	8.4	20.0	3.7	25,607	.07	.06	16	.33	.20	204	275	80	306,345
4	7.0	8.3	40.0	7.1	46,521	.17	.05	170	.69	.20	693	200	250	-70,700
5	7.0	8.7	40.0	6.5	53,533	.17	.06	176	.69	.20	783	200	261	-97,478
6	7.0	8.5	40.0	6.1	54,172	.17	.06	176	.69	.20	783	200	261	-97,478
7*	7.0	8.3	40.0	6.6	28,323	.17	.07	85	.69	.21	407	200	281	-68,688
8	7.5	8.2	20.0	5.6	29,866	.23	.08	311	1.38	.27	2,302	450	168	584,868
9	7.5	7.9	20.0	5.3	30,488	.23	.08	311	1.38	.27	2,302	450	168	584,868
10*	7.5	7.4	20.0	9.3	6,067	.23	.15	45	1.38	.24	646	450	328	69,174
11.	5.0	7.4	None	8.7	N.A.	.33	.16	93	None	.25	N.A.	500	341	86,655
12	5.0	7.4	None	8.4	N.A.	.33	.16	37	None	.23	N.A.	500	341	34,344
13	5.0	7.2	None	11.2	N.A.	.33	.16	27	None	.19	N.A.	500	596	-15,168

*Water Quality Control Point

Walker River Allowable Loads by Reach
Proposed Standards

	DO		BOD_{ult}			PO_4-P			NO_3-N			TDS		
Reach	Standard (mg/l)	Model Value (mg/l)	Standard (mg/l) ($4xBOD_5$)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) (.33xPO_4-PO4)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l) (.23xNO_3-NO_3)	Model Value (mg/l)	Allowable Load (lb/day)	Standard (mg/l)	Model Value (mg/l)	Allowable Load (lb/day)
1*	7.0	8.7	8.0	4.1	9,603	.07	.05	49	.23	.20	74	100	68	78,797
2*	7.0	8.0	8.0	4.0	8,230	.07	.06	21	.23	.19	82	150	80	144,018
3*	7.0	8.4	12.0	3.7	13,043	.10	.06	63	.51	.20	487	290	80	329,994
4	7.0	8.3	12.0	7.1	6,933	.16	.05	156	.28	.20	113	250	250	0
5	7.0	8.7	12.0	6.5	8,791	.16	.06	160	.28	.20	128	250	261	-17,582
6	7.0	8.5	12.0	6.1	9,431	.16	.06	160	.28	.20	128	250	261	-17,582
7*	7.0	8.3	12.0	6.6	7,494	.16	.07	125	.28	.21	97	250	281	-43,022
8	7.0	8.2	12.0	5.6	13,271	.26	.08	373	.41	.27	290	360	168	398,131
9	7.0	7.9	12.0	5.3	13,893	.26	.08	373	.41	.27	290	360	168	398,131
10*	7.0	7.4	12.0	9.3	1,531	.26	.15	62	.41	.24	96	360	328	18,144
11	5.0	7.4	None	8.7	N.A.	.33	.16	93	None	.25	N.A.	500	341	86,719
12	5.0	7.4	None	8.4	N.A.	.33	.16	37	None	.23	N.A.	500	341	34,344
13	5.0	7.2	None	11.2	N.A.	.33	.16	27	None	.19	N.A.	500	596	-15,034

*Water Quality Control Point

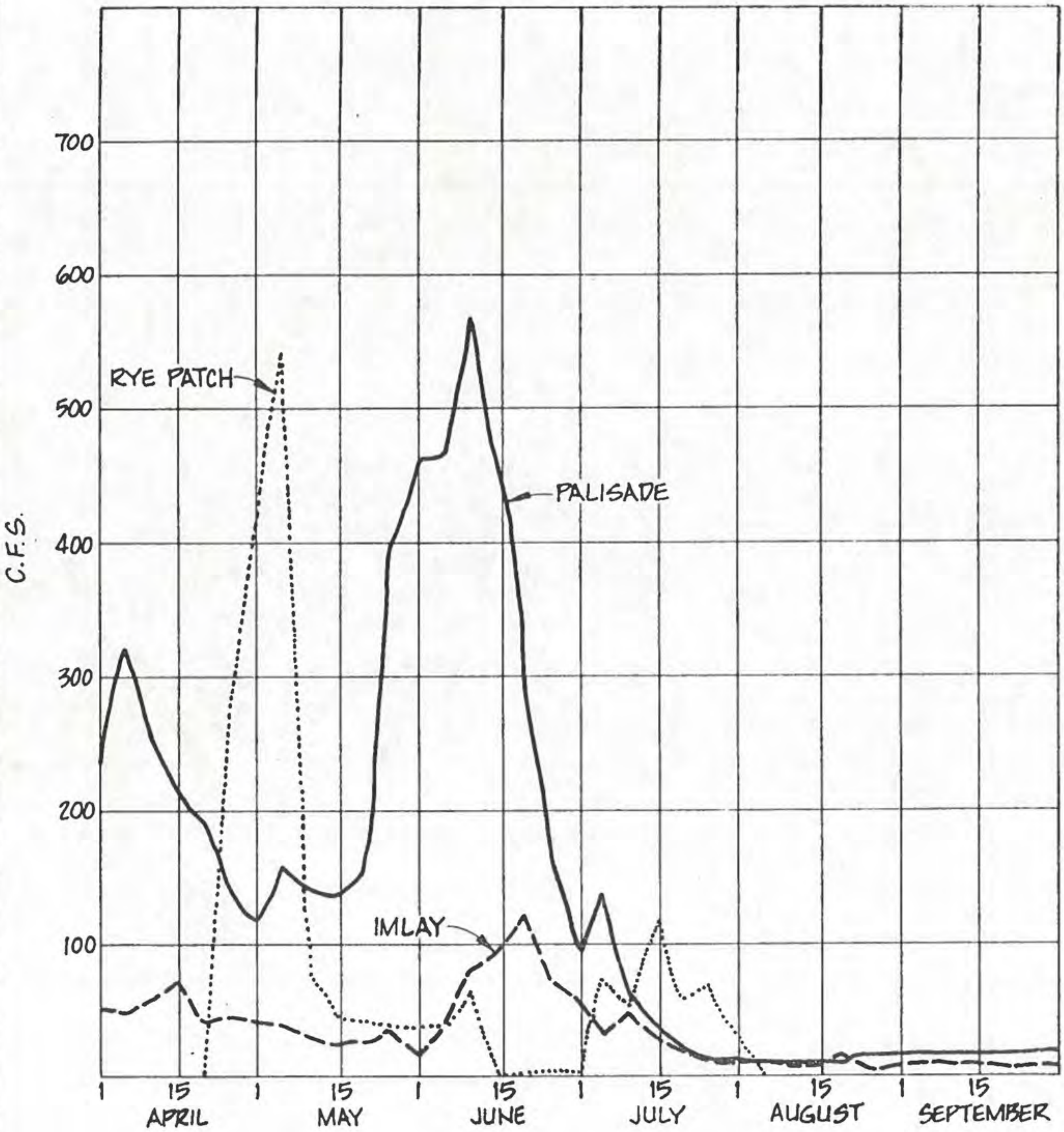


FIGURE 3

HUMBOLDT RIVER FLOW, APRIL-SEPTEMBER 1961

CH2M HILL

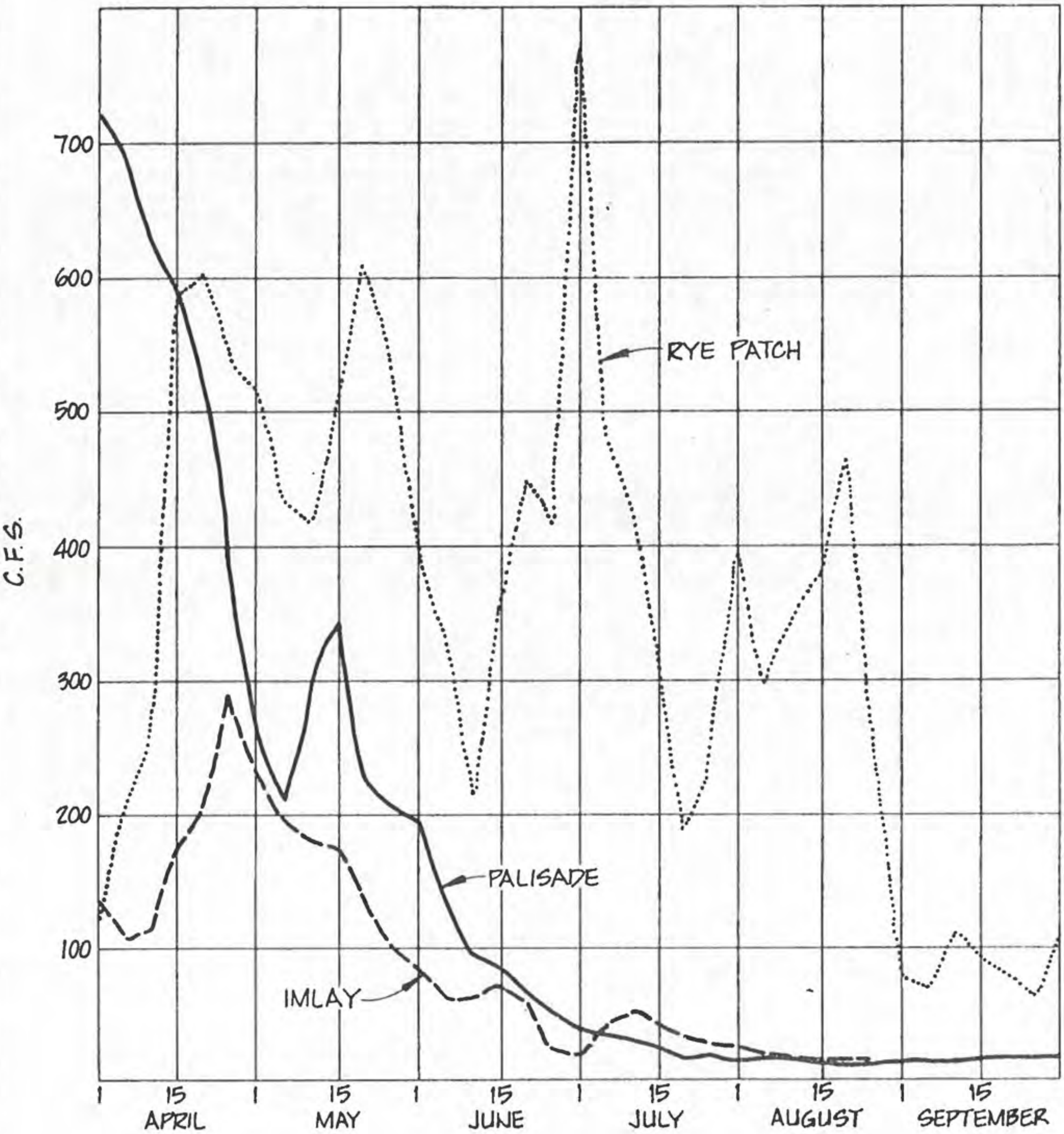


FIGURE 4
HUMBOLDT RIVER FLOW, APRIL-SEPTEMBER 1966

CH2M HILL

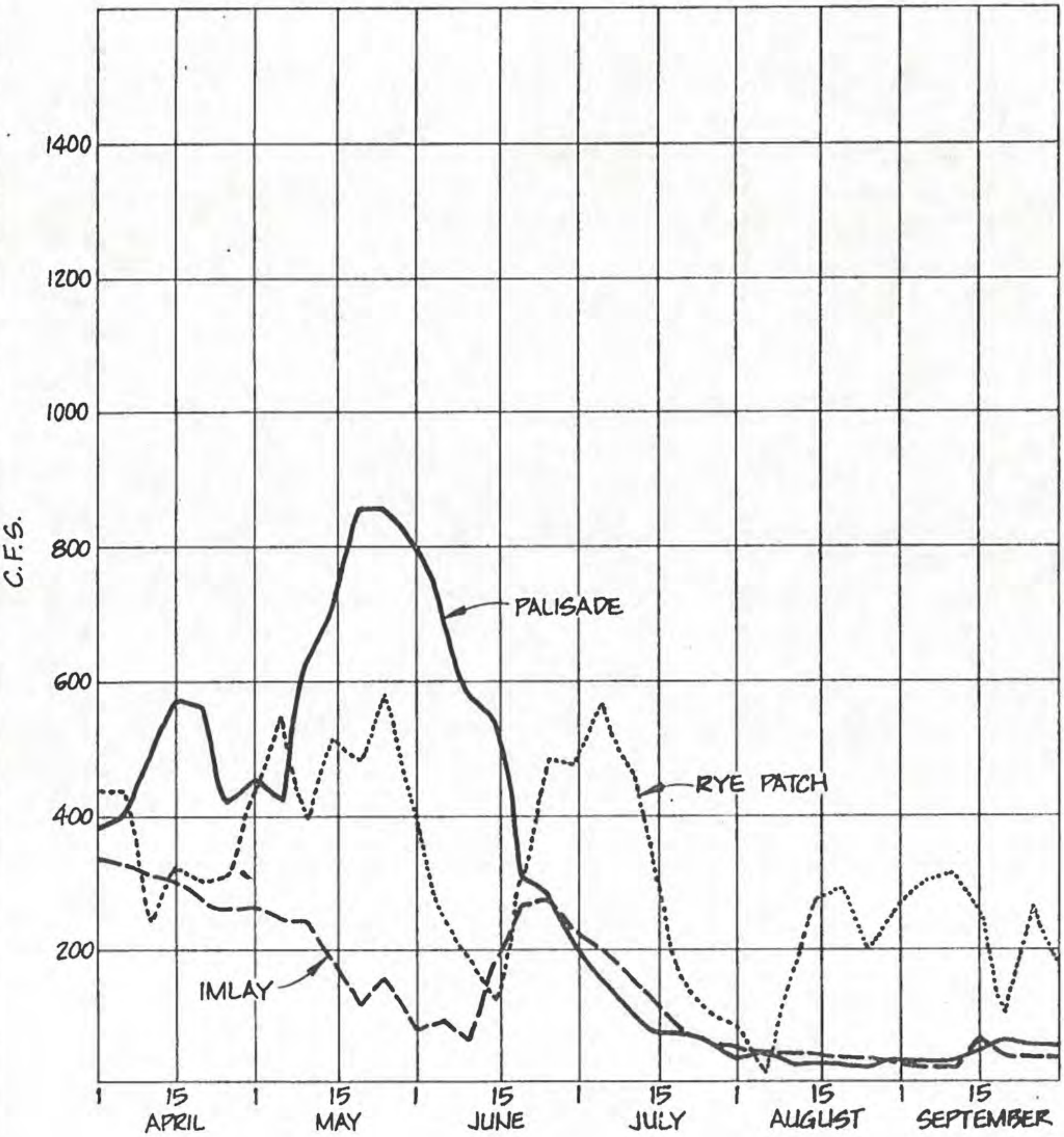


FIGURE 5
HUMBOLDT RIVER FLOW,
APRIL-SEPTEMBER 1976

CH2M HILL

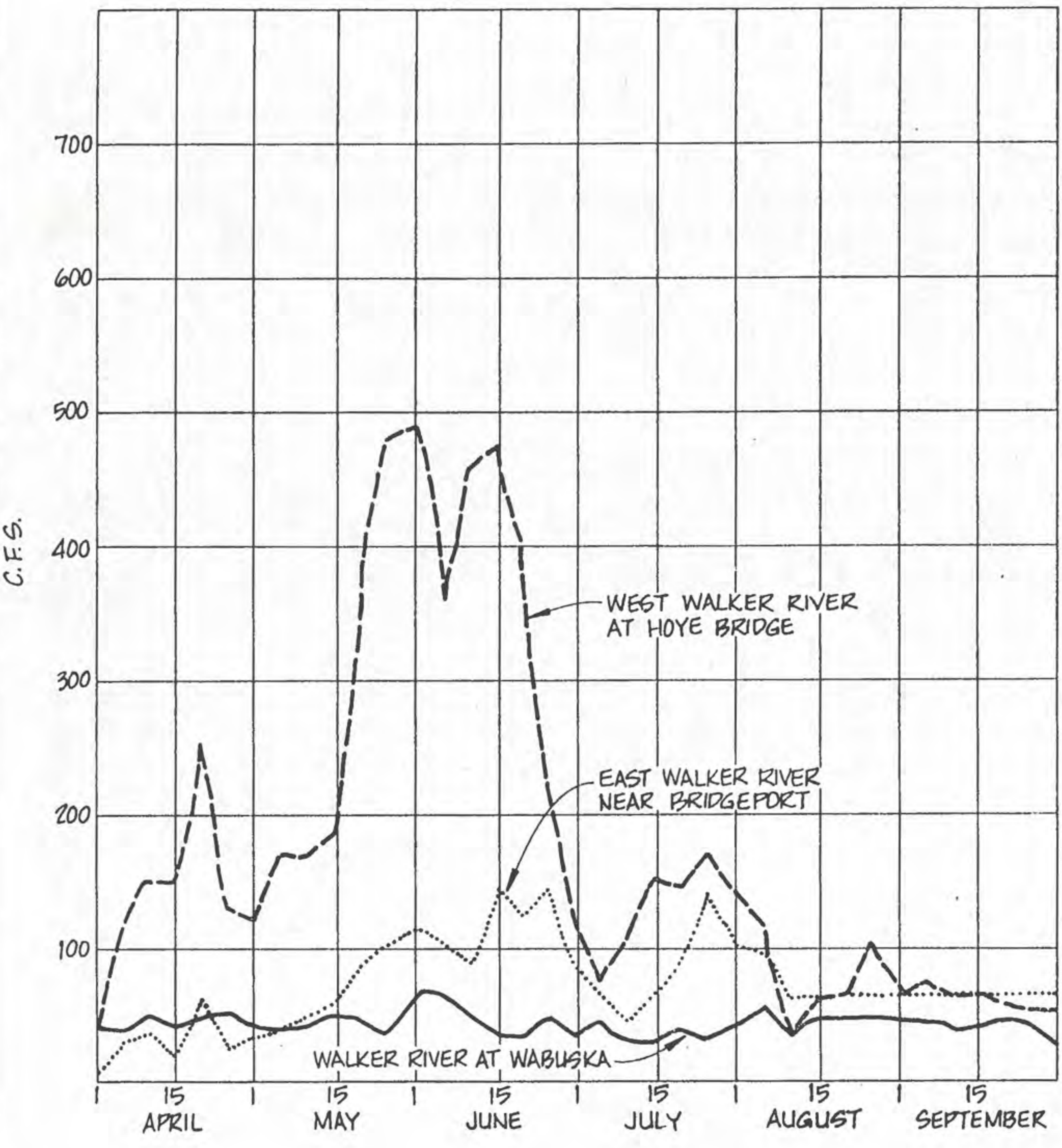


FIGURE 6
WALKER RIVER FLOW,
APRIL-SEPTEMBER 1961

CH2M HILL

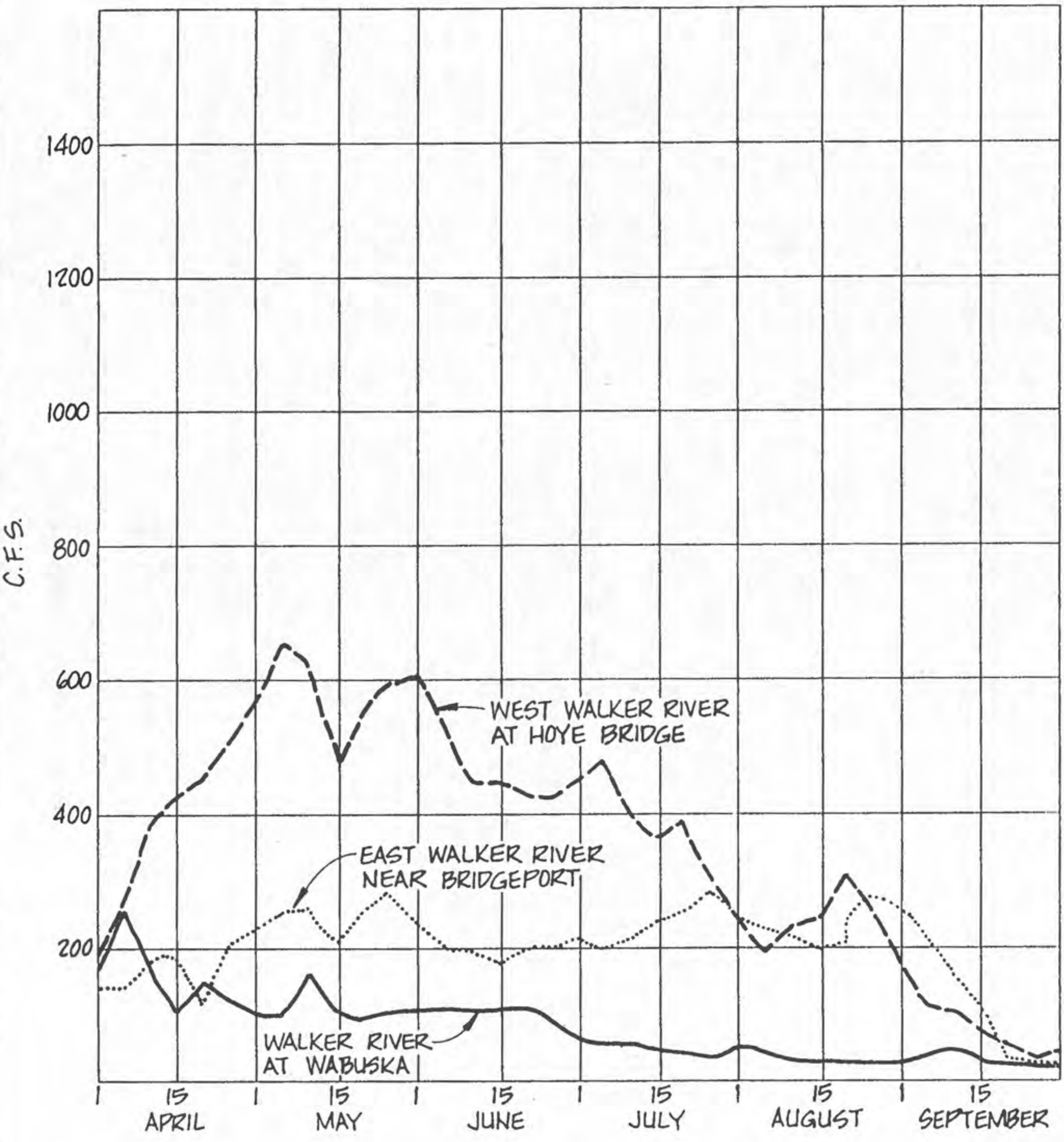


FIGURE 7

WALKER RIVER FLOW, APRIL-SEPTEMBER 1966

CH2M HILL

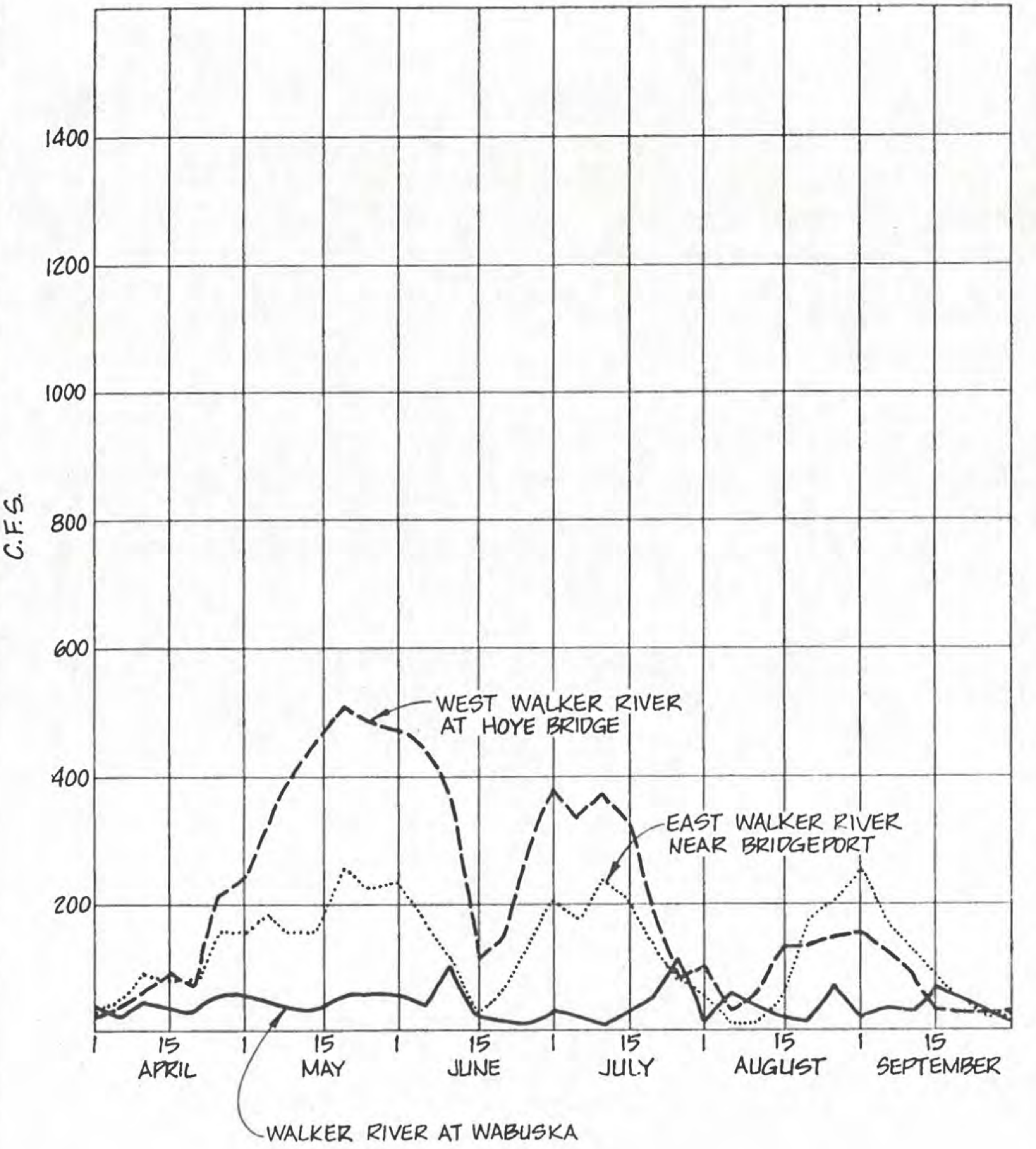
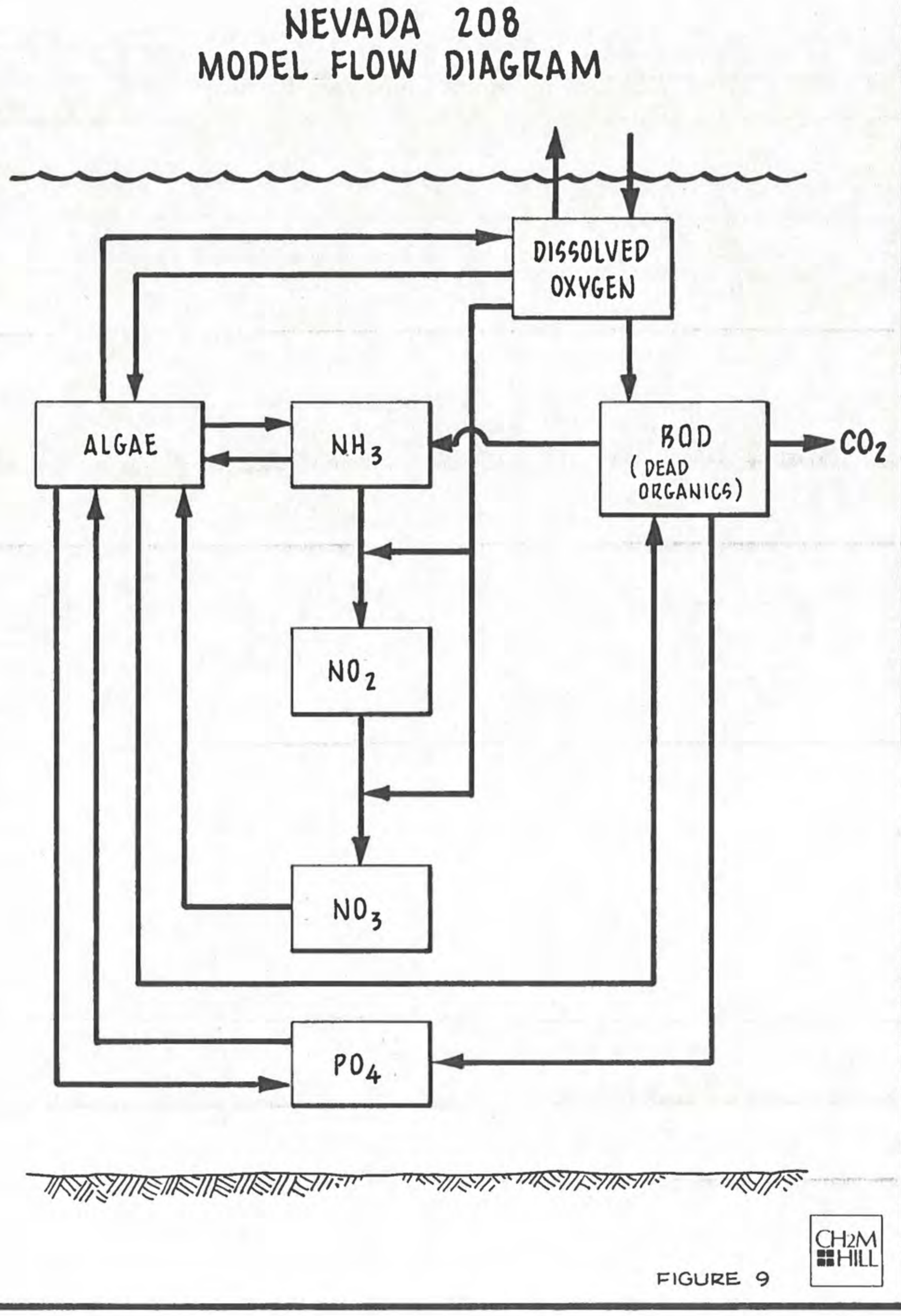


FIGURE 8

WALKER RIVER FLOW, APRIL-SEPTEMBER 1976


NEVADA 208
MODEL FLOW DIAGRAM
DISSOLVED OXYGEN
ALGAE
NH_3
BOD (DEAD ORGANICS)
CO_2
NO_2
NO_3
PO_4
CH2M HILL
FIGURE 9

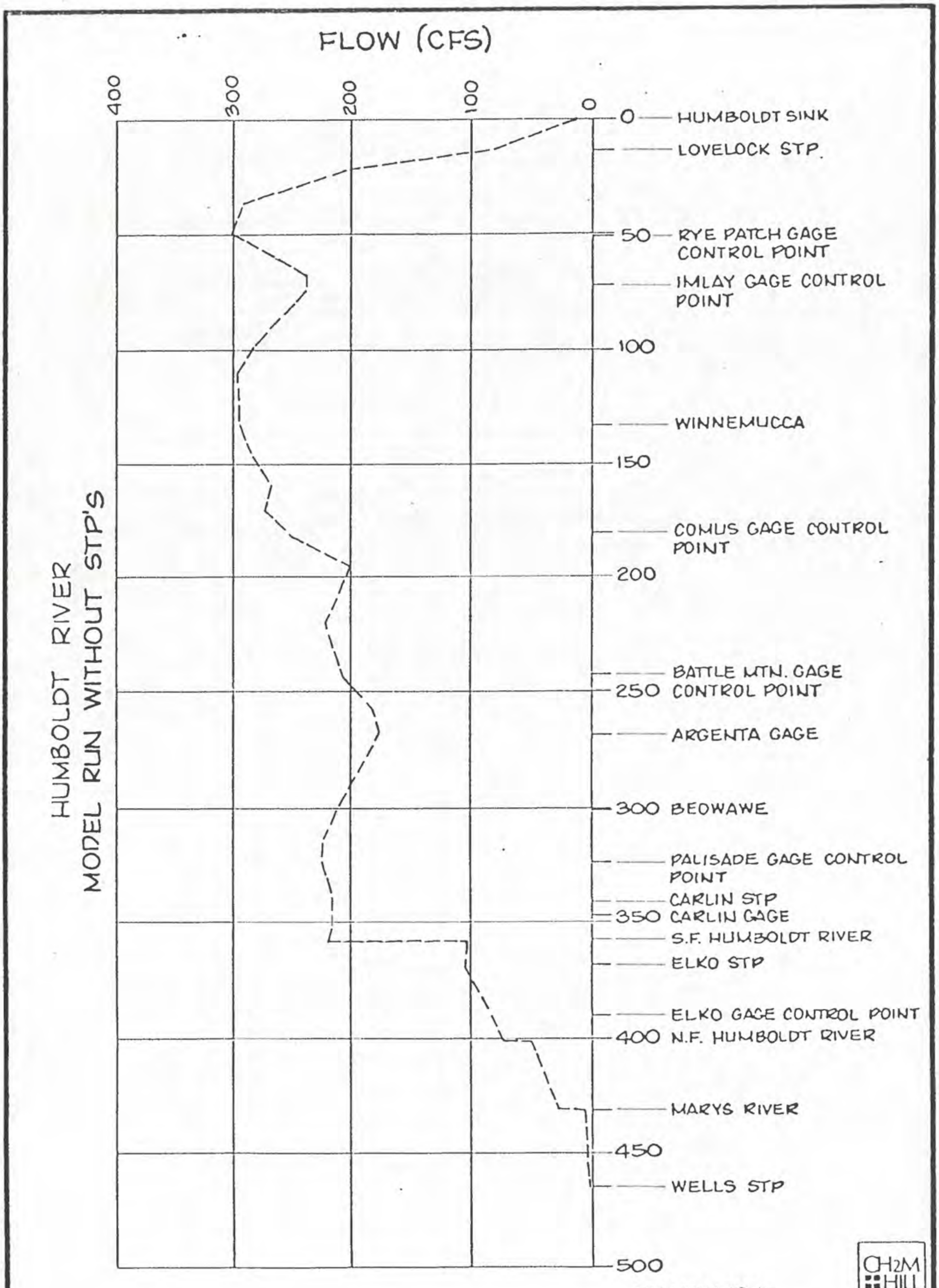
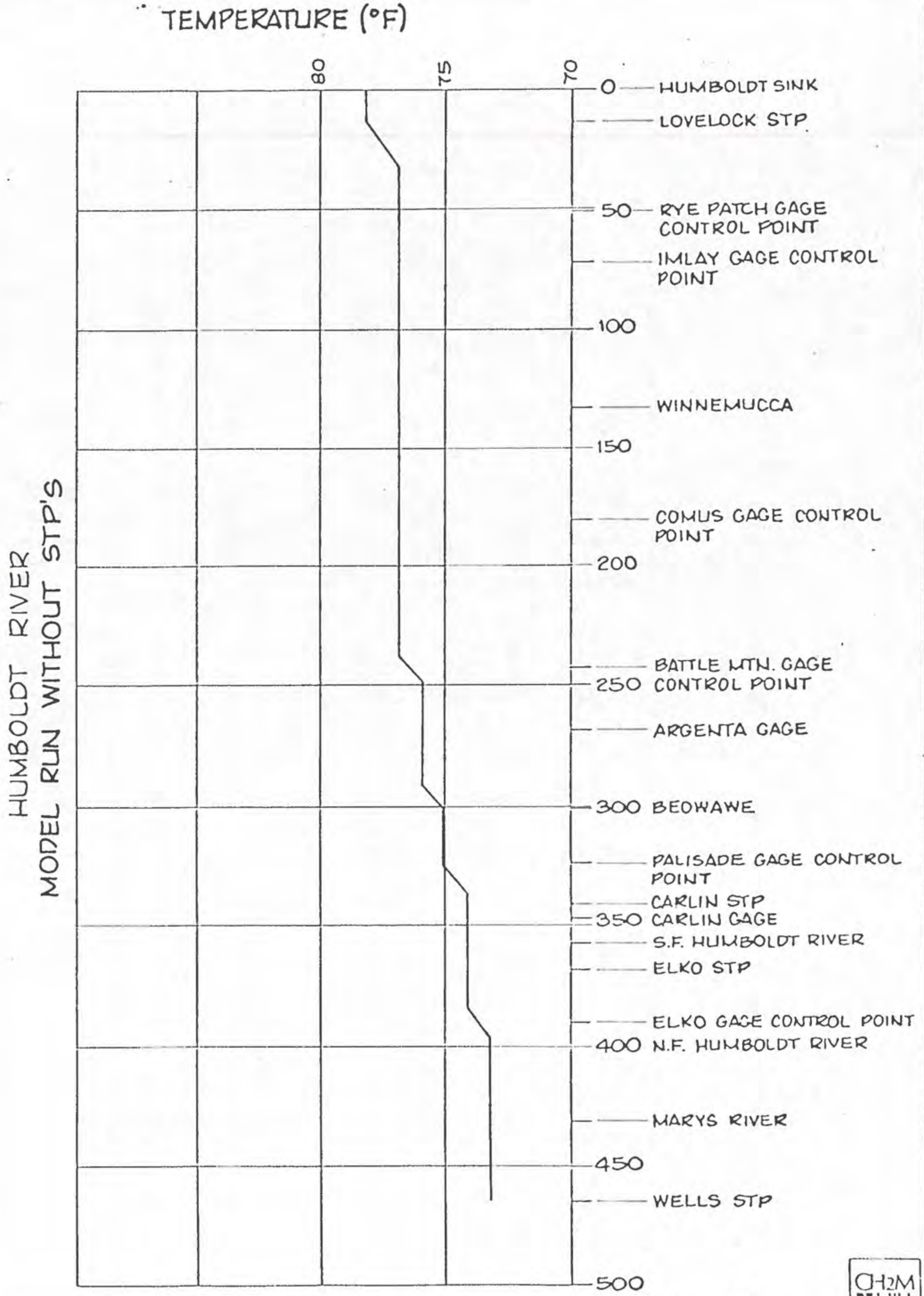

FLOW (CFS)
400
300
200
100
0
HUMBOLDT RIVER
MODEL RUN WITHOUT STP'S
0 HUMBOLDT SINK
LOVELOCK STP.
50 RYE PATCH GAGE CONTROL POINT
IMLAY GAGE CONTROL POINT
100
WINNEMUCCA
150
COMUS GAGE CONTROL POINT
200
BATTLE MTN. GAGE
250 CONTROL POINT
ARGENTA GAGE
300 BEOWAWE
PALISADE GAGE CONTROL POINT
CARLIN STP
350 CARLIN GAGE
S.F. HUMBOLDT RIVER
ELKO STP
ELKO GAGE CONTROL POINT
400 N.F. HUMBOLDT RIVER
MARYS RIVER
450
WELLS STP
500
CH2M HILL

FIGURE 10A,



TEMPERATURE (°F)
80
75
70
HUMBOLDT RIVER
MODEL RUN WITHOUT STP'S
0 HUMBOLDT SINK
LOVELOCK STP
50 RYE PATCH GAGE CONTROL POINT
IMLAY GAGE CONTROL POINT
100
WINNEMUCCA
150
COMUS GAGE CONTROL POINT
200
BATTLE MTN. GAGE
250 CONTROL POINT
ARGENTA GAGE
300 BEOWAWE
PALISADE GAGE CONTROL POINT
CARLIN STP
350 CARLIN GAGE
S.F. HUMBOLDT RIVER
ELKO STP
ELKO GAGE CONTROL POINT
400 N.F. HUMBOLDT RIVER
MARYS RIVER
450
WELLS STP
500
CH2M HILL

FIGURE 10 B,

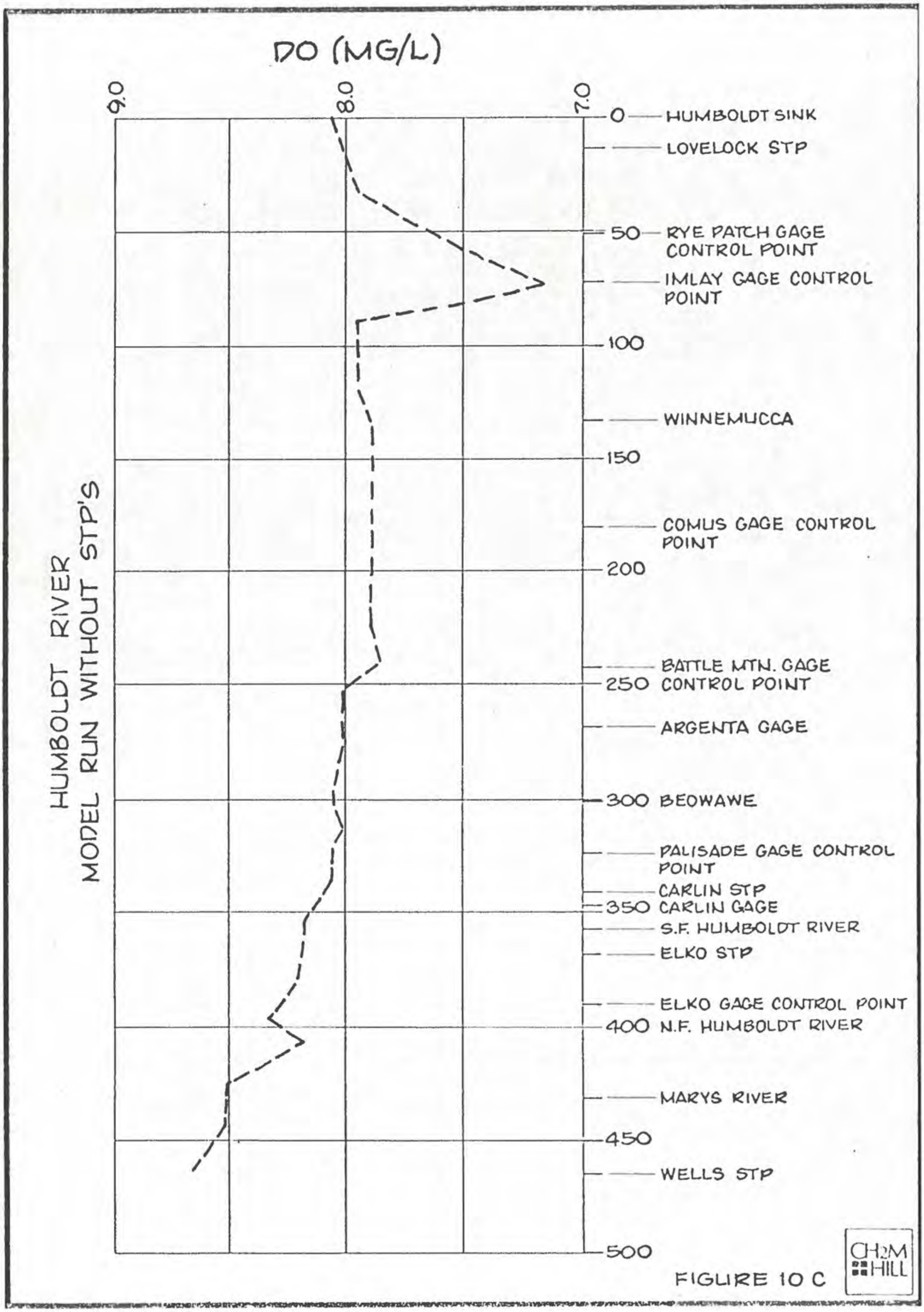


FIGURE 10 C

CH2M HILL

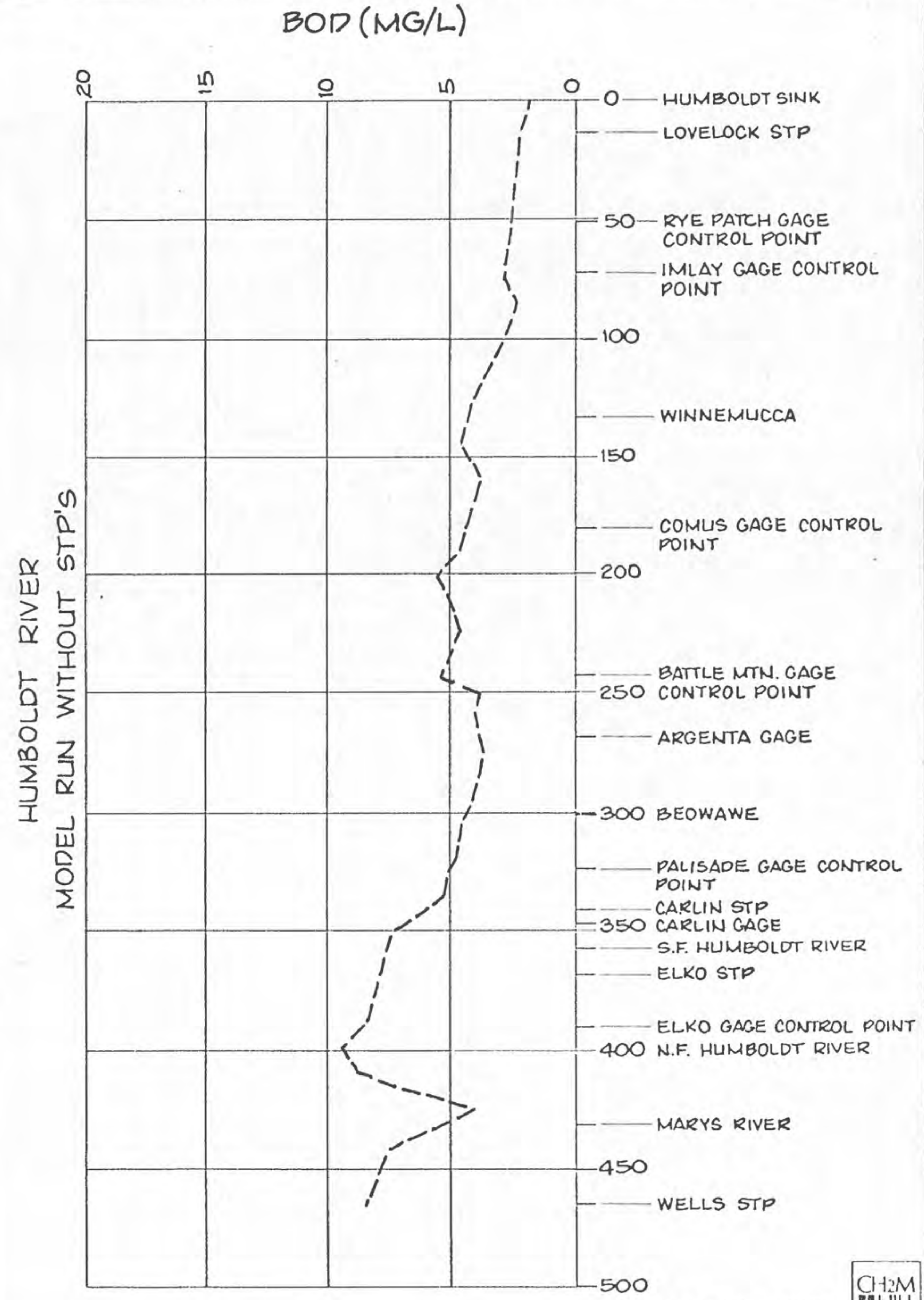
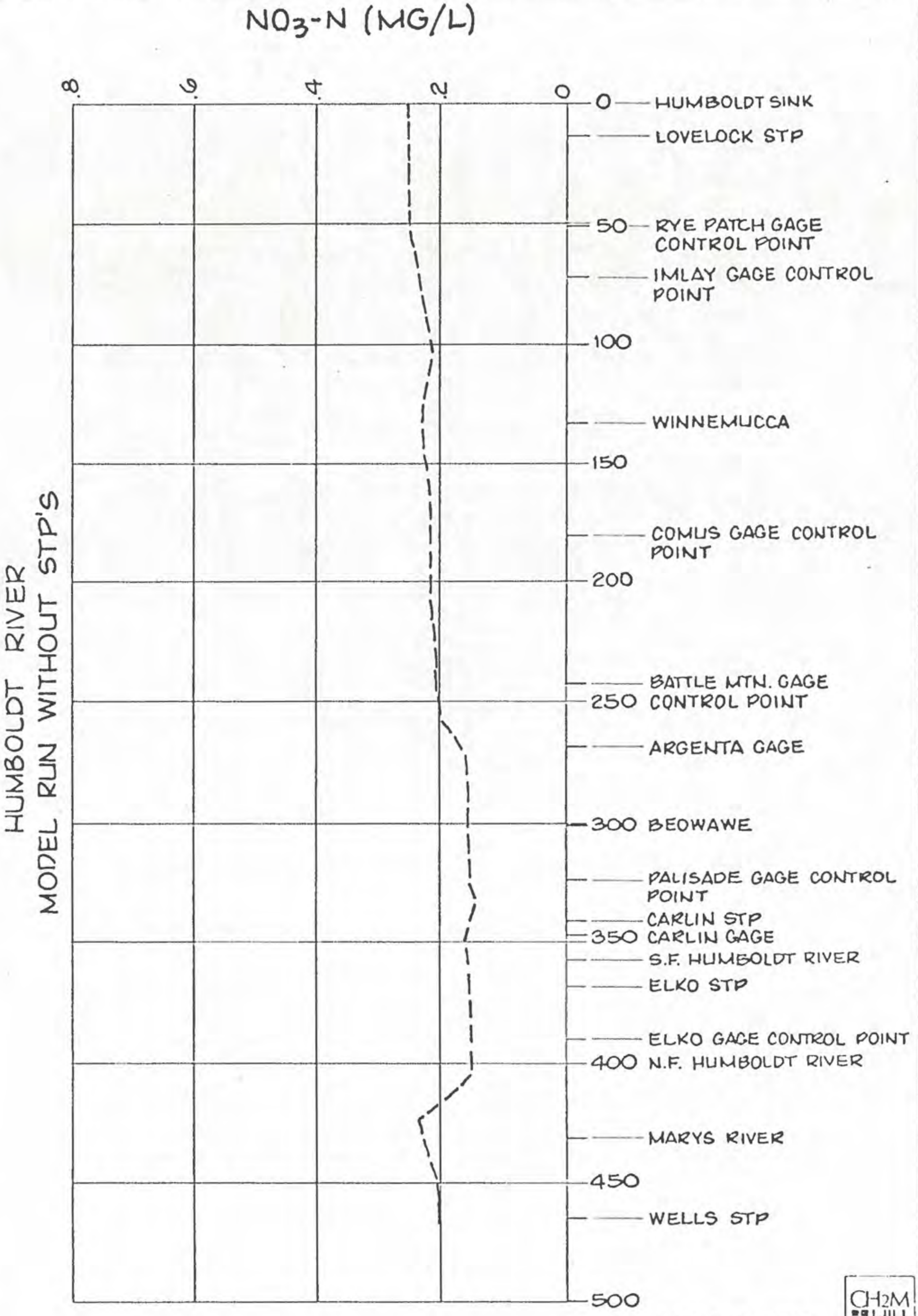


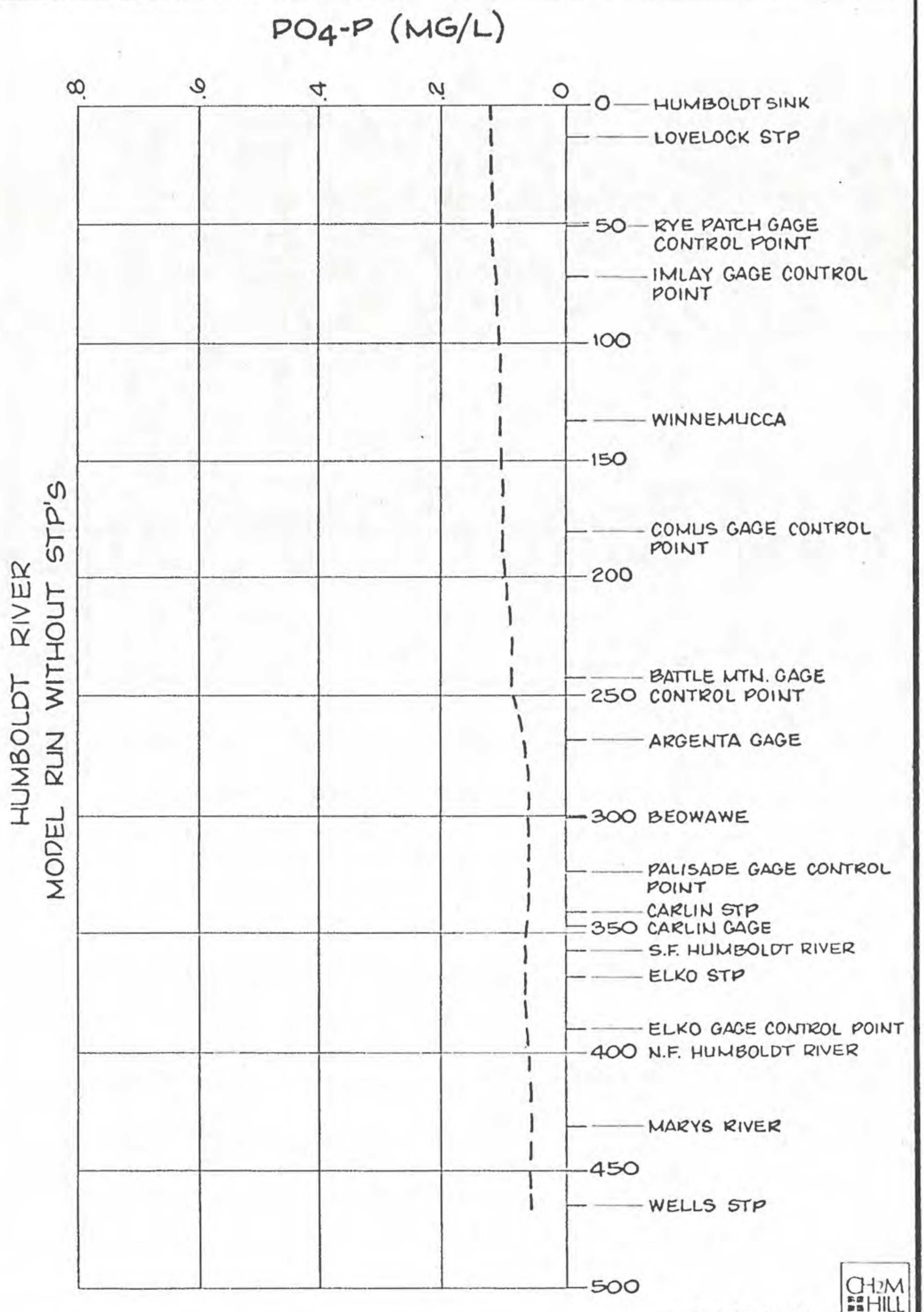
FIGURE 10 D

CH2M HILL



NO3-N (MG/L)
8
6
4
2
0
HUMBOLDT RIVER
MODEL RUN WITHOUT STP'S
0 HUMBOLDT SINK
LOVELOCK STP
50 RYE PATCH GAGE CONTROL POINT
IMLAY GAGE CONTROL POINT
100
WINNEMUCCA
150
COMUS GAGE CONTROL POINT
200
BATTLE MTN. GAGE
250 CONTROL POINT
ARGENTA GAGE
300 BEOWAWE
PALISADE GAGE CONTROL POINT
CARLIN STP
350 CARLIN GAGE
S.F. HUMBOLDT RIVER
ELKO STP
ELKO GAGE CONTROL POINT
400 N.F. HUMBOLDT RIVER
MARYS RIVER
450
WELLS STP
500

FIGURE 10E



HUMBOLDT RIVER
MODEL RUN WITHOUT STP'S
PO4-P (MG/L)
.8
.6
.4
.2
0
0 HUMBOLDT SINK
LOVELOCK STP
50 RYE PATCH GAGE CONTROL POINT
IMLAY GAGE CONTROL POINT
100
WINNEMUCCA
150
COMUS GAGE CONTROL POINT
200
BATTLE MTN. GAGE CONTROL POINT
250
ARGENTA GAGE
300 BEOWAWE
PALISADE GAGE CONTROL POINT
CARLIN STP
350 CARLIN GAGE
S.F. HUMBOLDT RIVER
ELKO STP
ELKO GAGE CONTROL POINT
400 N.F. HUMBOLDT RIVER
MARYS RIVER
450
WELLS STP
500

FIGURE 10 F

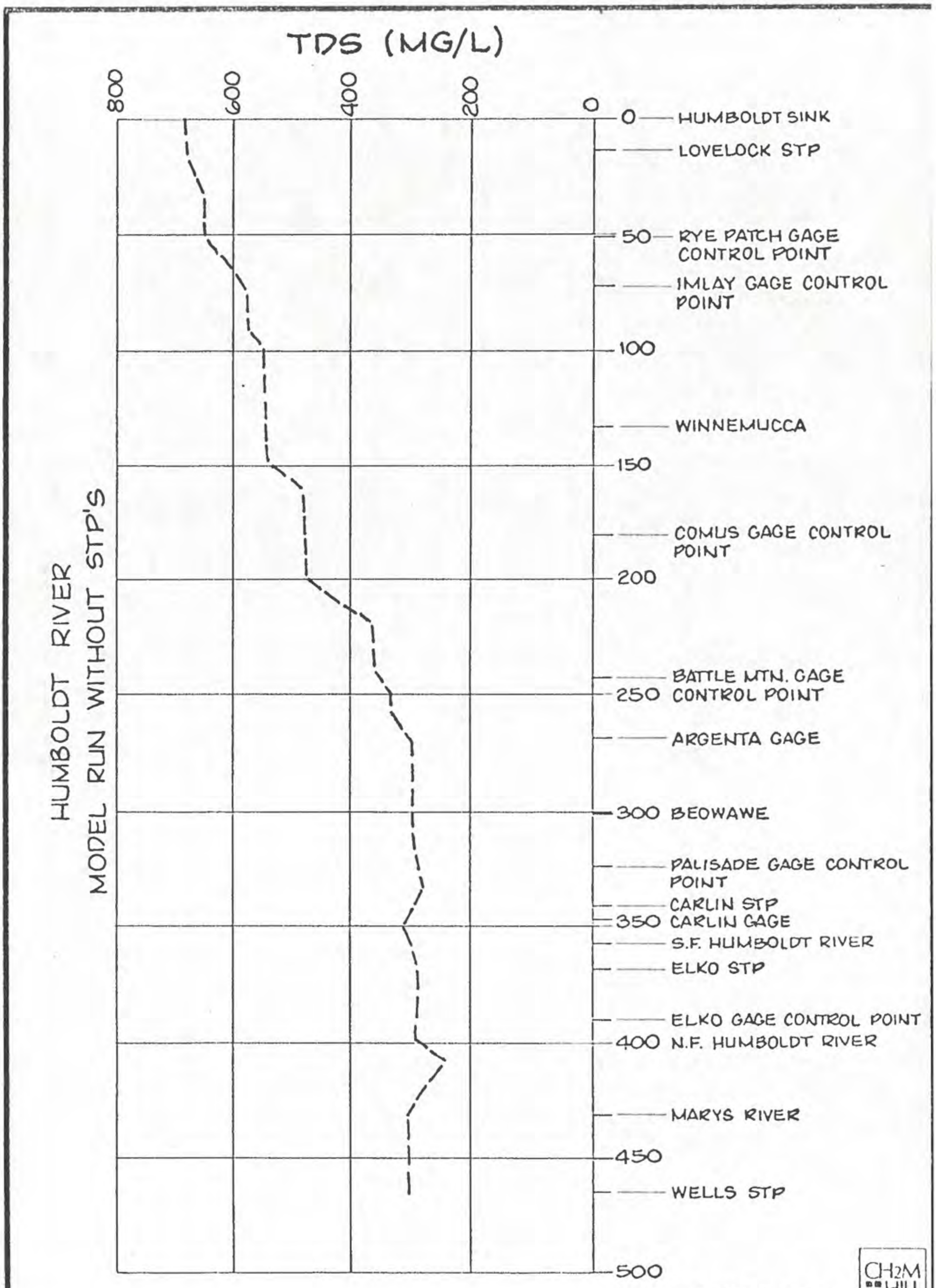

TDS (MG/L)
800
600
400
200
0
HUMBOLDT RIVER
MODEL RUN WITHOUT STP'S
0 HUMBOLDT SINK
LOVELOCK STP
50 RYE PATCH GAGE CONTROL POINT
IMLAY GAGE CONTROL POINT
100
WINNEMUCCA
150
COMUS GAGE CONTROL POINT
200
BATTLE MTN. GAGE CONTROL POINT
250
ARGENTA GAGE
300 BEOWAWE
PALISADE GAGE CONTROL POINT
CARLIN STP
350 CARLIN GAGE
S.F. HUMBOLDT RIVER
ELKO STP
ELKO GAGE CONTROL POINT
400 N.F. HUMBOLDT RIVER
MARYS RIVER
450
WELLS STP
500

FIGURE 10 G

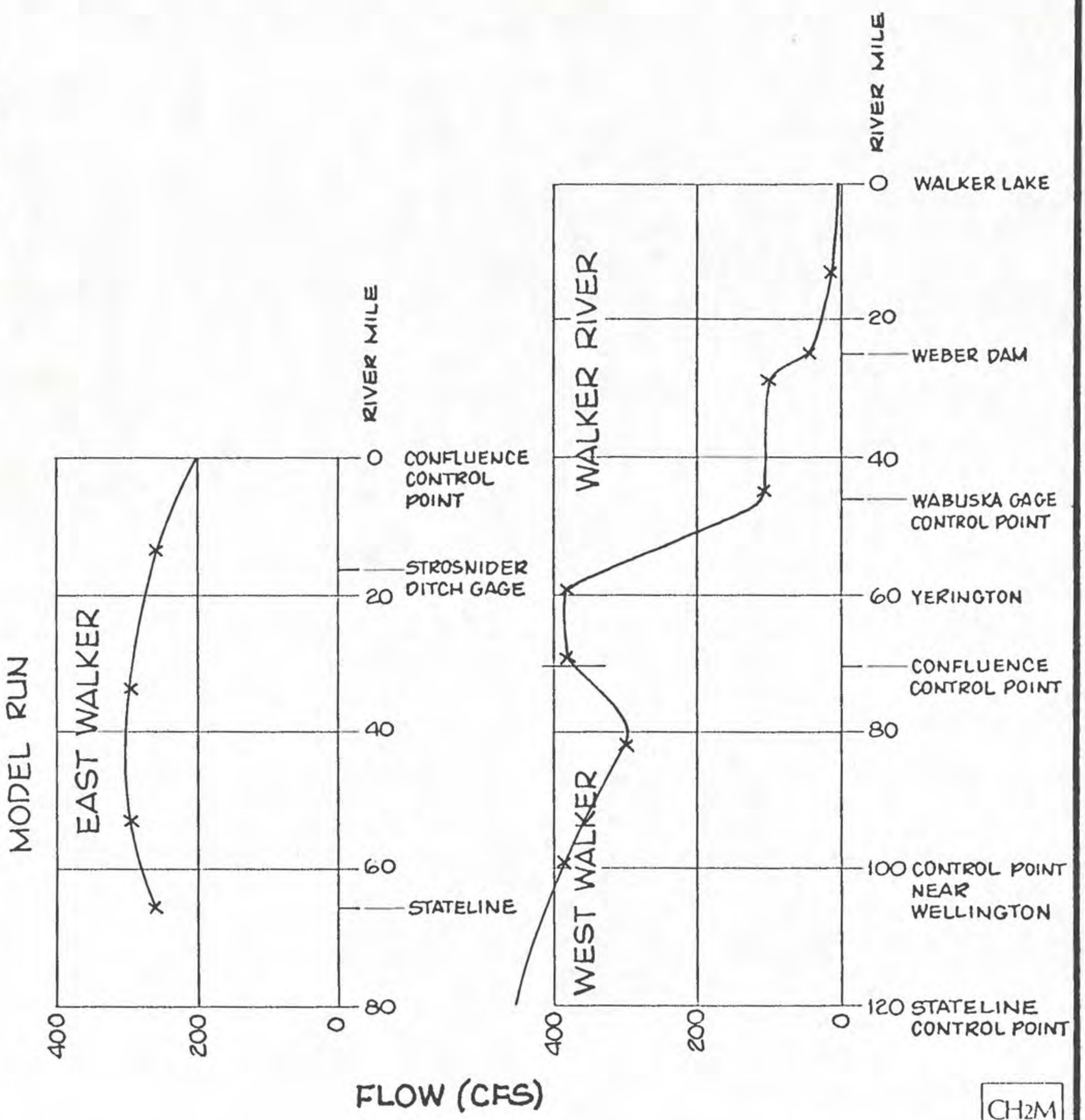

MODEL RUN
EAST WALKER
WALKER RIVER
WEST WALKER
FLOW (CFS)
400
200
0
RIVER MILE
0 CONFLUENCE CONTROL POINT
STROSNIDER DITCH GAGE
20
40
60
STATELINE
80
0 WALKER LAKE
20
WEBER DAM
40
WABUSKA GAGE CONTROL POINT
60 YERINGTON
CONFLUENCE CONTROL POINT
80
100 CONTROL POINT NEAR WELLINGTON
120 STATELINE CONTROL POINT

FIGURE 11A

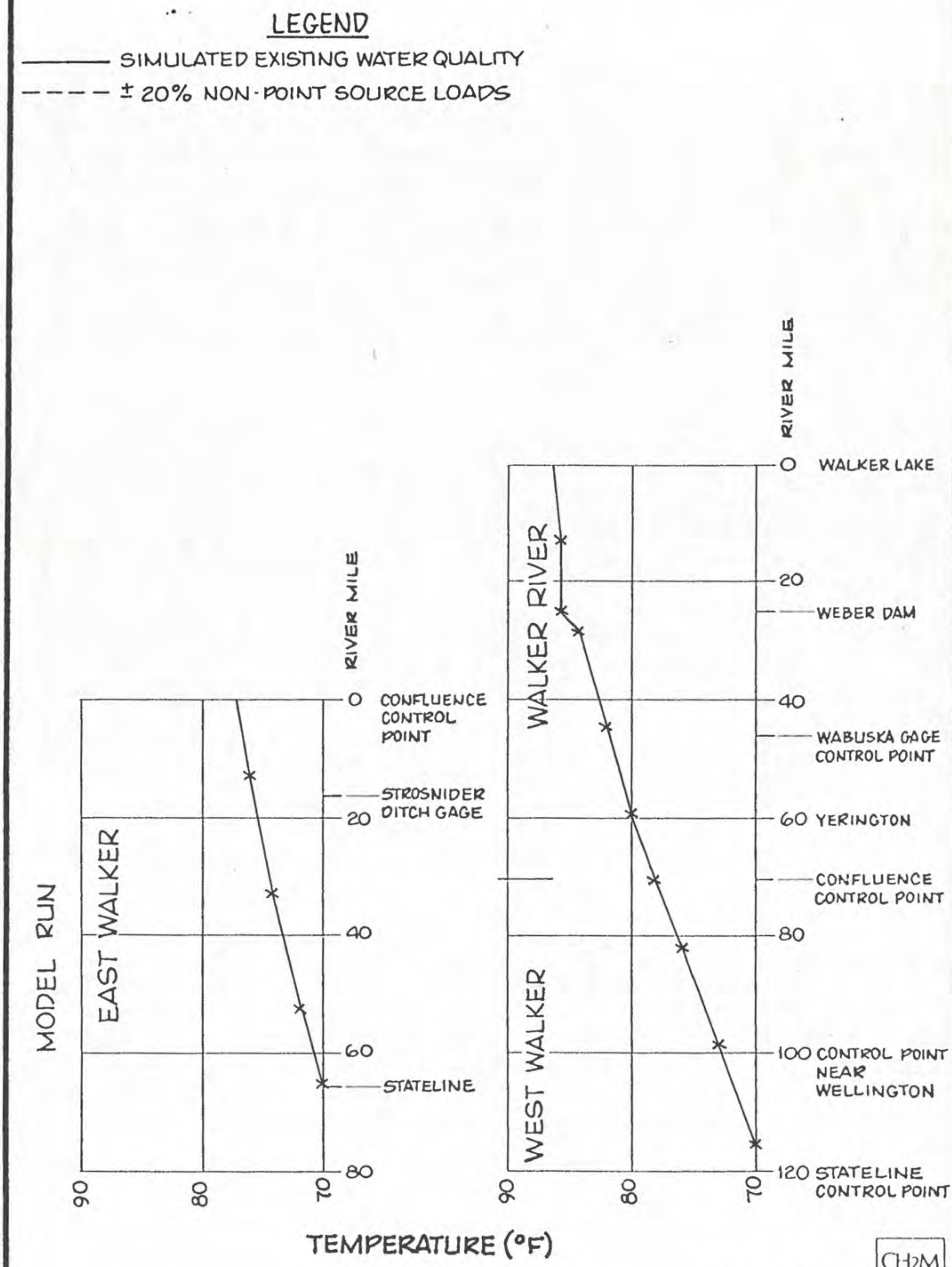
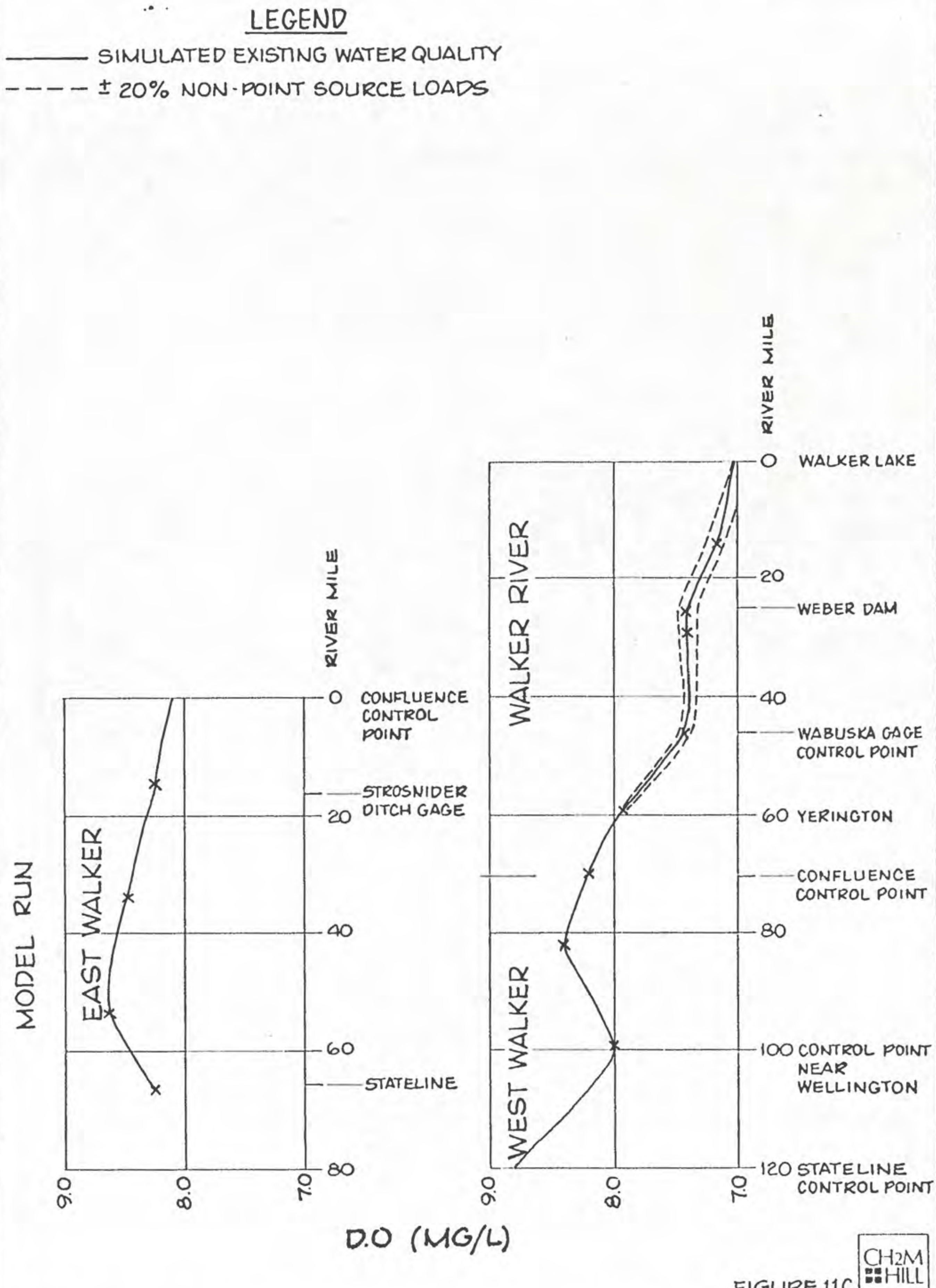


FIGURE 11 B

CH2M HILL



LEGEND
SIMULATED EXISTING WATER QUALITY
± 20% NON-POINT SOURCE LOADS
MODEL RUN
EAST WALKER
RIVER MILE
0 CONFLUENCE CONTROL POINT
STROSNIDER DITCH GAGE
20
40
60
STATELINE
80
9.0
8.0
7.0
WALKER RIVER
WEST WALKER
RIVER MILE
0 WALKER LAKE
20
WEBER DAM
40
WABUSKA GAGE CONTROL POINT
60 YERINGTON
CONFLUENCE CONTROL POINT
80
100 CONTROL POINT NEAR WELLINGTON
120 STATELINE CONTROL POINT
9.0
8.0
7.0
D.O (MG/L)
CH2M HILL

FIGURE 11C

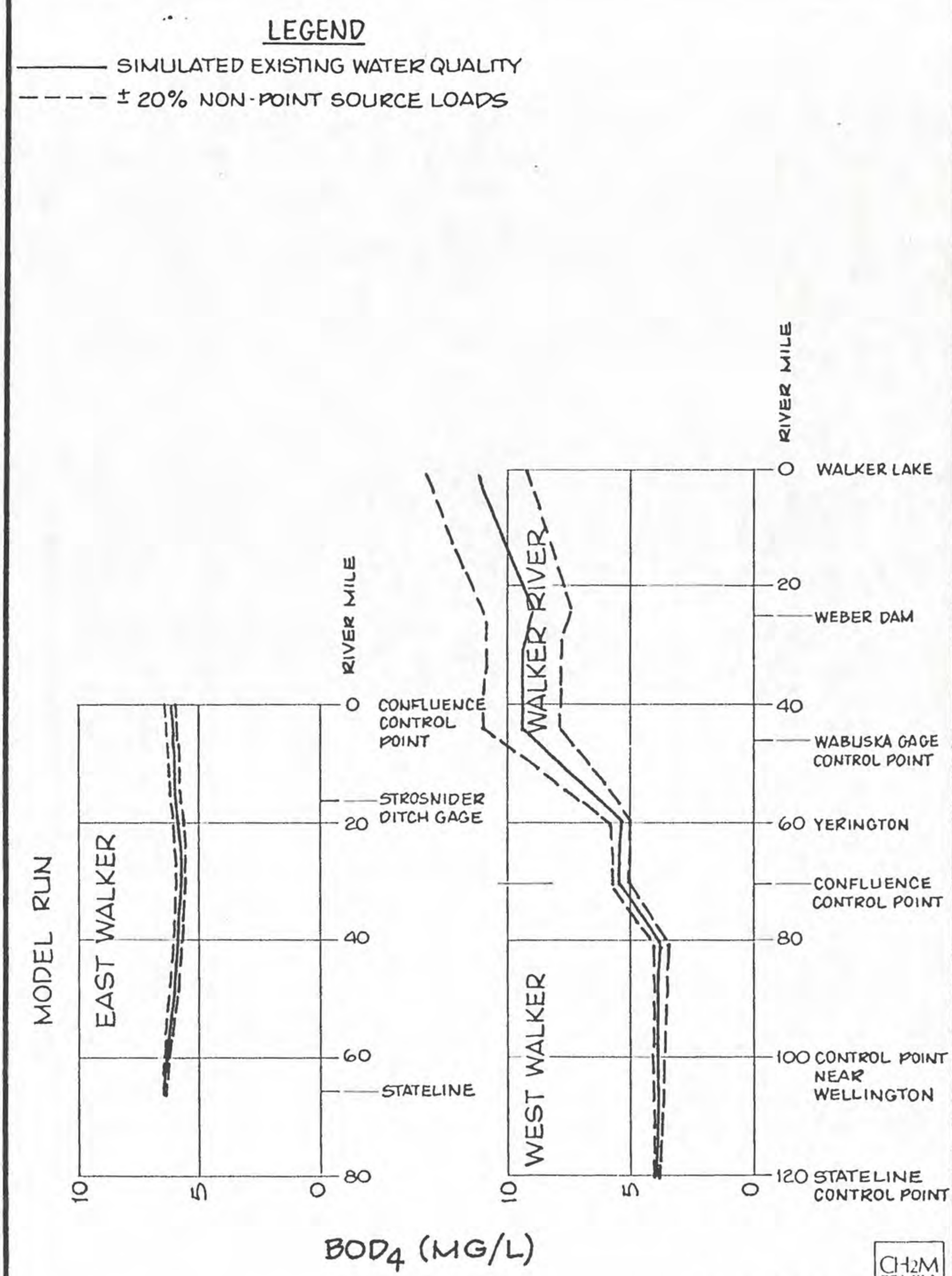

LEGEND
SIMULATED EXISTING WATER QUALITY
± 20% NON-POINT SOURCE LOADS
MODEL RUN
EAST WALKER
RIVER MILE
0
20
40
60
80
CONFLUENCE CONTROL POINT
STROSNIDER DITCH GAGE
STATELINE
WALKER RIVER
WEST WALKER
RIVER MILE
0 WALKER LAKE
20
WEBER DAM
40
WABUSKA GAGE CONTROL POINT
60 YERINGTON
CONFLUENCE CONTROL POINT
80
100 CONTROL POINT NEAR WELLINGTON
120 STATELINE CONTROL POINT
10
5
0
10
5
0
BOD_4 (MG/L)
CH2M HILL

FIGURE 11D

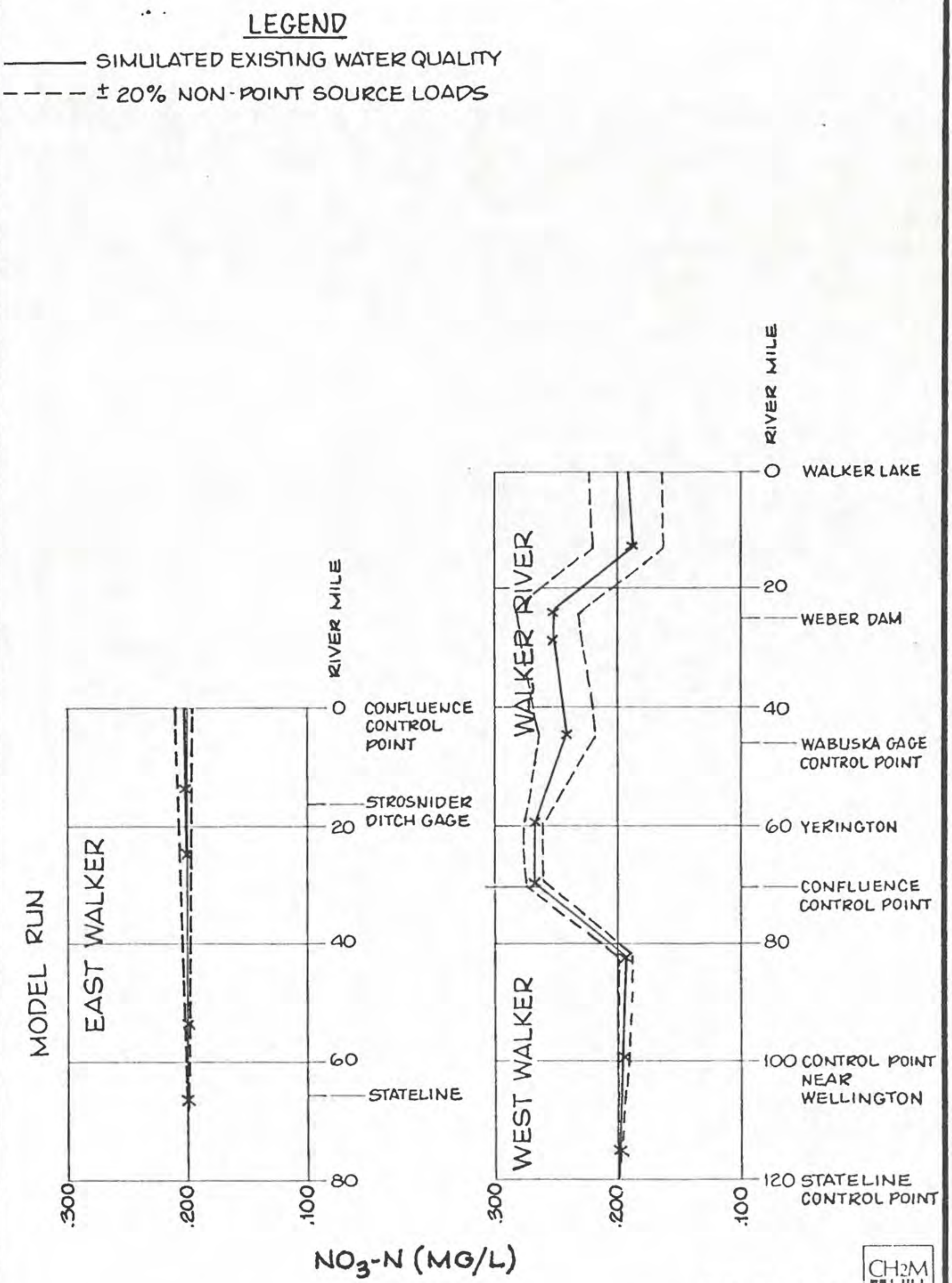


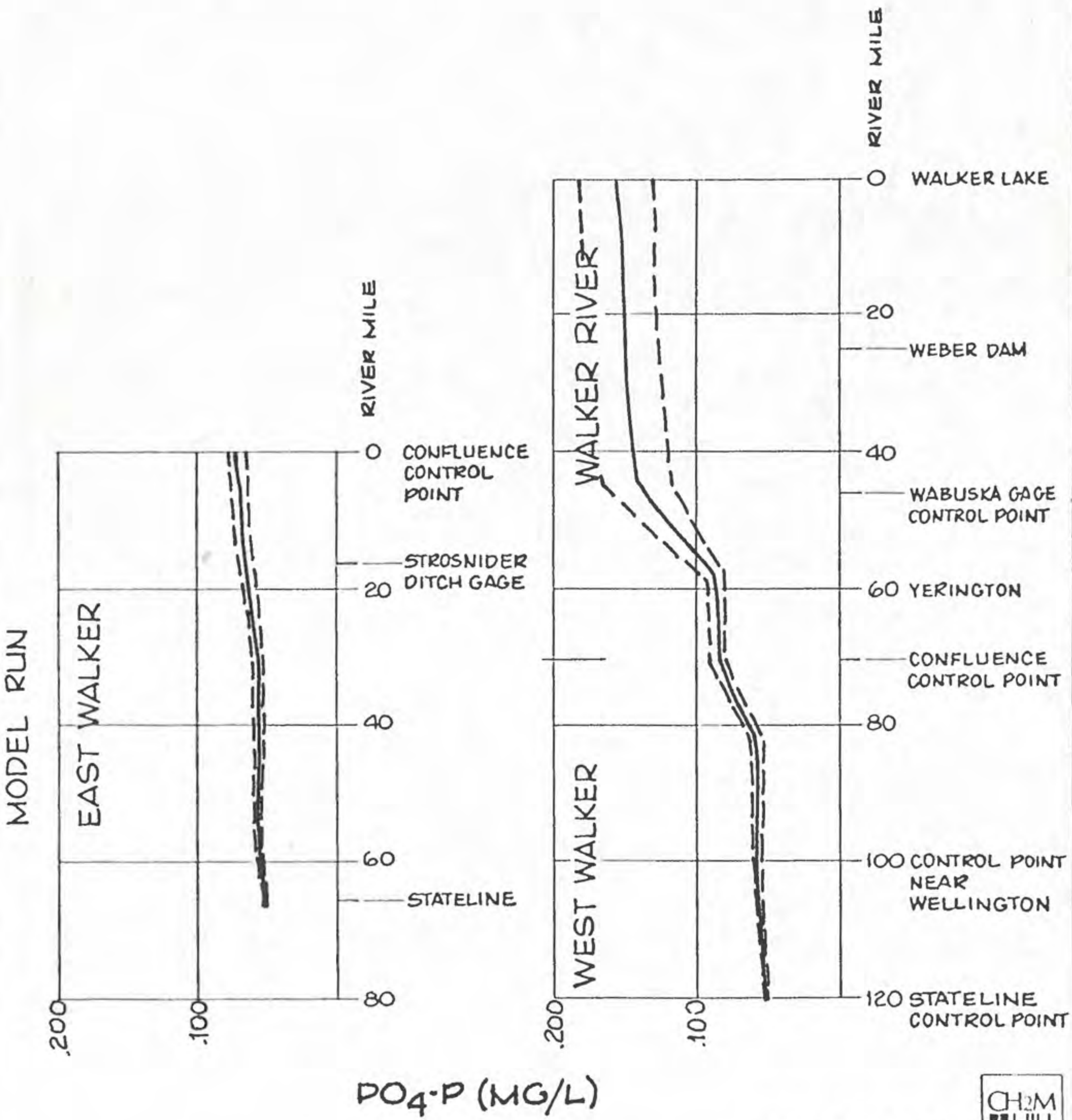
FIGURE 11E

CH2M HILL

LEGEND

——— SIMULATED EXISTING WATER QUALITY

– – – – ± 20% NON-POINT SOURCE LOADS



CH2M HILL

FIGURE 11 F

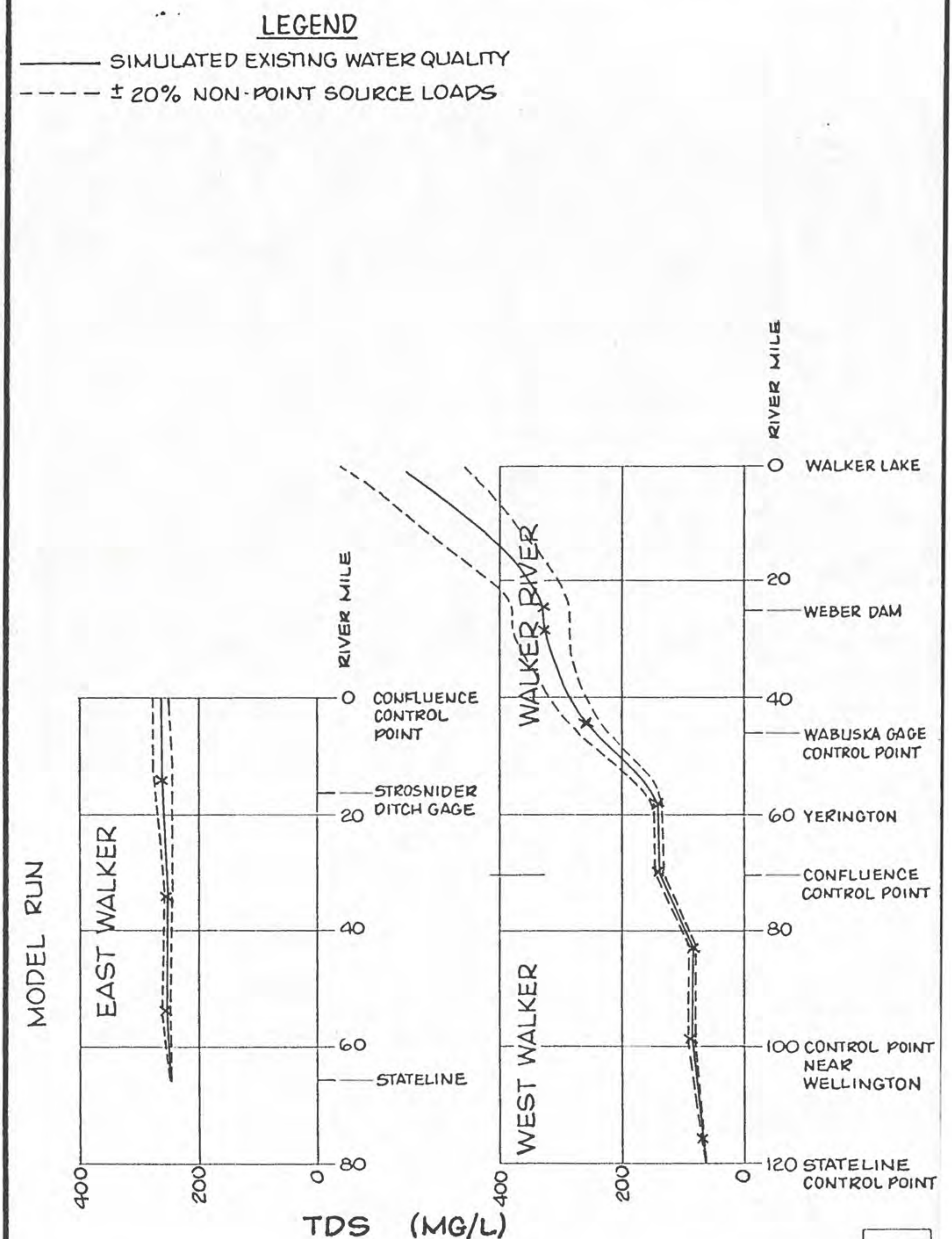

LEGEND
SIMULATED EXISTING WATER QUALITY
± 20% NON-POINT SOURCE LOADS
MODEL RUN
EAST WALKER
RIVER MILE
0 CONFLUENCE CONTROL POINT
STROSNIDER DITCH GAGE
20
40
60
STATELINE
80
400
200
0
WALKER RIVER
WEST WALKER
RIVER MILE
0 WALKER LAKE
20
WEBER DAM
40
WABUSKA GAGE CONTROL POINT
60 YERINGTON
CONFLUENCE CONTROL POINT
80
100 CONTROL POINT NEAR WELLINGTON
120 STATELINE CONTROL POINT
400
200
0
TDS (MG/L)
CH2M HILL

FIGURE 11G

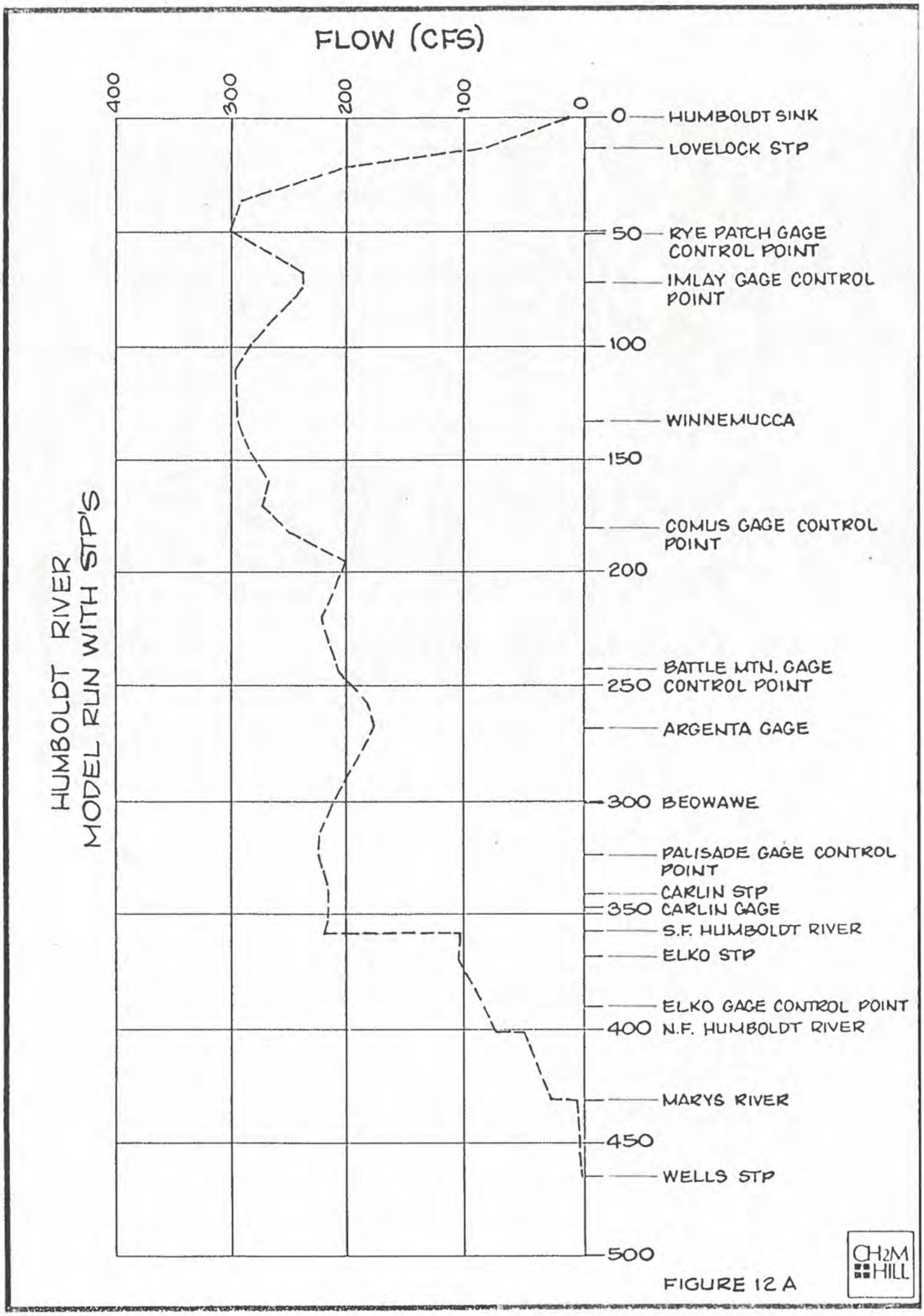

FLOW (CFS)
400
300
200
100
0
HUMBOLDT RIVER
MODEL RUN WITH STP'S
0 HUMBOLDT SINK
LOVELOCK STP
50 RYE PATCH GAGE CONTROL POINT
IMLAY GAGE CONTROL POINT
100
WINNEMUCCA
150
COMUS GAGE CONTROL POINT
200
BATTLE MTN. GAGE CONTROL POINT
250
ARGENTA GAGE
300 BEOWAWE
PALISADE GAGE CONTROL POINT
CARLIN STP
350 CARLIN GAGE
S.F. HUMBOLDT RIVER
ELKO STP
ELKO GAGE CONTROL POINT
400 N.F. HUMBOLDT RIVER
MARYS RIVER
450
WELLS STP
500
CH2M HILL

FIGURE 12 A

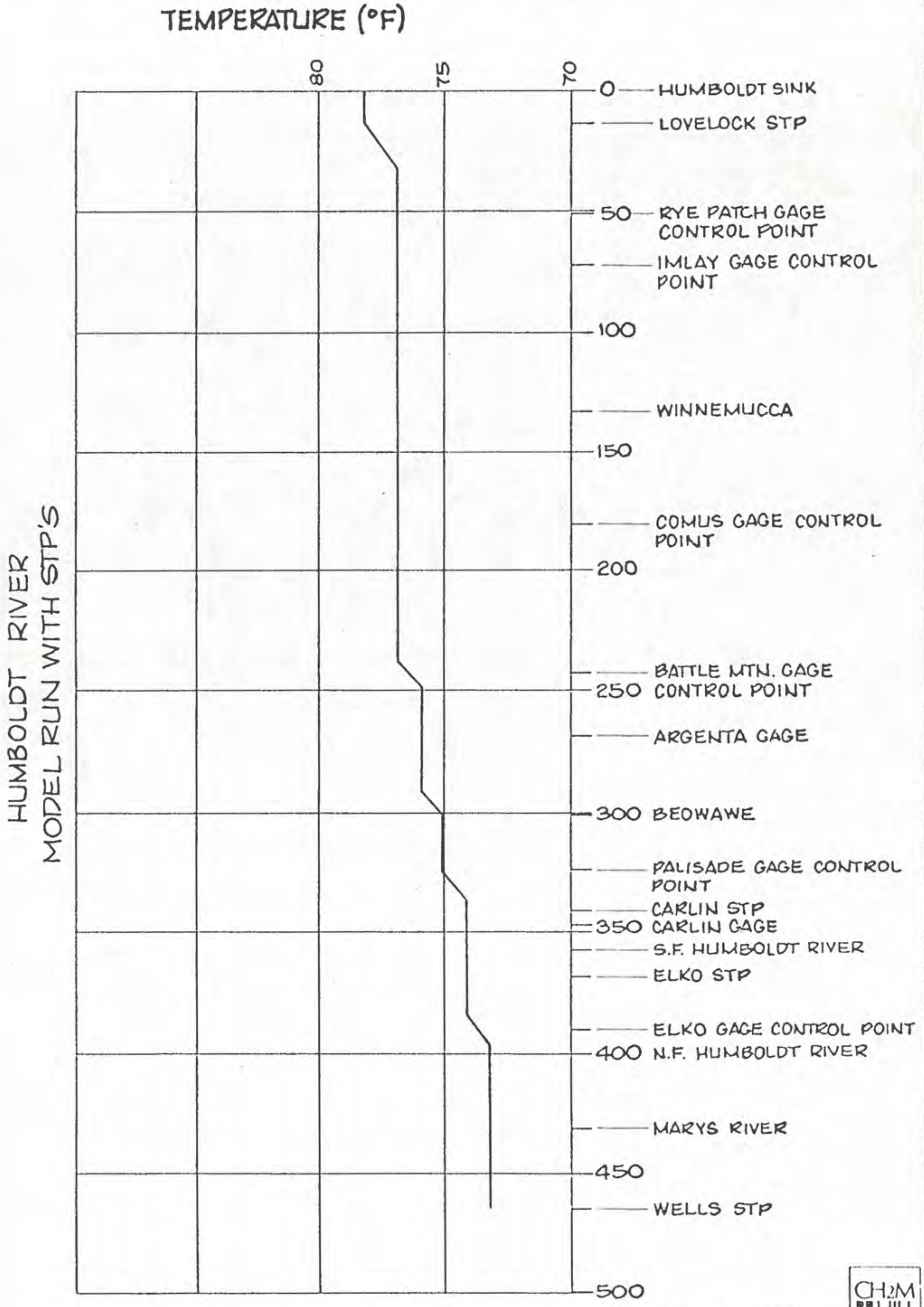


FIGURE 12 B

CH2M HILL

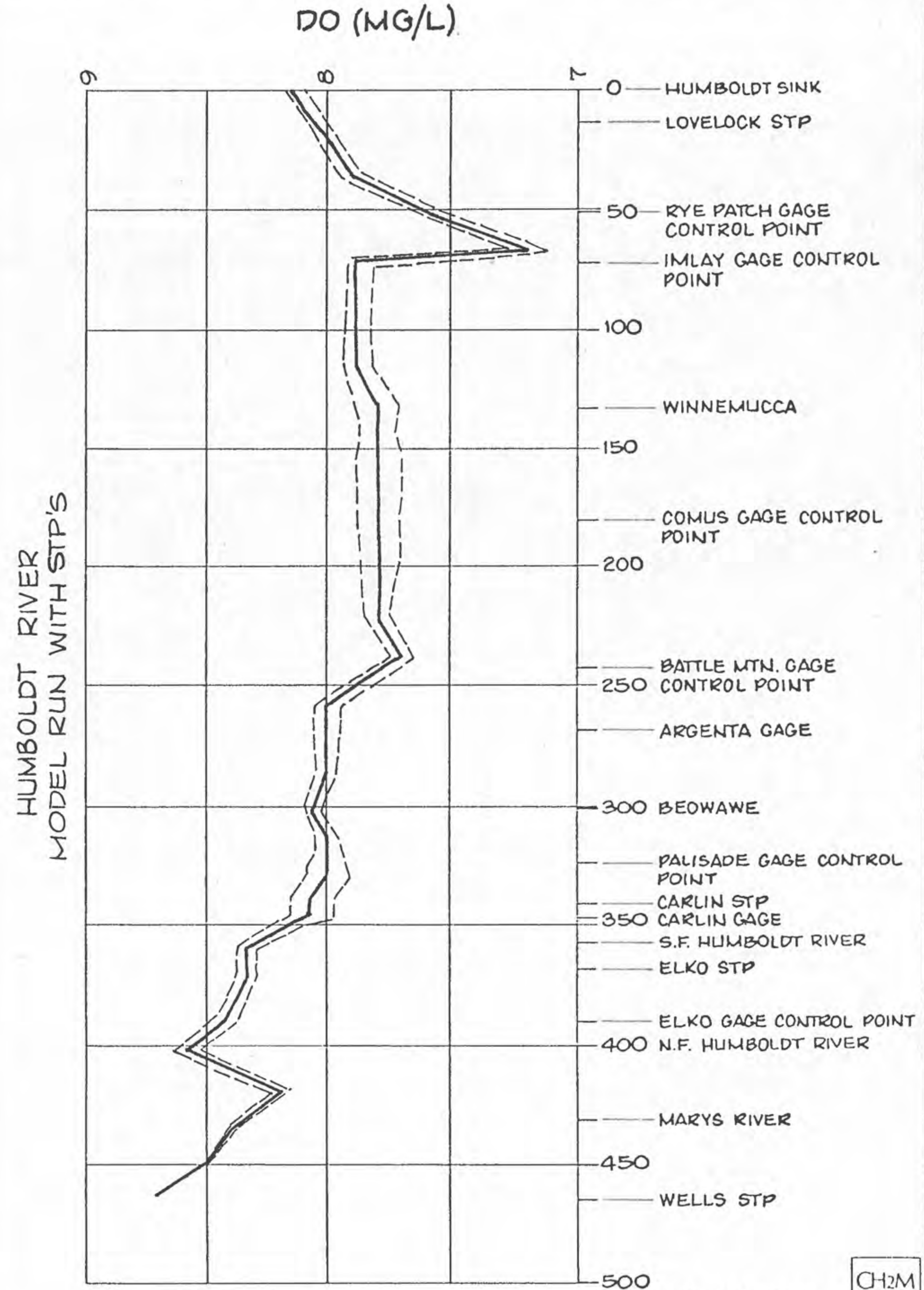


FIGURE 12C

CH2M HILL

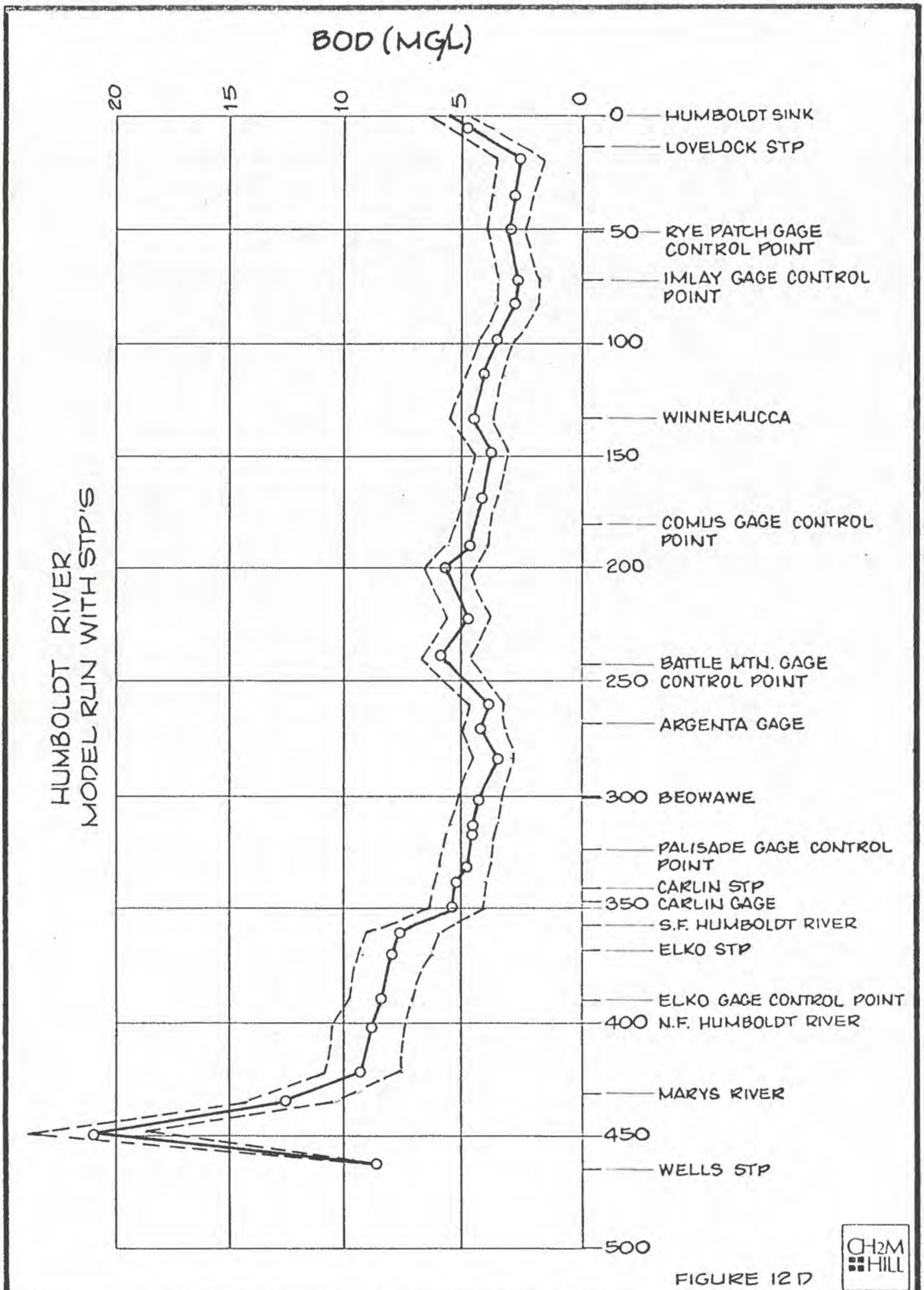
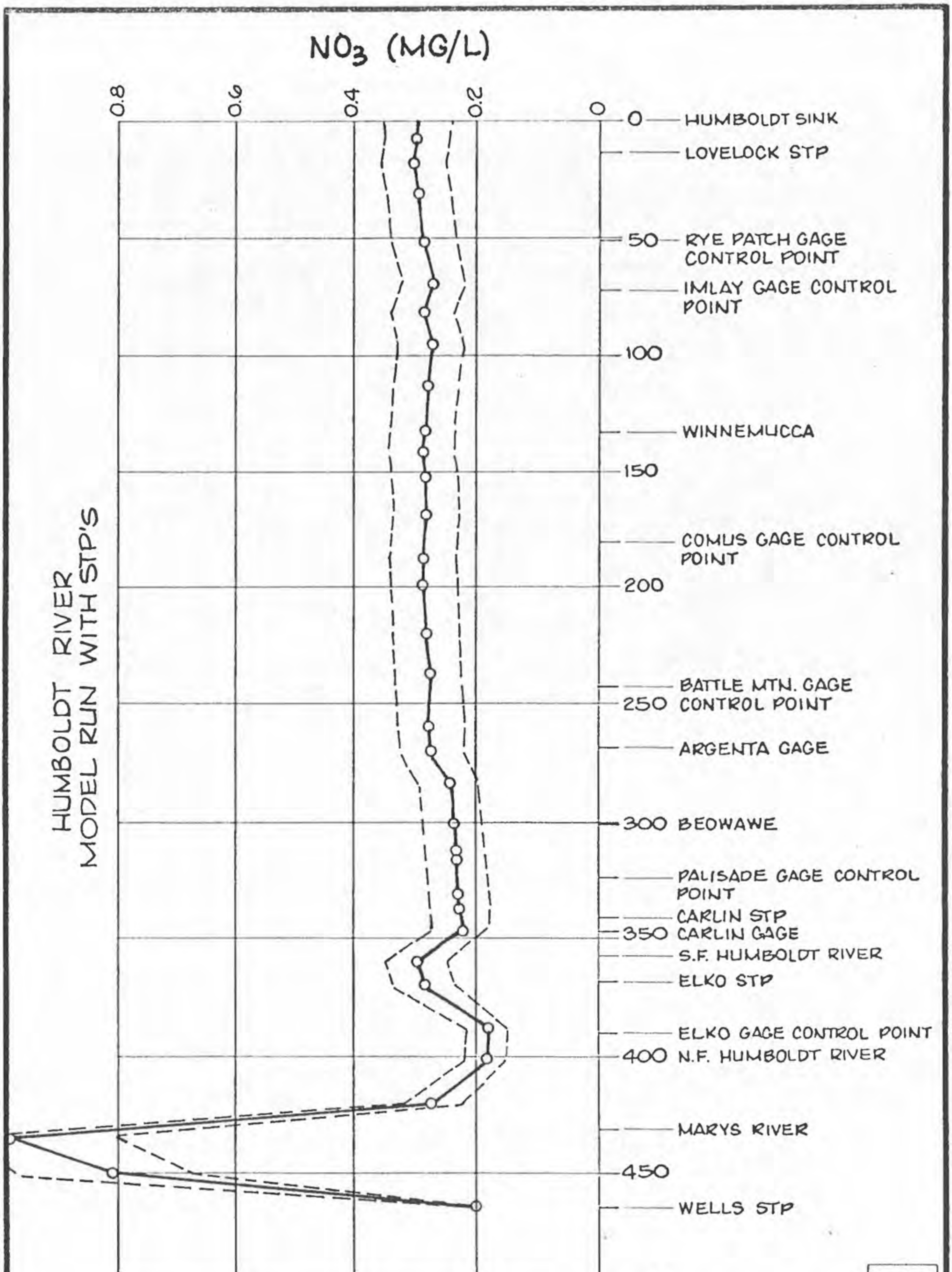

BOD (MG/L)
20
15
10
5
0
HUMBOLDT RIVER
MODEL RUN WITH STP'S
0
50
100
150
200
250
300
350
400
450
500
HUMBOLDT SINK
LOVELOCK STP
RYE PATCH GAGE CONTROL POINT
IMLAY GAGE CONTROL POINT
WINNEMUCCA
COMUS GAGE CONTROL POINT
BATTLE MTN. GAGE CONTROL POINT
ARGENTA GAGE
BEOWAWE
PALISADE GAGE CONTROL POINT
CARLIN STP
CARLIN GAGE
S.F. HUMBOLDT RIVER
ELKO STP
ELKO GAGE CONTROL POINT
N.F. HUMBOLDT RIVER
MARYS RIVER
WELLS STP
CH2M HILL

FIGURE 12 D



NO3 (MG/L)
0.8
0.6
0.4
0.2
0
0
HUMBOLDT SINK
LOVELOCK STP
50
RYE PATCH GAGE CONTROL POINT
IMLAY GAGE CONTROL POINT
100
WINNEMUCCA
150
COMUS GAGE CONTROL POINT
200
BATTLE MTN. GAGE CONTROL POINT
250
ARGENTA GAGE
300
BEOWAWE
PALISADE GAGE CONTROL POINT
CARLIN STP
350
CARLIN GAGE
S.F. HUMBOLDT RIVER
ELKO STP
ELKO GAGE CONTROL POINT
400
N.F. HUMBOLDT RIVER
MARYS RIVER
450
WELLS STP
500
HUMBOLDT RIVER
MODEL RUN WITH STP'S
CH2M HILL

FIGURE 12E

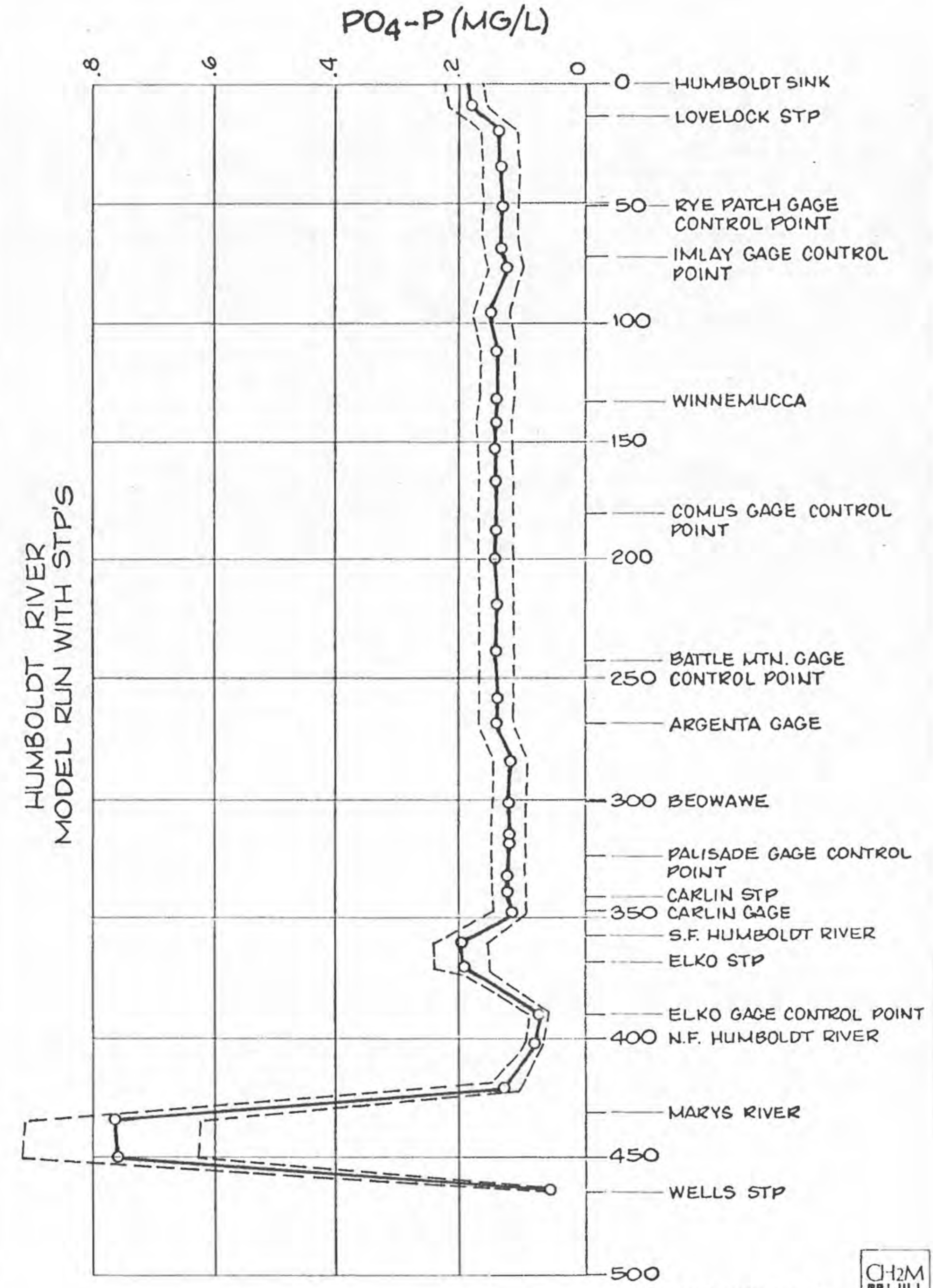


FIGURE 12 F

CH2M HILL

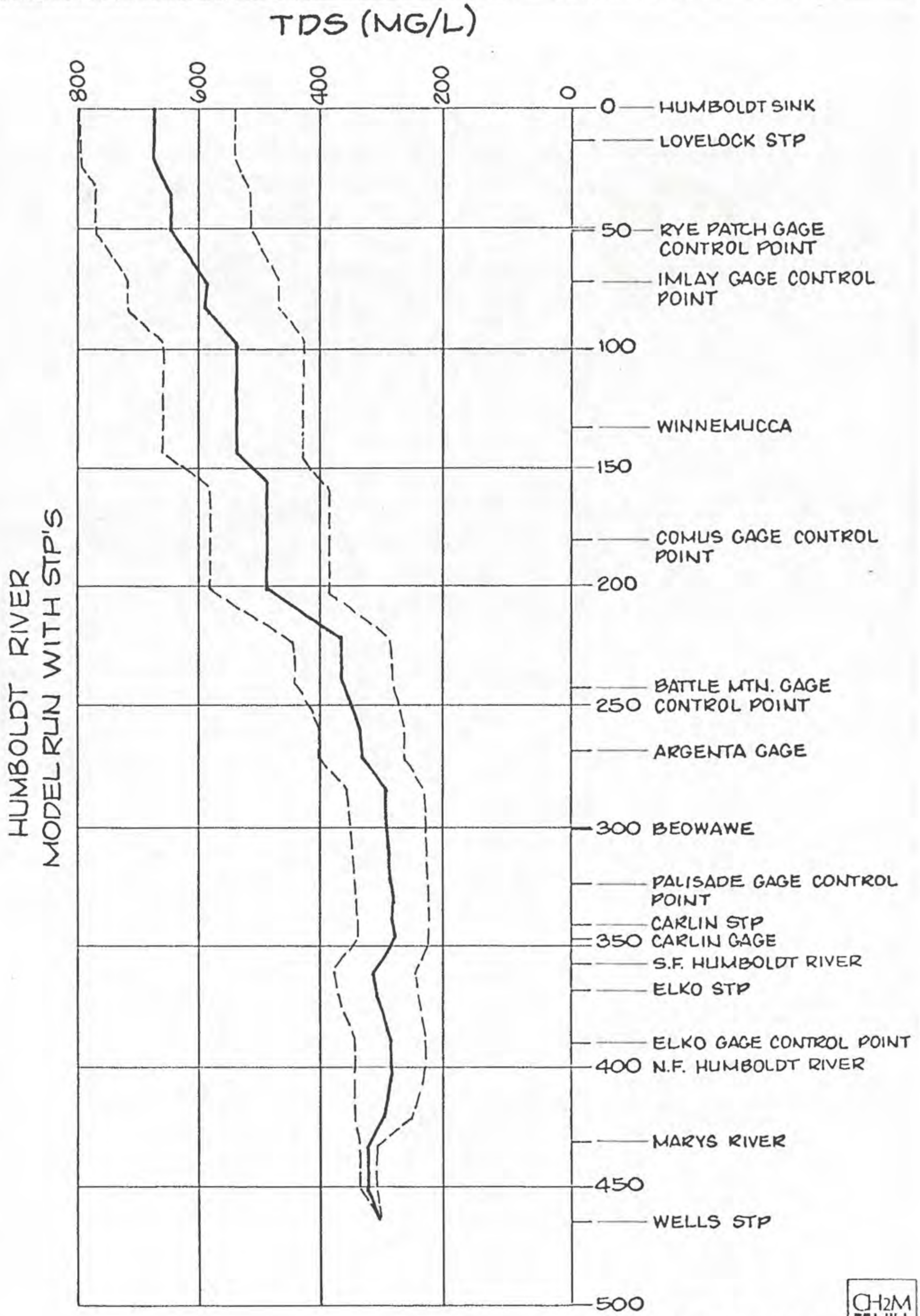


FIGURE 12 G

CH2M HILL