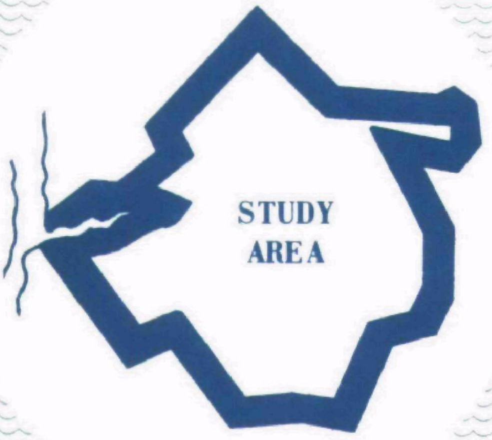
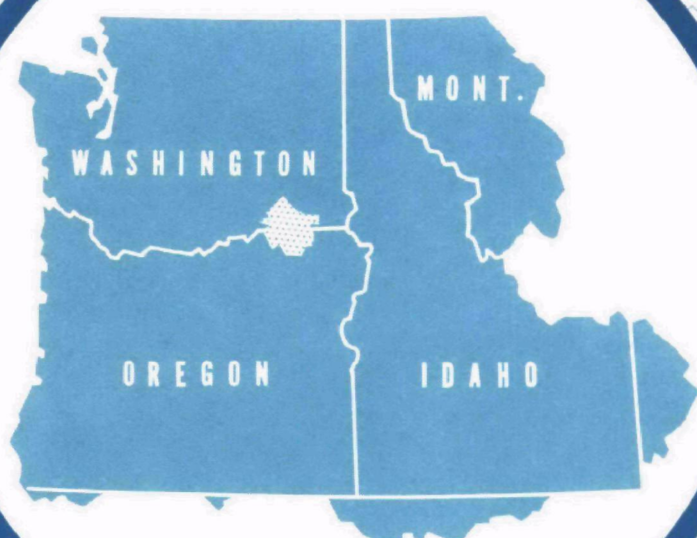
WATER QUALITY CONTROL STUDY



WALLA WALLA PROJECT

Marcus Whitman Division, Wash.
and
Milton-Freewater Division, Oregon

JULY
1967



NORTHWEST REGION

UNITED STATES
DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration

WATER QUALITY CONTROL STUDY

WALLA WALLA PROJECT

Marcus Whitman Division, Washington
and
Milton-Freewater Division, Oregon

A study has been made which discloses a need for storage in Walla Walla River Basin for streamflow regulation for water quality control. Future water requirements and quality projections are based on economic, demographic, and engineering studies.

Prepared at the Request of the
U. S. Department of the Interior
Bureau of Reclamation
Upper Columbia Development Office
Spokane, Washington

By the U. S. DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
Northwest Region
Portland, Oregon

JULY 1967

Table of Contents

LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION

A. REQUEST AND AUTHORITY

The Area Engineer, U. S. Bureau of Reclamation, Spokane, Washington, in a letter dated September 28, 1965, requested the advice of the U. S. Department of Health, Education, and Welfare concerning the needs for storage for water quality control in the proposed Marcus Whitman and Milton-Freewater Divisions, Walla Walla River Basin Project, Washington, and the value of the benefits resulting therefrom. Authority for the investigation is the Federal Water Pollution Control Act, as amended (33 U.S.C. 466 et seq.). Responsibility for these activities was transferred from the Department of Health, Education, and Welfare to the Department of the Interior by Reorganization Plan No. 2 of 1966, effective May 10, 1966.

B. PURPOSE AND SCOPE

The purpose of this report is to define the need for and value of storage for water quality control in proposed Mill Creek Reservoir on Mill Creek above Walla Walla, Washington, and in proposed Joe West Reservoir on Walla Walla River above Milton-Freewater, Oregon.

Available data on water uses, waste sources, and water quality in the study area were examined, evaluated and projected. Survey data obtained cooperatively by FWPCA and Walla Walla Sewage Treatment Plant personnel in June 1966 aided the evaluation.

Evaluations are based on projected conditions to the years 1980, 2000 and 2020. Much of the base information, projection data and evaluated results was taken from a report prepared by this office for the Corps of Engineers entitled "Water Supply and Water Quality Control Study, Mill Creek Project, Walla Walla River Basin, Washington--Oregon," dated December 1965. The economic base study prepared for this and the December 1965 report is summarized herein.

The study area covered is the Walla Walla Basin, excluding the drainage area of the Touchet River. The Touchet River was covered separately in a report to the Bureau of Reclamation entitled "Water Resource Study, Walla Walla River Basin, Dayton Reservoir, Washington, Study of Potential Needs and Value of Storage for Water for Municipal, Industrial and Quality Control Purposes," dated January 1962.

C. ACKNOWLEDGMENTS

This study was aided materially by officials of the Washington State Department of Health, Washington Pollution Control Commission, Oregon State Sanitary Authority, Washington State University, cities of Walla Walla, College Place, and Milton-Freewater, County of Walla Walla, Washington State Department of Game, and the Blalock and Gose Irrigation Districts. The use of information contained in the bibliography is also acknowledged.

II. SUMMARY of Findings and Conclusions

A. FINDINGS

1. The Bureau of Reclamation is evaluating the feasibility of utilizing Walla Walla Basin storage and Columbia River pumpage to irrigate new lands and to supplement the water supply of presently irrigated lands in the Marcus Whitman and Milton-Freewater Division areas. Two reservoir sites are being considered in the investigation; namely, Mill Creek Reservoir (65,000 acre-feet), also known as Blue Creek Reservoir, on Mill Creek, and Joe West Reservoir (about 108,000 acre-feet) on the upper Walla Walla River. Storage needs for municipal and industrial water supply, water quality control, flood control, fish and wildlife, and recreation are also being investigated for the multi-purpose development.

2. The area of study covers all of Walla Walla River Basin except that portion draining to the Touchet River. The area is in southeastern Washington and northeastern Oregon and is located mostly within Walla Walla and Umatilla Counties (see Location Map, inside back cover).

3. The drainage area of the Walla Walla Basin (excluding Touchet River drainage) is about 1,070 square miles. Existing water resource development in the basin is limited to channel structures which divert streamflow for irrigation and to an off-stream reservoir east of Walla Walla which provides flood protection to that city.

4. The average annual runoff of the basin, including the Touchet River, is over 410,000 acre-feet (567 cfs). The computed low mean monthly flow of the Walla Walla River near its mouth, on a one-in-ten year recurrence basis, is approximately six cfs and occurs in August. The minimum mean monthly one-in-ten year flow at the Mill Creek site is 23 cfs and at the Joe West site is about 81 cfs. Irrigation diversions dry up much of the river and tributary streams during summer months. Flows are also reduced due to losses to a highly pervious streambed immediately below Milton-Freewater.

5. Surface waters in the proposed watershed storage areas of the Walla Walla River are generally low in hardness (25-30 mg/l as $CaCO_3$), low in dissolved solids concentration, and suitable for municipal and industrial water supply, irrigation and most other uses. During late summer months, however, Mill Creek and Walla Walla River downstream from the city of Walla Walla develop stagnant

pools characterized by high nutrient concentrations which stimulate heavy algal blooms, high temperatures, low dissolved oxygen levels, and organic and bacterial pollution (see Appendix B, TABLES B-2, B-3, B-4, and B-5).

6. Agricultural activities form the economic base of the Walla Walla Valley. Major factors affecting water quality in the area, therefore, are those associated with the growing and processing of vegetables and other agricultural products. Studies show trends toward continued expansion of this economic base.

7. The 1960 population of the study area was 45,660, of which 36,660 persons (80 percent) resided in urban areas. There is potential for considerable population growth and industrial expansion. Employment and other development possibilities indicate the projected population for years 1980, 2000 and 2020 to be 59,200, 83,800 and 110,400, respectively.

8. Study area water use for municipal and domestic purposes averaged over 12 million gallons per day (mgd) in 1962. Three-quarters of the demand occurs at Walla Walla, where it is supplied from Mill Creek watershed supplemented by well supplies. College Place and Weston obtain water exclusively from underground sources. Milton-Freewater's groundwater supply is supplemented by water from South Fork Walla Walla River.

9. Most industrial water use is for food processing and is generally supplied by the municipal systems. The industrial demand, which occurs seasonally from May through November, was about six mgd in 1962.

10. Surface waters in the study area, in addition to being the major source of water for irrigation and municipal and industrial purposes, are also used for fish and game propagation, stock watering, recreation, and dilution and assimilation of municipal and industrial wastes. Stream waters in the lower basin are almost completely depleted by upstream irrigation diversions during the growing season. During this period, most flows originate from M&I waste effluent and surface and subsurface land drainage.

11. During periods of the year, stream waters below the proposed Mill Creek and Joe West reservoir sites support a limited game fishery and spring runs of steelhead trout. According to the Fish and Wildlife Service, a significant salmonid fishery could be established if provisions were made for additional streamflow, improved water quality, and passage facilities at diversion dams.

12. The four municipalities in the study area, i.e. Walla Walla, College Place, Milton-Freewater, and Weston, have plants providing secondary waste treatment. Seasonal industrial wastes at Walla Walla are treated by a combination of the municipal facilities, a separate industrial waste treatment plant, and land disposal. Over-all study area treatment efficiency (BOD removal) is estimated to be about 75 percent during peak load periods. Industrial wastes at Milton-Freewater and Weston are used for irrigation on offstream land areas where very limited amounts of residual wastes reach stream waters.

13. Average daily municipal waste production in the study area in 1960 (before treatment) was about 36,000 population equivalents (PE). With present treatment, it is estimated that about 5,400 PE of this waste reaches basin streams. Most of this waste is discharged to Mill Creek at Walla Walla.

14. Industrial food processing waste production (May - November) in the study area varies widely from year to year, but in recent years has averaged about 450,000 PE during the peak month of July. Existing study area industrial waste disposal practices accomplish an over-all average BOD reduction of about 340,000 PE. The residual load, consisting primarily of pea-processing waste, is discharged to Mill Creek at Walla Walla. Irrigation return flows, farm animal wastes, and other agricultural waste materials also contribute to the organic loading of basin streams.

B. CONCLUSIONS

1. Annual municipal and industrial (M&I) water supply requirements in the study area are expected to triple during the study period, totalling 60,000 acre-feet (53 mgd) by the year 2020. Developed sources of supply at Walla Walla are of adequate quality for continued use but are of insufficient quantity. The city of Walla Walla has, therefore, expressed interest in obtaining supplemental water from the U. S. Army Corps of Engineers' Mill Creek Reservoir Project. Future rural-domestic water needs, M&I needs in the Milton-Freewater area, and demands in smaller community areas are expected to be adequately met by continued use of existing groundwater sources. Some shallow groundwater areas near Milton-Freewater are subject to bacterial contamination and require disinfection for continued use.

2. The municipal, industrial and agricultural growth projected for the study area intensifies the need for greater control of wastes to maintain adequate water quality, particularly in Mill Creek and downstream Walla Walla River. Continued disposal of waste to land, as presently practiced in the Milton-Freewater and Weston areas, is expected to provide adequate protection of water quality in the upstream Walla Walla River area.

3. Municipal and industrial waste production in the study area during the food-processing season for 1980, 2000 and 2020 is projected to be 794,000, 1,189,700 and 1,733,100 population equivalents (PE), respectively. Residual loads in the treated discharge of this waste, together with uncontrolled loads from other sources (i.e., animal waste) pose a continuing and increasing hazard to fish and wildlife, recreation, public health and general appearance of surface waters in the basin. By 1980, 2000, and 2020, treated wastes from municipal and industrial sources alone are expected to average some 35,900, 53,500, and 76,900 PE, respectively. Much of this waste, together with residual animal waste which has been estimated to total 10,000 PE, will require assimilation in Mill Creek and lower Walla Walla River.

4. Oxygen-balance computer studies, utilizing factors obtained during stream surveys in the Walla Walla Basin, indicate that low mean monthly flows available on a one-in-ten year recurrence frequency (Mill Creek--2 cfs and Walla Walla River--6 cfs) would not provide satisfactory control of present or projected residual waste loadings. Even with treatment, or other control of waste to greater than 85 percent BOD removal, stream uses cannot be protected or preserved without storage releases for quality control.

5. There is a need in the Walla Walla Basin for adequate waste treatment to provide at least 85 percent BOD removal, for disinfection of treatment plant effluents, for control of surface and subsurface irrigation drainage, and for assured quantities of streamflow at prescribed times and places to dilute and assimilate residual waste materials received in the stream from municipal, industrial and agricultural sources.

6. Maintenance of a dissolved oxygen (DO) concentration of 2.0 mg/l in the critical zone of Mill Creek and lower Walla Walla River would provide a minimum level of stream protection--prevention of nuisance conditions. Maintenance of a 6.0 mg/l DO concentration in these reaches would provide the highest level of protection of the basin's stream uses and would allow the reestablishment of a salmonid fishery. The selected objective, DO concentrations of at least 5.0 mg/l, would assure an acceptable level of quality.

7. The immediate and long range need to maintain a 5.0 mg/l DO concentration, in addition to adequate waste treatment for control of water quality in Walla Walla Basin, is for storage to yield 110 cfs and 205 cfs during July and August of projected years 1980 and 2020, respectively. No need is foreseen for flow regulation for quality control in that portion of the Walla Walla River upstream from the Mill Creek confluence.

8. The flow needed by 2020 to maintain a 5.0 mg/l DO level will require an annual draft-on-storage* of 31,300 acre-feet from Mill Creek Reservoir or from a combination of Mill Creek and Joe West Reservoirs. Combined releases would necessitate a minimum of 4,200 acre-feet from Mill Creek Reservoir supplemented by up to 27,100 acre-feet from Joe West Reservoir. A total draft-on-storage of about 15,000 acre-feet will be needed by year 1980.

9. Storage releases for control of water quality would provide benefits in terms of restored stream uses and prevention of future stream damage. These releases would complement provisions for adequate waste controls at the source and would not, therefore, be a substitute for these prerequisite measures.

10. The beneficiaries of controlled water quality in the Walla Walla River Basin are the persons utilizing basin surface waters for irrigation, fish and wildlife and recreation activities, and aesthetic enjoyment. The riparian land owners and surrounding areas' population, which is projected to total 100,000 persons by 2020, would also benefit from this control. Many of these beneficiaries are identifiable in general terms; but the monetary value

of the benefits is not directly measurable by known means. Benefits, therefore, are considered both tangible and intangible and are widespread, both in area and type of beneficiary.

11. The minimum value of the benefit assignable to project storage for quality control in Walla Walla Basin is considered equal to the cost of accomplishing similar control by a single-purpose alternative means in the absence of the project. As found in studies for the Corps of Engineers on Mill Creek Project, single-purpose storage at the Mill Creek site would accomplish the desired control at an annual cost of $15.50 per acre-foot.

12. The minimum value of the water quality control benefit assignable to an annual draft-on-storage of 31,300 acre-feet in Mill Creek Reservoir, or in Mill Creek and Joe West Reservoirs combined, is estimated to be $485,000.

13. An annual draft-on-storage of more or less than 31,300 acre-feet would increase or decrease the annual value at the rate of $15.50 per acre-foot. No benefits would accrue until at least the minimum regulation (17,300 acre-feet in 2020) considered necessary to control stream nuisances (2 mg/l DO) has been provided. Maximum benefits would be realized by providing an annual draft-on-storage of about 48,000 acre-feet in 2020. Releases from this storage would maintain DO levels above 6.0 mg/l, which would allow the highest uses of basin streams.

14. Planning for additional water resource development in the Walla Walla River Basin should consider preserving the excellent quality of water in the upper basin spawning areas and maintaining satisfactory quality in the lower river to permit passage of anadromous fish. Maintenance of water quality for at least a put-and-take fishery would assure continued multiple-use of the lower river. The accomplishment of this goal would necessitate continued improvement and updating of waste treatment facilities, and the reservation of at least 31,300 acre-feet of storage for release to the lower river.

15. After the project is in operation, a system of water quality and waste monitoring and streamflow forecasting will be needed in order to fully utilize flow regulation for water quality control.

* Annual draft-on-storage is the sum of incremental excesses of needed releases over inflows during a climatic year (April through March). This is the additional quantity needed in the lower Walla Walla River and does not include storage and transmission losses.

III. PROJECT DESCRIPTION

A. LOCATION

The Walla Walla project is a land and water resource development investigation of the entire Walla Walla River Basin, located in southeastern Washington and northeastern Oregon. For investigation purposes, the USBR has separated the project into three divisions--the Marcus Whitman, Milton-Freewater, and Touchet. The Marcus Whitman division includes the Walla Walla drainage in Washington and some of its tributary drainage in Oregon; the Milton-Freewater division covers most of the basin in Oregon; and the Touchet division covers the Touchet River drainage. Because of the inter-relationship between irrigation water supply and delivery areas, the Marcus Whitman and Milton-Freewater divisions are being investigated as one unit. The Touchet division has been covered in a previous study and will not be considered in this report.

Sites of major structures being considered are shown on the Location Map (inside back cover).

B. PROPOSED PROJECT

1. Storage Development

Part of the water requirements would be met by developing storage at Mill Creek Dam and Reservoir site on Mill Creek and Joe West Dam and Reservoir site on Walla Walla River.

a. Mill Creek Dam and Reservoir

Mill Creek Dam is being planned by the Corps of Engineers to serve the purposes of flood control, irrigation, recreation, fish and wildlife, municipal and industrial water supply, and water quality control. The dam site is located immediately below the confluence of Mill Creek and Blue Creek, about 9 miles upstream from the city of Walla Walla. Runoff from the drainage area above the site (87 square miles) has averaged about 81,000 acre-feet annually for the past twenty-five years.

Mill Creek Dam would be an earth and rock fill structure about 190 feet high. Storage capacity of Mill Creek Reservoir would total 65,000 acre-feet, of which a minimum pool of 10,000 acre-feet would be maintained for sediment accumulation, recreation, and fishery purposes.

As discussed in Chapter I, the FWPCA prepared a report on this development for the USACE in December 1965.

b. Joe West Dam and Reservoir

Development of the Joe West storage site is being investigated by the USBR for irrigation, recreation, and fish and wildlife purposes. Some flood control would be obtained by operating the reservoir on a rule curve or modified forecast basis. Runoff from the 125 square mile drainage area above the Joe West site averaged 162,000 acre-feet annually during the period 1930 through 1963.

Joe West Dam would be an earth and rock fill structure about 260 feet high with a crest length of 3,400 feet. When full, the reservoir would contain 108,000 acre-feet (13,000 acre-feet inactive) and would have a surface area of 1,020 acres.

A fish hatchery would be constructed below the dam to mitigate the existing steelhead fishery. A multi-gated outlet in the dam would be used to control the water temperature for the hatchery. Releases of 22 cfs June through December, and 32 cfs January through May would be made for hatchery operation.

2. Irrigation Development

a. Marcus Whitman Division

Lands being considered for development in the Marcus Whitman Division area consist of 21,500 acres of presently irrigated land requiring a supplemental water supply and 15,700 acres of presently dry land needing a full water supply. The 21,500 acres of irrigated lands and about 1,800 acres of dry land scattered throughout the irrigated areas would receive water through existing irrigation facilities. The remaining 13,900 acres of dry land would receive water through project-constructed facilities.

Major structures under consideration are Mill Creek Dam and Reservoir (USACE development), Mill Creek Diversion Dam, Wallula pumping plant and relift pumping plants, and the low and high Wallula-Gardena canals.

Mill Creek Diversion, 3 miles downstream from Mill Creek Dam, would divert water into a buried pipe system to serve 5,000 acres on the Airport Bench.

A pump-canal system, which would supplement the Walla Walla River supply by lifting water from the Columbia River and conveying it to the main irrigated area of the basin, is a key feature of the plan. This system consists of the Wallula pumping plant on the Columbia (400 cfs capacity), a relift pumping plant (385 cfs capacity), a canal connecting the two plants, a main canal up the Walla Walla Valley, several small relift pumping plants, and many miles of smaller delivery canals and buried pipe distribution systems.

The pump-canal system would pump 18,000 acre-feet to Oregon lands in exchange for a full supply for 5,000 acres in Washington which lie adjacent to the Spofford area of the Milton-Freewater Division.

b. Milton-Freewater Division

Facilities under consideration to develop this Division would provide supplemental water to 15,400 acres of presently irrigated land and a full supply to 13,200 acres of presently dry land. About 9,600 acres of the dry lands are in the Spofford area. The remaining 3,600 acres are scattered throughout the existing irrigated area.

Water for this development would come from Joe West Reservoir. A tunnel from the reservoir (about 7,500 feet long) and a buried pipe system would serve 9,600 acres in the Spofford area. An extension of the Spofford system would serve 5,000 acres in the Russel Creek area in Washington.

IV. STUDY AREA DESCRIPTION

A. LOCATION AND BOUNDARIES

The study area includes portions of Walla Walla and Columbia Counties in southeastern Washington, and Wallowa and Umatilla Counties in northeastern Oregon. This study, which considers all the Walla Walla Basin except the Touchet River drainage, covers an area of about 1,070 square miles (see Location Map, inside back cover). The Walla Walla River and its main tributaries originate in the Blue Mountains and flow westerly to the Columbia River. The basin is bounded on the north and east by the Snake River Basin, and on the south by the Umatilla River Basin.

B. GEOGRAPHY AND TOPOGRAPHY

The elevation of the study area ranges from about 400 feet at the confluence of the Walla Walla and Columbia Rivers near Wallula to about 6,000 feet in the Blue Mountains. The Walla Walla Valley is largely farms and range land whereas the upper portion of the basin is forest-covered. The lower portion of the study area is a part of the Columbia Plateau, where well-rounded hills with long, steep slopes are characteristic. The soils of the plateau are of a deep, loessial material which is susceptible to erosion. Soils on the flanks of the Blue Mountains are coalesced fans of coarse gravel and cobble deposited by the streams emerging from the mountains. The present streams have cut channels in these fans.

Mill Creek originates on the western slopes of the Blue Mountains in northeastern Oregon and southeastern Washington, about 21 miles east of Walla Walla. The stream, which is characterized by steep slopes of 35 to over 100 feet per mile, flows in a westerly direction through the city of Walla Walla to its confluence with the Walla Walla River, six miles west of the city. The Mill Creek watershed contains about 100 square miles, of which 87 square miles lie above the dam site and 96 square miles lie above Walla Walla.

The chief contributory drainage to Mill Creek is Blue Creek, which drains about 17 square miles of mountainous, forested terrain and enters Mill Creek about 9 miles above Walla Walla. Yellowhawk and Garrison Creeks are small delta alluvium branches of Mill Creek which pass through Walla Walla and join the Walla Walla River upstream from the mouth of Mill Creek.

The North and South Forks of the Walla Walla River drain a mountainous area of about 125 square miles which is poorly covered with timber and grass. From this point, the location of Joe West Dam site, the river flows 18 miles, through Milton-Freewater and the surrounding agricultural bench land, to its confluence with Mill Creek, thence another 16 miles to its confluence with the Touchet River.

C. CLIMATE

The climate of the study area is typically hot and dry during the summer, and cold and wet in winter. The mean annual temperature at Walla Walla is 53 degrees. Mean annual precipitation ranges from about 15 inches in the valley to 50 inches in the mountains. Approximately 75 percent of the total annual rainfall occurs between November and May, while only 3 percent falls during July and August. The frost-free growing season in agricultural areas averages about 220 days.

D. PRINCIPAL COMMUNITIES AND INDUSTRIES

The population of the study area is approximately 46,000. Principal urban places and their populations (1960 census) are as follows:

Walla Walla, Wn.	24,536
Milton-Freewater, Ore.	4,110
College Place, Wn.	4,031
Weston, Ore.	783

The basin economy is oriented primarily towards agriculture, with most activity directed toward farming, stock raising, and food processing, and providing services to an eight-county trading area. Lumbering activities also contribute to the economy.

V. WATER RESOURCES of the Study Area

A. SURFACE WATER

1. Existing Water Resource Development

Irrigation of the basin's flat river bottomland was practiced on an individual farm basis by the earliest settlers. By 1900, companies were being formed to promote development of land not susceptible to individual development. Natural surface flows are normally very low after the first of July, which requires most irrigators to supplement their surface supply by pumping from wells. A few irrigators with the earliest water rights obtain surface water throughout the irrigation season.

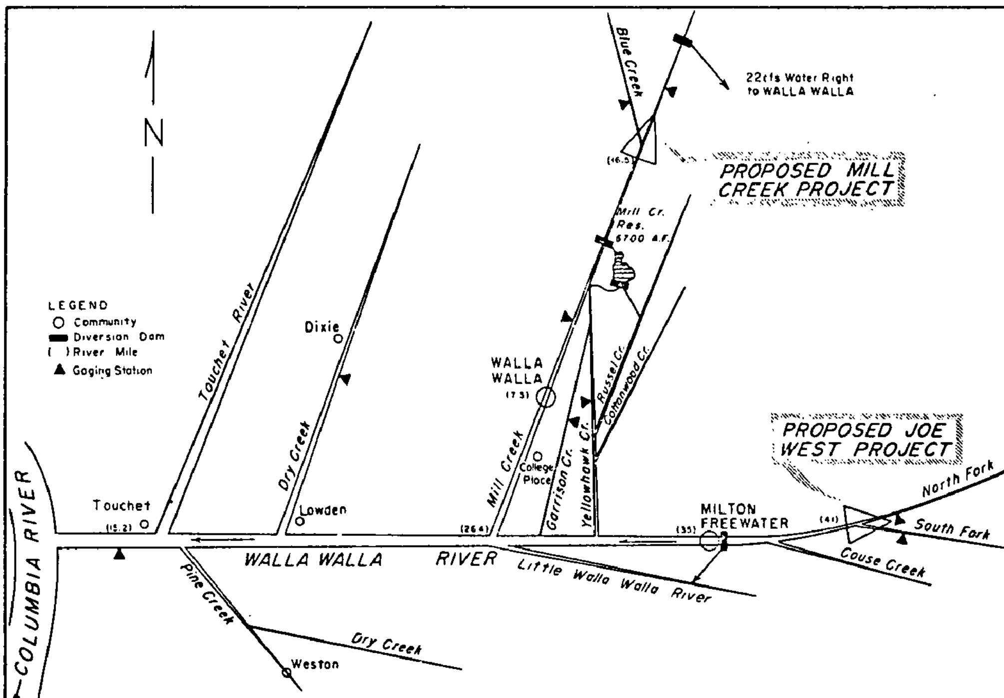
Surface sources are used to meet over three-quarters of the present average annual municipal and industrial water demand in the study area. Walla Walla obtains most of its water from Mill Creek and uses groundwater only as a supplemental supply, whereas Milton-Freewater depends primarily on ground water sources and uses its facilities on South Fork Walla Walla River only during periods of peak demand.

Water rights in the Walla Walla Basin, adjudicated in 1927, are largely committed to irrigation. The appropriation of water is based on a prior rights doctrine. The Washington decree lists irrigation rights to serve 15,130 acres, or 151 cfs, during July, August, and September. In Oregon, irrigation rights total 157 cfs for the same months.

The city of Walla Walla has a water right of 14.3 mgd from Mill Creek for municipal supply purposes. Milton-Freewater has a right to 5 mgd from the South Fork Walla Walla River. There are no other rights for municipal or industrial water supply diversions in the study area.

A 1930 decision by the U. S. Supreme Court gives the State of Oregon a superior right to water originating in Oregon. Under Oregon law, no waters located within the State shall be diverted, impounded or in any manner appropriated for diversion or use beyond the boundaries of the State except upon the express consent of the Legislative Assembly. The Oregon Water Resources Board has set aside 40,000 acre-feet of water a year for future livestock, irrigation, domestic, municipal and industrial uses. This water is in addition to present water rights or uses. Under these conditions, assuming the necessary consent of the Oregon State Legislative Assembly can be secured, only 20,000 acre-feet of water a year would be available for downstream release from the proposed Joe West Reservoir for fish and wildlife and water quality control.

Existing flood protection facilities on Mill Creek include a diversion works above the city of Walla Walla, an offstream flood control reservoir (see Schematic Diagram, FIGURE 1), channel improvements below the diversion works, and a concrete flood channel through the city of Walla Walla. The Walla Walla River channel has been improved to pass flood flows through the Milton-Freewater reach.



SCHEMATIC DIAGRAM

Figure 1

Above Walla Walla, flood flows are diverted from Mill Creek and stored in the offstream reservoir, which has a total capacity of 6,700 acre-feet. About one-half mile downstream from the diversion works, any remaining flows that exceed the Mill Creek channel capacity through Walla Walla are divided between Garrison and Yellowhawk Creeks.

Low head dams have been constructed across Mill Creek every 60 feet to provide channel stabilization in the improved reach through Walla Walla. These barriers create pools which are conducive to resident fish propagation and also cause stream turbulence which induces aeration of the water.

2. Hydrology and Streamflow Frequency Analysis

The average annual discharge of the Walla Walla River below the Touchet River confluence was 567 cfs (410,500 acre-feet per year) during the 1952 through 1964 period. Estimates of flows in Mill Creek at Walla Walla, in the Walla Walla River below the Touchet River, and at the proposed damsites are shown in APPENDIX A, Tables A-1, A-2, A-3, and A-4. These tables were prepared using available surface water records published by the U. S. Geological Survey and information furnished by the Bureau of Reclamation. Gaging stations are shown on the Location Map (inside back cover).

Flows at the Mill Creek damsite averaged 112 cfs during the 1940 through 1964 period. Most of the runoff takes place in the winter with only 10 percent of the annual yield occurring between July and October. Streamflows at the damsite have averaged about 35 cfs during August and September. Irrigation diversions reduce this flow to less than 4 cfs near the mouth of Mill Creek.

The combined flows of the North and South Forks of the Walla Walla River, which make up the flow at the proposed Joe West site, range from a low of 107 cfs during the months of August and September to a high of 430 cfs in April. Mean flow, as determined from recorded flows for the period 1930 through 1963, is 225 cfs.

During the irrigation season, essentially all available streamflow is diverted to the Little Walla Walla River at Milton-Freewater. The main stem is dry for several miles below this point, although under normal conditions, flows increase north of the State line as a result of irrigation return flows. If all existing water rights in the basin were exercised, this dry-stream condition in the Walla Walla River would prevail down to the vicinity of Mill Creek.

In addition to irrigation withdrawals, considerable streamflow is lost to an alluvial fan of permeable gravels which underlies this area. These gravels are exposed throughout a 3/4-mile reach located immediately downstream from Milton-Freewater. It has been estimated that up to 60 cfs is lost to this ground water aquifer, resulting in a dry stream as early as May and extending into the month of November.

Low flow frequency analyses, with recurrence intervals of 5, 10, and 20 years, were performed for Mill Creek at the damsite and at Walla Walla, and for the Walla Walla River at the Joe West damsite and below the mouth of the Touchet using the mean monthly flows of record at each of the locations. These estimated flows are presented in APPENDIX A, Tables A-5, A-6, A-7, and A-8. The mean annual low flows, on a one-in-ten year frequency basis, at the Mill Creek and Joe West damsites are 74 and 176 cfs, respectively. The minimum monthly one-in-ten year low flow for Mill Creek at Walla Walla and for Walla Walla River below the mouth of the Touchet are 2 and 6 cfs, respectively. These flows normally occur in August.

3. Quality of Water Available

Surface water quality problems in the upper Mill Creek Watershed are limited to excessive turbidity and vegetative color during short periods of high runoff in the early spring. Water above the site is generally low in mineral content and essentially free of man-caused bacterial pollution. About 35 square miles of National forest land in the upper basin have been closed to livestock and trespassing to protect Walla Walla's municipal supply. Water impounded in the proposed reservoir, therefore, is expected to be of adequate quality for all planned uses, including domestic supply.

During the past few years, the water quality of lower Mill Creek has received considerable attention, as excessive industrial wastes discharged during the summer at Walla Walla have caused oxygen deficiency and algae problems. Despite attempts to improve the waste treatment provided at Walla Walla, this reach has been characterized by offensive odors and by heavy slime growths which interfere with irrigation use of the waters. Even with improved treatment of the high summertime waste loads, periods of zero dissolved oxygen still occur in lower Mill Creek. In addition, a substantial diurnal fluctuation in the dissolved oxygen is caused by profuse algae.

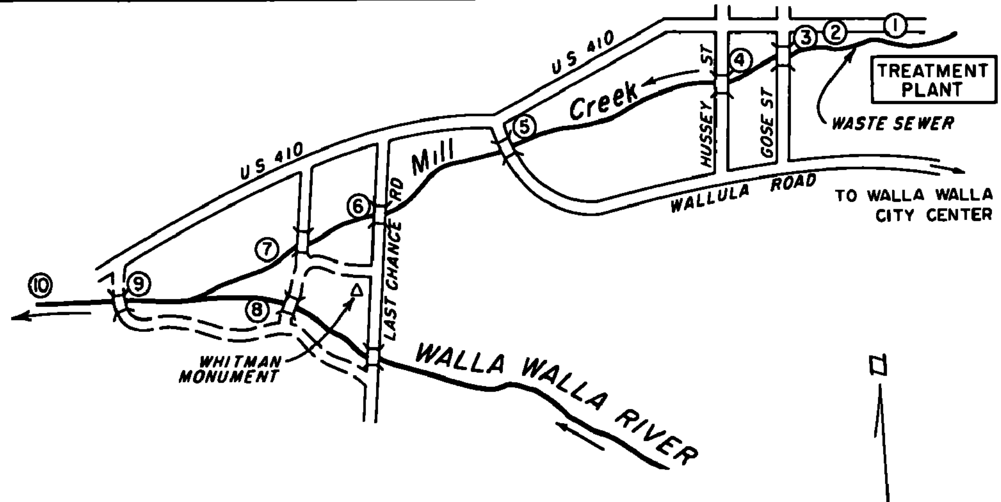
The watershed above the proposed Joe West Dam is similar in nature to the upper reaches of Mill Creek. Surface water is low in hardness, low in dissolved solids, and generally suitable for municipal supply with minimal treatment. Analytical results presented in TABLE V-1 of a sample collected in July 1962 from the Milton-Freewater water supply demonstrate the good quality of these waters.

TABLE V-1
Surface Water Quality
South Fork Walla Walla River, Washington-Oregon

Substance	Sample Concentration (mg/1)	Maximum Recommended Concentration 1/
Total hardness as $CaCO_3$	27	soft 2/
Magnesium as $CaCO_3$	17	--
Total alkalinity as $CaCO_3$	33	--
Chlorides as Cl	2	250
Sulphates as SO_4	9	250
Silica as SiO_2	30	--
Iron as Fe	Trace	0.3
Carbon dioxide (CO_2)	2 5	--

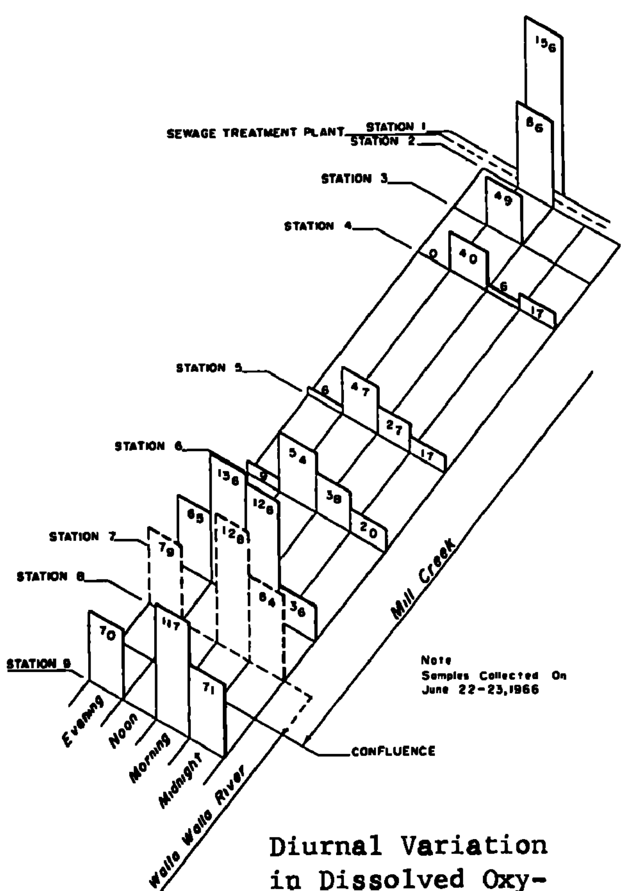
1/ U. S. Public Health Service, Drinking Water Standards, 1962.

2/ Hardness of less than 50 mg/l as $CaCO_3$ defined as soft.



Location of Sampling Stations-Walla Walla Stream Survey, 1966

Figure 2

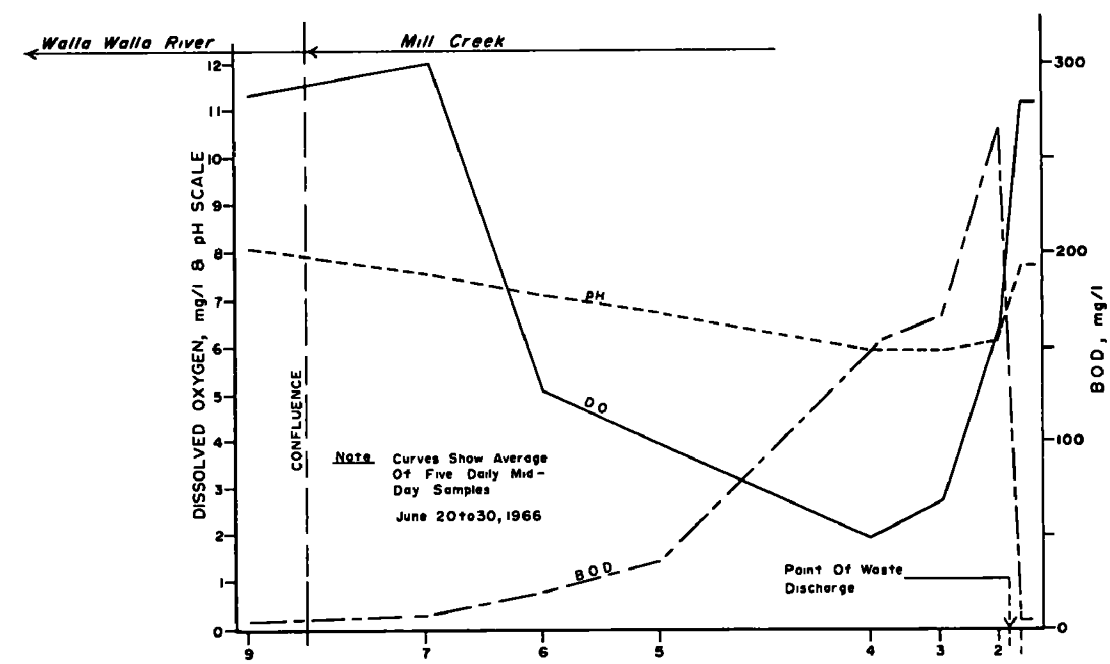


Diurnal Variation in Dissolved Oxygen, % Saturation

Figure 3

Stream surveys on Mill Creek and lower Walla Walla River were conducted in 1966. The location of sampling points, and the results of the survey are shown on FIGURES 2, 3, and 4. In June, organic waste loads caused a maximum recorded 5-day bio-chemical oxygen demand (BOD) of 325 mg/1 (see Table B-1, APPENDIX). Additional water quality data is included in APPENDIX B.

It is apparent from FIGURE 4 that wastes discharged at Walla Walla have a profound effect on the water quality of Mill Creek. The dissolved oxygen (DO) is rapidly depleted below the sewage treatment plant and usually drops to a concentration of less than 2 mg/l. In the 5-mile reach of Mill Creek between the treatment plant and Station No. 7, however, self-purification creates sufficient oxidation of organic wastes to prevent adverse effects further downstream in the Walla Walla River. The sizable oxygen demand experienced in Mill Creek occurs to some extent throughout the season of greatest irrigation withdrawals (April-September), but especially during the pea-processing season (June and July) as a result of increased waste loadings. Mill Creek normally has enough streamflow during the winter and spring months (November-May) to maintain adequate water quality.



Quality of Waste Receiving Waters

Figure 4

The phosphate and nitrate concentrations shown in Table B-2 (APPENDIX) are in excess of threshold limits for prevention of the overstimulation of nuisance aquatic organisms.

Table B-3, APPENDIX, presents data collected on the lower Walla Walla River near Touchet from 1962 to 1965. The chemical composition of the water remained reasonably uniform during periods of high and medium stages of discharge. Specific conductance ranged from 83 to 836 micromhos per cm. The river transported 49,000 tons of dissolved solids past the sampling point during the 1960 water year.

In terms of sanitary quality, surface waters in the upper portion of the study area are considered to be relatively unpolluted. The only significant source of contamination is the waste treatment plant at Walla Walla. Treated municipal and industrial wastes discharged to Mill Creek in 1964 were reported to contain coliform and enterococcus bacteria in quantities sufficient to render the stream undesirable for several uses including (1) drinking water, (2) stock watering, especially milk cows, (3) irrigation of vegetables, berries, or fruits that may be eaten raw, and (4) swimming or bathing (see Table B-4, APPENDIX).

Bacterial pollution of the Walla Walla River near Touchet is variable but often reaches serious levels. For 11 samples collected near Touchet at approximately monthly intervals beginning in July 1959, the most probable number of coliform bacteria (MPN) per 100 ml ranged from 430 to more than 150,000. These values exceed the limit for safe swimming, and the higher values represent a potential health hazard to fishermen. For domestic supply purposes, water from this source would require the treatment of coagulation, sedimentation, filtration and disinfection.

Headwater streams in the Walla Walla Basin have relatively cool water in the summer. Short-term thermograph observations near Milton-Freewater indicate maximum temperatures of 63, 62 and 56°F in July, August and September, respectively. Mill Creek stream temperatures below Walla Walla were found to be as high as 78°F (25.5°C) in June 1966 (Table B-1, APPENDIX). A three-year record of daily afternoon water temperatures near Touchet is summarized in the APPENDIX (Table B-5). The highest and lowest values recorded are 94°F and 31°F, respectively. The highest average monthly temperature was 80°F and occurred in July.

B. GROUNDWATER

1. Quantity

Walla Walla and Milton-Freewater are located at the head of large alluvial fans where Mill Creek and the Walla Walla River flow out of the Blue Mountains. These fans, composed mostly of coarse gravels, are recharged by precipitation, by surface streams, and by irrigation waste water. Groundwater levels rise materially during the irrigation season.

The study area is underlain at depth by the Columbia River Basalt Formation. The basalt aquifer is recharged by rainwater and snowmelt in mountainous areas where the formation is exposed to the surface, and by percolation from overlying sedimentary deposits. Most groundwater obtained from the basalt is used for municipal and industrial purposes.

About 48,000 acre-feet of groundwater from the gravel and 16,000 acre-feet from the basalt is pumped annually for irrigation, industrial, domestic, and public use. Annual recharge of aquifers underlying the basin is estimated to be about 300,000 acre-feet, much greater than the present groundwater withdrawal, although local overdrafts do occur. An estimated 500,000 acre-feet of water is stored in the old gravel and in the saturated top 100 feet of the basalt. Pumping lifts are commonly less than 200 feet.

2. Quality

The groundwaters of the Walla Walla River Basin generally are of excellent chemical quality. With few exceptions, the sources sampled yield water that is low in dissolved solids, soft to moderately hard, and relatively free of troublesome trace elements (see Table B-6, APPENDIX).

It has been recommended by local health officials that water from shallow wells in the study area should not be used for domestic purposes without first receiving proper disinfection. A survey by the Umatilla County Health Department in the winter of 1962-63 disclosed bacteriological contamination of the shallow wells along Dry Creek northwest of Milton-Freewater. Individual samples over a period of years indicate that the shallow wells in this entire area are either contaminated or in danger of contamination. The sources of contamination are judged to be feed lots, barnyards, septic tanks, etc.

Because of the faulting and jointing characteristics of the Columbia River basalt, even deep wells in the Milton-Freewater area are endangered by contamination from seepage of polluted surface water into the aquifers. For this reason, all water drawn from deep wells should also be disinfected before use.

VI. THE ECONOMY

A. GENERAL

The demand for water for municipal and industrial purposes, and the amount and character of waste waters resulting from such uses are determined largely by the activities associated with a region's economic base. The purpose of this section is to present economic and demographic data for use in projecting the water needs for municipal and industrial purposes and for estimating the future amounts and types of waste material that may be expected to enter stream waters of the Walla Walla River system.

The economic base study area for this report includes all of Walla Walla County, Washington, and that part of the northeastern portion of Umatilla County, Oregon, included in the 1960 U. S. Census County Divisions of Athena, Umapine, Crockett, Upper Walla Walla, and Weston. These political divisions correspond very closely to the physical boundaries of the Walla Walla River Basin.

B. PRESENT

1. Economic Activities

The economy of the study area depends largely on agriculture and food processing. Although grains occupy the greatest acreage, the most important crop is green peas, upon which a substantial food processing industry in Walla Walla is based.

Development of agriculture in the study area in recent years has been uneventful. Farm consolidation was apparent, with the total number of farms reduced 10.9 percent between 1954 and 1959 in Walla Walla County. The amount of land in farms and of crop land harvested remained almost unchanged between 1954 and 1959, with greater per-acre output providing increased production without any reduction in fallowing. The amount of pasture land was essentially unchanged, and the number of acres irrigated increased by 4,300 or 13.2 percent.

In terms of crop patterns, grain plantings declined, with some increase for barley failing to offset the lesser acreage devoted to oats and wheat. Cattle populations of the two counties were stable from 1954 to 1959, and the number of sheep roughly doubled.

TABLE VI-1 summarizes agricultural data for Walla Walla County.

TABLE VI-1
AGRICULTURE AND LAND USE PATTERNS
WALLA WALLA COUNTY, 1959 [a/]

Number of Farms	981
Land in Farms (acres)	822,729
Average Size of Farms (acres)	838.7
Land Irrigated (acres)	37,296
Crop Land Harvested (acres)	279,538
Not Harvested & Not Pastured (acres)	239,328
Crop Land Pastured	29,061
All Other Pasture (acres)	234,625
ACRES DEVOTED TO PRINCIPAL CROPS	
Winter Wheat	152,893
Barley	62,554
Green Peas	16,286
Spring Wheat & Other Grains	17,513
Hay	15,186
Field Seeds	5,119
Sugar Beets	4,214
Vegetables (incl. Potatoes)	5,122
Dry Peas	4,234
Orchards & Berries	237
LIVESTOCK POPULATIONS	
Cattle & Calves	26,829
Hogs & Pigs	7,238
Sheep & Lambs	23,263

a/ U. S. Census of Agriculture.

A vigorous food processing industry is dependent on the agricultural output of the Walla Walla Basin. Six large plants in the basin freeze or can peas and other vegetables grown in the area, and at the peak of the season over 4,000 people are employed by the food processors.

Food processing is highly seasonal, with activity beginning to rise in the second quarter of the year and peak employment occurring during June and July, near the harvest time for peas. Introduction of other vegetable products creates a second, but more limited focus of activity in the early fall.

Service industries have reached an unusual level of development for a resource-oriented region. At Walla Walla, the Veterans' Hospital, State Penitentiary, and Whitman College are responsible to a considerable degree for the high ratio of service employment. Both transportation and retail trade provide employment at levels somewhat beyond what would appear to be required by the population of the area. This may probably be ascribed to relative inefficiencies of distribution in an area of relatively low population density, as well as the need to transport a large amount of bulk materials originating in the agricultural and food processing sector of the economy.

Pulp and paper production is of importance to Walla Walla County, but is centered at Wallula, Washington, outside the study area. Forest lands of the region are utilized by local sawmills in Mill Creek Watershed area to produce merchantable timber and pulp logs for rail shipment to mills.

2. Population

As shown in TABLE VI-2, population in the study area rose rapidly between 1940 and 1950, but growth slowed sharply in the next decade. Between 1950 and 1960 there was a decline in the number of rural residents and population growth slowed perceptibly in the towns.

TABLE VI-2
POPULATION GROWTH, 1940-1960[a/]
STUDY AREA

Region	Population			Annual Growth Rate (%)		
	1940	1950	1960	1940-50	1950-60	1940-60
Walla Walla Area	19,381	27,276	31,765	3 5	1 6	2 5
Rural Washington	4,903	5,800	4,550	1 6	-2 5	-0 4
Milton-Freewater	2,569	2,843	4,110	0 9	3 8	2 4
Weston	489	679	783	3 3	1 4	2 4
Rural Oregon	5,377	5,405	5,015	0	-0.8	-0 4
Study Area	32,719	42,003	46,223	2 5	1.0	1 7
Oregon State	.	.		3.3	1 6	2 3
Washington State				3 1	1 8	2 5

a/ U S Census of Population, 1950 and 1960

3. Land Uses

The level of irrigation development in Walla Walla and Umatilla Counties is not high compared to other Pacific Northwest agricultural areas.

Irrigation practices in the two counties differ, to some extent, from one another. For example, in 1959, about 40 percent of the irrigation in Umatilla County was accomplished by use of sprinklers, whereas in Walla Walla County 65 percent was by sprinklers. In 1959, Umatilla County organizations provided water to 24,700 acres and cooperated with other farm supplies to irrigate another 12,200 acres. An additional 8,000 acres in Umatilla County were irrigated with farm groundwater, 6,700 acres were irrigated with farm surface water, and 4,700 acres were irrigated by a combination of ground and surface water. In Walla Walla County, irrigation organizations provided water for only 7,100 acres, while 8,000 acres were irrigated with farm groundwater, 4,600 acres with farm surface water, and 8,800 acres with a combination of ground and surface water from farm sources.

C. FUTURE ECONOMIC GROWTH

The future expansion of the economic base of the study area is presumed to follow trends already in effect. Agriculture is expected to provide a significant portion of the region's total output. Greater use of land of less than highest agricultural capability, more intensive utilization of crop land presently in fallow, and additional irrigation in the future is expected to make large scale increases in agricultural output possible. Crop patterns are expected to demonstrate increasing attention to vegetables and forage, with decreasing acreage in food grains. A marked increase in potato growing, for which the area is well suited, is a distinct possibility.

Based on the area's ability to increase agricultural output, further expansion of food processing is anticipated. Growth in the output of food products in this area relates to national population, since the bulk of regional production is sold in national markets. On this basis, gross output is predicted to rise at a rate in excess of the rate of national population growth (i.e., about 1.8 percent per year, based on U. S. Census Bureau projections of population). Production is expected to continue to stress the same types of vegetables now produced in the area, with more attention in the future to later-maturing vegetables to balance out the seasonal production pattern enforced by peas. Additional irrigation, inshipments, cold storage of raw materials, continuing shift of food production from urbanizing California to the Pacific Northwest regions are all calculated to enter into the equation suggesting output growth at a rate greater than that of population increase and over an extended processing season. The appearance of potato processing is possible. Employment is forecast to increase at the same rate as production.

Growth of other manufacturing is not expected to be substantial, since the study area lacks other natural resources and is distant from major market areas.

Construction employment, abnormally high for several decades as a result of a series of major public works, must be expected to come closer to levels which the local economy can maintain. However, the relatively undeveloped nature of the region suggests a level of construction somewhat higher than the national average.

It appears that services are adequately represented in the study area and that the service ratio is not likely to rise in the immediate future. Increased population and urbanization, together with the national trend to greater concentrations of services, is expected to increase the service ratio slightly in the 1980-2020 period.

These production factors are summarized, in terms of their projected impact on the labor force, in TABLE VI-3.

TABLE VI-3
DISTRIBUTION OF LABOR FORCE
WALLA WALLA STUDY AREA, WASHINGTON-OREGON

Industry	Number Employed (thousands)			
	1960	1980	2000	2020
Agriculture, Forestry, Fisheries & Mining	2.6	2.4	2.3	2.3
Construction	1.8	1.6	2.0	2.6
Manufacturing:				
Lumber & Products	0.5	0.6	0.7	0.9
Pulp & Paper	0.0	0.4	0.6	0.7
Food Processing	1.4	2.0	2.9	3.9
All Other	0.8	1.1	1.6	2.0
Services	11.8	16.3	23.0	30.8
Unemployed	1.0	1.0	1.3	1.7
Labor Force	20.9	25.4	34.4	44.9

D. FUTURE POPULATION

TABLE VI-4 shows the present and projected distribution of population in the study area. The rural portion of the study area population was forecast to remain constant on the strength of the number of employment opportunities to counter declining agricultural employment--notably the pulp and paper mill at Wallula. The projection of population is based on the assumption that the ratio of the area's labor force to total population will be the same as the national ratio in 1960.

TABLE VI-4
DISTRIBUTION OF POPULATION
WALLA WALLA STUDY AREA, WASHINGTON-OREGON

Location	Population			
	1960	1980	2000	2020
Mill Creek Watershed Area:				
Walla Walla	24,536	34,920	50,670	67,350
Suburban Walla Walla	3,200	4,550	6,610	8,780
College Place	4,031	5,730	8,320	11,070
Upper Walla Walla Basin Area:				
Milton-Freewater	4,110	4,900	8,400	12,500
Weston	783	1,100	1,800	2,700
Rural Area	9,000	8,000	8,000	8,000
TOTAL	45,660	59,200	83,800	110,400

VII. WATER REQUIREMENTS
Municipal & Industrial

A. GENERAL

Data on past and present municipal and industrial water use and projections of future needs are included in the "Mill Creek Project" report prepared by this office for the USACE in December 1965. The information contained in that report has been summarized and is presented in this chapter in a condensed form.

B. PRESENT WATER USE

In 1962, the cities of Walla Walla, College Place, Milton-Freewater, and Weston were served by municipal water systems. These systems also provided water for industrial use.

Walla Walla and Milton-Freewater use both surface and ground-water sources for their M&I supply. For Walla Walla, Mill Creek furnishes the primary supply which is supplemented by pumping from wells during peak use periods or when the quality of Mill Creek water does not permit its use. In Milton-Freewater, wells furnish the primary supply, which is supplemented by surface flows from South Fork Walla Walla during peak demand periods. The cities of College Place and Weston obtain their supplies from wells only.

Municipal and industrial water use in the study area in 1962 (see TABLE VII-1) averaged about 18 mgd (20,150 acre-feet annually).

TABLE VII-1
AVERAGE MUNICIPAL AND INDUSTRIAL WATER USE, 1962
WALLA WALLA STUDY AREA, WASHINGTON-OREGON
(mgd)

Location	Municipal	Industrial	Total
Mill Creek Watershed Area:			
Walla Walla	9.1	3.0	12.1
College Place	0.7	0.0	0.7
Upper Walla Walla Basin Area:			
Milton-Freewater	2.2	2.1	4.3
Weston	0.15	0.71	0.86
TOTAL	12.15	5.81	17.96

C. FUTURE WATER REQUIREMENTS

Projections of future municipal and industrial water demands, summarized by service areas, are summarized in TABLE VII-2.

TABLE VII-2
PROJECTED MUNICIPAL AND INDUSTRIAL WATER DEMAND
WALLA WALLA STUDY AREA, WASHINGTON-OREGON

Location	1980		2000		2020	
	mgd	Ac-Ft.	mgd	Ac-Ft.	mgd	Ac-Ft.
Mill Creek Watershed Area:						
Walla Walla	17.1	19,150	24.3	27,200	32.6	36,500
College Place	1.2	1,350	1.7	1,900	2.2	2,460
Upper Walla Walla Basin Area:						
Milton-Freewater	6.8	7,620	10.6	11,870	14.6	16,350
Weston	1.6	1,790	2.5	2,800	3.8	4,250
TOTAL	26.7	29,910	39.1	43,770	53.2	59,560

The groundwater supplies at College Place, Milton-Freewater, and Weston are considered adequate to meet the M&I needs of these cities throughout the study period. The developed sources at Walla Walla; however, are inadequate to meet future needs of that city. The city of Walla Walla has expressed interest in obtaining supplemental water from the Mill Creek Reservoir.

VIII. WATER QUALITY CONTROL

A. NEED FOR CONTROL

1. General

Surface waters, in addition to being used consumptively for municipal and industrial supply, irrigation, and stock watering, are used instream for fish and game propagation, recreation, and the disposal of wastes from various sources. Stream waters in lower basin areas receive, and at times consist almost entirely of, M&I waste effluent, return flows and drainage water from irrigated lands.

2. Irrigation

More water is used for irrigation in the basin than for any other purpose, although the demand is not high compared to other agricultural areas in the Pacific Northwest. Approximately 46,000 acres are presently being irrigated--about 60 percent of which lie within the Milton-Freewater Division. The net consumptive use in the basin has been estimated to be between 1.9 and 2.6 acre-feet per acre, or a total average annual consumptive use of about 104,000 acre-feet.

Essentially all of the natural summer flow of streams in the area is allocated to, and presently used for, irrigation. In addition, groundwater use exceeds 50,000 acre-feet per year. At present, sprinkler irrigation is practiced on more than half of the irrigated acreage. This ratio is expected to increase in the future, resulting in more efficient use of the available water. According to agricultural standards, the mineral quality of water, including irrigation return flows that are available in lower portions of the basin, is suitable for irrigation use.

3. Municipal and Industrial Water Supply

Water from surface sources in the study area serves about 28,000 persons and a number of food processing industries. The chemical quality of water used for M&I supply is generally within the limits of the U. S. Public Health Service Drinking Water Standards.

4. Fisheries

Steelhead trout are the only anadromous fish presently in the Walla Walla Basin. It has been estimated that a total of

5,000 steelhead return to the basin each year. Formerly, spring chinook, fall chinook, and coho salmon were present; however, low flows and degraded water quality have eliminated these species. Steelhead survive because their migrations occur during high river flows.

Resident game fish include rainbow and Dolly Varden trout, mountain whitefish, smallmouth bass and catfish. Fish habitat in the lower parts of the basin is poor because of high turbidity, high water temperatures, low summer flows, and excessive waste discharges to the stream.

Fishery agencies have stated that the Walla Walla River could support additional steelhead and other salmonid fish runs if water of satisfactory quality and quantity were available and if facilities were provided to pass fish over the existing Mill Creek diversion dam and over any new dams to be constructed. Full development of the basin's capabilities for fish propagation would increase the estimated steelhead spawning population to a total of 6,500 fish. Spring chinook and coho salmon populations would reach a total of approximately 900 fish.

5. Recreation

Except for sport fishing, riverside recreational activities have limited development potential in the Walla Walla Basin. Most waters in the lower portion of the basin are not suitable for wading due to high bacterial concentrations, murkiness of the water, and excessive aquatic growths. Boating, swimming, and similar water-oriented activities take place in the Columbia River near Wallula. The construction of the proposed storage reservoirs may stimulate these activities in the upper basin. The condition and aesthetic attractiveness of Mill Creek and the Walla Walla River are important assets to the setting of Whitman National Monument, which is located near the Mill Creek confluence.

B. MUNICIPAL, INDUSTRIAL, AND AGRICULTURAL POLLUTION

1. Present Municipal

At the present time, all communities in the basin provide secondary treatment of their waste waters and all except Milton-Freewater discharge to surface streams (see TABLE VIII-1). Part of the effluent from Walla Walla, College Place and Milton-Freewater is discharged to irrigation systems during summer months. The total population served by the municipal plants in the basin is over 36,000, with an estimated overall treatment efficiency above 85 percent.

TABLE VIII-1
PRINCIPAL SOURCES OF MUNICIPAL WASTES
WALLA WALLA RIVER BASIN, WASHINGTON-OREGON

Community	Estimated Sewered Population 1960	Type of Treatment
Mill Creek Watershed Area:		
Walla Walla	27,700	Secondary treatment (two stage, high and standard-rate trickling filters), chlorination, and discharge to Mill Creek and/or irrigation systems.
College Place	4,000	Secondary treatment (two stage, high rate trickling filter) and chlorination. Effluent discharged to Walla Walla River December-April and to irrigation systems May-November.
Upper Walla Walla Basin Area:		
Milton-Freewater	4,100	Secondary treatment (single stage, standard rate trickling filter), chlorination, and discharge to irrigation system.
Weston	800	Secondary treatment (single stage, high rate trickling filter), chlorination, and discharge to Pine Creek.

For the purpose of computing flow requirements for quality control, a factor of 1.25 was applied to the urban population to approximate the total municipal waste load reaching the river. This increase accounts for wastes which are difficult to measure, such as those emanating from domestic garbage grinders, commercial and light industrial plants, uncontrolled domestic sources located near the streams, and urban drainage.

2. Future Municipal

In projecting waste loads for the area, it is assumed that all municipal wastes would continue to receive secondary treatment or its equivalent for 85 percent BOD removal. This treatment requirement is considered reasonable for the Walla Walla Basin. It is further assumed that the present pattern of using treated waste water for irrigation purposes would continue throughout the study period.

TABLE VIII-2 shows projected waste loads for each major community during the critical summer months. Wastes at Walla Walla are assumed to receive adequate treatment (85 percent BOD removal) before discharge to Mill Creek. Also, because streamflow in Pine Creek is usually less than one cfs during the summer, Weston's treated municipal waste waters will soon be used for spray irrigation.

TABLE VIII-2
MAXIMUM MONTHLY MUNICIPAL WASTE LOADINGS
WALLA WALLA RIVER BASIN, WASHINGTON-OREGON
(1,000 Population Equivalents)

Area	Raw Load			Treated Load		
	1980	2000	2020	1980	2000	2020
Walla Walla	49.3	71.6	95.2	7.4	10.7	14.3
College Place	7.2	10.4	13.8	0	0	0
Milton-Freewater	6.1	10.5	15.6	0	0	0
Weston	1.4	2.2	3.5	0	0	0
TOTAL	64.0	94.7	128.1	7.4	10.7	14.3

3. Present Industrial

Industrial wastes in the study area result mostly from food processing and are highly variable in strength and volume. Except at Walla Walla, essentially all of these wastes are used for spray irrigation or discharged to non-overflowing lagoons.

In 1962, a separate industrial sewer and treatment plant was constructed at Walla Walla to serve three local food processors. The plant consists of two high-rate trickling filters operated in parallel. Some of the industrial wastes are treated in the municipal plant. Effluents from both plants discharge to Mill Creek and/or to irrigation systems. There are no major industries at College Place.

At Milton-Freewater, three food processing plants discharge untreated wastes to an irrigation system which also receives the municipal treatment plant effluent. No wastes are discharged directly to the Walla Walla River in this area. At Weston, cooling water and food processing wastes are distributed over 230 acres of land just west of town. Excess flow and runoff drain into several lagoons near Pine Creek. It is estimated that daily loads to Pine Creek from this source presently amount to about 180 PE.

The total raw waste production in the study area fluctuates widely from year to year, depending on the volume of peas harvested. Average monthly waste production during the pea-processing season (mid-June through July) has averaged 450,000 PE in recent years, although daily peaks of 600,000 to 800,000 PEs have been recorded. At Walla Walla, where about 50 percent of this industrial load is generated, an overall efficiency of about 75 percent BOD removal, in terms of waste received in Mill Creek, can be achieved with present waste treatment and with partial disposal of effluents to land. Irrigation districts in the vicinity of the treatment plant have the right, but are not obligated, to utilize up to 11 cfs (7.1 mgd), or about half, of the total treatment plant effluent.

4. Future Industrial

Future industrial waste projections, presented in TABLE VIII-3 are seasonal averages. These loads fluctuate widely and during some years will be double the averages used herein for design purposes. It is anticipated that industrial waste treatment methods will be progressively improved to the point that a BOD reduction efficiency of at least 85 percent will be achieved within the study period at Walla Walla. Continued disposal of waste waters to land is indicated in the Milton-Freewater and Weston areas.

5. Agricultural

Agricultural wastes contribute a recognizable portion of the organic and mineral pollutants to surface waters of the study area. Numerous livestock facilities such as feedlots, dairies, sheds and pastures are located adjacent to the basin's streams and drainage canals. The 60,000 cattle, hogs, and sheep presently in the area produce an estimated waste load of 200,000 PE. An estimated five percent, or 10,000 PE, of this agricultural waste reaches the waterways. Return flow from irrigation is another source of quality degradation that cannot be overlooked, especially during the season of low natural streamflow. Studies on return flow in

TABLE VIII-3
MAXIMUM MONTHLY INDUSTRIAL WASTE LOADINGS*
WALLA WALLA RIVER BASIN, WASHINGTON-OREGON
(1,000 Population Equivalents)

Area	Raw Load			Treated Load		
	1980	2000	2020	1980	2000	2020
Walla Walla	380	570	835	28.5	42.8	62.6
Milton-Freewater	210	315	460	0	0	0
Weston	140	210	310	0	0	0
TOTAL	730	1,095	1,605	28.5	42.8	62.6

* Waste production during pea-processing season (between mid-June and end of July).

Note: One half of the waste load at Walla Walla is assumed disposed of by means of spray irrigation and the balance given adequate treatment (85 percent BOD removal).

other areas show that significant BOD concentrations occur in these drains. Nutrients are suspected of promoting excessive aquatic growths.

In estimating future stream loadings originating from agricultural sources, these wastes are considered proportional to, and are accounted for in, the municipal waste projections.

C. WATER QUALITY CRITERIA

The quality of stream waters can be described in terms of temperature, turbidity, chemical constituents, bacteriological quality, DO-BOD relationships, and others. The significance of several of these quality indicators was discussed in Chapter V. For the purpose of this report, consideration has been given primarily to those aspects of water quality which could be improved and maintained most effectively by streamflow regulation. On the basis of the several present and anticipated water uses noted in Section A, dissolved oxygen is selected as the governing criteria to determine the need for and value of storage for quality control purposes.

The highest uses of the basin's streams would be protected by maintaining a minimum DO concentration of 6 mg/l. This level of control would insure conditions suitable for complete multiple use of the basin's streams, including quality requirements for passage of anadromous fish and for the propagation of resident fish. Maintenance of 6 mg/l in critical stream reaches would result in higher DO concentrations further upstream and would thereby promote a more suitable environment for fish spawning and rearing. Flow regulation for maintenance of DO at 6 mg/l would also control stream temperatures to 65 degrees Fahrenheit, a condition favorable for the re-establishment of the salmonid fishery.

An objective of 2 mg/l is generally recognized to be the minimum DO concentration necessary to prevent gross nuisance, health hazards, or degradation of the stream's aesthetic values. This level will not guarantee the support of desirable fish and aquatic life within the critical stream reach, but it will shorten this critical reach and provide more rapid recovery of the stream through the natural process of self-purification. Such waters could become septic when diverted to irrigation ditches where reaeration would probably be less than in the stream.

Streamflows for maintenance of dissolved oxygen at 4 mg/l would provide significantly greater protection and control of aesthetic conditions and other values along the stream. Additional capacity to control day-to-day fluctuations in waste treatment efficiencies and to receive uncontrolled urban and rural runoff would be provided. Control at this level would also provide short-term benefits in terms of added protection during lag periods when waste treatment efficiencies are being brought up to design standards. Recreational opportunities and a put-and-take fishery program might also be made possible, particularly during interim years. Stream temperatures would be more favorable for fishlife (less than 70 degrees Fahrenheit) and the present steelhead run in the Touchet River would be assured greater protection.

For purposes of this study, a minimum DO objective of 5 mg/l in Mill Creek and the lower reaches of the Walla Walla River has been adopted. This objective agrees with the Washington Pollution Control Commission's program for maintenance of water quality in the Walla Walla River Basin. Although full benefit will not be realized by establishing a DO objective of 5 mg/l, with advancement in waste treatment technology, it may be possible at some time in the future to achieve a quality suitable for development of a more widespread resident fishery or an anadromous fishery.

D. FLOW REGULATION

The "Federal Water Pollution Control Act (33 U.S.C. 466b(b))" provides that storage for regulation of streamflow for the purpose of water quality control shall not be provided as a substitute for adequate treatment or other methods of controlling waste at the source. Adequate treatment is considered by the FWPCA to mean effective waste collection and secondary treatment for domestic wastes and equivalent reduction of industrial waste loads by a combination of process control, internal waste savings, water reuse and effluent treatment. At the present time, efficiently operated trickling filter plants, widely used in intermediate size communities, are considered capable to 80 to 90 percent BOD removal, while activated sludge is considered capable of 85 to 95 percent removal. Despite the effect of diurnal fluctuations in waste loads, problems of efficient operation to maintain such high removals, probability of lags in plant construction to keep abreast of growth in waste loads, and urban storm water and/or combined sewer overflows, it is considered reasonable to expect that well-operated treatment systems will maintain an overall BOD removal efficiency of at least 85 percent.

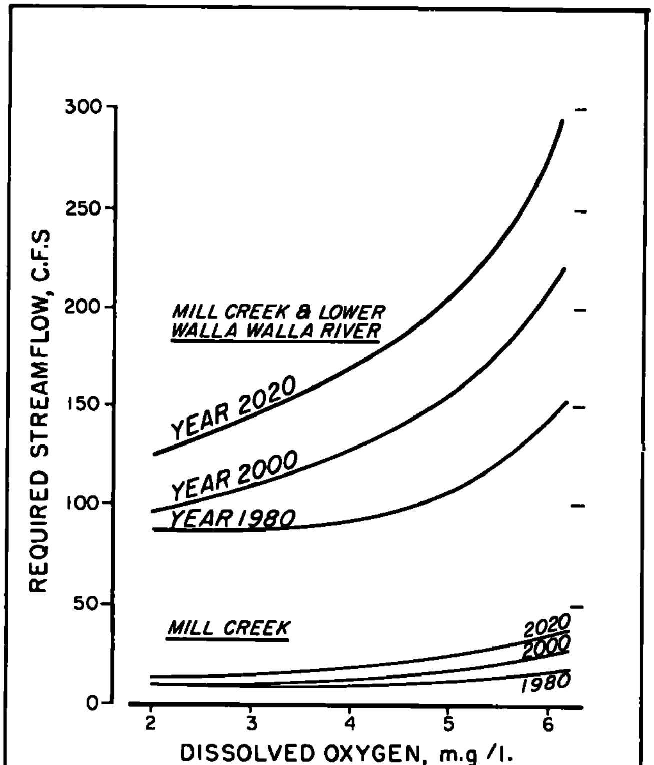
Regulation necessary to achieve the specified quality objectives in the Walla Walla River Basin is based on streamflows required to assimilate projected organic waste loads to be discharged to basin streams. The provision of adequate treatment of all collectible wastes has been assumed in establishing the waste loads to be assimilated by these streams. The projected waste loads are summarized in TABLE VIII-4 and, as indicated, only the community of Walla Walla discharges treated wastes to the basin's surface waters.

TABLE VIII-4
MAXIMUM MONTHLY M&I WASTE LOADS
WALLA WALLA RIVER BASIN, WASHINGTON-OREGON
(1,000 Population Equivalents)

	Raw Load			Treated Load		
Area	1980	2000	2020	1980	2000	2020
Walla Walla	429.3	641.6	930.2	35.9	53.5	76.9
College Place	7.2	10.4	13.8	0	0	0
Milton-Freewater	216.1	325.5	475.6	0	0	0
Weston	141.4	212.2	313.5	0	0	0
TOTAL	794.0	1189.7	1733.1	35.9	53.5	76.9

The load projected to be discharged at Walla Walla is based on attaining on 85% reduction of BOD in both domestic and industrial wastes, and disposing of one half the treated industrial wastes through spray irrigation.

Streamflows required to maintain the desired objectives under 1980, 2000, and 2020 conditions were computed by means of a technique for balancing the oxygen supply with oxygen consumed in the stream.



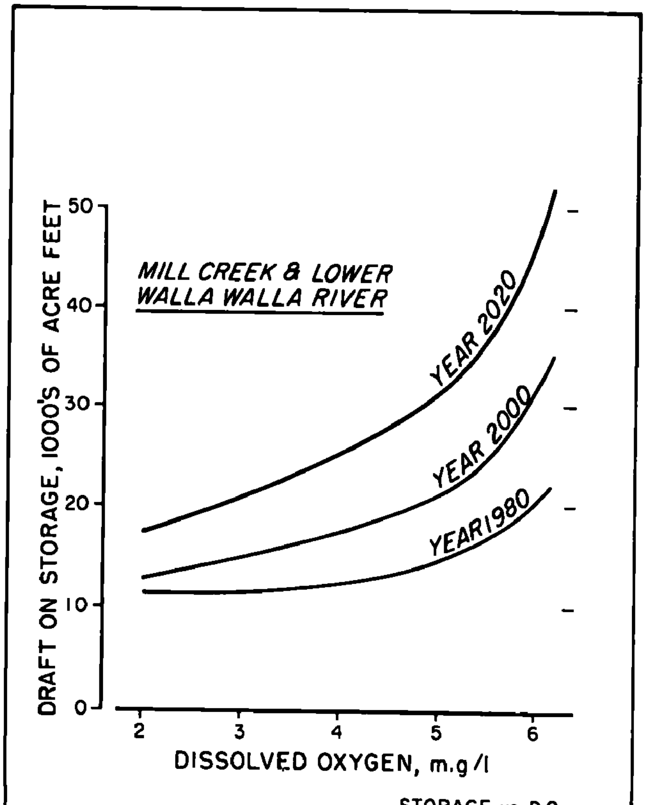
REQUIRED FLOW vs. D O

FIGURE 5

FIGURE 5 shows the increasing flow required to meet dissolved oxygen objectives of 2 mg/l through 6 mg/l in the critical reach of Mill Creek and the downstream portion of the Walla Walla River. These curves are based on average waste loads discharged to the stream after adequate treatment during July of each design year. Flow requirements are less in other months. During winter and spring, when requirements are minimal, a flow of 10 cfs is needed to maintain adequate quality.

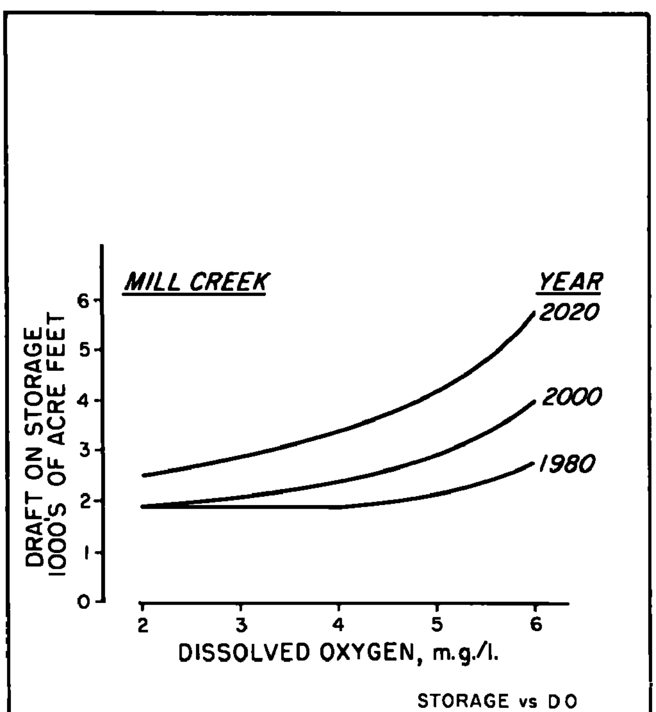
Storage volumes to provide flow regulation for quality control throughout the specified range of DO objectives are presented in FIGURES 6 and 7, on the following page. These are the annual drafts-on-storage needed to augment the unregulated streamflow available on an average monthly one-in-ten year low-flow frequency basis.

The one-in-ten year frequency, which would assure meeting quality goals in nine out of ten years, would be expected to provide adequate protection of stream uses. When minimum flows of lesser frequency occur, flow regulation will substantially decrease water quality degradation. Because nearly all of the basin runoff is consumed during July and August, the difference between streamflows expected to occur once-in-ten years (average 10 cfs) and once-in-twenty years (average 7 cfs) is not significant compared to the flow required for quality control (see FIGURE 5). For this



STORAGE vs DO

FIGURE 6



STORAGE vs DO

FIGURE 7

reason, failure to meet desired flow requirements in years when flows are less than those expected one-year-out-of-ten will not be especially damaging.

By the respective years 1980 and 2020, a maximum monthly flow of 110 cfs and 205 cfs will be needed to maintain a DO concentration of at least 5 mg/l at the mouth of the Walla Walla River. The required monthly streamflow regimen and the resulting total annual storage is developed in TABLE VIII-5. Also included is a suggested flow release schedule for each month of the design year. As indicated, there will be a need by 2020 for an annual draft-on-storage of 31,300 acre-feet to maintain the desired water quality objective. By year 1980, approximately 15,000 acre-feet will be required (see FIGURE 6).

The above flow and storage requirements are predicated on the exclusive use of the proposed Mill Creek Reservoir. However, the Joe West Reservoir could also be utilized to furnish all or a portion of the additional flow needed in the

TABLE VIII-5
REQUIRED STREAMFLOW REGIMEN FOR QUALITY CONTROL PURPOSES
WITH DISSOLVED OXYGEN OBJECTIVE OF 5 mg/1*
MILL CREEK AND LOWER WALLA WALLA RIVER, WASHINGTON
YEAR 2020

Month	Required Streamflow (cfs)	Base Flow** (cfs)	Estimated Release Schedule (cfs)	Estimated Release Schedule (mgd)	Draft-on-Storage*** (Acre-Feet)
January	10	350	0	0	
February	13	605	0	0	
March	13	570	0	0	
April	25	560	0	0	
May	23	385	0	0	
June	91	87	5	3	300
July	205	13	195	126	11,600
August	205	6	200	129	11,900
September	112	14	100	65	5,950
October	69	46	25	16	1,490
November	38	97	0	0	
December	13	335	0	0	
ANNUAL AVERAGE	68	255			
ANNUAL TOTAL					31,240

* Based on adequate treatment of organic wastes discharged to stream.

** Streamflow available at the mouth of the Walla Walla River on an average monthly one-in-ten year low flow frequency basis.

*** This is the additional quantity needed in the lower Walla Walla River and does not include storage and transmission losses.

lower reaches of the Walla Walla Basin. For this purpose TABLE VIII-6, which shows the flow regulation storage required (4,200 acre-feet) to maintain a DO concentration of 5 mg/l in Mill Creek, is included. Accordingly, storage to yield as much as 27,100 acre-feet may be included for quality control in the Joe West Project. The Oregon Legislative Assembly, however, may not permit such releases. Storage releases from either reservoir would be expected to produce the same degree of control in the lower Walla Walla River downstream from the Mill Creek confluence.

Municipal and industrial wastes in Milton-Freewater and Weston areas are adequately handled by treatment, lagoons and land disposal resulting in little, if any, residual waste discharge to stream waters. With continued future handling of wastes in this manner, no need for storage in Joe West Reservoir is foreseen for control of water quality in the Walla Walla River at Milton-Freewater. On the other hand, operation of the reservoir to provide water for the proposed irrigation project is not expected to have any significant effect on downstream water quality.

1. Stream Temperature Evaluation

Preliminary studies of the reservoirs' potentials for regulating stream temperature indicate that significant temperature control would accompany storage releases made to maintain a dissolved oxygen objective of 6 mg/l. Mill Creek Reservoir has the capability of supplying water at a temperature of approximately 55°F during July of an average year. Releases of 100 cfs from the reservoir may attain a temperature of 70°F at the mouth of Mill Creek. Releases of 200 cfs would probably maintain temperatures below 65°F in this reach. Similar releases would exercise a greater degree of thermal control in August, September and October.

A reservoir at the Joe West site could discharge water to the Walla Walla River at about 50°F during July. A 100 cfs release would hold Walla Walla water temperatures below 70°F to the confluence of Mill Creek. Releases of 200 cfs would maintain downstream water temperatures below 70°F to the mouth of the Touchet River. These temperature estimates are preliminary and should be taken only as indications of approximate thermal conditions. A more complete evaluation would be required to substantiate these findings.

TABLE VIII-6
REQUIRED STREAMFLOW REGIMEN FOR QUALITY CONTROL PURPOSES
WITH DISSOLVED OXYGEN OBJECTIVE OF 5 mg/l*
MILL CREEK AT WALLA WALLA, WASHINGTON
YEAR 2020

Month	Required Streamflow (cfs)	Base Flow** (cfs)	Estimated Release Schedule (cfs)	Estimated Release Schedule (mgd)	Draft-on-Storage*** (Acre-Feet)
January	10	55	0	0	
February	10	78	0	0	
March	10	63	0	0	
April	10	80	0	0	
May	10	47	0	0	
June	12	15	0	0	
July	26	2	24	15.5	1,480
August	26	2	24	15.5	1,480
September	15	2	13	8.4	780
October	10	3	7	4.6	430
November	10	20	0	0	
December	10	47	0	0	
ANNUAL AVERAGE	13	35			
ANNUAL TOTAL					4,170

* Based on adequate treatment of organic wastes discharged to stream.

** Streamflow available at Walla Walla on a one-in-ten year low flow frequency basis.

*** This is the additional quantity needed in Mill Creek at Walla Walla and does not include storage and transmission losses.

IX. BENEFITS

Storage releases for control of water quality are needed in Mill Creek and in lower Walla Walla River to protect fish and wildlife, maintain recreational opportunities, safeguard public health, and preserve the aesthetic attractiveness of stream waters. Monetary benefits applicable to all improvements or damages avoided, however, are impossible to thoroughly evaluate at this time. Economic waste and land treatment methods capable of complete control of all waste materials are not presently known. Many benefits, such as those resulting from temperature reduction, decreased concentrations of dissolved solids, maintenance of the aquatic habitat, increased land values along the stream, and general protection of aesthetic values, are particularly difficult to completely assess in monetary terms.

Because of the multiplicity of improvements that would be realized through the control of water quality by flow regulation, the minimum value of storage for this purpose is considered to be at least equal to the cost of an equivalent alternative which would accomplish similar results. Examination of several alternatives to flow regulation disclosed that, except for single-purpose storage, no other alternative would provide equivalent control--that is, maintenance of a live stream within which waste effluents and uncontrolled urban and rural runoff wastes would be diluted and assimilated.

The major water quality problems in Mill Creek could be solved by transporting wastes from the Walla Walla area to mainstem Walla Walla River. However, discharge of waste effluents to the Walla Walla River would merely transfer the problem downstream since extremely low flows also occur in the Walla Walla River. Also, waste waters transported to the Walla Walla River would be unavailable for reuse for irrigation in areas adjacent to Mill Creek. Consideration is also given to the disposal of waste waters underground and to additional disposal on land. Underground disposal would be expected to interfere with groundwater supplies and additional surface disposal, particularly of pea processing wastes on the limited land areas available, could promote nuisance odor conditions objectionable to residents in the surrounding areas.

A single-purpose reservoir at the Mill Creek site is found to be the most likely alternative means of providing the necessary storage for control of water quality. Based on costs provided by the Corps of Engineers for the water quality control study report on Mill Creek Project, the unit annual acre-foot alternate value of storage for quality control in Walla Walla River Basin is $15.50. This $15.50 per acre-foot value would apply to storage that would maintain downstream DO levels between the 2 mg/l and 6 mg/l established as the range within which water quality benefits would accrue. Flow releases to maintain DO concentrations above 2 mg/l, the level at which it is felt nuisance conditions would be averted, would require about 17,300 acre-feet of storage space. To maintain DO concentrations above 6 mg/l, the point at which the highest level of stream uses, including the re-establishment of the salmonid fishery, could be accommodated, would require about 48,000 acre-feet of storage. At $15.50 per acre-foot, the minimum value of the benefit assignable to an annual draft-on-storage of 31,300 acre-feet (storage required by 2020 to maintain DO levels above the 5 mg/l objective selected for Mill Creek and Walla Walla River) in the proposed project is $485,000. For an annual draft-on-storage of more or less than 31,300 acre-feet, the annual value would be increased or accordingly reduced at the rate of $15.50 per acre-foot. No benefits would accrue to project regulation maintaining DO concentrations below 2 mg/l or above 6 mg/l.

Controlled water quality will have an important impact on the area for which regulation would be provided. The riparian owners, downstream water users, and surrounding area population (projected to 100,000 persons) would be the recipients of the benefits of this control. Benefits, therefore, are both tangible and intangible and are widespread both in area and type of beneficiary. In the Walla Walla River Basin, the lower six miles of Mill Creek and 40 miles of the Walla Walla River would be affected by this control.

After the project is in operation, a system of water quality and waste monitoring and stream forecasting will be needed in order to fully utilize flow regulation for water quality control.

X. BIBLIOGRAPHY

1. Review Report on Mill Creek, Washington and Oregon; U. S. Army Engineer District, Walla Walla Corps of Engineers, June, 1963.

2. Report on a Reconnaissance Study of the Feasibility of Participation in the Mill Creek Storage Project by the City of Walla Walla, Washington; Cornell, Howland, Hayes & Merryfield, Consulting Engineers, February, 1961.

3. Experimental Treatment of Food Processing Waste Waters of Walla Walla, Washington, in 1959; Skrinde, R. T., Washington State University, Sanitary Engineering Section, Report No. 19, November, 1959.

4. Cooperative City-Industry Treatment Facilities at Walla Walla; Zickafoose, C. S. and Boydston, J. R.

5. Treatment of Pea Processing Waste Waters at Walla Walla, Washington, 1962; City of Walla Walla Report, August, 1962.

6. Biological Treatment of Pea Processing Waste, Walla Walla, Washington, 1963; Kramer, G. F., August, 1963.

7. Biological Treatment of Pea Processing Waste, Walla Walla, Washington, 1964; Kramer, G. F.

8. Engineering Report on a Water System Investigation; City of Walla Walla, Washington, Parts I and II, 1952-53; Cornell, Howland, Hayes & Merryfield, Consulting Engineers.

9. Report of Survey, Walla Walla River Watershed, Washington & Oregon; U. S. Department of Agriculture, Soil Conservation Service, October, 1950.

10. Municipal Water Facilities Inventory; U. S. Department of Health, Education, and Welfare, Public Health Service, 1963.

11. Artificial Recharge of a Well Tapping Basalt Aquifer, Walla Walla Area, Washington; State of Washington, Department of Conservation, Water Supply Bulletin No. 7, 1960.

12. Studies on the Control of Slime in Cannery Waste Water in the Walla Walla Area; Institute of Technology, State College of Washington, Pullman, Washington, 1958, 24 pp.

13. Quality of Surface Waters in the Lower Columbia River Basin; Geological Survey Water Supply Paper 1784, U. S. Government Printing Office, Washington, 1965, 78 pp.

14. Geology and Groundwater Resources of Walla Walla Basin; Washington Division of Water Resources, Water Supply Bulletin No. 21, 1965, 151 pp.

APPENDIX A

HYDROLOGICAL DATA

TABLE A-1
ESTIMATED MEAN MONTHLY STREAM FLOWS
AT MILL CREEK DAMSITE
WALLA WALLA RIVER BASIN, WASHINGTON
(cfs)

Water Yr.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1940	21	26	42	57	248	210	198	84	35	29	28	31
41	31	67	104	100	60	52	52	96	102	41	28	31
42	41	106	138	67	122	123	122	132	125	50	25	24
43	28	118	240	133	200	162	278	185	100	44	30	28
44	44	52	62	37	83	172	188	92	50	28	26	30
45	28	36	37	128	158	162	214	180	95	34	29	33
46	33	115	182	218	180	240	218	164	92	55	35	34
47	52	160	278	205	133	176	212	88	54	38	32	35
48	68	195	178	205	232	142	248	382	132	57	43	42
49	40	91	137	70	208	320	326	223	77	48	40	37
1950	42	55	76	112	340	380	265	250	184	62	48	46
51	62	166	208	212	300	190	180	110	124	46	42	41
52	117	117	150	100	228	170	312	170	80	64	40	38
53	40	38	41	267	226	222	210	162	104	48	40	38
54	39	55	182	168	176	106	188	93	138	44	40	38
55	41	45	50	67	81	93	208	200	92	41	30	31
56	38	96	243	185	100	223	258	178	63	37	33	31
57	40	56	146	50	164	240	235	180	55	40	36	35
58	40	58	158	182	318	118	340	195	60	40	34	35
59	38	114	256	314	175	186	202	154	78	43	37	50
1960	76	125	82	77	172	182	182	146	70	36	42	42

Drainage Area: 90 square miles (approximately)
Average Discharge: 112 cfs=81,000 acre-feet per year
Period of Record: 25 years (1939-1964)
Maximum Day: 3335 cfs
Minimum Day: 16 cfs

TABLE A-2
ESTIMATED MEAN MONTHLY STREAM FLOWS
WALLA WALLA RIVER AT JOE WEST DAMSITE
WALLA WALLA RIVER BASIN, OREGON
(cfs)

Water Yr.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1940	97	93	128	160	433	392	450	248	102	80	77	85
41	95	144	201	174	144	174	176	233	235	108	84	96
42	115	194	306	171	230	212	344	296	250	138	80	78
43	89	198	374	264	306	260	617	467	368	148	96	94
44	112	124	140	116	180	308	413	312	162	101	91	93
45	95	108	118	233	275	368	394	525	302	106	87	95
46	100	188	270	238	210	322	438	508	276	140	107	112
47	132	220	516	312	280	314	430	308	178	124	115	120
48	180	352	275	312	297	261	455	818	556	187	140	140
49	141	184	207	147	255	402	535	594	270	145	124	124
1950	130	145	161	198	348	405	402	520	502	181	140	133
51	151	910	336	315	355	282	404	360	316	144	128	126
52	186	200	227	173	277	264	572	495	252	182	130	124
53	125	126	130	365	372	336	420	410	307	153	131	125
54	127	145	250	232	276	236	390	312	315	144	125	122
55	124	133	125	141	170	170	310	457	335	145	110	106
56	121	170	362	302	225	283	437	470	225	127	112	107
57	112	130	302	152	267	358	478	530	202	120	107	109
58	125	140	224	244	396	223	528	560	220	127	115	114
59	113	204	374	410	300	295	406	376	216	130	123	177
1960	218	241	191	177	260	337	402	360	216	125	117	114
61	122	198	150	160	446	383	381	386	205	122	109	116
62	122	122	184	218	190	241	452	350	197	113	102	105

Drainage Area: 125 square miles (approximately)
Average Discharge: 225 cfs=162,000 acre-feet per year
Period of Record: 33 years (1930-1963)
Maximum Day: 4410 cfs
Minimum Day: 73 cfs

TABLE A-3
ESTIMATED MEAN MONTHLY STREAM FLOWS
MILL CREEK AT WALLA WALLA
WALLA WALLA RIVER BASIN, WASHINGTON
(cfs)

Water Yr.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1940												
41	6	35	70	90	60	40	30	50	35	6	3	10
42	7	44	91	82	118	98	55	72	65	9	6	8
43	11	62	190	116	210	112	240	130	34	4	5	4
44	18	24	35	16	62	140	157	40	7	3	3	3
45	6	6	5	64	158	148	190	113	37	3	2	5
46	4	45	157	208	180	240	110	83	27	6	5	6
47	7	89	131	130	16	3	10	15	7	3	5	8
48	17	147	112	144	120	115	247	344	88	6	6	4
49	4	20	47	53	206	320	248	153	21	5	5	5
1950	7	11	33	87	330	337	190	108	118	4	1	2
51	14	137	155	212	332	167	134	72	88	5	5	4
52	96	47	112	60	187	115	276	97	12	10	1	2
53	3	4	5	261	227	208	160	123	67	8	6	6
54	6	12	142	122	153	60	143	33	114	5	4	4
55	2	7	13	26	30	46	180	160	26	6	3	3
56	4	51	247	180	84	234	193	107	23	7	1	1
57	5	9	110	34	170	243	194	125	9	3	2	2
58	1	8	120	170	295	75	293	121	25	4	2	2
59	1	64	205	277	152	180	167	97	17	1	1	8
1960	22	56	42	45	150	154	148	96	13	3	4	3
61	2	51	41	51	296	307	130	97	14	4	4	4
62	3	18	101	90	49	172	179	72	8	2	2	2

Drainage Area: 96 square miles
Period of Record: 23 years (1941-1964)
Maximum Day: 2760 cfs
Minimum Day: zero flow
Remarks: Several diversions upstream. These records reflect stream flows available at the sewage treatment plant.

TABLE A-4
ESTIMATED MEAN MONTHLY STREAM FLOWS
WALLA WALLA RIVER DOWNSTREAM FROM TOUCHET RIVER
WALLA WALLA RIVER BASIN, WASHINGTON
(cfs)

Water Yr.	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1952	392	447	873	1048	1836	993	1525	800	137	95	23	59
53	63	124	295	1555	1509	1173	1076	766	385	36	18	23
54	78	172	924	964	1300	770	974	298	471	41	35	71
55	103	171	287	484	593	518	1134	1048	296	46	12	4
56	139	528	1807	1576	861	1686	1539	1052	189	36	23	49
57	103	215	805	334	1177	1730	1559	1217	142	16	13	21
58	164	184	711	963	1872	737	2165	1147	166	27	7	29
59	65	436	1317	1888	1389	1287	1154	687	207	28	17	181
60	336	531	490	470	1069	1157	1076	761	162	10	12	36
61	88	384	427	642	2096	1843	932	699	148	7	5	14
62	64	150	658	782	590	1224	1217	845	190	21	11	31
63	226	416	820	435	1411	662	912	309	26	19	10	14
64	46	107	139	312	247	282	478	325	189	60	39	42

Drainage Area: 1,657 square miles
Average Discharge: 567 cfs=410,500 acre-feet per year
Period of Record: 13 years (1951-1964)
Maximum Day: 16,300 cfs
Minimum Day: 1.9 cfs

TABLE A-5
MEAN MONTHLY LOW FLOW FREQUENCIES BASED UPON
ESTIMATED STREAM FLOWS
AT MILL CREEK DAMSITE, WASHINGTON

Month	Percent of Annual Mean	Recurrence Interval - Years		
		Five (cfs)	Ten (cfs)	Twenty (cfs)
January	122	107	90	78
February	161	142	119	103
March	160	141	118	102
April	191	168	141	122
May	144	127	107	92
June	79	70	58	51
July	38.2	34	28	24
August	30.4	27	23	19
September	31.3	28	23	20
October	40.0	35	30	26
November	78	69	58	50
December	124	109	92	79
ANNUAL MEAN		88	74	64

TABLE A-6
MEAN MONTHLY LOW FLOW FREQUENCIES BASED UPON
ESTIMATED STREAM FLOWS
WALLA WALLA RIVER AT JOE WEST DAMSITE, OREGON

Month	Percent of Annual Mean	Recurrence Interval - Years		
		Five (cfs)	Ten (cfs)	Twenty (cfs)
January	97	184	171	160
February	110	209	194	182
March	137	260	241	226
April	187	355	329	308
May	182	346	320	300
June	110	209	194	182
July	55	105	97	91
August	46	87	81	76
September	47	89	83	77
October	52	99	91	86
November	81	154	143	134
December	99	188	174	163
ANNUAL MEAN		190	176	165

TABLE A-7
MEAN MONTHLY LOW FLOW FREQUENCIES BASED UPON
ESTIMATED STREAM FLOWS
MILL CREEK AT WALLA WALLA, WASHINGTON

Month	Percent of Annual Mean	Recurrence Interval - Years Five (cfs)	Ten (cfs)	Twenty (cfs)
January	160	78	55	44
February	226	104	78	62
March	183	84	63	50
April	232	107	80	64
May	136	62	47	37
June	43.5	20	15	12
July	5.8	3	2	2
August	5.8	3	2	2
September	5.8	3	2	2
October	8.7	4	3	2
November	58	27	20	16
December	136	62	47	37
ANNUAL MEAN		46	35	28

TABLE A-8
MEAN MONTHLY LOW FLOW FREQUENCIES BASED UPON
ESTIMATED STREAM FLOWS
WALLA WALLA RIVER DOWNSTREAM FROM TOUCHET RIVER, WASHINGTON

Month	Percent of Annual Mean	Recurrence Interval - Years Five (cfs)	Ten (cfs)	Twenty (cfs)
January	136	530	350	230
February	237	925	605	405
March	223	870	570	380
April	219	855	560	370
May	151	590	385	255
June	34	133	87	58
July	5.2	20	13	9
August	2.3	9	6	4
September	5.7	22	14	10
October	18.2	71	46	31
November	38	148	97	65
December	131	510	335	223
ANNUAL MEAN		390	255	170

APPENDIX B

WATER QUALITY DATA

TABLE B-1
SURFACE WATER QUALITY DATA
WALLA WALLA RIVER BASIN, WASHINGTON
June 1966

DATE	TIME	ITEM	STATION								
			1	2	3	4	5	6	7	8	9
20	1330	Temp., °C	23.5	22.0	24.0	23.5	24.0	24.0	24.0	24.0	23.5
	-1515	pH	8.6	6.2	5.1	5.3	6.7	7.4	8.6	8.3	8.3
		D.O., mg/l	12.7	6.4	1.3	0.8	2.5	7.4	15.9	11.0	11.2
		BOD_5, mg/l	3	269	218	156	42	12	14	9	10
22	1430	Temp., °C	24.0	22.0	25.5	25.5	23.0	23.5	24.0	24.0	24.0
	-1545	pH	8.2	6.2	6.2	6.3	6.7	7.0	6.8	8.1	8.2
		D.O., mg/l	12.7	7.4	3.9	4.9	2.9	0.9	8.4	11.4	11.4
		BOD_5, mg/l	6	148	200	134	54	35	8	4	4
24	1000	Temp., °C	14.5	18.5	15.5	16.0	15.5	15.0	16.0	14.5	14.5
	-1200	pH	6.1	6.1	5.8	5.5	6.3	6.4	6.8	7.3	7.3
		D.O., mg/l	9.3	7.1	3.5	1.4	3.2	4.2	11.2	11.6	11.6
		BOD_5, mg/l	3	325	142	214	37	27	8	2	2
28	1515	Temp., °C	22.0	23.0	24.0	24.0	22.0	22.0	22.0	22.0	22.0
	-1700	pH	7.6	6.1	5.6	5.4	6.6	6.9	7.5	8.3	8.4
		D.O., mg/l	10.0	5.4	1.3	0.6	1.1	2.3	11.4	11.2	10.7
		BOD_5, mg/l	3	290	204	197	44	18	6	3	3
30	1330	Temp., °C	23.5	24.0	25.0	25.5	22.0	22.0	24.0	24.0	24.0
	-1530	pH	8.0	6.4	6.6	6.7	6.8	7.6	8.5	-	8.4
		D.O., mg/l	11.2	6.2	3.6	1.9	7.0	10.9	13.0	11.7	11.7
		BOD_5, mg/l	2	305	64	53	11	11	6	4	4

NOTE: Stations refer to Figure 2. Samples were collected during the pea-processing season by Walla Walla Sewage Treatment Plant personnel in cooperation with the FWPCA. Stream flow averaged 8 to 10 cfs at confluence with Walla Walla River (which averaged about 20 cfs).

TABLE B-2
SURFACE WATER QUALITY DATA
WALLA WALLA RIVER BASIN, WASHINGTON
July 1963

Station	Miles Downstream from STP*	Water Temp. (°C)	pH	DO	5-Day BOD	COD	Phosphates Ortho	Phosphates Soluble	Phosphates Insoluble	Nitrogen Organic	Nitrogen Ammonia
				Concentration in mg/l							
MILL CREEK:											
2	0.1	21	6.5	5.6	216	423	0.8	1.9	6.9	31.3	18.9
2A	0.3	20	6.5	3.0	237	378	2.8	4.4	2.7	33.9	18.7
3	0.6	19.5	6.5	1.2	211	359	5.2	6.0	1.9	30.1	20.5
4	1.2	19	6.6	0.6	210	329	4.0	5.0	3.9	19.2	10.0
5	3	17	6.9	0.6	103	171	3.9	4.2	0.0	17.8	10.4
6	4	17	7.0	0.5	104	175	4.7	5.1	0.3	18.3	11.4
7	5	17.5	7.3	4.4	12	36	2.5	2.4	0.3	5.4	5.1
Confluence	6										
WALLA WALLA RIVER:											
8	0.5 mi. above Mill Creek	17.5	7.9	10.5	2	8	0.5	0.4	0.0	0.9	0.3
9	0.5 mi. below Mill Creek	18	7.9	9.6	4	6	0.7	0.5	0.0	1.0	1.3

* Walla Walla Sewage Treatment Plant

Source: FWPCA survey, July 3, 1963 (6 to 8 a.m.)

TABLE B-3
SURFACE WATER QUALITY DATA

14018500 WALLA WALLA R NR TOUCHET WASH 1660. SQ. MILES PAGE 127

DATE	DSCHARGE	CALCM CA	MAGNS MG	SODIUM NA	PTSM K	CHLORDE CL	SULFTE SO4	FLRD F	BICB HCO3	CRB CO3	DISV. SOLIDS	SPEC. COND. UMHOS	SLCA SIO2	NTRT NO3	PHST PO4	TOTL PHST PO4	BRON B	DSOXY MGL	MPN E COLI	TEMP CENT	PH	CLR
		----- CATIONS MGL ----				------- ANIONS MGL --------																
112362	195.	23.	8.6	17.	4.5	12.	16.	.2	122		180	261	36.	2.3	.58						7.8	
112062	246.	24.	8.6	18.	4.0	13.	14.	.2	124		181	268	36.	1.7	.47						7.9	
121762	876.	14.	4.4	9.1	2.8	5.5	6.8	.2	70		125	145	34.	2.9	.62						7.2	
012363	360.	19.	6.6	13.	3.1	8.0	11.	.1	98		149	209	37.	2.9	.46						7.8	
022663	960.	14.	4.6	9.3	2.5	5.0	6.0	.1	73		122	154	34.	2.4	.41						7.4	
032563	665.	17.	4.7	8.8	2.4	4.8	7.2	.2	81		127	160	34.	1.6	.34						7.9	
042663	981.	13.	3.8	7.3	2.7	3.8	6.2	.1	64		106	129	33.	1.0	.30						7.3	
052363	132.	28.	9.5	21.	4.4	11.	23.	.2	145		201	304	30.	1.7	.30						7.7	
061463	22.	46.	17.	35.	6.0	22.	48.	.3	220		318	494	28.	1.9	.31						7.7	
071863	19.	62.	26.	66.	9.2	40.	93.	.4	306		473	746	22.	1.2	.30						7.9	
082363	11.	81.	28.	62.	12.	42.	106.	.5	349		569	836	43.	4.6	.80						7.9	
092563	31.	60.	23.	55.	8.6	34.	69.	.4	304		424	672	31.	.5	.28						8.2	
112063	172.	21.	7.9	16.	3.9	10.	13.	.2	115		167	242	36.	1.5	.36						7.5	
121063	250.	20.	8.4	18.	4.4	11.	15.	.2	114		175	246	35.	2.6	.49				930	2.0	7.4	5
011564	456.	16.	6.0	12.	3.0	7.0	8.2	.2	86		132	181	33.	2.4	.35						7.2	5
021864	605.	14.	5.6	9.2	3.0	6.0	6.0	.2	75		126	159	33.	2.5	.44		.06				7.2	10
032364	685.	12.	4.9	8.3	2.5	4.2	6.8	.2	66		106	140	32.	2.6	.38			12.2	240	9.0	7.3	20
042064	650.	10.	4.8	7.8	2.2	4.0	5.8	.1	62		102	125	32.	1.0	.25						7.6	5
051964	1100.	7.0	3.0	4.9	1.8	1.5	3.0	.1	44		78	83	25.	.9	.21						7.1	5
062264	236.	18.	7.6	19.	3.8	14.	13.	.2	101		159	235	31.	1.9	.35			8.6	11000	22.5	7.5	5
072364	27	[illegible]	19.	46.	[illegible]	28.	56.	.3	241	7	356	579	23.	1.0	.35						8.5	5
081764	14.	56.	24.	54.	7.9	31.	87.	.3	272		424	673	26.	1.1	.25		.10				8.2	5
092364	36.	46.	18.	42.	7.1	23.	46.	.3	248		338	536	28.	1.0	.30			9.7	11000	20.0	8.0	5
1 2164		35.	15.	31.	5.4	16.	33.	.5	199		265	420	28.	.9	.25						7.6	5
112064		29.	11.	25.	5.2	14.	22.	.3	163		216	345	33.	1.7	.45						7.9	5
121264		11.	3.9	6.9	2.9	4.0	5.6	.1	58		112	124	29.	2.7	.48		.01	13.5	2400	3.0	7.7	10
011165		17.	5.4	11.	3.1	7.0	10.	.1	83		129	185	31.	2.1	.31						7.1	5
022365		12.	4.4	7.3	2.6	5.0	6.8	.1	60		107	133	29.	3.9	.37						7.2	10
031365		16.	5.1	9.6	3.	6.2	9.6	.1	76		126	171	28.	4.2	.36			11.4	2400	1.8	7.6	[illegible]
042265		7.2	3.1	5.0	2.4	2.5	3.2	.1	42		81	85	27.	1.7	.31						7.0	20
061265		31.	11.	27.	5.3	26.	26.	.2	148		223	357	33.	1.4	.29		.12	8.7	1500	20.3	7.4	5
071665		52.	20.	46.	7.4	30.	55.	.4	260		375	587	35.	1.8	.37						7.7	[illegible]
081965		53.	19.	41.	7.3	24.	54.	.3	254		358	573	27.	1.9	.38		.10				7.7	5
090465		36.	14.	27.	6.1	17.	29.	.3	186		252	399	34.	2.7	.46			8.2	230	17.9	7.7	5

Source: Washington Pollution Control Commission - Basic Data Station

TABLE B-4
BACTERIOLOGICAL EXAMINATIONS
WALLA WALLA SEWAGE TREATMENT PLANT, WASHINGTON
1964

Sample Date	Chlorine Residual (mg/1)	Colonies per 100 ml 1/	
		Enterococcus	Coliform
Industrial Plant Effluent			
June 30	1.75	200	3500
July 8	1.75	200	2900
July 15	2.0	500	1700
July 21	1.5	400	1600
July 28	0.75	2025	1700
Sanitary Plant Effluent			
June 30	1.75	200	19200
July 8	1.6	0	17100
July 15	2.0	100	200
July 21	1.5	50	1000
July 28	1.0	50	5200

1/ Membrane Filter Technique

Source: Reference No. 7

TABLE B-5
WATER TEMPERATURE DATA
WALLA WALLA RIVER NEAR TOUCHET, WASHINGTON
(Degrees Fahrenheit)

Year	Daily Temperature	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1959	High								76	77	78	70	50
	Low								59	60	64	61	35
	Average								65	66	68	-	39
1960	High	53	60	52	59	65	70	76	85	70	60	50	40
	Low	32	32	31	45	50	54	65	59	57	45	37	33
	Average	37	42	44	51	56	65	71	68	62	53	42	38
1961	High	48	52	56	62	69	89	88	94	73	69	48	49
	Low	34	39	44	49	53	68	71	69	60	45	34	35
	Average	40	46	49	54	62	77	80	79	64	58	42	41
1962	High	-	49	52	64	59	70	81	89	79			
	Low	-	35	37	48	43	48	48	62	58			
	Average	-	43	45	54	52	59	62	74	69			

Source: WPCC - measurements taken once-daily during afternoon.

PAGE NOT

AVAILABLE

DIGITALLY