FEDERAL WATER POLLUTION CONTROL ADMINISTRATION

NORTHWEST REGIONAL OFFICE

UMATILLA RIVER BASIN

WATER QUALITY REPORT

JULY 1969

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WATER QUALITY REPORT

United States Department of the Interior
Federal Water Pollution Control Administration
Northwest Region
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INTRODUCTION

Purpose

The Bureau of Reclamation (BR) is preparing a comprehensive plan for water resource development of the entire Umatilla Basin. In developing the proposed plan for construction of dams, canals, and other facilities, they have considered all water needs, such as irrigation, municipal and industrial water supplies, fisheries, and recreation. An intensive development as proposed in the plan, where water is stored, diverted, and reused, will exert a significant effect upon the basin's water quality. In addition to meeting general water quality standards, there are special water quality requirements associated with the fishery function of the plan.

The purpose of this investigation was to predict the water quality resulting from project development and to recommend steps to improve water quality where it will not meet requirements. Although the Federal Water Pollution Control Administration (FWPCA) was consulted from the inception of this latest Bureau plan, not until early 1969 were manpower resources available to prepare this investigation. At that time, the plan had been structured and nearly completed, so this water quality analysis is largely an impact study. Nevertheless, coordination was effected among the fishery agencies, Bureau of Outdoor Recreation, and FWPCA to assure that the water quality necessary to support the fish and recreation functions could be achieved.

Scope

The major aspect of this study is the prediction of future water quality. A dissolved oxygen model was developed for the main stem Umatilla River from Ryan Reservoir to the mouth. Predictions of dissolved oxygen levels were prepared for the time horizons of 1980, 2000, and 2020. Conditions with and without the project were modeled. Since only available water quality and stream characteristic data were used in defining the model, an explicit determination of reaeration and deoxygenation rates and time of travel was not feasible, nor was it possible to test the predictive accuracy against a measured control situation. Nevertheless, experience and judgment indicate that the model satisfactorily represents the stream oxygen dynamics for study purposes.

The Ryan, Beacon, and Snipe Reservoirs were modeled for temperature conditions throughout the year. Ryan and Beacon outflow characteristics were then used as an input to the river temperature model, which extended from Ryan Reservoir to the Columbia River. These models were used not only to predict downstream temperatures under the proposed project operating conditions, but also to vary reservoir operations to achieve specific temperature goals. Again, available data were used to develop the models.

In examining the future 50-year period, a single, most likely, economic forecast was selected. It was based upon the Columbia-North Pacific Type 1 Framework Economic Study and interviews in the basin identifying presently developing trends.

Authority

The FWPCA is responsible for providing water quality analyses and recommendations for all Federal water resource development projects. This function is described in Section 3 of the Federal Water Pollution Control Act and in Executive Order 11288, which describes procedures for the prevention of water pollution by Federal activities.

FINDINGS AND RECOMMENDATIONS

Findings

1. The proposed Bureau of Reclamation (BR) water resource development plan for the Umatilla Basin will improve water quality during the summer when quality levels are the lowest. The increased summer flows will maintain average daily dissolved oxygen concentration levels above State standards. This will enhance fishery and recreation use of the stream.

2. Summer temperatures in the Umatilla River below Ryan Reservoir can be lowered through proper operation of Ryan and Beacon Reservoirs. These lowered temperatures will, in most instances, meet the requirements for anadromous fish. Two levels of outlets at Ryan Reservoir, at elevation 2,000 and 2,140, and three levels at Beacon Reservoir, at elevations 1,100, 1,190 and 1,205, will be sufficient to provide needed temperature control of the releases.

3. The Umatilla stream system carries sufficiently high levels of nutrients that there is a potential for excessive algal growths in the proposed Beacon, Stage and Stanfield reservoirs. Should excessive growths occur, recreation would be adversely affected and dissolved oxygen would be depleted in the lower levels of the reservoir. More data is required to define this condition.

4. Return flows from the proposed irrigation of 100,000 acres of newly developed lands will have a significant influence upon Umatilla River dissolved oxygen and nutrient concentrations. Minimizing the quantities of these return flows will correspondingly minimize the effects on water quality.

5. Irrigation of cover crops with treated waste effluent should be practiced in this basin to provide an effective means for ultimate waste disposal.

6. The present management of the wheat-producing lands results in major soil loss to the streams, causing periodic large sediment loads and deposits and aesthetically displeasing water color and turbidity.

Recommendations

1. Water quality enhancement be included as a project purpose.

2. Attainment of temperature objectives for anadromous fish be a recognized purpose in operating Ryan and Beacon Reservoirs.

3. The incremental flows in the Umatilla River will annually save $30,000 in waste handling costs, required to meet Oregon State Water Quality Standards. This saving should be credited to the proposed project development.

4. Additional data be collected and further study be devoted to defining the algal productivity potential in the proposed reservoirs.

5. Good water conservation measures, such as sprinkler irrigation systems and canal linings, be made a major objective in the proposed plan.

6. Proper land management and conservation practices on the wheat fields and grazing lands surrounding Pendleton-Hermiston be more strictly implemented to prevent further major erosion losses to the stream system.

STUDY AREA DESCRIPTION

The Umatilla River Basin, shown on Figure 1, is situated in northeastern Oregon and contains 3,241 square miles of land ranging from an agricultural plain on the north to the forested Blue Mountains on the south. The northeastern agricultural plain is almost exclusively wheat or irrigated crops, with trees scattered only along the river or in the communities in the basin. Climate is temperate and semi-arid, varying somewhat with elevation. About 86 percent of the basin is privately owned, with the remainder administered by governmental agencies. Land use is as follows: 48 percent rangeland; 36 percent cropland (19 percent wheat); 14 percent forestland; 0.5 percent in towns.

The Umatilla River is a perennial stream flowing generally west through the basin, turning north in its final reaches to discharge into the Columbia River. Most of the tributaries that feed the Umatilla River are intermittent, flowing only during fall rains and spring snowmelt periods. For much of its length below Gibbon, the Umatilla is a relatively shallow stream flowing over a broad, rocky bed or gentle gravel bars. Below Pendleton, there are reaches where the river narrows and deepens.

ECONOMY

The basin economy is principally dependent upon agriculture and forest products. Livestock accounted for the largest portion of the total farm products sold in 1964. A small amount of food processing--primarily pea processing--a small mobile home manufacturer, and a community college are also significant contributors to the basin's economy.

Present

Just over half of the basin's population of approximately 38,000 live in and around Pendleton and Hermiston. Six small, scattered communities in the basin contain most of the remaining population. Emigration from the area has more than balanced natural increase.

While there has been little relative change in total basin population over the last 15 years, there is a general trend of people moving from rural areas and the widely scattered small towns into Pendleton and Hermiston. This trend toward urbanization has begun to manifest an urban sprawl around these two communities. Pendleton has dominated the area in the past.

Thousands of acres of wheat surround Pendleton. Irrigation along the rivers and in the Stanfield-Hermiston area provides some food products for processing, as well as hay for cattle production. Among the irrigated lands, 40,000 acres are devoted to pea production, resulting in a significant food-processing industry in Pendleton. Three cattle feedlots and one hog feedlot, each holding several thousand animals, are scattered through the basin.

Forest products manufacturing includes several sawmills, principally the Harris mill in Pendleton and the Georgia-Pacific mill in Pilot Rock. U. S. Gypsum has a small fiberboard and hardboard plant also at Pilot Rock.

Future

Population and industrial production were projected for the basin, using the Columbia-North Pacific economic projections as a framework. Near term trends and potential developments helped shape the short-range projections.

Although the basin economy has been relatively stable in the past, significant growth is expected in the future. It is expected that relatively large areas in the northern portion of the basin will come under irrigation with or without Federal money. This will induce the establishment of several food-processing plants and a concomitant growth in service employment.

Most of the expected growth will be in the Hermiston-Umatilla area (particularly around the port area) rather than around the Pendleton area. Since those industries locating in the lower end of the basin will have little or no impact on the Umatilla River, only industries and population in the upper portion of the basin were projected. Indices of industrial growth for major waste-producing industries in the upper portion are shown below.

TABLE 1
INDUSTRIAL GROWTH INDICES

	1963	1980	2000	2020
Hermiston food processing	1.0	1.8	2.4	3.4
Pendleton food processing	1.0	1.5	2.0	2.7
Pendleton meat packing	1.0	1.6	1.6	1.6
Pendleton woolen mills	1.0	1.3	1.3	1.3

Food-processing plants have large quantities of residual waste loads to handle. Nearby watercourses such as the Umatilla River are potential sinks for their wastes, so these plants are critical to an appraisal of the future condition of the river's quality. For that reason, attention was given to the future seasonal period of operation for food-processing plants, projections of which are:

Year	Period
1980	May 25 - August 15
2000	May 25 - September 15
2020	May 25 - October 31

In summary, the Umatilla Basin is expected to exhibit strong population and economic growth in the future, with agriculture and forest products continuing their dominance. Although a shift is expected in population and industrial growth towards the Hermiston-Umatilla area, the upper portion of the basin around Pendleton is expected to continue to realize a moderate growth. Population in the basin is expected to grow as follows:

1980	52,400
2000	68,900
2020	80,000

Population projections for major communities are listed below.

TABLE 2
POPULATION PROJECTIONS

	1980	2000	2020
Hermiston	9,000	18,000	22,000
Pendleton	18,000	22,000	26,000
Pilot Rock	1,500	1,500	1,500
Stanfield-Echo	1,800	2,100	3,000

WATER RESOURCES

The hydrology of the Umatilla River, as well as the existing and planned developments, are described in detail in the Bureau of Reclamation report. The following discussion briefly describes aspects having significance to the subsequent water quality analysis. All hydrologic computations were prepared by the Bureau of Reclamation.

The 1931 water year was used in the quality analyses, since it represented approximately a one-in-ten-year low flow situation. The 1931 flows as recorded are used to approximate the hydrologic conditions without the proposed development. Following that discussion, the proposed development and the expected flows are described.

Without Basin Development

McKay Reservoir presently stores up to 73,000 acre-feet of winter flows each year for summer releases down the Umatilla River mostly to the irrigation districts surrounding Hermiston. Normally, storage is exhausted by August, but the State Engineer considers this a full water supply for existing lands if properly utilized. The districts are undertaking water conservation methods to reduce losses and extend the supply.

Cold Springs Reservoir, with a capacity of 50,000 acre-feet, is fed by winter and spring Umatilla River flows diverted near Echo. Cold Springs storage serves primarily the Hermiston lands.

The present system acts to augment Umatilla River flows from McKay Creek to about Echo during the late spring to early summer period. Around late August, when storage is normally exhausted, flows drop down towards unregulated base flow levels. Hydrographs of present summer flows are shown on Figure 2 for three stations on the river, compared to flows with the proposed development.

With Basin Development

Figure 1 shows the major facilities proposed for the basin. Ryan Dam would store up to 110,000 acre-feet of main stem flood flows for later release during the summer. Beacon Dam would store 80,000 acre-feet of flows in excess of downstream requirements which are diverted from the Umatilla River below Ryan. These flows would also be released to the river during the summer.

Denning Dam on Birch Creek would have 16,500 acre-feet of active storage capacity, releases of which would primarily irrigate lands lying along Birch Creek. This would not have a significant effect upon Umatilla River flows during late summer.

Snipe Dam would store 63,000 acre-feet offstream of Camas Creek in the John Day Basin for transbasin diversion to irrigate lands lying along Butter Creek. Snipe Dam, as is Beacon Dam, is expected to support heavy recreation use as well as irrigation water supply storage.

The effect these facilities would have upon streamflows in the Umatilla River is shown on Figure 2. It is evident that flows during the critical low water period of July-September are augmented all the way downstream from Ryan Dam. In the same manner, although not shown, Birch Creek and Butter Creek summer flows would be increased substantially over present levels.

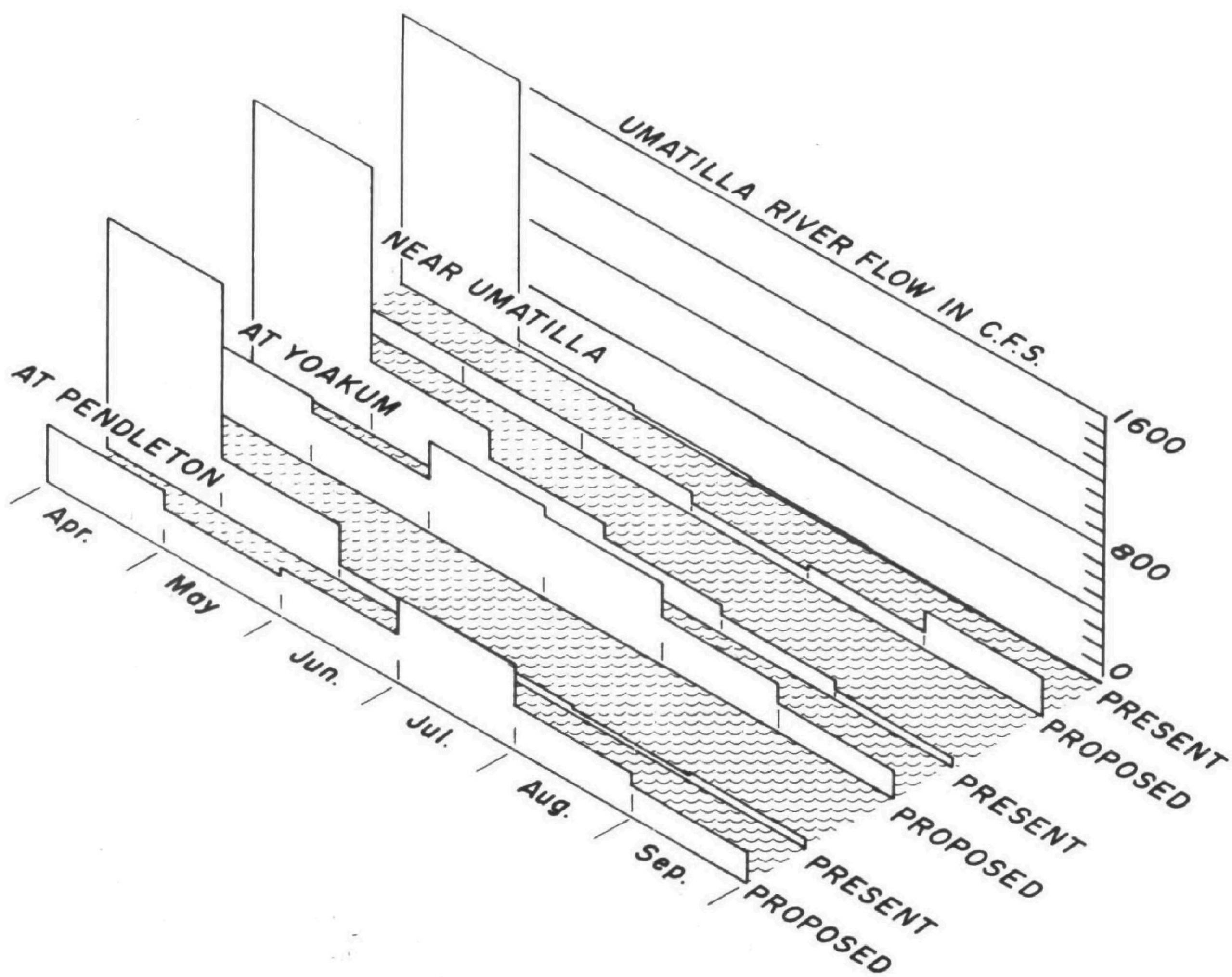


FIGURE 2. HYDROLOGY - UMATILLA RIVER BASIN

WATER USES

The principal use of surface water is irrigation, with irrigation diversions in effect since the late 1800's. Fishery and recreation water uses are also extensive.

Municipal-Industrial Supplies

All communities and industries draw their supplies from ground water. Two lumber mills use surface waters for their mill ponds, however. Most future municipal and industrial supplies are expected to come from ground water, although Pendleton holds surface rights to 21.7 cfs of natural flow in the Umatilla River. The project plan includes a municipal and industrial water supply for the City of Pendleton.

Irrigation

Nearly 30,000 acres in the lower Umatilla Basin are irrigated from the Umatilla River. Storage at McKay and Cold Springs Reservoirs supplements natural flows for about 17,000 of these acres. Through the project facilities provided in the recommended plan, about 100,000 acres of presently dry lands would be furnished a full irrigation supply. The project facilities would also provide supplemental water for about 20,000 acres in the basin.

Fishery

At one time, the Umatilla River supported large runs of spring and fall chinook salmon and steelhead trout. Now, because of the pattern of stream regulation and lowered water quality, steelhead trout is the only anadromous species left in significant numbers in the system. A few chinook salmon remain and coho are being planted, but unless summer flows are increased in quality and fall flows in quantity and quality, the salmon runs will not be re-established. Steelhead have survived because their runs correspond with the periods of high flows. Young steelhead are reared in the upper areas of the watershed where summer flows are not diverted and remain cool.

The proposed project has been developed to enhance conditions sufficient to re-establish and develop the large chinook salmon runs, establish coho salmon runs, and increase the size of the steelhead runs. Thus, under future conditions, it is expected that these species would again use the system extensively.

Resident game fish include Dolly Varden, brook, and rainbow trout; bass; and bluegills. Fishing takes place in certain areas along the river, although much of it is limited because of limited access by the Umatilla Indian Reservation or private land posted against trespass.

Under projected development, stream fishery catch is expected to double, and reservoir fishery is projected to grow to 30 times the present level.

Recreation

Water-based recreation occurs on the basin's rivers and reservoirs as long as adequate quantities of water are available. The types of recreation include fishing, boating, and picnicking.

There is a large demand for water-based recreation here. Swimming, water skiing, and boating are all popular sports requiring suitable resources. The planned development anticipates considerable recreation usage of the reservoirs, as well as increased stream recreation use with increased flows.

WATER QUALITY REQUIREMENTS

The Department of Environmental Quality (DEQ) has established general water quality standards which apply to the Umatilla River. These standards state in part: "No wastes shall be discharged and no activities shall be conducted which either alone or in combination with other wastes or activities will cause. . .:

1. The dissolved oxygen content . . . to be less than six (6) mg/l . . .

4. The development of fungi or other growths having a deleterious effect on stream bottoms, fish or other aquatic life, or which are injurious to health, recreation or industry.

7. Objectionable discoloration, turbidity, scum, oily slick or floating solids, or coat aquatic life with oil films.

8. Bacterial pollution or other conditions deleterious to waters used for domestic purposes, livestock watering, irrigation, bathing . . . or be otherwise injurious to public health."

(On comparable streams, the standards state: "Average concentrations of coliform bacteria not to exceed 1,000 per 100 ml, with 20% of samples not to exceed 2,400 per 100 ml.")

These standards indicate minimum levels of acceptable water quality.

The reestablishment of the chinook and coho salmon runs is predicated upon attaining recommended stream quality requirements. These include a minimum dissolved oxygen content of 7 mg/l throughout the Umatilla River. Water temperatures from September 15 to June 1 should not exceed 14° C. (57.2° F.) between Ryan Dam and Echo. Water temperatures should not exceed 19° C. (66.2° F.) in this reach from June 1 to September 15.

The use of surface waters for water-based recreation is closely related to such water quality factors as clarity, color, and temperature. It has been demonstrated that recreation demand decreases proportionately to decreasing water quality. Two causes of these problems in the Umatilla are biological growths such as algae which cause turbidity and slimes, and sediment which causes turbidity. Algal growths are highly dependent upon dissolved nutrients in the water. Much research is under way to determine the relationship between nutrients and algal densities, but in the interim the following recommended maximum levels have been used as limiting for nuisance algal growths:

Flowing streams	Nitrogen	1.0 mg/l
	Phosphorus	0.1 mg/l
Lakes, impoundments	Nitrogen	0.3 mg/l
	Phosphorus	0.015 mg/l

Algal and aquatic growths can occur with lesser nutrient levels, but the density is generally tolerable. Above these levels, with other environmental factors being adequate, excessive growths will occur which may result in floating scums, with suspended matter giving rise to murky, turbid water or attached filaments. Besides being aesthetically obnoxious, excessive algae cause diurnal fluctuations in dissolved oxygen and pH.

WASTE INPUTS

Accurate analysis and prediction of water quality depend mainly upon a good appraisal of waste inputs. For the dissolved oxygen model, this description takes the form of the ultimate biochemical oxygen demand (BOD ult.) for each waste. Reference was made to DEQ waste discharge data, which represent spot measurements taken at various times over the past five years. These were adjusted to account for known changes in growth or treatment capabilities.

Agricultural wastes could not be defined directly. Estimates of waste loads were prepared, using data from the Yakima Basin.

Municipal and Industrial Wastes

Waste inputs to the Umatilla River system can be seen on Figure 3. Pendleton is both the uppermost and the largest waste source discharging to the Umatilla River. Therefore, prediction of water quality is highly sensitive to economic projections for Pendleton. Presently, Pendleton has a major food-processing plant, a woolen mill, and a meat-packing plant that contribute significant waste loads in addition to the waste loads from the normal mix of people and commercial establishments. It is planned that an overloaded secondary sewage treatment plant will be expanded and upgraded within the next two years, and the expanded plant will treat the mix of industrial and municipal wastes, with effluent disposal to the river. The predicted growth in raw waste loads, treatment efficiency, and waste input to the river for Pendleton as well as the other municipalities is shown on Table 3 at the end of this section.

Echo has no sewer system and is presently served by individual septic tanks. Stanfield is sewered, with an acceptable secondary treatment plant. Hermiston is also sewered with an acceptable secondary treatment plant, but high ground-water infiltration during the summer irrigation season overloads the existing plant, resulting in reduced removals of organic material.

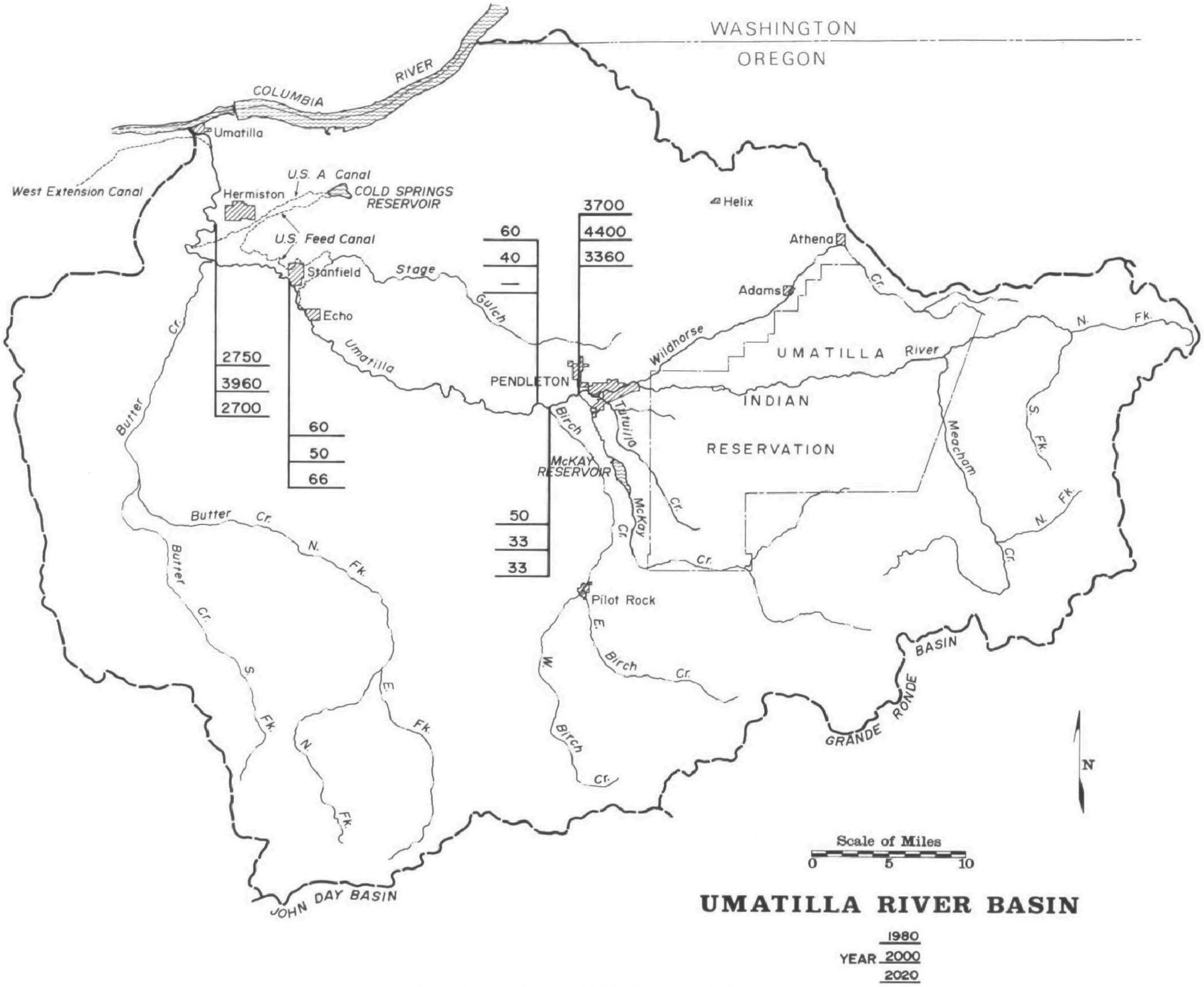


FIGURE 3. PROJECTED WASTE INPUTS

On Birch Creek, Pilot Rock has an adequate sewer system and waste stabilization pond. The U. S. Gypsum plant at Pilot Rock, manufacturing hardboard and plasterboard products, disposes of its waste to land the year around, with no effluent discharged directly to the creek.

Athena, along Wildhorse Creek, provides secondary treatment for its small tributary population. The cannery at Athena applies its waste effluent to land. Adams has no system, relying upon individual septic tanks for waste handling. During the summer and late fall, Wildhorse Creek contributes little flow to the Umatilla River.

Projected waste inputs were developed by applying unit loads to the projected economic growth indices shown on Table 1, Economic Section. Following consultation with DEQ, the levels of treatment efficiencies shown in the table were assumed. It was also assumed that U. S. Gypsum would continue land disposal of its waste, that Wildhorse Creek would not contribute significant waste loads to the Umatilla River during the low-flow period, and that Echo would be sewered.

Agricultural Wastes

Three main pollutants are contributed to the Umatilla River through agricultural operations. These are: (1) cattle wastes from feeding pens on watercourses, which introduce oxygen-demanding material, bacteria, and nutrients to the stream, (2) irrigation return flows, introducing mostly nutrients and some oxygen-demanding organics, and (3) sediment. There is no information on the effects of the cattle wastes or irrigation return flows. For future waste inputs, it was assumed that cattle feed lots would be removed from all streams around 2000. Irrigation return flows were expected to persist unchanged without the project, and with the project would increase in quantity according to Bureau of Reclamation projections. Irrigation return flows were assumed to be divided approximately 75% surface and 25% subsurface. The surface flows were assumed to have a 1 mg/l oxygen deficit, while subsurface flows enter the stream with zero dissolved oxygen. The BOD of the cattle wastes was estimated from information derived from the literature for the expected size of feeding operations during the low-flow season. The BOD of the irrigation return flows was estimated from data collected for the Yakima River Basin.

TABLE 3

PROJECTED WASTE INPUTS 1/
BOD ULTIMATE/DAY - POUNDS

	1980			2000			2020		
	Raw Waste	Treatment Efficiency	Waste Discharge	Raw Waste	Treatment Efficiency	Waste Discharge	Raw Waste	Treatment Efficiency	Waste Discharge
Pendleton	37,000	90%	3,700	44,000	90%	4,400	56,000	94%	3,360
Pilot Rock	330	85%	50	330	90%	33	330	90%	33
Echo-Stanfield	420	85%	60	500	90%	50	660	90%	66
Hermiston	27,500	90%	2,750	39,600	90%	3,960	54,000	95%	2,700

1/ Loads during canning season, as defined in Economic Section of Report.

PRESENT WATER QUALITY

The quality of the Umatilla River is adequate to serve most uses. Table 4 at the end of this section shows the range of concentrations measured at two stations on the river. In the Blue Mountain source headwaters, the water is cool, clear, low in pollutants, and high in dissolved oxygen. After it flows past Pendleton and through the wheat fields to the Columbia River, its character has been degraded as a result of present waste discharges and land management practices. The water carries heavy sediment loads at times, has high bacterial levels, lowered dissolved oxygen levels, and some algal growths. These factors are discussed for the river's condition during July and August, when use demands are at a maximum and flows are at a minimum.

Dissolved Oxygen

A relatively shallow, fast-moving stream, the Umatilla has a large capacity for accepting atmospheric oxygen. In the past, waste loads have not driven oxygen levels down excessively, with measured dissolved oxygen levels consistently exceeding 8 mg/l. Several measurements in the lower reaches show significant supersaturated levels, indicating considerable algal activity in the summer and fall months. Because dissolved oxygen measurements were taken only during the day a few times a year, actual levels and their range of fluctuation are not known.

Temperature

The stream temperatures usually reach their highest levels in July and August. In the upper reaches above Meacham Creek, maximum temperatures of 74° F. have been recorded during August. The average August maximum temperature is around 69° F. Downstream near Umatilla, stream temperatures are substantially higher, with 85° F. the highest recorded measurement. August temperatures here normally range in the middle 70's.

Temperature requirements for anadromous fish, as previously mentioned under Water Quality Requirements, are September 15 to June 1 water temperatures not to exceed 57° F. and June 1 to September 15 water temperatures not to exceed 66° F.

Nutrients

Concentrations of nitrates (NO_3 - N) and phosphates (PO_4) have been quite high. Above Pendleton, average measurements by DEQ have been about one-third of those below Pendleton indicating that a major source of nutrients is the Pendleton waste load. However, as an example, nutrient levels above Pendleton are more than twice those experienced in the Willamette River.

Station Location	NO_3 - N mg/l	PO_4 mg/l
Above Pendleton	0.10	0.13
At Rieth Bridge	0.38	0.44
At Yoakum Bridge	0.25	0.40
Near Umatilla	0.40	0.28

These nutrient-rich waters cause significant aquatic growths in both Cold Springs and McKay Reservoirs as well as in the Umatilla River. Beginning about June in the reservoirs, algal growths emerge and grow to peak density in July and August. The algae are suspended in the surface waters, reducing visibility and giving the water a greenish cast. The density of algal growth depresses fishing and water-contact sports during July and August. Odors are apparent from the algal die-off along the shoreline. No adverse effects on the reservoir fisheries due to oxygen depression from the algal growths have been noted.

The aquatic stream growths are primarily mosses and slimes on the bottom of the river. Photosynthesis of these growths have caused a recorded 170% supersaturated stream dissolved oxygen level.

Bacteriological

Pendleton waste effluent and the cattle feed lot at Rieth exert the primary effect upon bacteriological quality. Above Pendleton, coliform bacteria levels are generally below 1,000 MPN per 100 ml. The median measurement has been 230 MPN per 100 ml. Below Pendleton, measurements are normally above 6,000 with a median of 7,000 and seven measurements of 70,000 MPN per 100 ml. By the time the river reaches Umatilla, recorded levels have decreased to the range of 45 to 7,000, with a median of 700 MPN per 100 ml. Adequate, consistent treatment and chlorination of Pendleton wastes, control of feed lots, and prevention of animal entry to the surface waters would bring bacterial levels down to acceptable limits.

Sediment

The Umatilla River and its tributaries normally yield large amounts of sediments. Peak levels occur during periods of high streamflows caused by rainstorms or rapid snowmelt. Most of the sediment is derived from the agricultural lands below Meacham Creek lying around and west of Pendleton. These lands alternate annually between wheat and fallow fields. Less than 20% of the fallow fields are kept in stubble mulch, the remainder being barren and particularly susceptible to erosion forces.

The effect of silt erosion on water quality is extreme turbidity and the appearance of light chocolate color. The water is aesthetically displeasing, adversely affects fish life by depressing their respiration capabilities, and clogs and fills water conveyance and storage facilities.

Suspended sediment has been measured and recorded for the Umatilla River near Umatilla since October 1962. The peak sediment load was 39,000 ppm recorded in July 1965. During the December 1964 flood, a peak of 21,000 ppm was recorded. Annual sediment movement reported past the gage has ranged up to over 2,000,000 tons per year. The Forest Service has recently installed additional sediment sampling stations, but data from these stations are not presently available.

The existing storage facilities of McKay and Cold Springs Reservoir are not particularly effective in reducing sediment transport because of their locations relative to sediment source and conveyance. Cold Springs Reservoir has lost approximately 10% of its capacity in 60 years of operation due to storage of eroded silts.

TABLE 4

WATER QUALITY
UMATILLA RIVER

	Range of Concentrations (Minimum to Maximum) mg/l, except as noted	
Constituents	Umatilla River above Pendleton 1/	Umatilla River above Echo 1/ (at Yoakum Bridge)
Sulfate	1-7	3-11
Chloride	1-5	1-9
Alkalinity ($CaCO_3$)	22-48	28-74
Hardness ($CaCO_3$)	20-39	22-63
Total Solids	66-133	79-1,420
Suspended Solids	4-25	3-1,280
Nitrate	0.01-0.20	0.02-0.55
Phosphate	0.03-0.44	0.07-1.80
pH Units	7.2-9.0	7.1-9.0
Temperature °F	39-82	34-75
Turbidity (JCU)	1-16	0-80
Coliform (MPN/100 ml)	13-6,200	210-70,000
Dissolved Oxygen	7.9-13.2	9-14.3
Percent Saturation	90-115	85-170

1/ Data from Department of Environmental Quality. Sampled monthly from 1960-1962, biannually thereafter.

PREDICTED WATER QUALITY

The future water quality, with which we are concerned here, will depend upon many factors controllable by man: (1) the type and adequacy of waste treatment facilities for the towns and industries, as well as the competency of operation, (2) the kinds and sizes of major waste-producing industries that will locate here and the treatment provided for their wastes, (3) the type of water and land management.

Prognostications of these factors were made discretely for the predictive models. Waste treatment levels which could be expected were considered, and a most reasonable level within the framework of expected Oregon State Department of Environmental Quality management policy, Water Quality Standards, and projected technological advances was selected. Similar considerations went into each assumption built into the model, so that many alternatives were evaluated and discarded at a low level of analysis. This did not allow sensitivity testing of the model for possible synergistic effects that might occur with variance of the assumptions around the selected design. Basic assumptions regarding treatment efficiencies, waste loadings, and stream characteristics were identical for both the "with" and "without" project conditions.

Hydrologic data were furnished by the Bureau of Reclamation. The design water year selected was 1931, which represented about a one-in-ten-year recurrence low-flow event.

A mathematical simulation, or model, of the dissolved oxygen system of the Umatilla River from Ryan Dam to the mouth was developed. There were no time-of-travel data available, so velocity-discharge relationships were derived from stream cross-section data. Data of biochemical oxygen demand (five-day), dissolved oxygen previously collected on the river were considered to be not representative of deoxygenation and reaeration characteristics during the critical summer low-flow period. Reaeration rate constants were derived from the Krenkel-Orlob and Langbein-Durum equations. Deoxygenation rates were derived through evaluation of the available data and adjusted to represent expected conditions. During the canning season, k_1 was assumed to be 0.58.

Stream temperatures were taken from the temperature model for the "with" and "without" project conditions. Stream hydrology, including the quantity and location of irrigation return flows and diversions, was included in the model. Following consultation with the BR, irrigation return flows were assumed to be 25% subsurface and 75% surface, with the subsurface flows containing zero dissolved oxygen.

Temperature was modeled, for Ryan and Beacon Reservoirs and the Umatilla River, reflecting the influence of the reservoir releases. Data defining the reservoir conformation and average weather conditions at both reservoirs were available.

Each model was used to predict conditions at the three time horizons of 1980, 2000, and 2020 for the situation if the basin does not undergo the proposed water resource development and for conditions with the proposed basin plan implemented. The discussion below treats predicted oxygen levels and temperature conditions under each level of development.

Nutrients were not modeled and are discussed under each section only in a qualitative manner. Sediment considerations are also generally discussed. Butter Creek was not modeled for either dissolved oxygen or temperature, primarily because there are no data for the stream from which to derive a model. Neither is it expected to support a significant fish population, so exceptional quality requirements are not a major consideration in the plan. Finally, it is expected that the cool, high quality summer releases from Snipe Reservoir should provide at least as good, if not better, quality streamflows as exist without the project.

Without Basin Development

Very little additional Umatilla River water use for irrigation development is expected, since storage is required to gain adequate water supplies both for some of the presently irrigated lands as well as for any new increment of irrigation. Some development of irrigation will probably take place along the Columbia River, with water supply pumped from the Columbia to suitable adjacent lands.

Flow characteristics would be expected to remain the same in the Umatilla River. Thus, no additional summer flows will be available for assimilation of the anticipated growth in Pendleton and Hermiston waste effluent.

Dissolved Oxygen

The predicted growth of Pendleton is largely independent of the effects of the proposed water resource development. Therefore, future waste effluent discharged to the river is likely to increase to the same degree, with or without the project. Oxygen-demanding organics, nutrients and solids, will impose a growing load upon the river's oxygen resources.

The predicted average daily oxygen profile without project development is shown on Figure 4 for August 1980. This profile represents the most adverse oxygen condition during the year. Profiles for the years 2000 and 2020 are comparable, as the projected increase in waste treatment effectiveness approximately counter balances the predicted waste load growth.

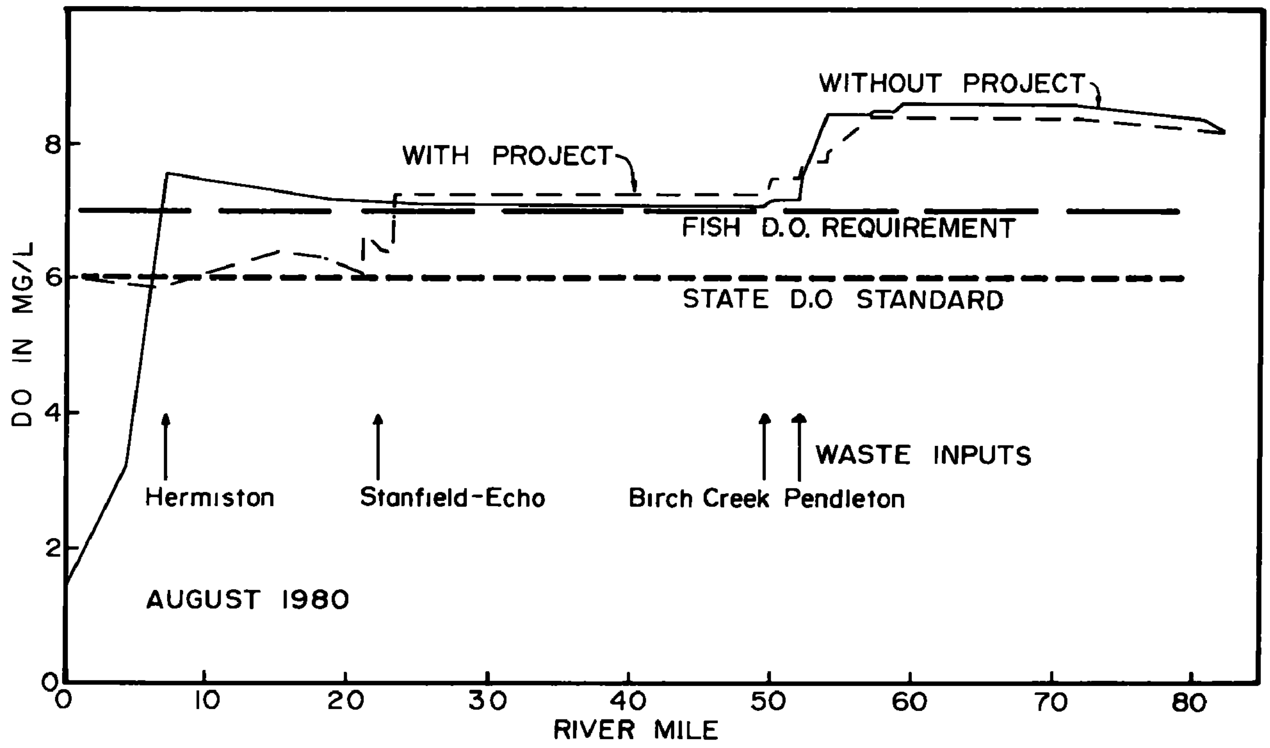


FIGURE 4. PREDICTED UMATILLA RIVER DISSOLVED OXYGEN PROFILE

The predicted dissolved oxygen level remains above 7 mg/l all the way down the river to the Hermiston waste effluent input, where concentrations plunge to less than 2 mg/l. Although the Pendleton effluent has a marked effect upon the dissolved oxygen regime, it does not drive levels below the 7 mg/l level needed for anadromous fisheries. Hermiston's effluent exerts such an immediate and significant effect because Umatilla River flows are extremely low through this last reach. These predicted oxygen levels, however, are for average daily oxygen conditions, and do not take into account diurnal oxygen fluctuations. Data show daytime values up to 170% of saturation so nighttime levels could be correspondingly lower, depending upon future levels of algal activity.

Temperature

There will be no change in the existing temperature regime, and maximum summer temperatures below Pendleton will continue to range around the mid-70's, with peaks in the 80's.

Nutrients

Concentrations of nitrogen and phosphorus are expected to increase in direct proportion to the growing contribution of these constituents from municipal and industrial waste effluent, along with agricultural contributions. Benthic slimes, existent below Pendleton during the summer now, will probably increase in the future.

Sediment

The amount of lands devoted to wheat, grazing, and sagebrush around Pendleton-Hermiston will remain essentially the same. Presuming the existing land management practices persist, the present sediment and turbidity problems will remain. Only if good conservation practices, such as stubble mulching of fallow wheat lands, are initiated, can the problems be alleviated.

With Basin Development

The modification of flow regime with construction of the storage proposed in this basin-wide plan will generally benefit water quality. The increased late summer flows and the possibility for releases of cool bottom waters from the reservoirs are the means for this improvement.

Dissolved Oxygen

Predicted August 1980 dissolved oxygen levels with the planned development in operation are shown on the profile on Figure 4. Pendleton's treated waste effluent again drives oxygen levels down from above 8 mg/l to about 7 mg/l. The different curve conformations between the "with" and "without" project conditions derive from the changed pattern of irrigation return flows. The subsurface portion exerts an immediate influence upon the dissolved oxygen regime with its zero dissolved oxygen content. This is especially significant at River Mile 23, where the river's dissolved oxygen concentration drops to 6 mg/l and is roughly sustained at this level to the mouth.

Temperature

Ryan Reservoir will modify the summer temperatures of the Umatilla River downstream to Pendleton. The stream from Ryan to Pendleton is generally shallow and broad; thus, the cool reservoir releases are rapidly warmed, increasing in temperature by Pendleton to levels approaching an equilibrium temperature. Ryan Reservoir is deep, however, and affords a good opportunity for late summer release of very cool water that will lower stream temperatures to levels required by the anadromous fisheries.

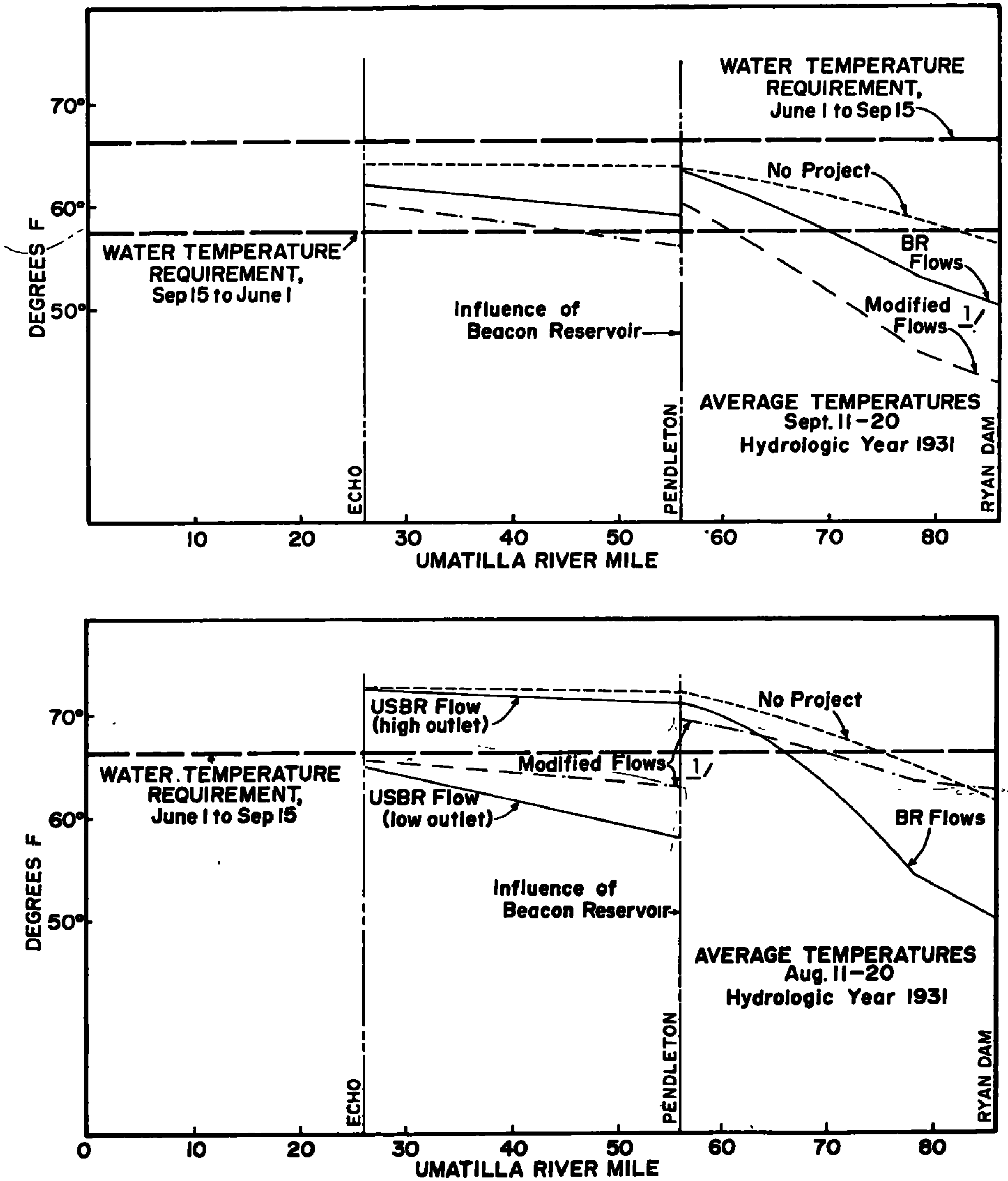
Fortunately, from a temperature standpoint, Beacon Reservoir releases enter the river just below Pendleton. Beacon can also retain significant cool water for late summer releases. The Umatilla River below Beacon is generally deeper than the reaches above Pendleton, and will warm up to equilibrium conditions at a slower rate. Thus, the effects of Beacon's cool releases are retained further downstream.

The period of maximum predicted temperature is mid-August, when required stream temperatures for optimum anadromous fisheries are below 66^{o} F. After mid-September, stream temperatures should not exceed 57^{o} F. for fishery requirements. The predicted profiles of stream temperatures under three conditions for these two time periods are shown in Figures 5 and 6.

These predicted temperatures were based upon average weather conditions imposed upon the 1931 water year runoff, about a 1-in-10 low-flow occurrence. Thus, in an average water year, the predicted stream temperatures would be somewhat lower since there would be larger stored flows for temperature control.

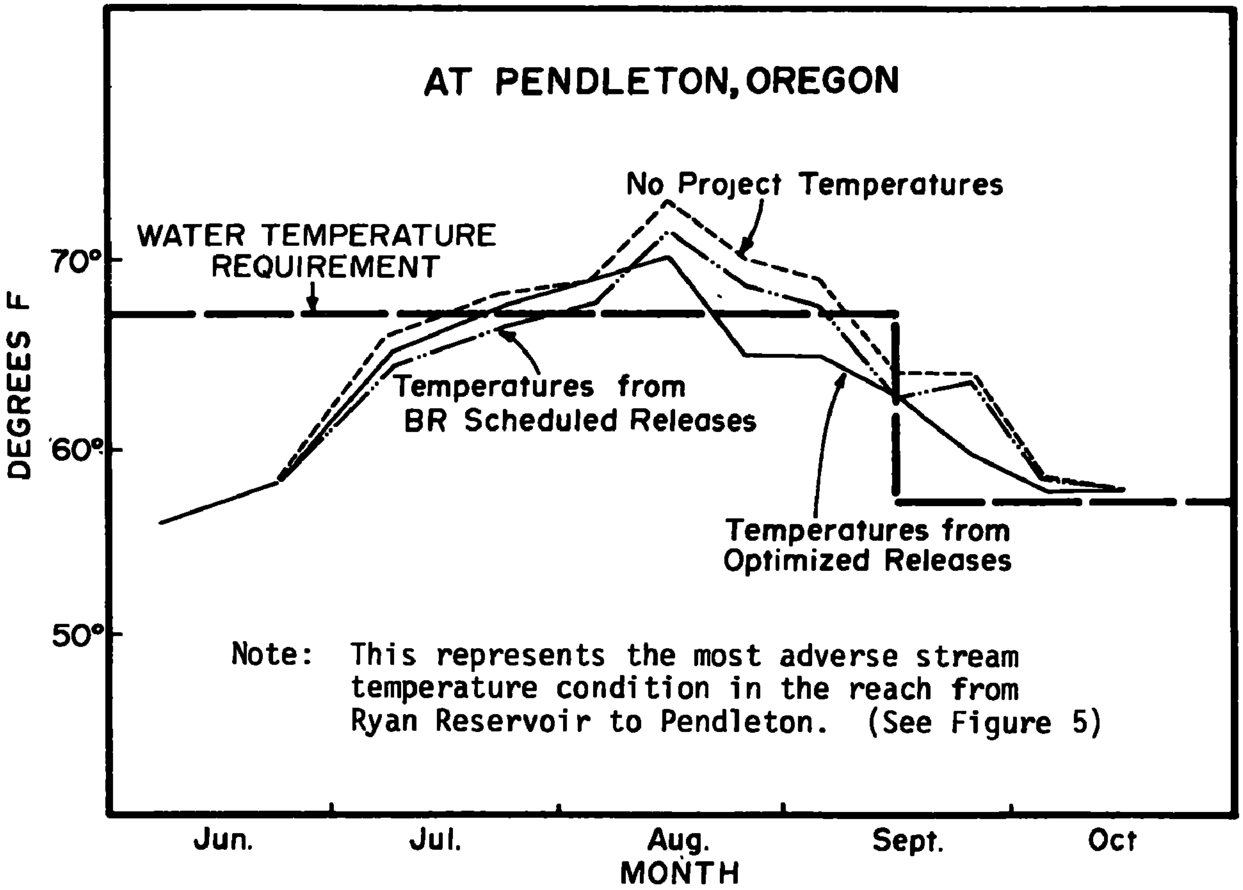
Where the profiles are not parallel, the flows are of different size. Lower flows result in longer travel times and shallower streamflows, and thus warm more rapidly.

The two profiles should be read together. The low August temperatures below Beacon for the proposed Bureau flows were attained at the expense of lower September temperatures. If the cooler waters are spent in August to overcome the lower quantity of releases, then that cool water is not available in September. As can be noted on the profiles, stream temperatures exceed temperature requirements over most of the stream without reservoir releases. With Ryan and Beacon operated for irrigation and fishery quantity releases using two and three levels of multiple outlets, respectively, temperatures over much of the river are substantially reduced, but still exceed fishery requirements over certain river reaches. Modification of the operation of Ryan and Beacon more specifically for temperature control can further reduce stream temperatures. The temperature regime in Ryan and Beacon Reservoirs, as well as the recommended reservoir operation schedule, is shown on Figures 7 and 8.



1/ Modified flows refer to releases from the reservoirs that were changed within physical limits to optimize downstream temperatures for fishery requirements.

FIGURE 5. STREAM TEMPERATURE PROFILES FROM RYAN DAM TO ECHO, OREGON



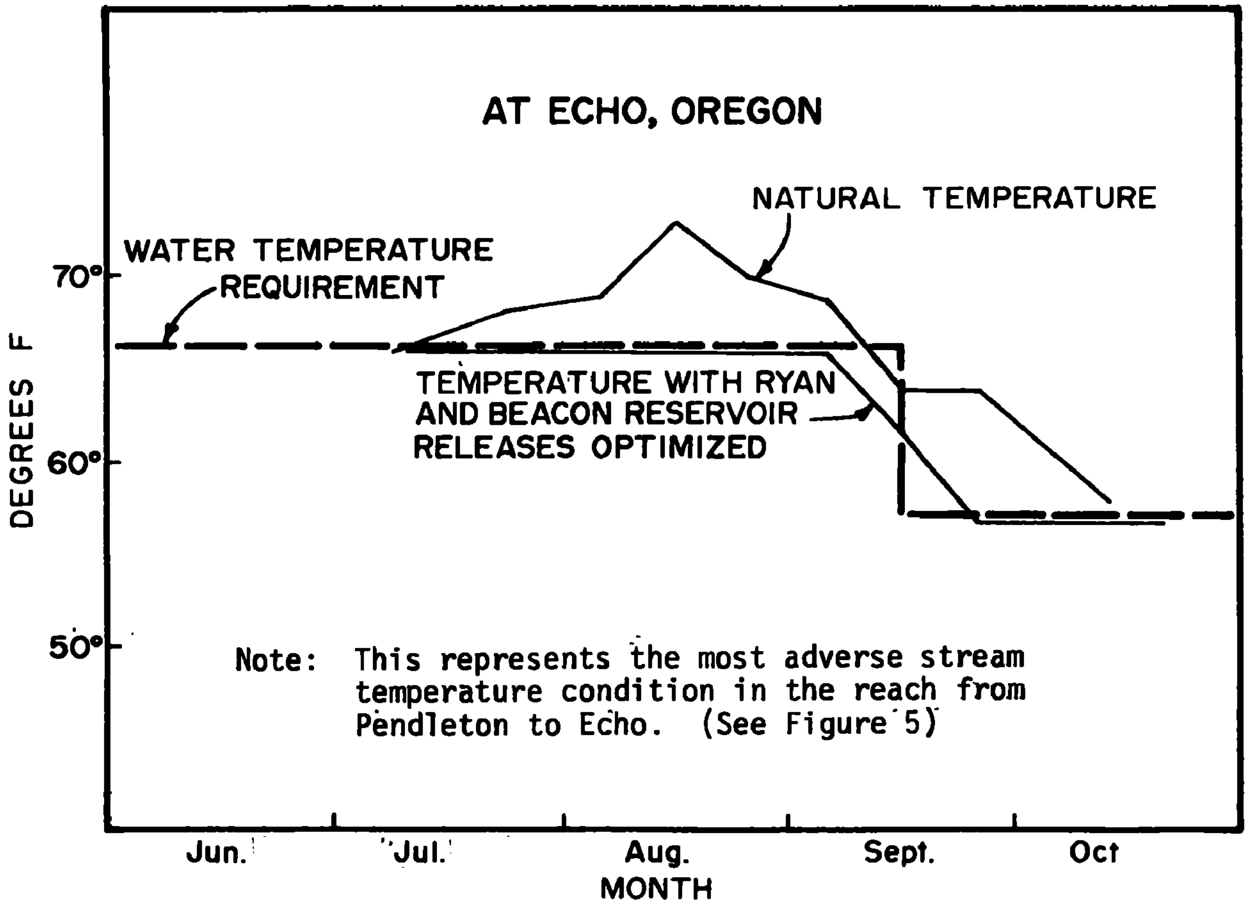


FIGURE 6. UMATILLA RIVER TEMPERATURES

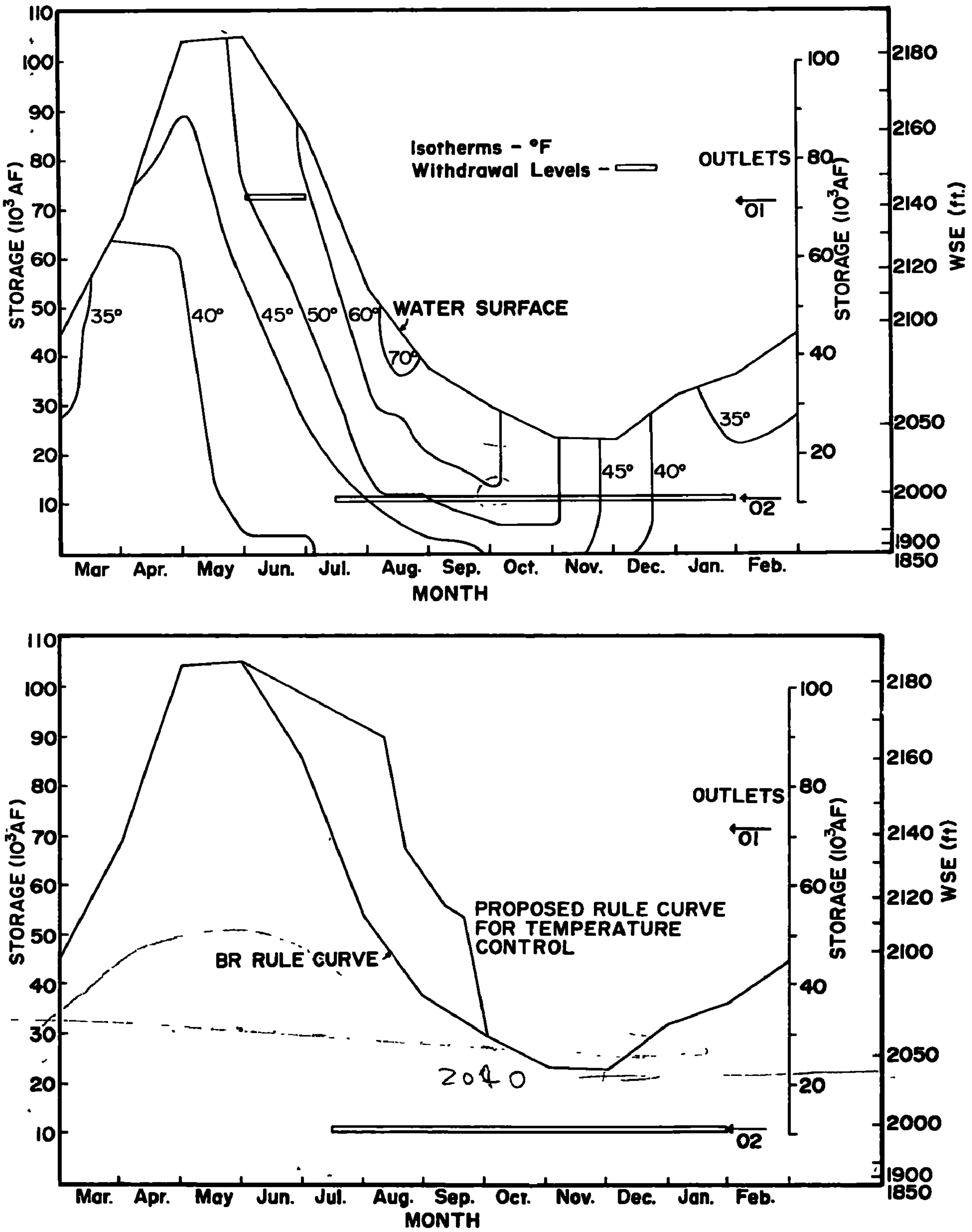


FIGURE 7. RYAN RESERVOIR - TEMPERATURE PROFILE AND COMPARISON OF TWO OPERATING SCHEMES

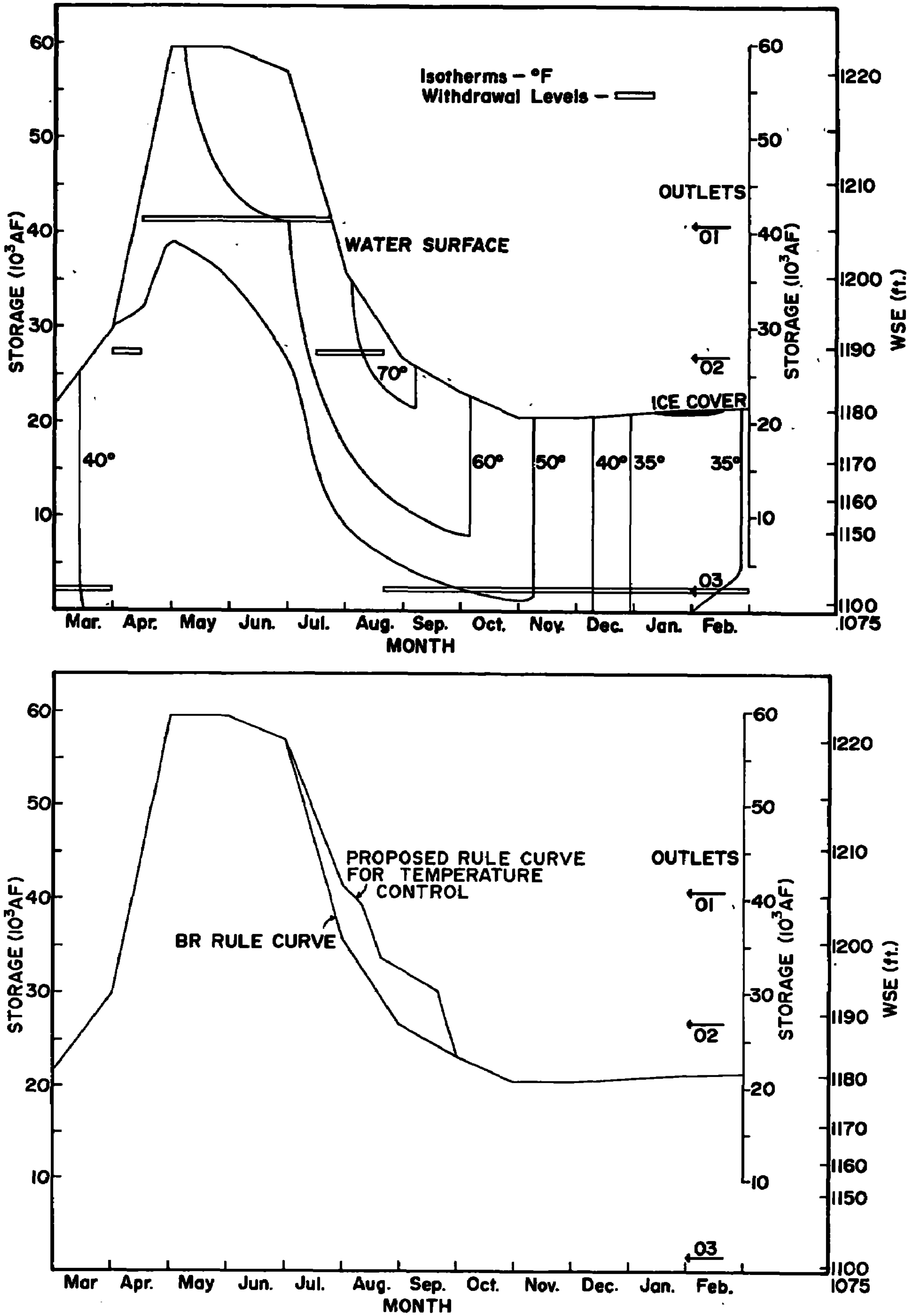


FIGURE 8. BEACON RESERVOIR - TEMPERATURE PROFILE AND COMPARISON OF TWO OPERATING SCHEMES

An analysis of the requirements for multi-level outlets in the proposed Ryan and Beacon Reservoirs to achieve stream temperature control showed that two levels of outlets in Ryan and three in Beacon are all that are needed. Formerly, it had been considered necessary to specify four levels of outlets.

The reservoir operation study of the Bureau of Reclamation (BR) for the period 1928 through 1953 was evaluated to determine, year by year, the stream lengths in which average daily water temperatures would be under 70° F. During August, the proposed Bureau operation would result in approximately 10 miles of the 60-mile river length having water temperatures over 70° F. when averaged over the period. About 20 miles would have September temperatures exceeding 60° F. when an average of the period was taken. Under modified operation, where releases were optimized to achieve temperature requirements, the temperatures of 70° F. and 60° F. would not be exceeded in all 60 miles in any year.

Surface water temperatures for Ryan and Beacon Reservoir are plotted in Figure 9. These show what may be expected for water contact recreation during the season.

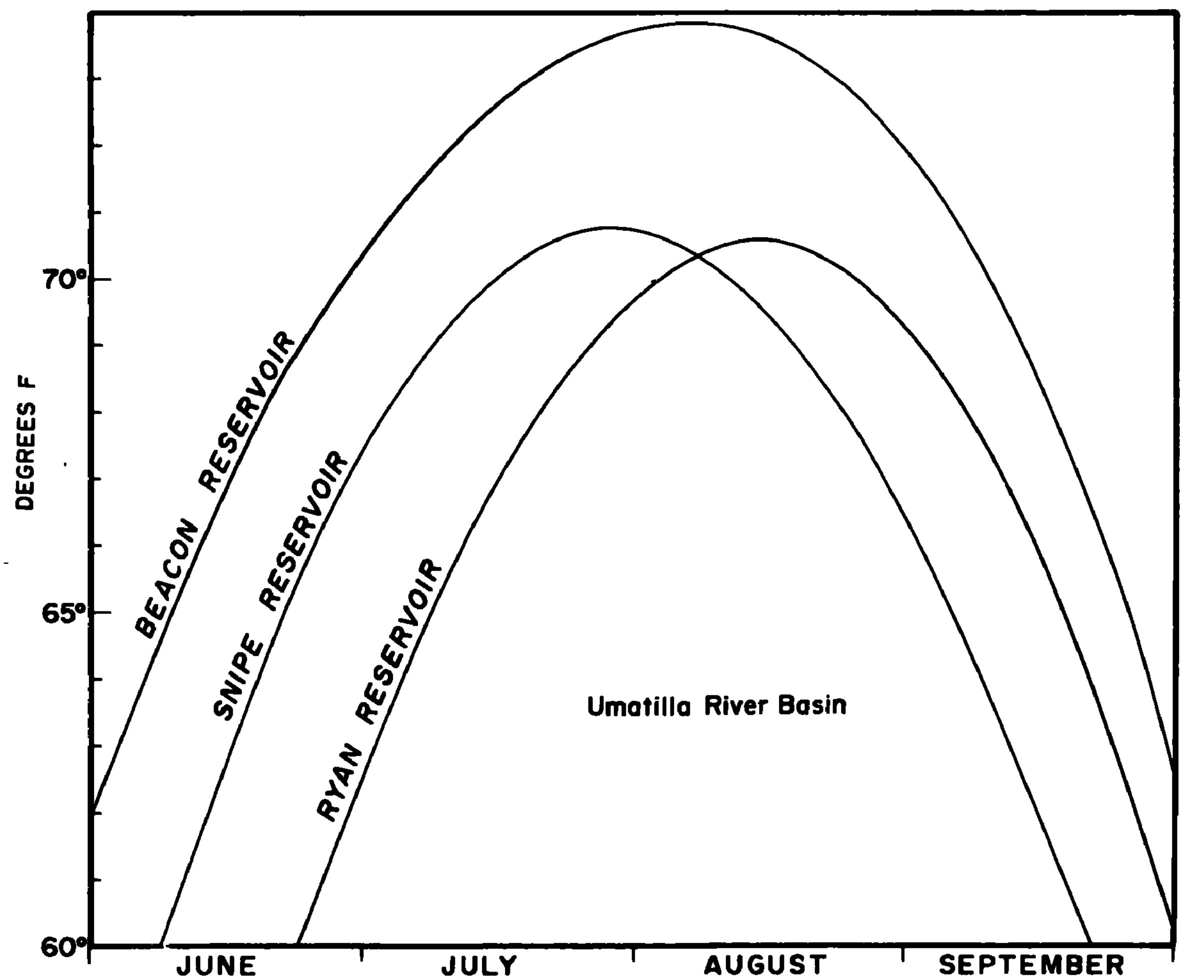


FIGURE 9. RESERVOIR SURFACE WATER TEMPERATURE PREDICTED

Nutrients

The increased flows will be derived from the headwaters, and will be relatively low in nutrients. The added flows will provide dilution of the nutrients contributed by Pendleton, thus reducing the potential for algal growths when compared to the without condition. Under current levels of waste treatment technology and growth of nutrients in sewage, however, the problems of algae in the stream will persist in the future.

The reservoirs, especially Beacon, will have a potential for nuisance algal growths. As noted in the Water Quality Requirements section, the concentrations of nitrogen and phosphorus that limit algal growth in reservoirs is less than in flowing streams. Measurements of stream concentrations to date show existing levels in excess of those theoretical limits. However, a firm prediction of algal problems cannot be made until more water quality data is obtained. The primary effects of excessive algal activity upon the reservoirs would be to aesthetically degrade the recreation experience on the reservoir and to depress dissolved oxygen levels, especially near the bottom where the dead algae would deposit and decay. Release of this lower level cool water with low oxygen concentrations would have an adverse effect on stream quality in reaches immediately below the reservoir. Accurate prediction of the conditions will allow a proper planning evaluation by the Recreation and Fishery Agencies and an appraisal of possible approaches towards minimizing the problem.

Sediment

Installation of the proposed plan will convert around 100,000 acres of dry lands to irrigated cropland. A majority of the irrigated acreage will be devoted to a permanent cover crop such as alfalfa, which will nearly eliminate this as a source of erodible soil and somewhat improve the sediment-turbidity problem in the basin. Still, good land management conservation practices, including stubble mulching of fallow wheat lands, are necessary to get at the basic sediment problem in the basin.

The proposed diversion from Snipe Reservoir into Butter Creek results in a significant sustained increase in flows between the reservoir and irrigated lands. There is a potential for serious erosion in the channel under these conditions. The Bureau has made provision to protect the channel, and it has been presumed that these measures will be adequate to meet any problems that may develop.

EVALUATION

A comparison of water quality with and without project development shows a general improvement in water quality under project conditions. Cool reservoir releases during the summer will significantly lower stream temperatures to the benefit of the fisheries. Increased flows will reduce nutrient concentrations, thus resulting in less favorable conditions for algal growth. The additional flows will also generally improve dissolved oxygen levels, although increased irrigation return flows in one reach will lower oxygen levels somewhat below the without project situation. Still, the dissolved oxygen levels will exceed State water quality standards with the project flows.

The proposed development exerts a specific beneficial effect by providing increased flows for assimilating Hermiston's treated waste effluent without oxygen levels being driven below State standards. Thus, without development of the proposed plan, Hermiston will be required to select some means of handling their effluent other than discharge to the river, at an increment of expense. The flows incidentally provided by the project have a value equivalent to the "in lieu of" expense of the most likely alternate means of handling the treatment plant effluent.

It was presumed that DEQ would require Hermiston to not discharge their treatment plant effluent to the Umatilla River if the proposed project was not constructed, and that Hermiston would select land disposal of the effluent as the most economical method of disposal. An estimate of the added annual cost for this means of disposal (including capital cost amortized over 20 years at 6%) is $30,000. This estimate was based upon the assumption that the city would purchase the land and manage it specifically to receive the effluent to always assure having an adequate receiving area.

If the project is built, the need for Hermiston to provide this added facility beyond secondary treatment would be obviated. Thus, the flows associated with construction of the project would save a total annual investment of $30,000. The source of funds for this investment would be a combination of Federal, State and local. The quality requirement for the river is based upon, among other uses, the needs of steelhead which use the river. Therefore, the value of the savings from these two standpoints is widespread. This value represents a benefit to water quality provided by the project, incidental to the formulated functions, widespread in application, and should be so recognized in the final plan. Although the dilution of nutrients with subsequent reduction of algae growths and improvement of stream quality will be another incidental benefit of project development, a value cannot be assigned to this with available information.

The benefits attributable to temperature control are reflected in the Fish and Wildlife study and the benefits for anadromous fish.

Recreation projections and benefits on Snipe, Beacon and Ryan Reservoirs are based upon adequate quality reservoir water during the recreation season. As mentioned before, there is a possibility that algal blooms in Beacon Reservoir may be of sufficient density to adversely affect swimming. This should be studied in greater depth following collection of suitable data in the basin prior to final plan development. Snipe and Ryan Reservoirs will probably have less dense algal growths, not adversely affecting recreation.

Analysis of the dissolved oxygen model run showed that the predicted oxygen levels in the river were quite sensitive to the subsurface irrigation flows. Reduction of these flows would thus have a significant beneficial effect on the river quality. Proper irrigation management such as sprinkler application of irrigation water and canal lining would noticeably reduce subsurface return flows here.

Pendleton and Hermiston waste loads exert a major effect through addition of organics and nutrients to the stream system. The long term application of their treated effluent to lands used for cover crops such as alfalfa would benefit both the river quality plus adding to the productive use of the surrounding lands.

Major recreation development and usage have been projected for Beacon, Snipe and, to a lesser extent, the other proposed reservoirs. It has been presumed that adequate facilities will be installed to collect and handle all wastes associated with these developments, and that there will be no waste input to the surface waters.

As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs are other major concerns of America's "Department of Natural Resources."

The Department works to assure the wisest choice in managing all our resources so each will make its full contribution to a better United States--now and in the future.