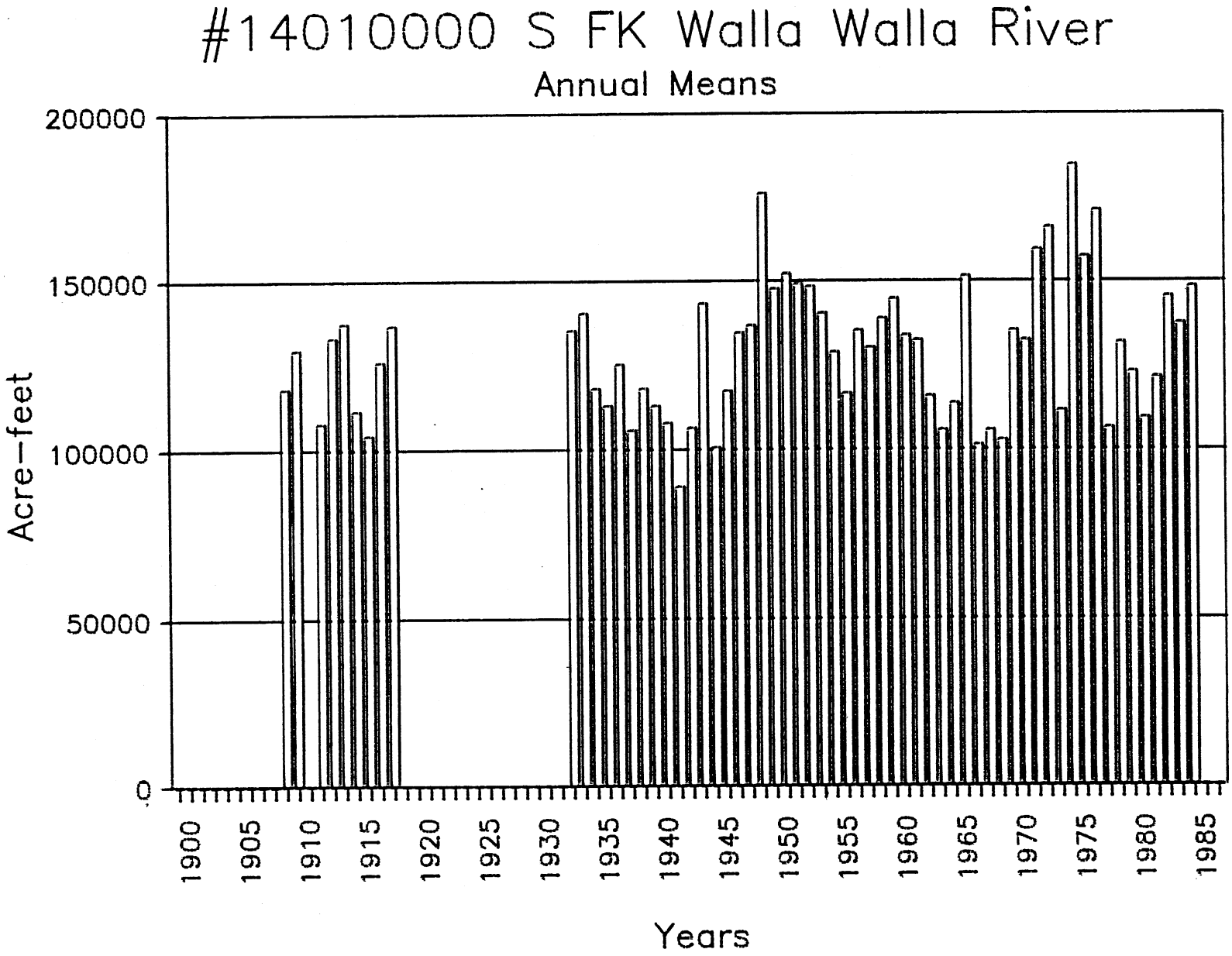
DISCUSSION

The Oregon method provides rational application of fisheries knowledge and streamflow measurement data to the problem of minimum streamflow requirements for fish populations. The method has been largely supplanted today by that of the Cooperative Instream Flow Service Group (IFG), Western Energy and Land-Use Team, U.S. Fish and Wildlife Service, Fort Collins, Colorado. The IFG method derives in basic respects from the Oregon method, but integrates hydraulic, water quality and biological considerations through computer simulation. The IFG method also offers analysis of flow requirements for warm water fish. The IFG method is now being field tested in Oregon in planning specific water development projects (Galesville Reservoir in Southern Oregon for example). Preliminary indications are that the Oregon and IFG methods produce comparable results. The Department of Fish and Wildlife encourages the use of the IFG method in new applications, but still regards recommendations derived through the Oregon method, and reported to the Board in our Basin Investigation Reports, as valid.

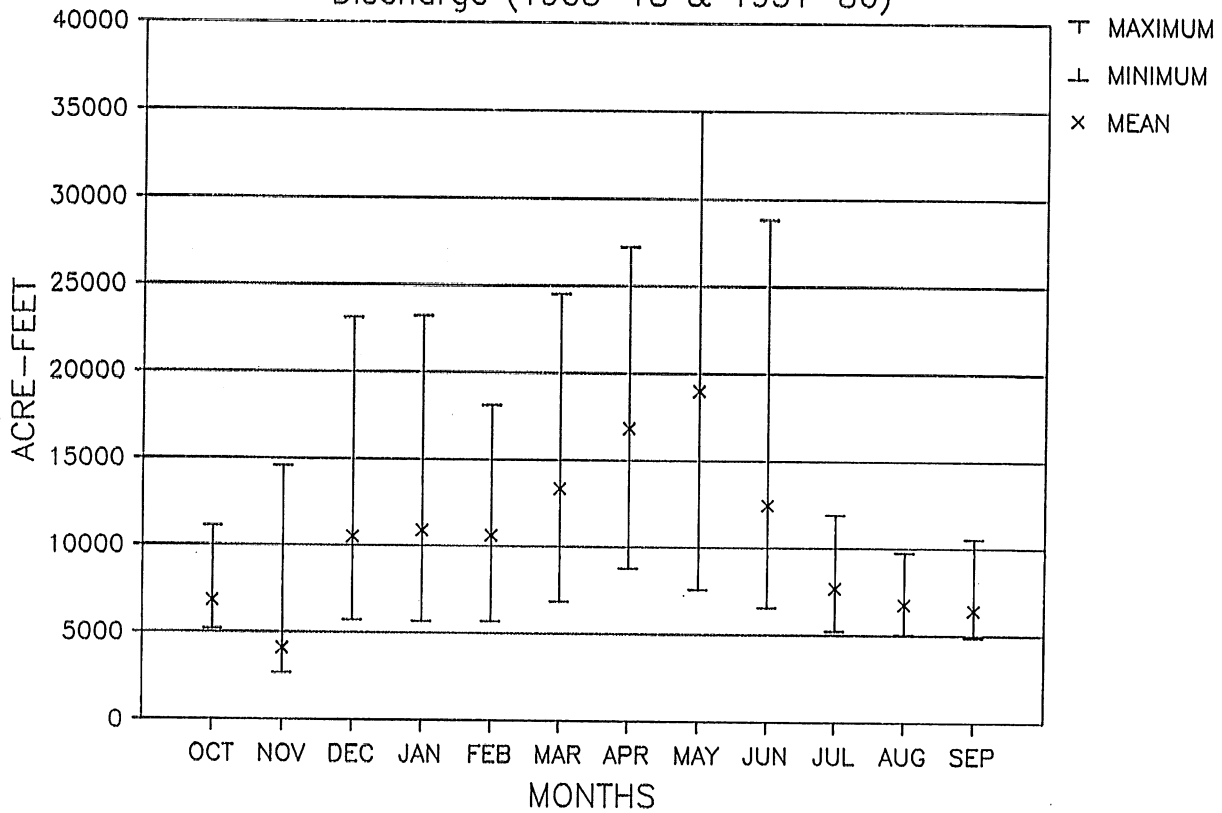
APPENDIX B

HYDROGRAPHS


#14010000 S FK Walla Walla River
Annual Means
200000
150000
100000
50000
0
Acre-feet
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
Years

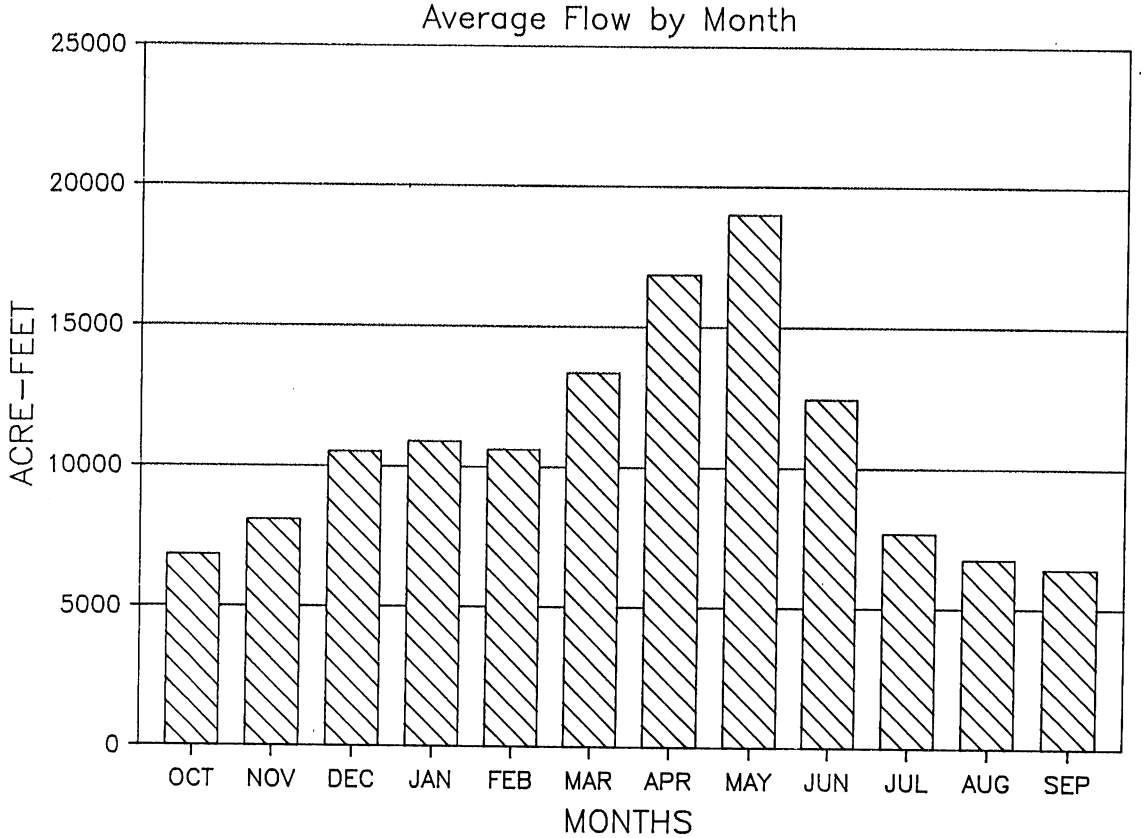
#1401000 S FK Walla Walla River

Discharge (1903–18 & 1931–86)



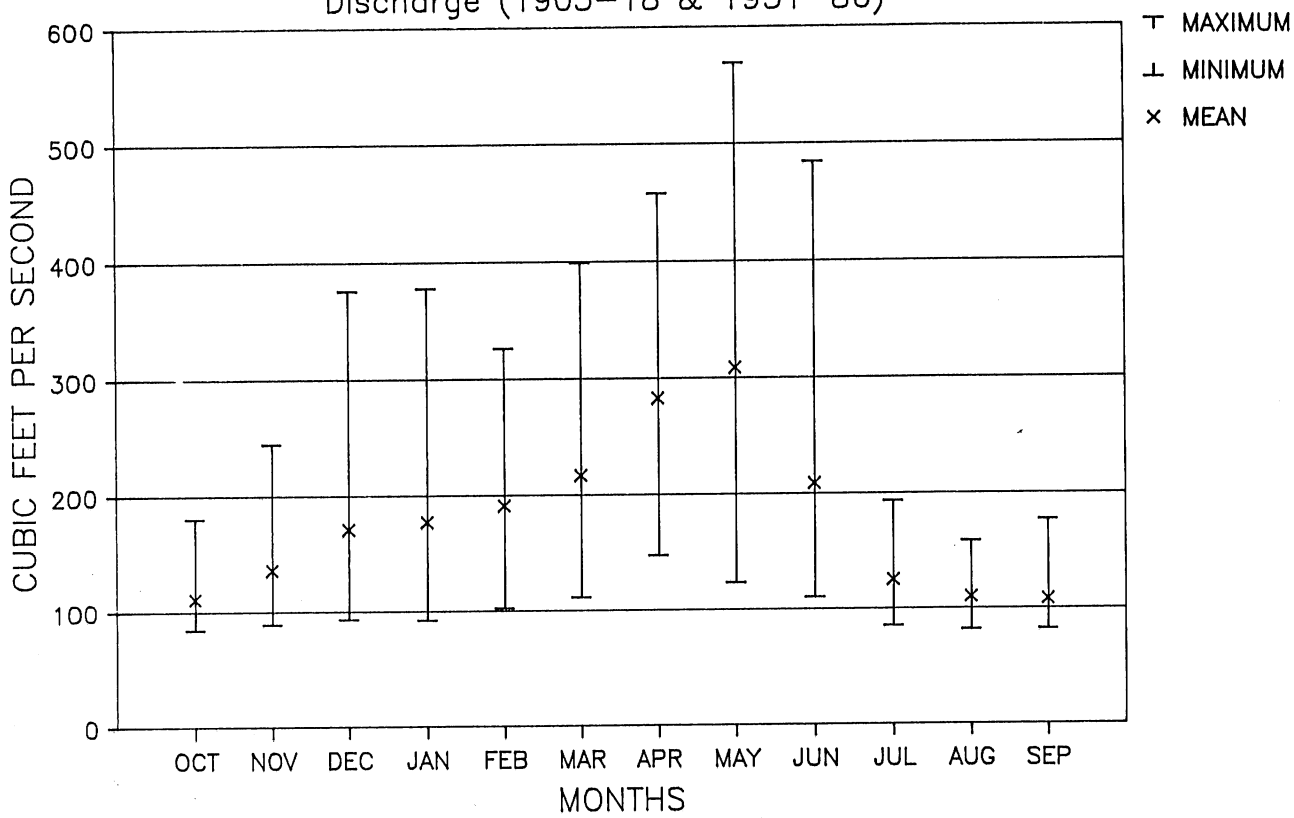
#14010000 S FK Walla Walla River

Average Flow by Month



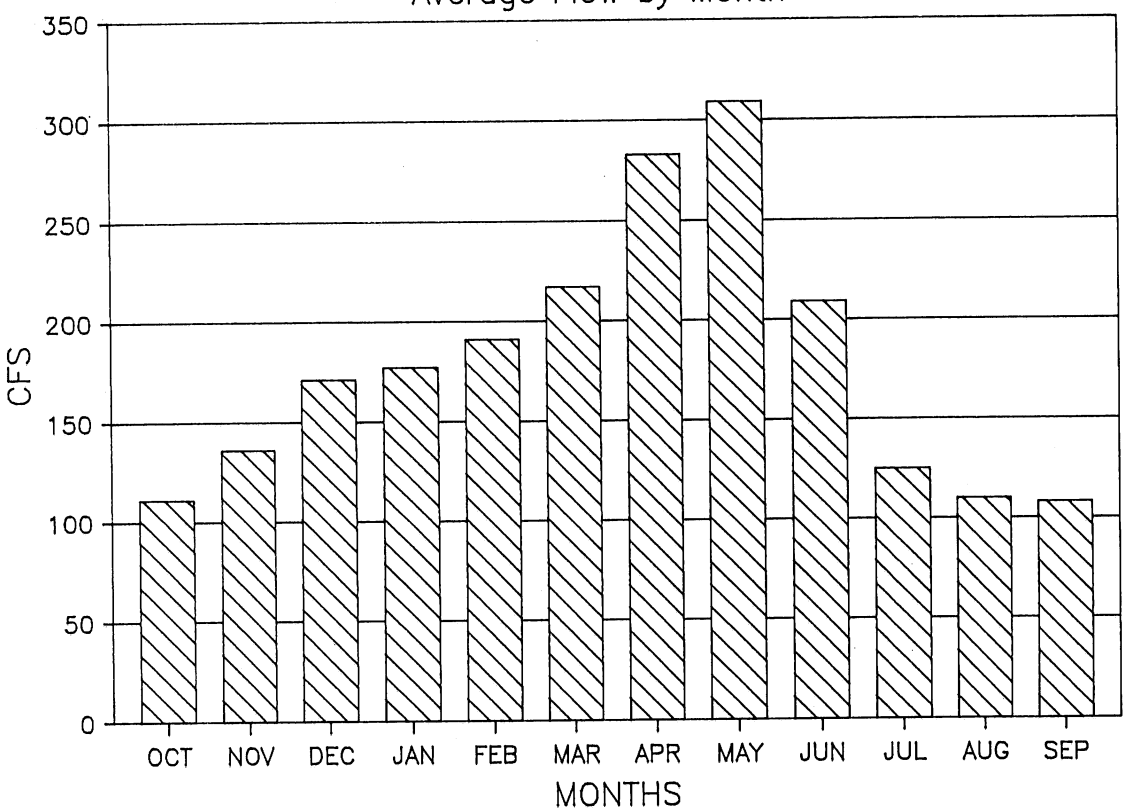
#1401000 S FK Walla Walla River

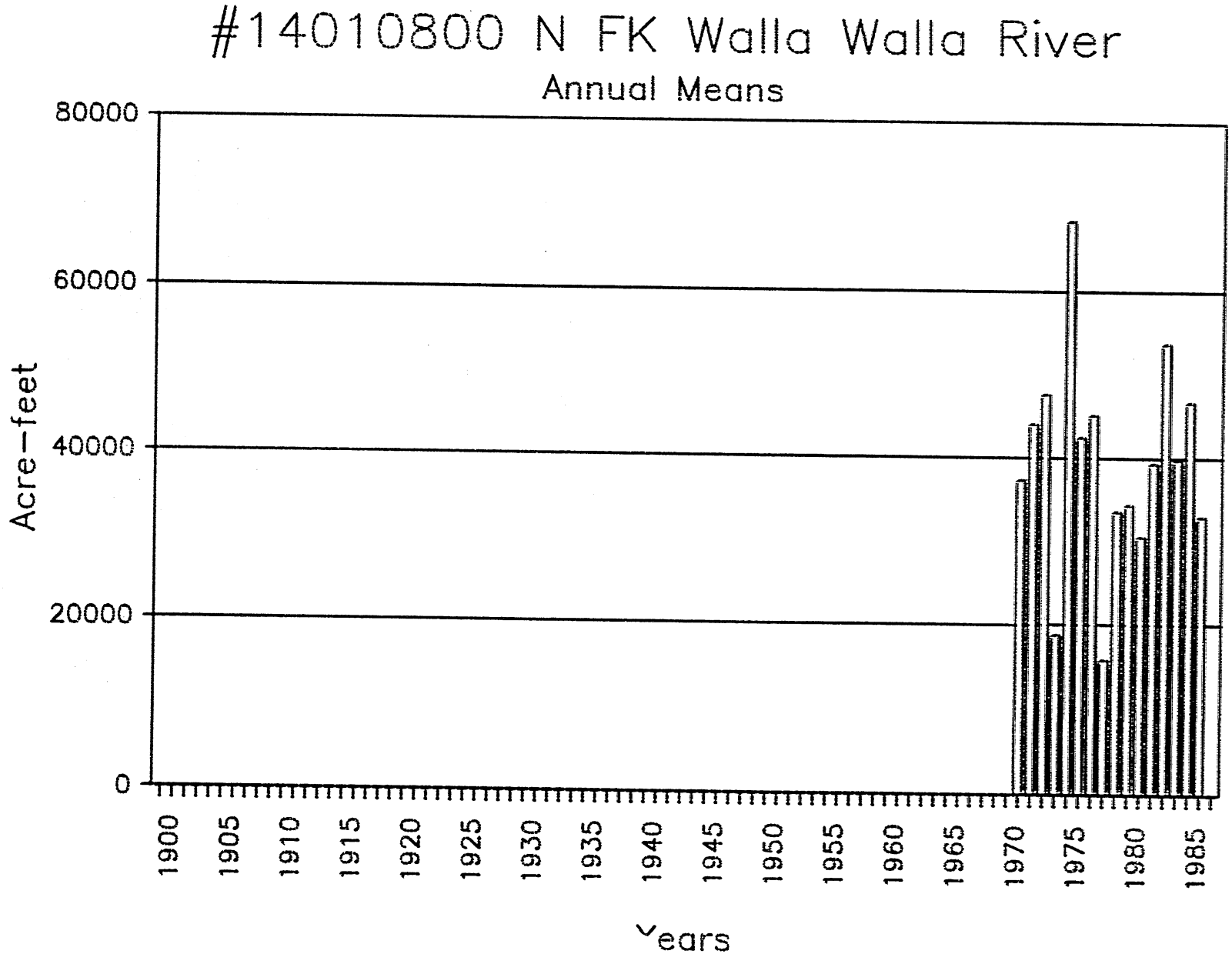
Discharge (1903–18 & 1931–86)



#14010000 S FK Walla Walla River

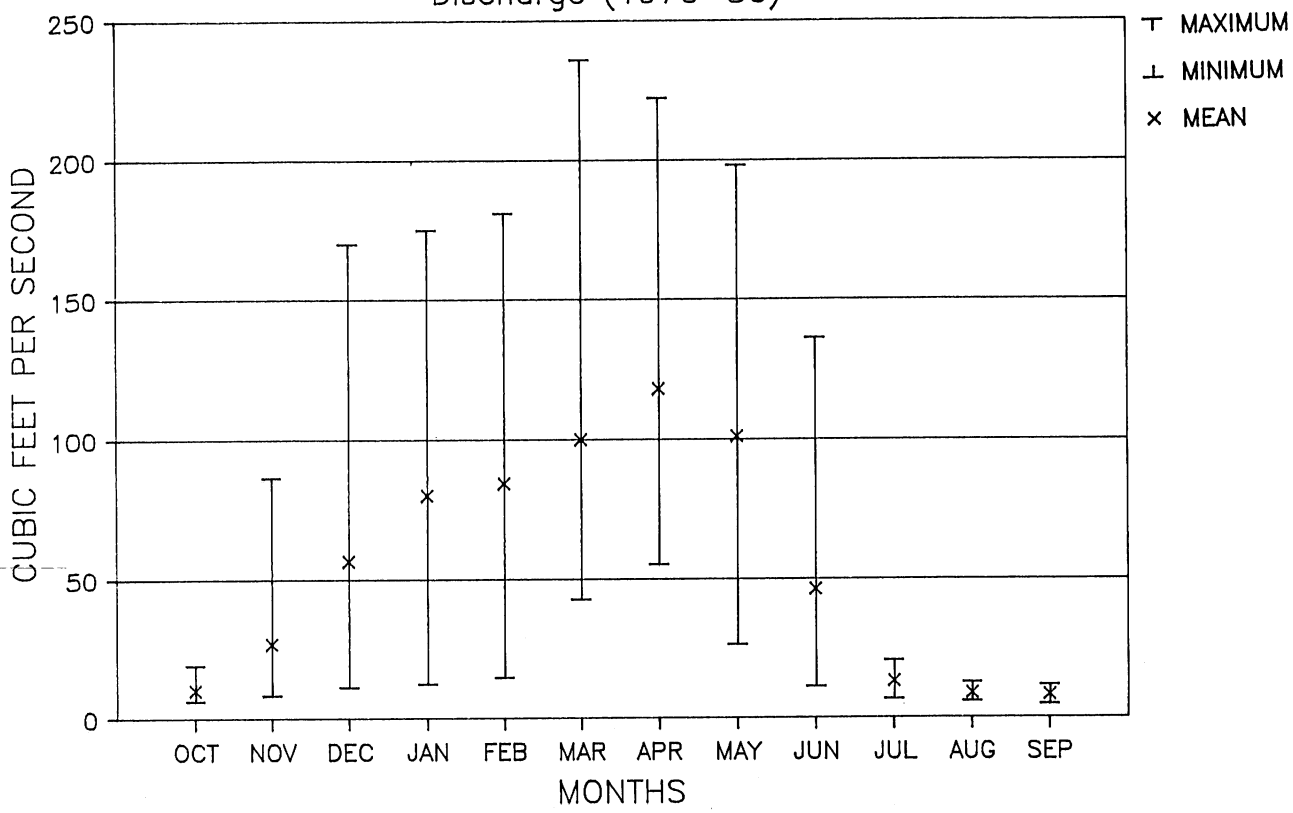
Average Flow by Month




#14010800 N FK Walla Walla River
Annual Means
80000
60000
40000
20000
0
Acre-feet
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
Years

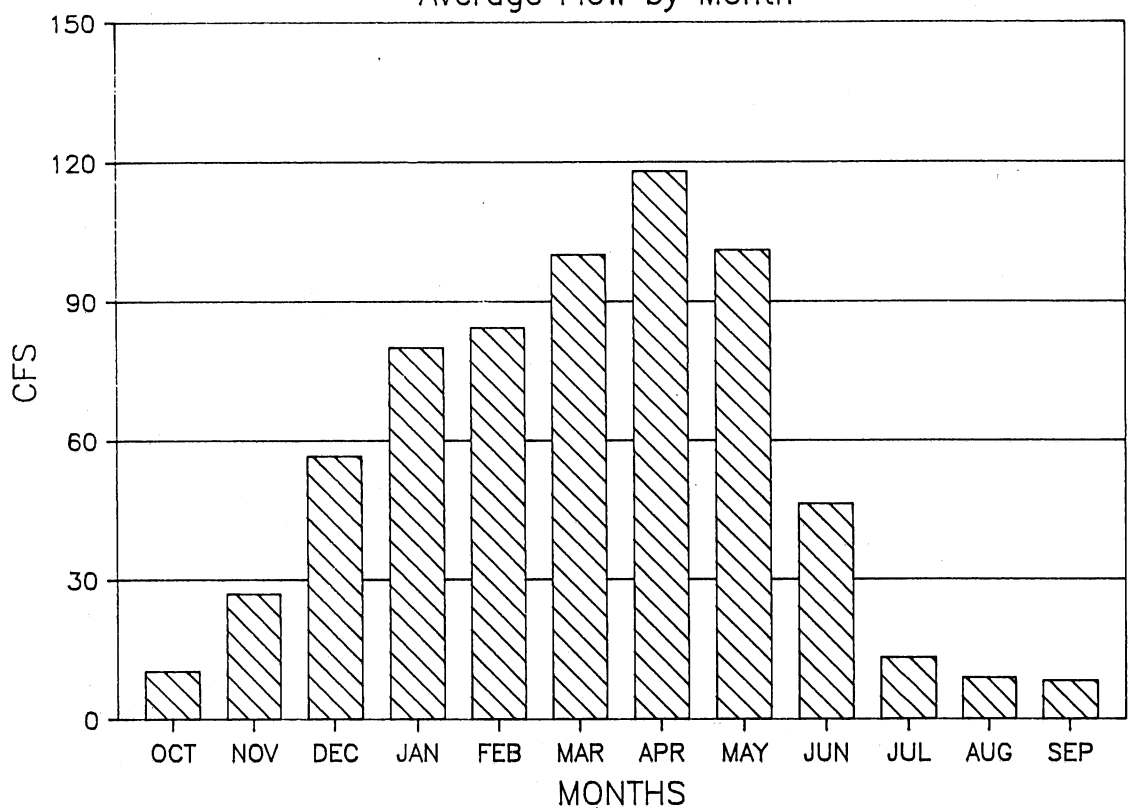
#14010800 N FK Walla Walla River

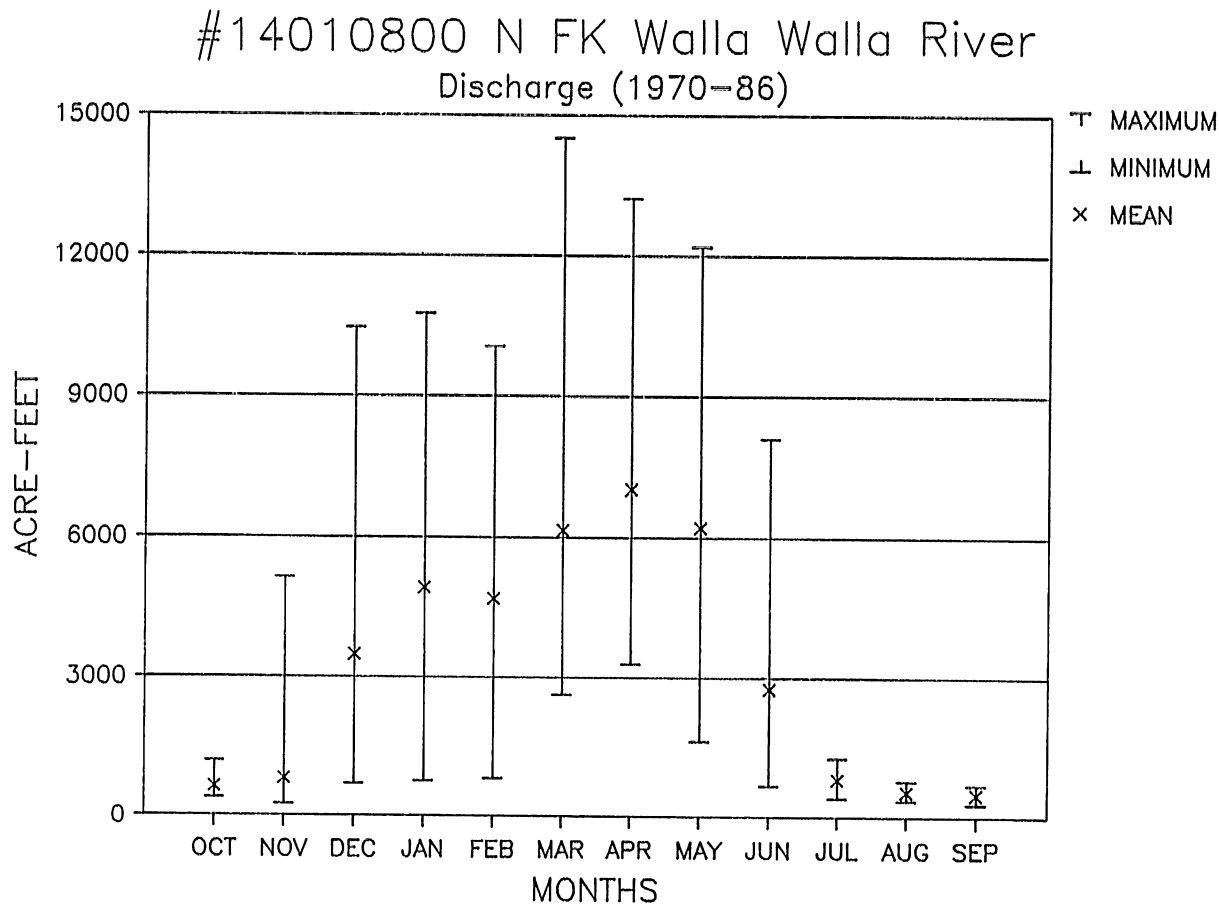
Discharge (1970–86)

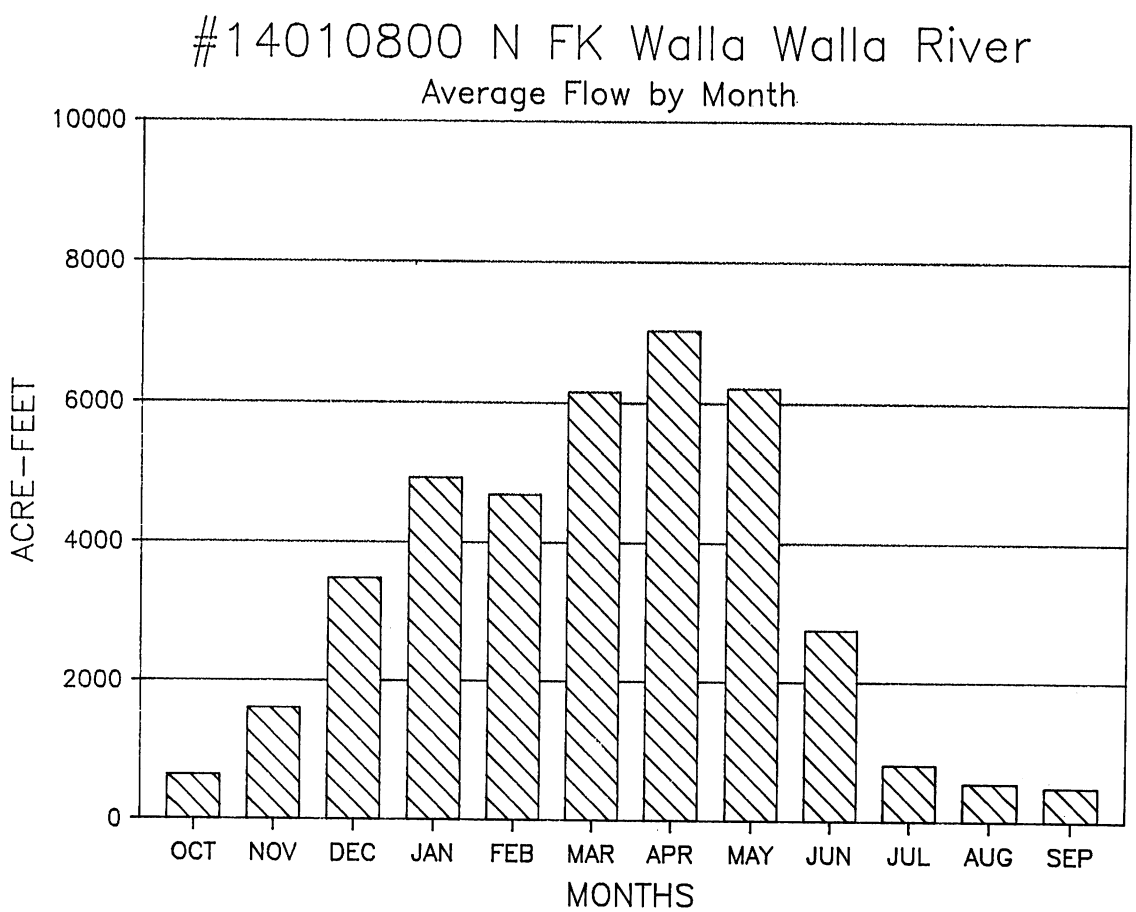


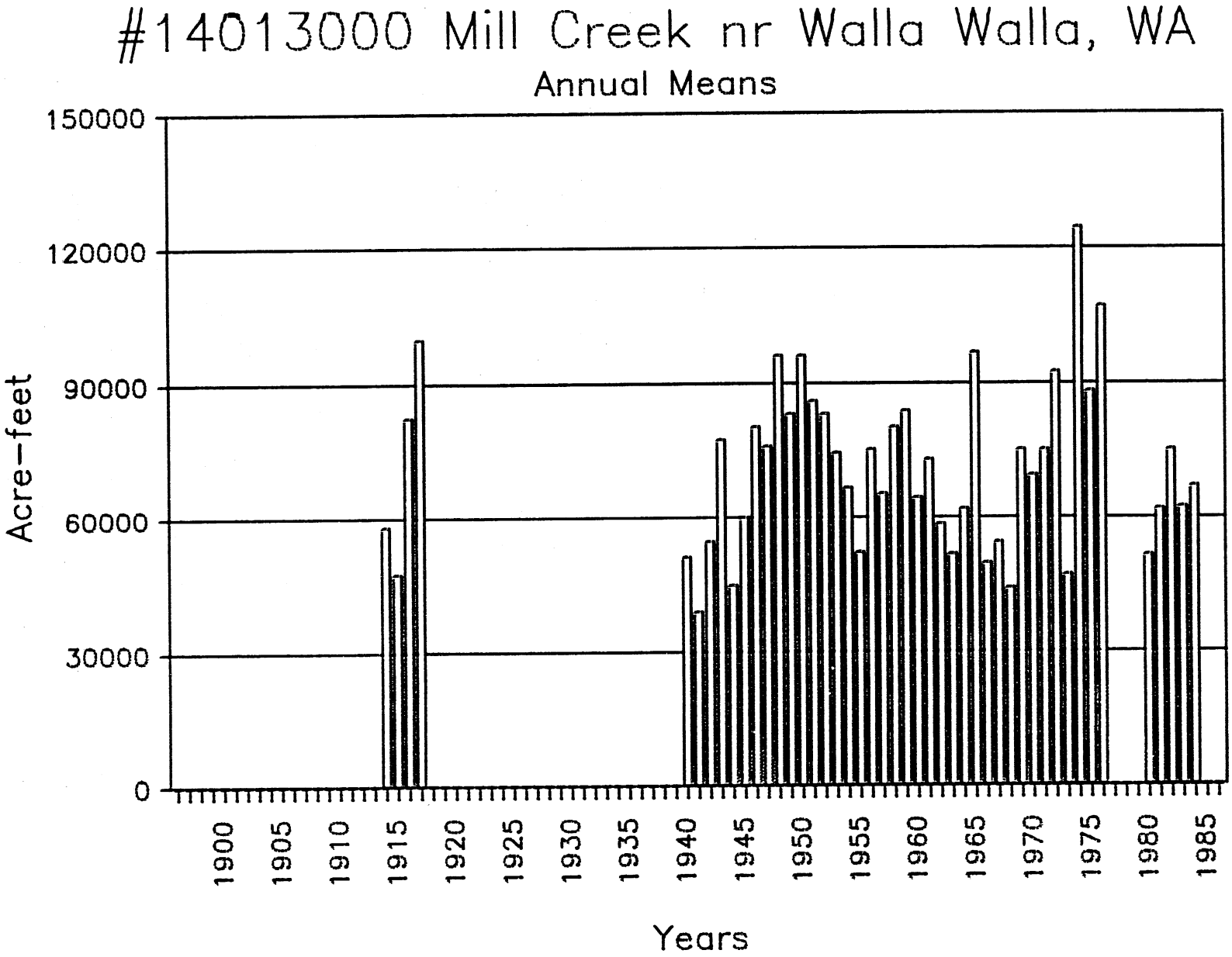
#14010800 N FK Walla Walla River

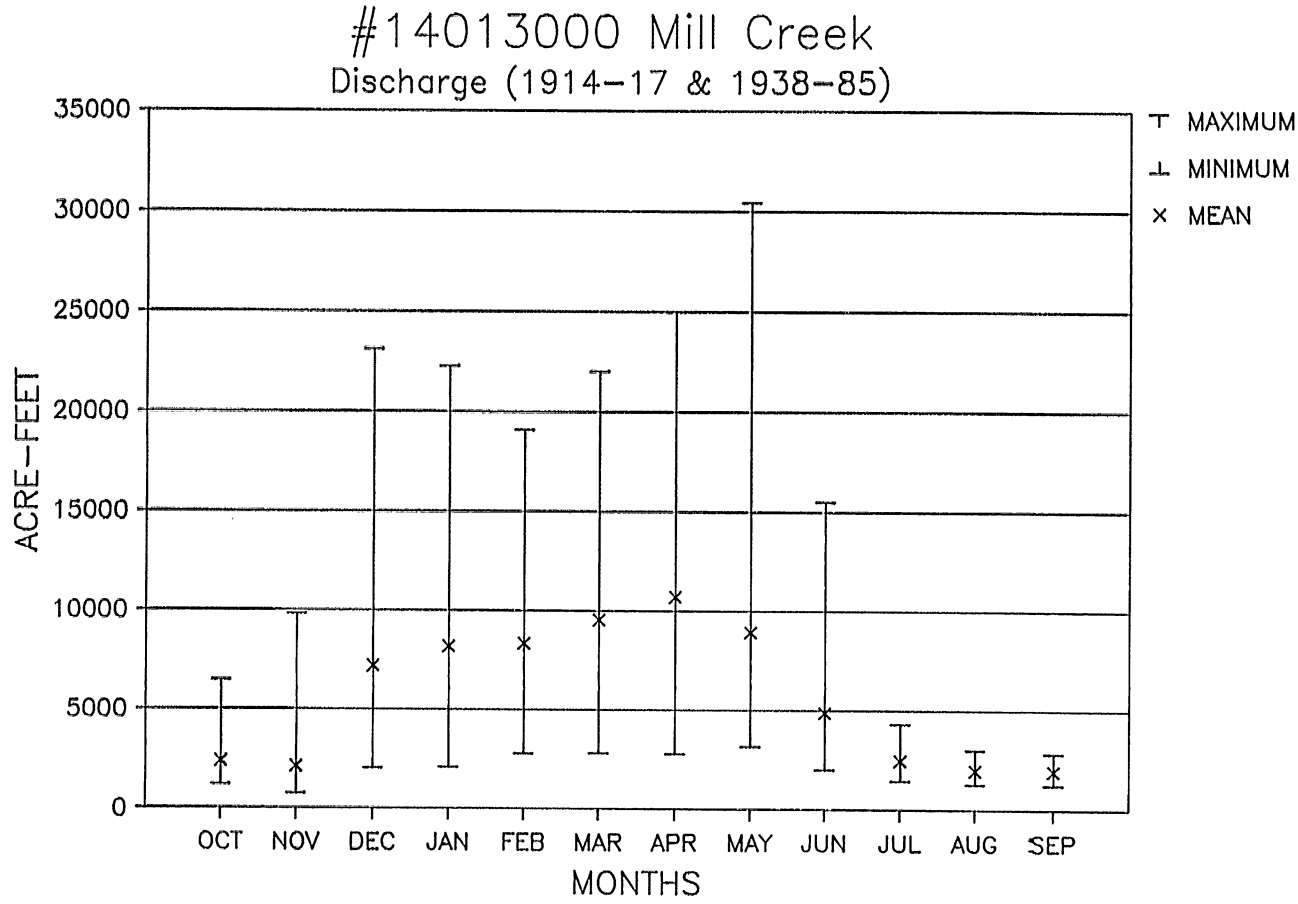
Average Flow by Month

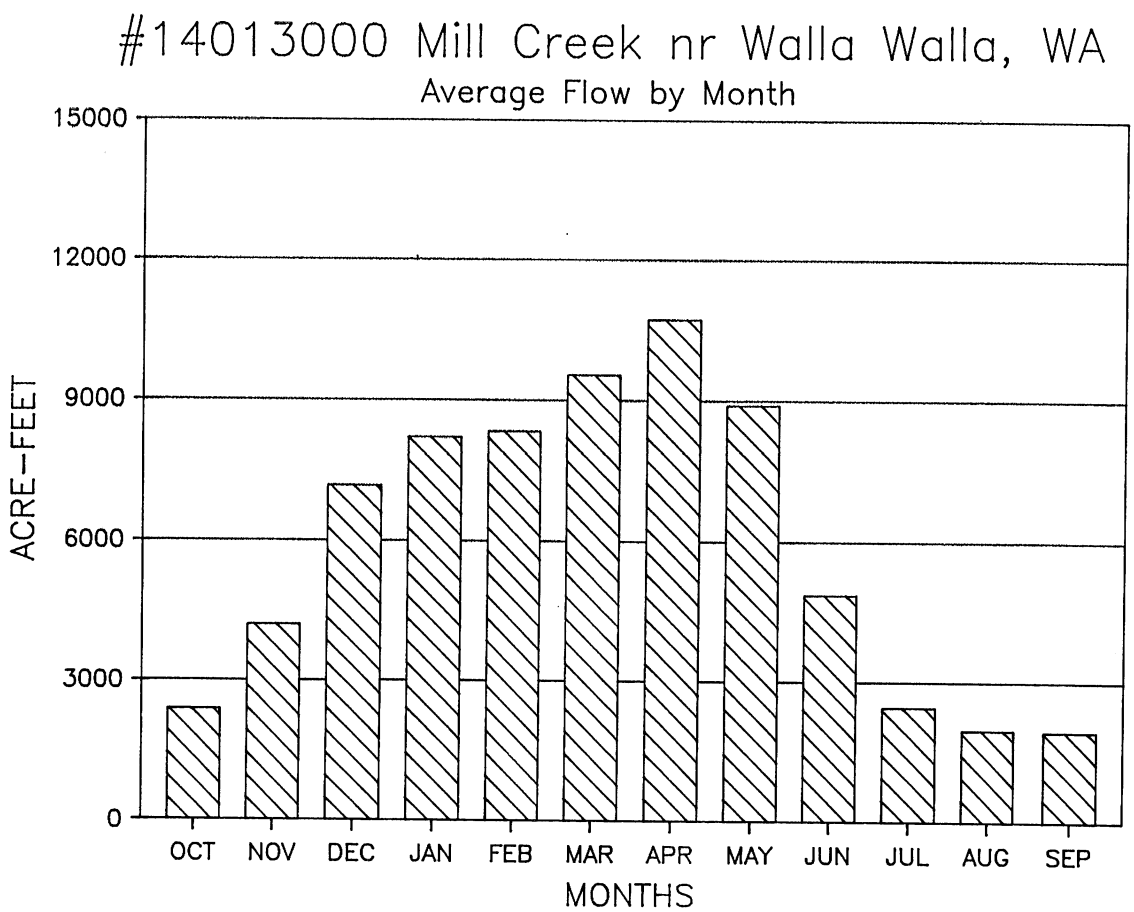



#14010800 N FK Walla Walla River
Discharge (1970-86)
MAXIMUM
MINIMUM
MEAN
15000
12000
9000
6000
3000
0
ACRE-FEET
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
MONTHS


#14010800 N FK Walla Walla River
Average Flow by Month
10000
8000
6000
4000
2000
0
ACRE-FEET
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
MONTHS

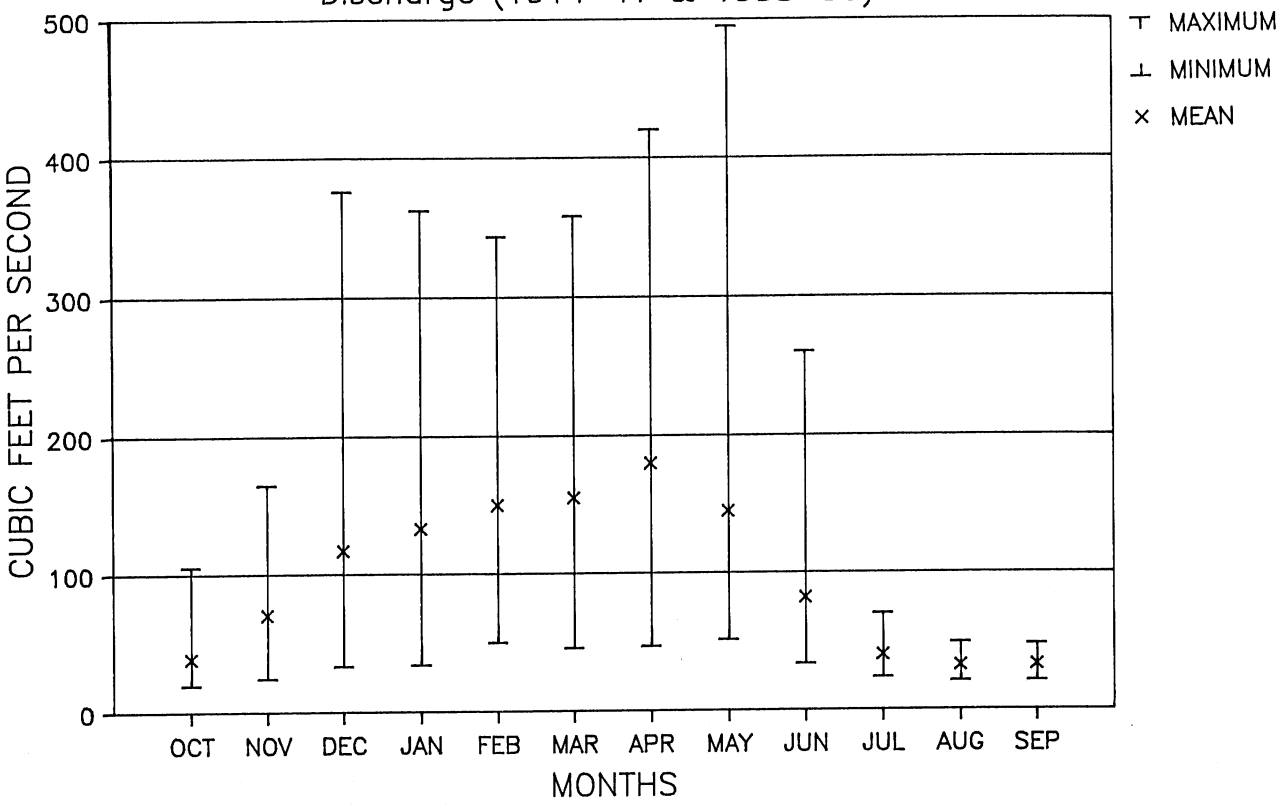

#14013000 Mill Creek nr Walla Walla, WA
Annual Means
150000
120000
90000
60000
30000
0
Acre-feet
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
Years


#14013000 Mill Creek
Discharge (1914–17 & 1938–85)
35000
30000
25000
20000
15000
10000
5000
0
ACRE–FEET
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
MONTHS
MAXIMUM
MINIMUM
MEAN


#14013000 Mill Creek nr Walla Walla, WA
Average Flow by Month
15000
12000
9000
6000
3000
0
ACRE–FEET
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
MONTHS

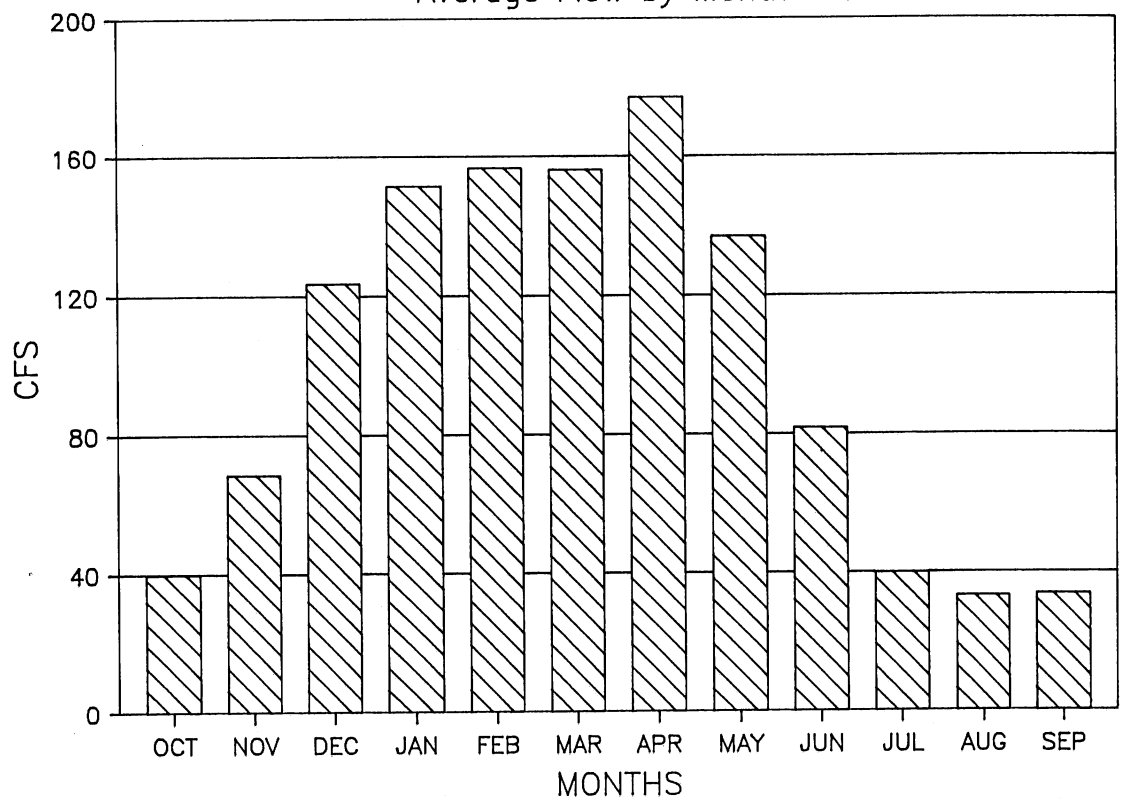
#14013000 Mill Creek

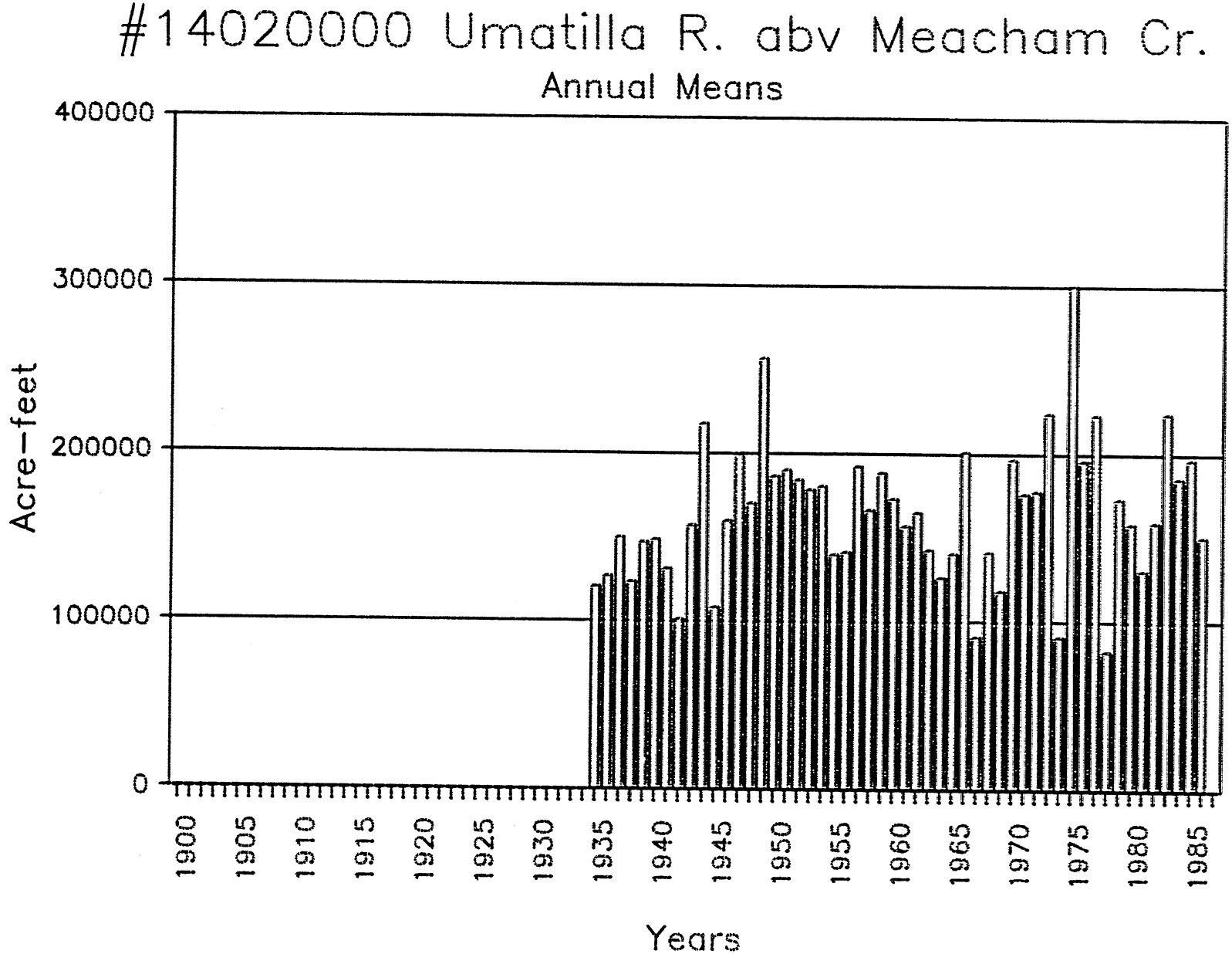
Discharge (1914–17 & 1938–85)



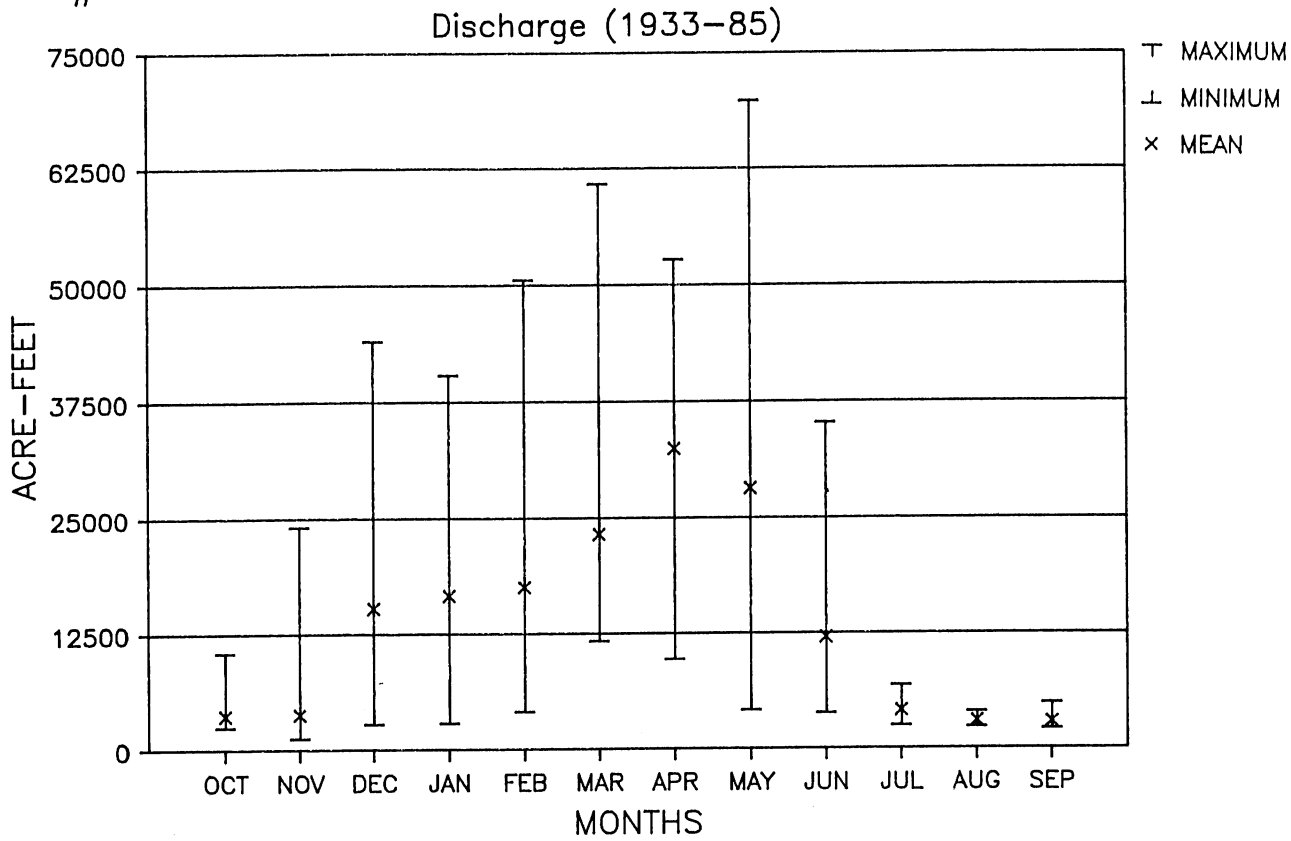
#14013000 Mill Creek nr Walla Walla, WA

Average Flow by Month

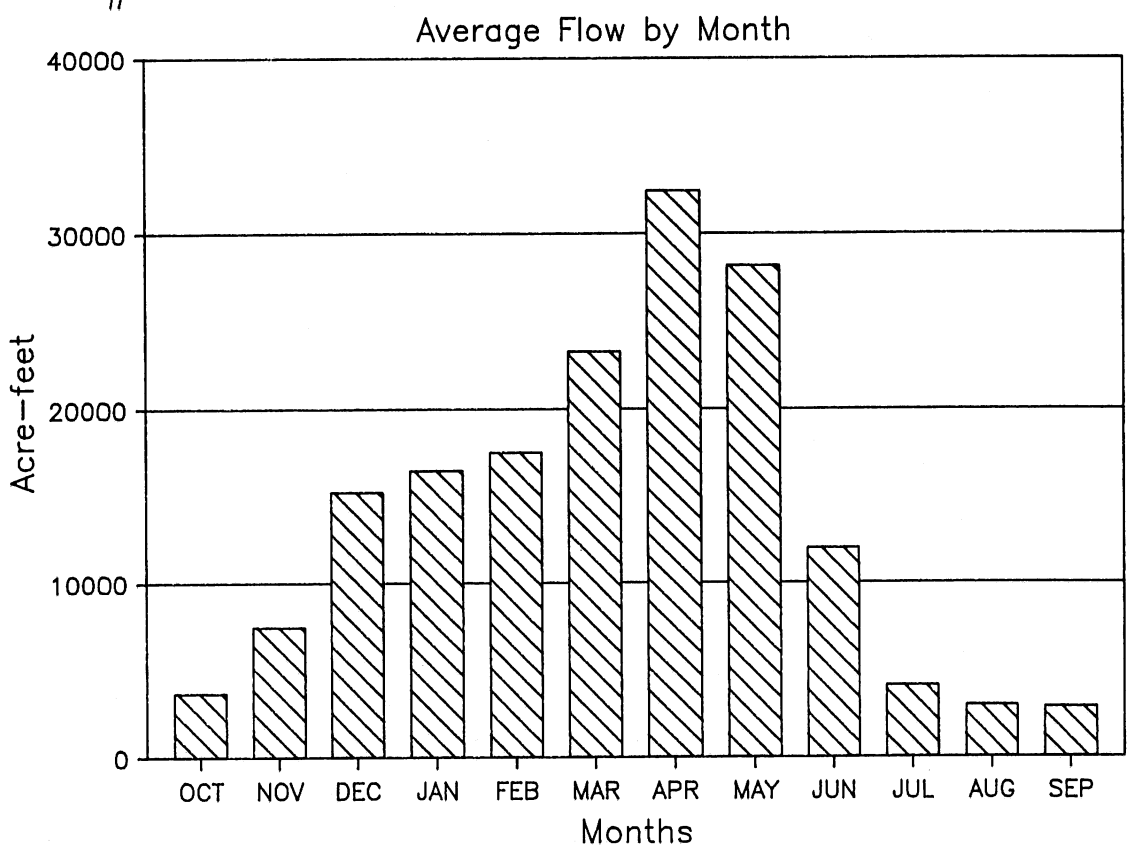


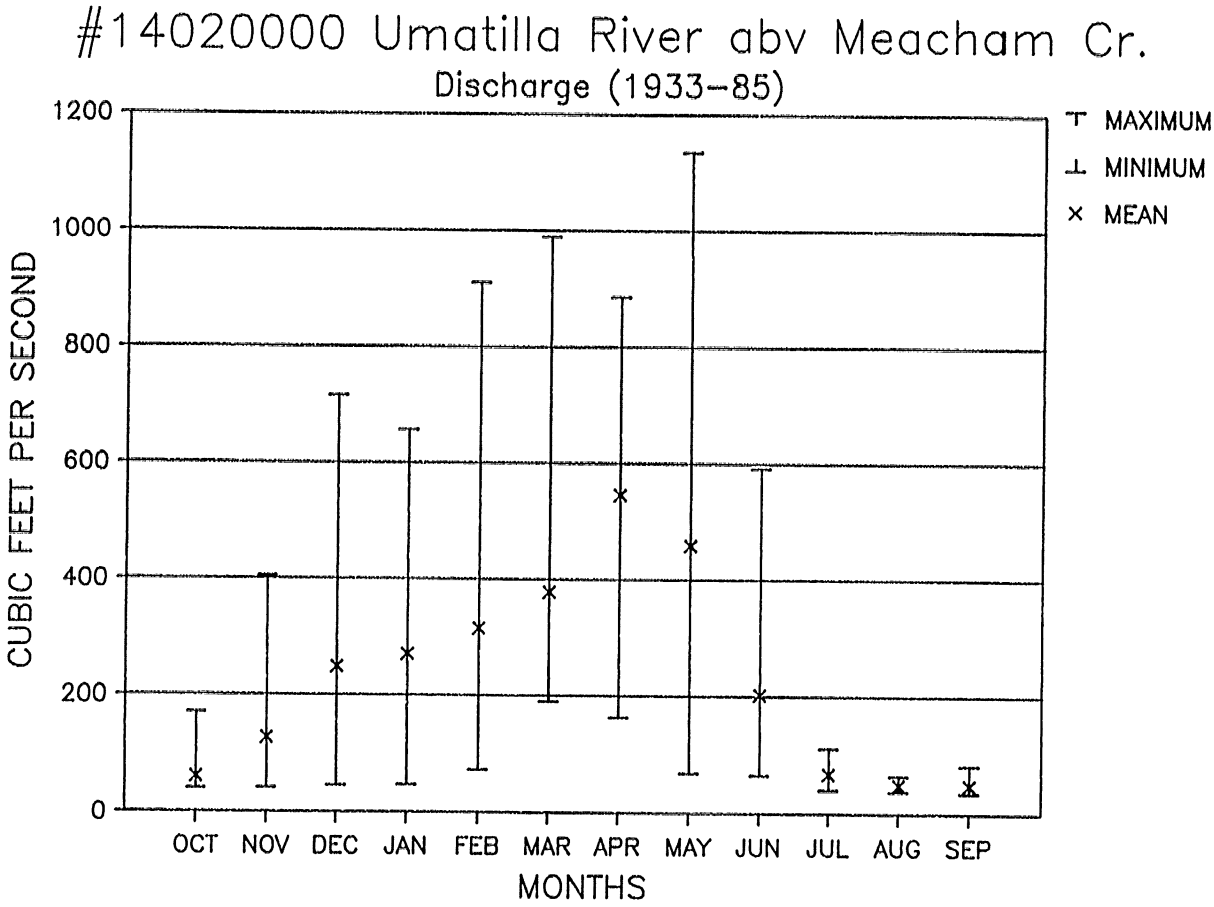

#14020000 Umatilla R. abv Meacham Cr.
Annual Means
400000
300000
200000
100000
0
Acre-feet
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
Years

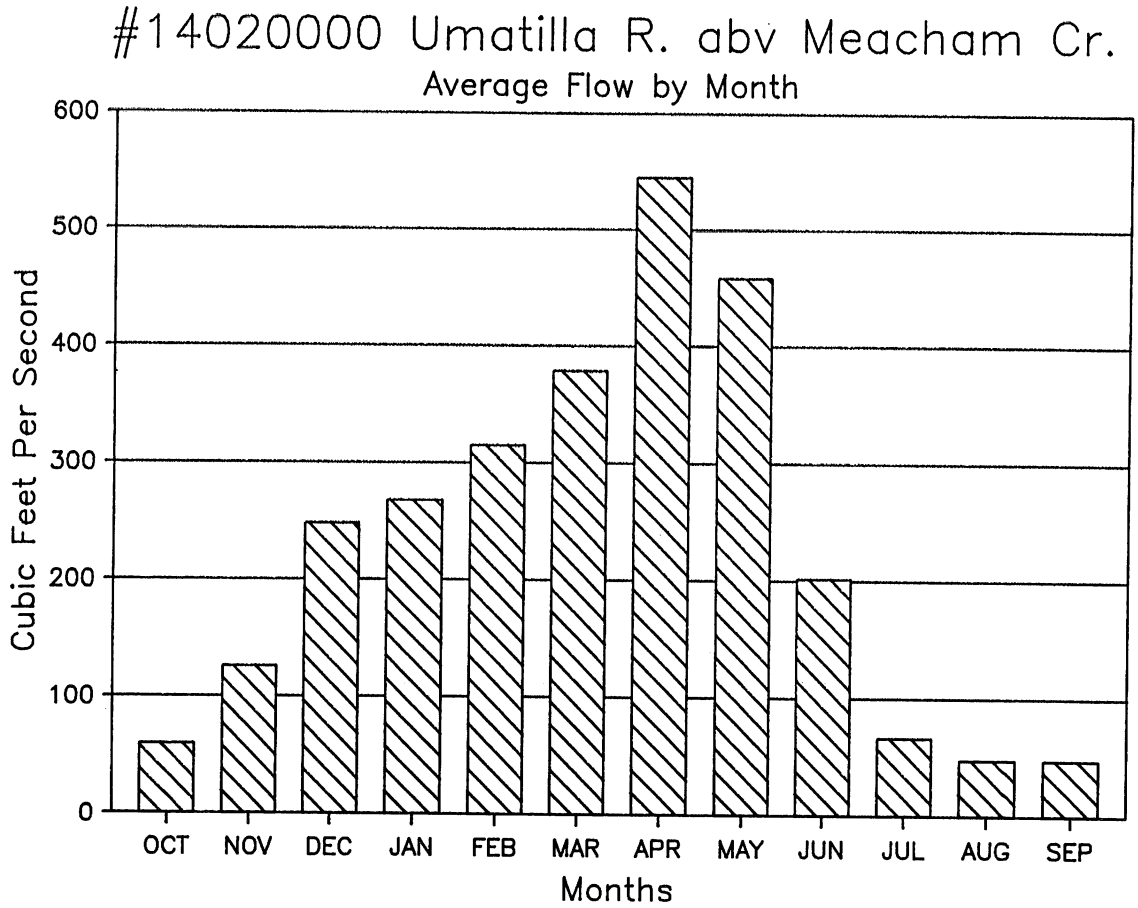
#14020000 Umatilla River abv Meacham Cr.

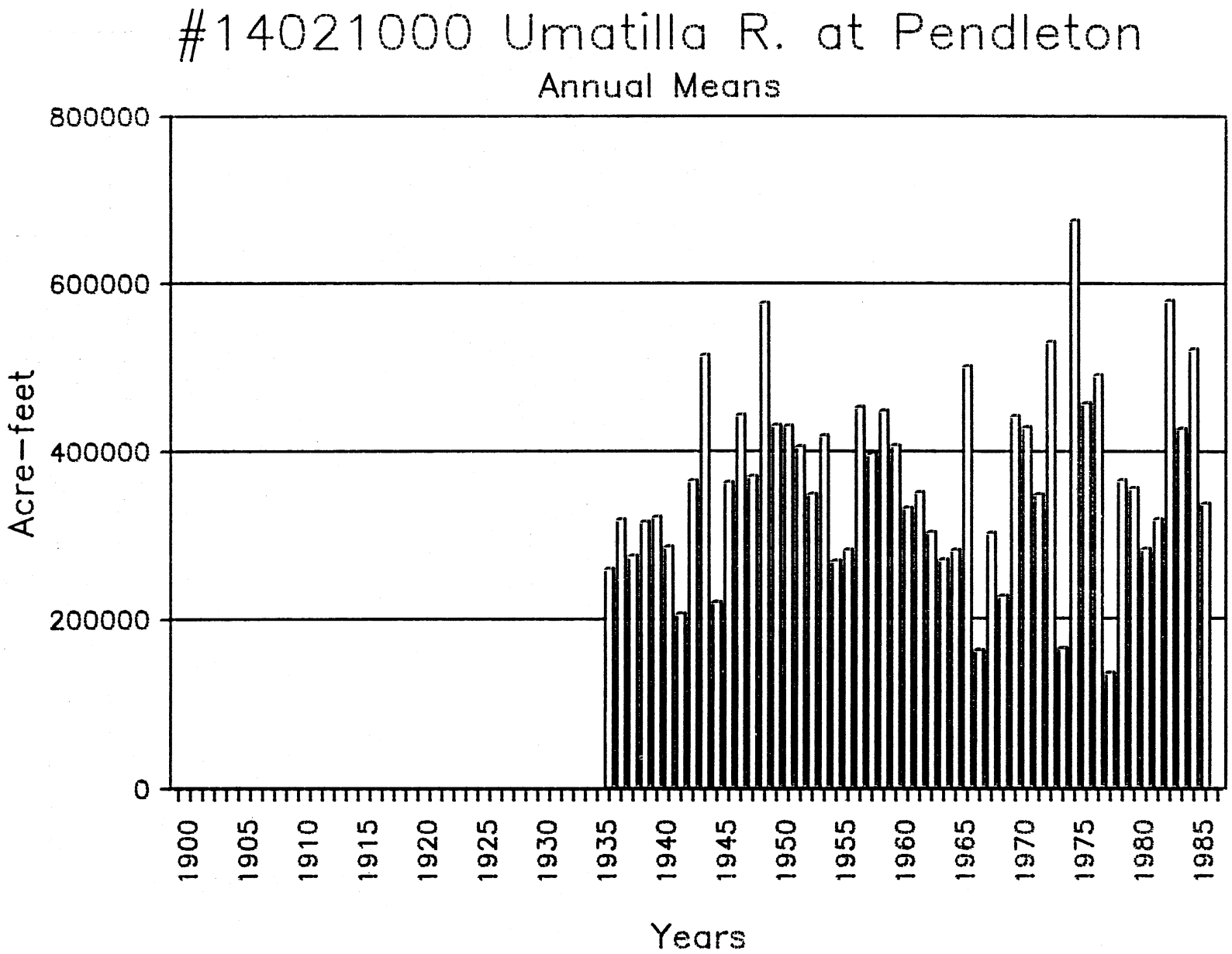


#14020000 Umatilla R. abv Meacham Cr.



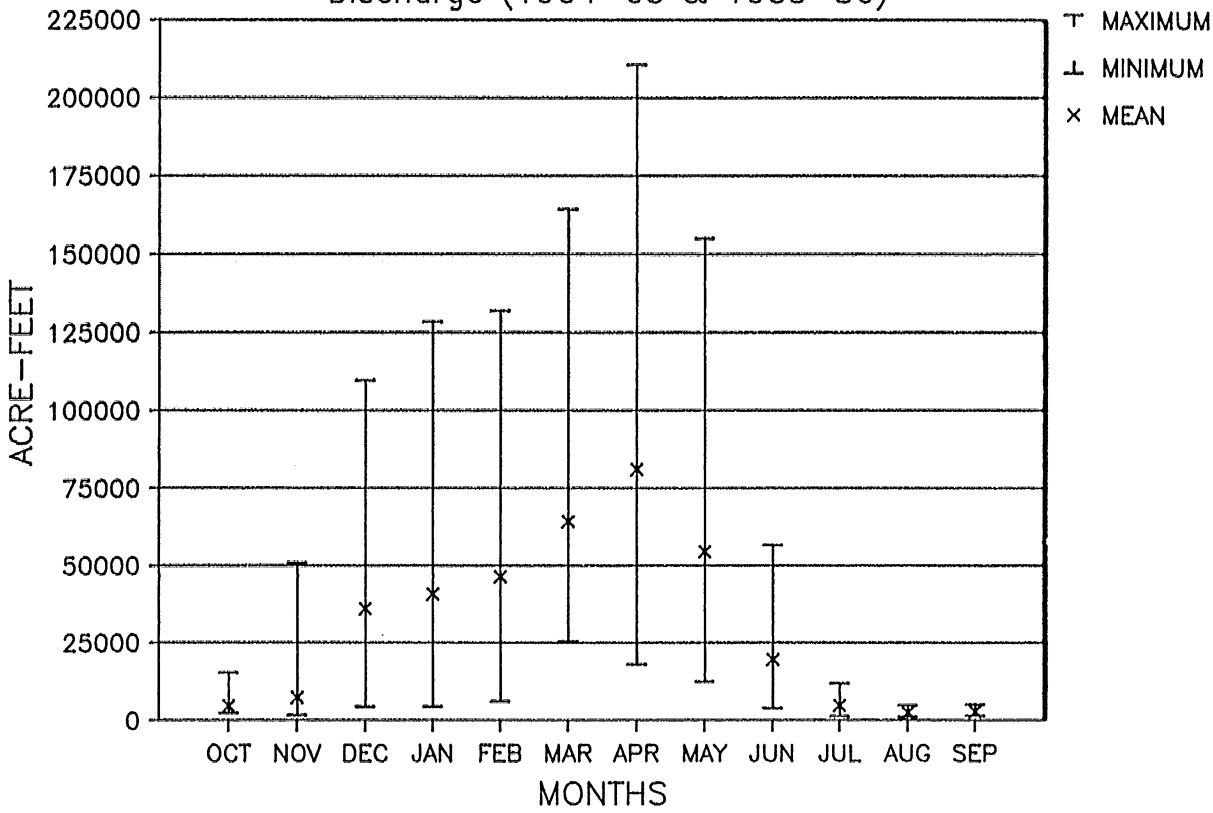

#14020000 Umatilla River abv Meacham Cr.
Discharge (1933-85)
MAXIMUM
MINIMUM
MEAN
CUBIC FEET PER SECOND
1200
1000
800
600
400
200
0
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
MONTHS


#14020000 Umatilla R. abv Meacham Cr.
Average Flow by Month
Cubic Feet Per Second
600
500
400
300
200
100
0
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
Months


#14021000 Umatilla R. at Pendleton
Annual Means
800000
600000
400000
200000
0
Acre-feet
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
Years

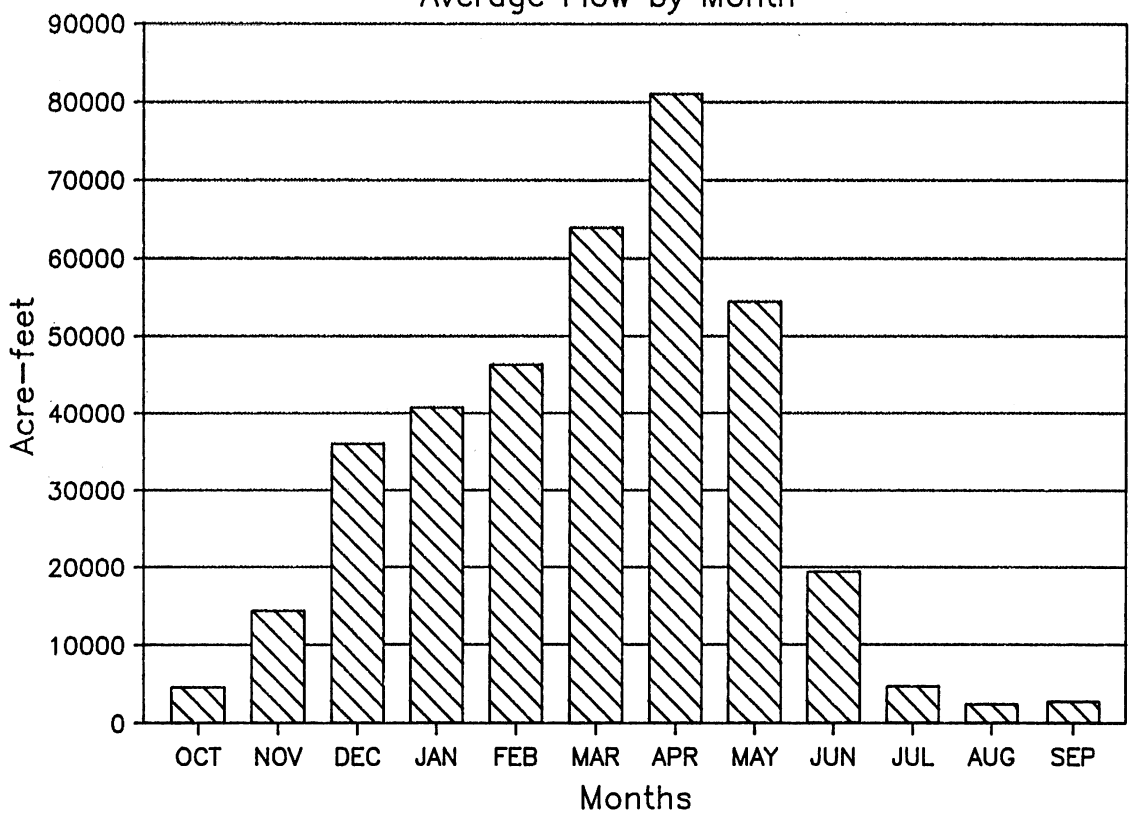
#14021000 Umatilla River at Pendleton

Discharge (1904–05 & 1935–86)



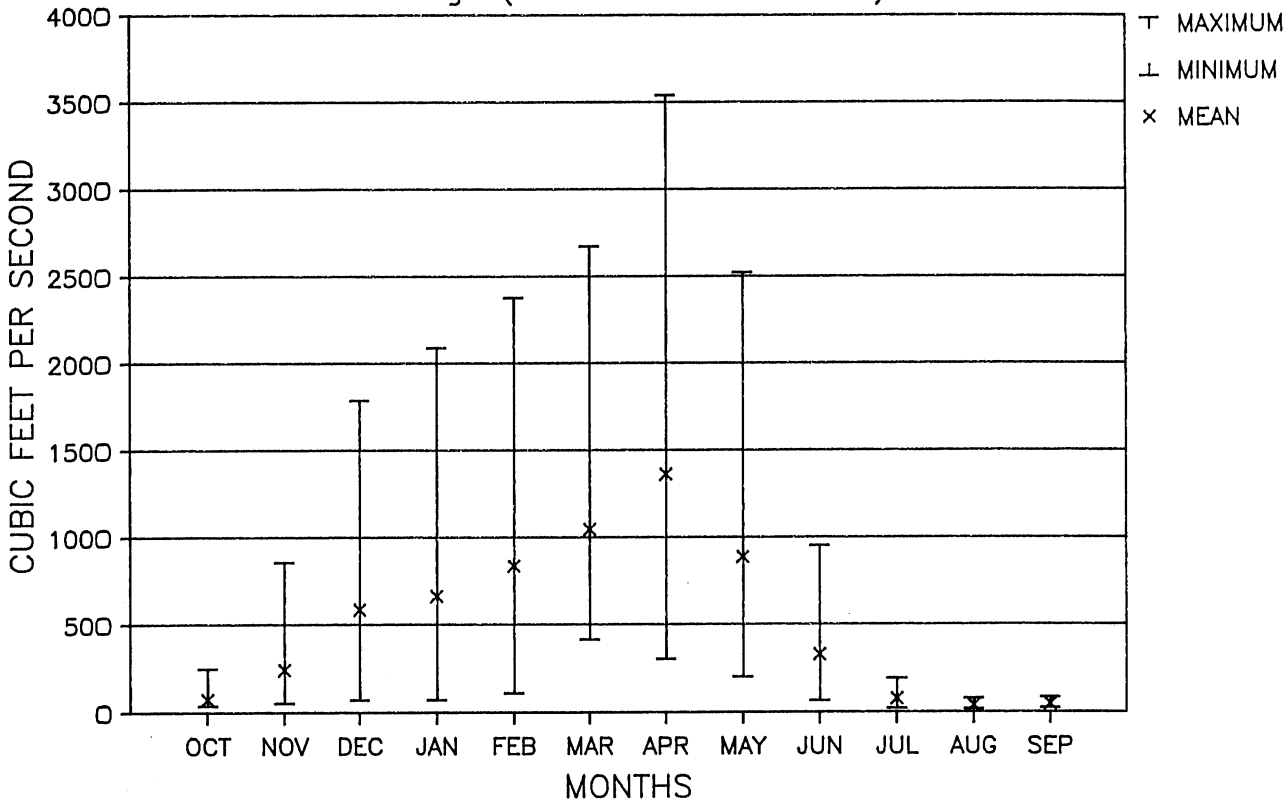
#14021000 Umatilla R. at Pendleton

Average Flow by Month



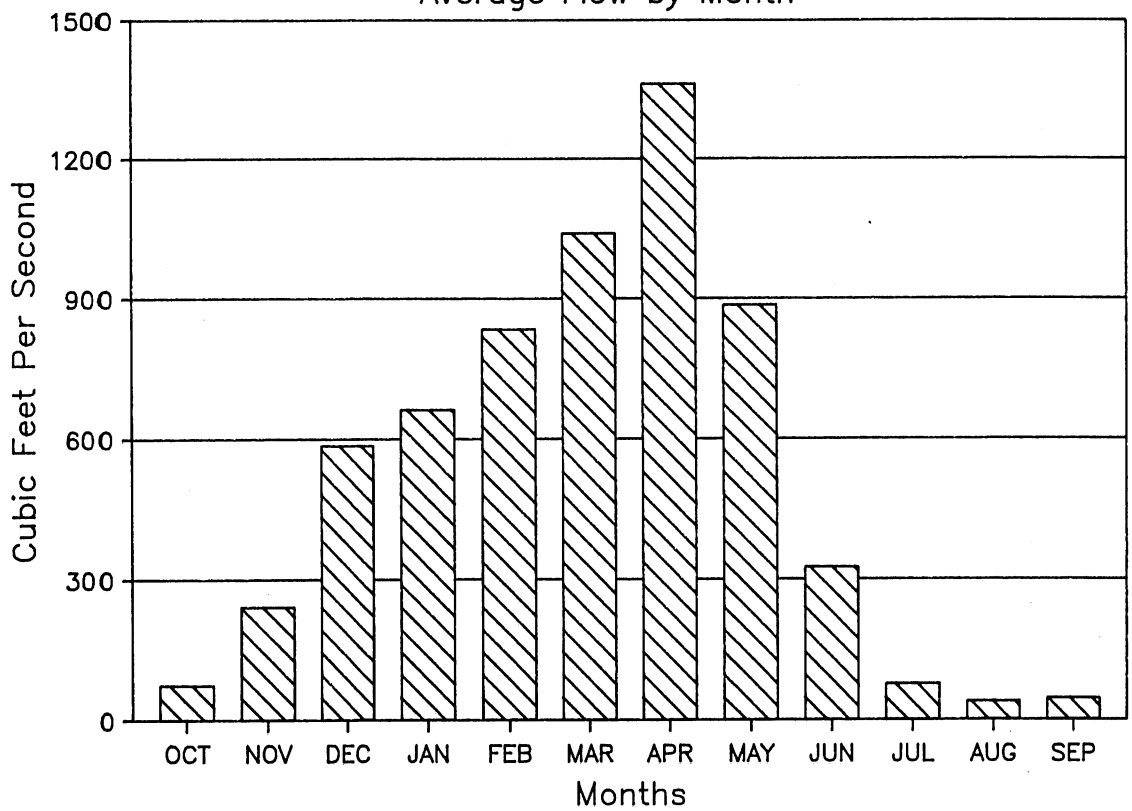
#14021000 Umatilla River at Pendleton

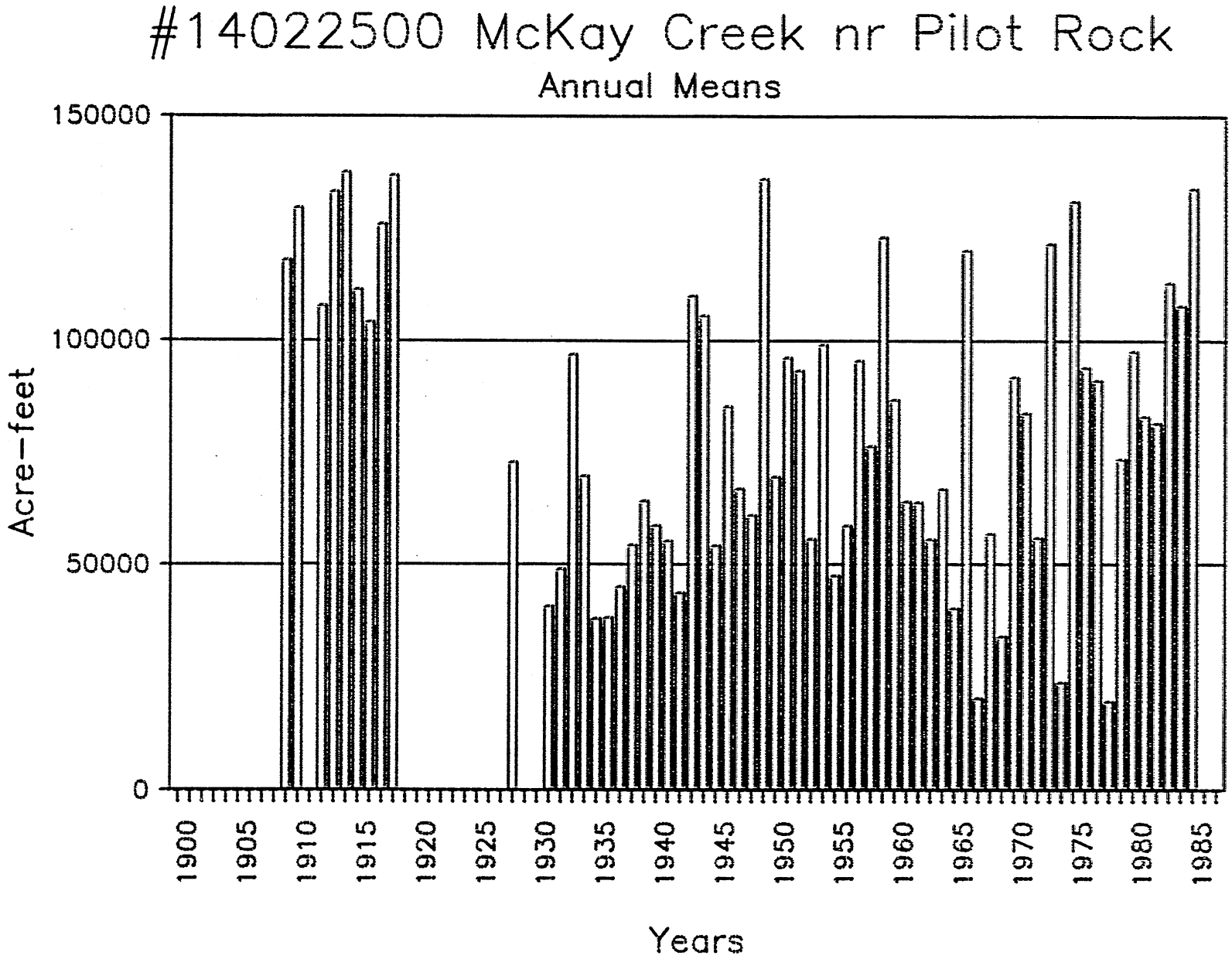
Discharge (1904–05 & 1935–86)



#14021000 Umatilla R. at Pendleton

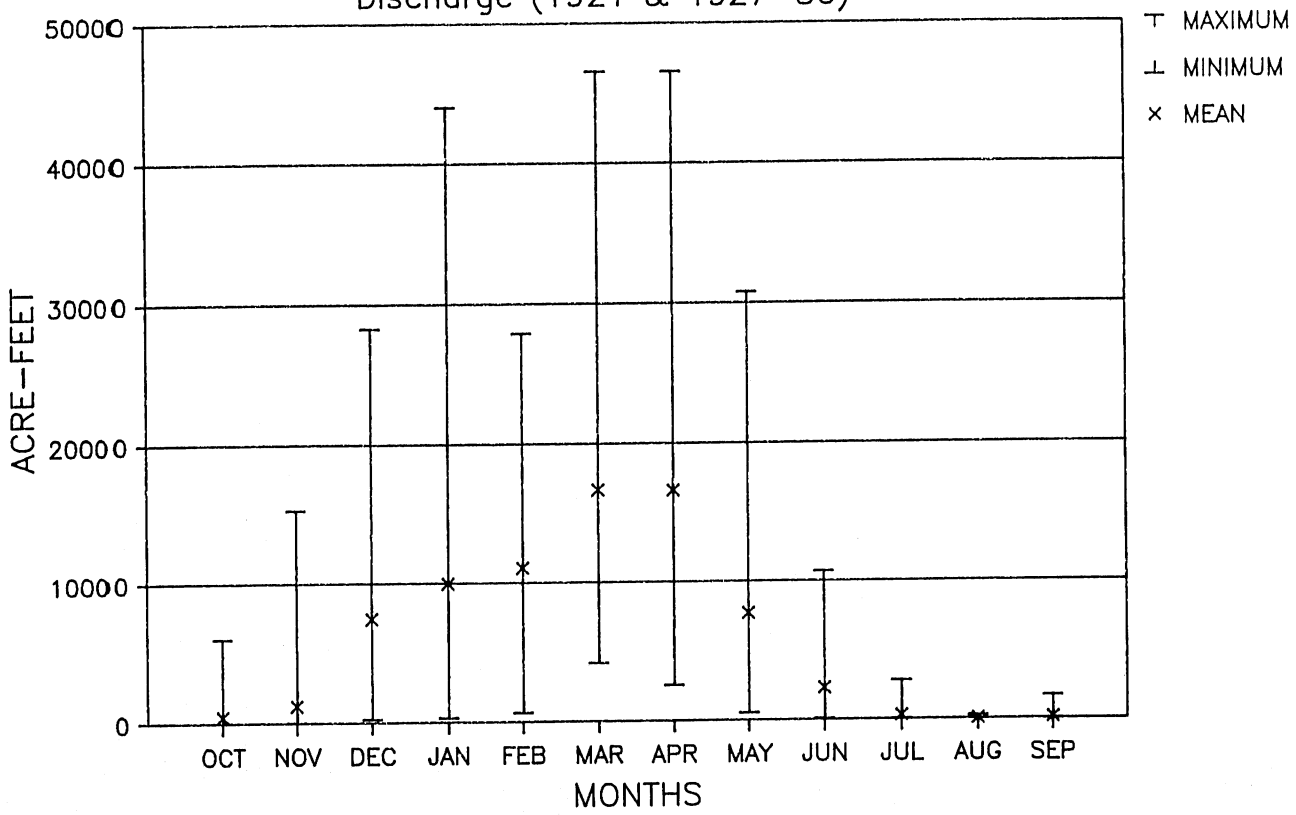
Average Flow by Month




#14022500 McKay Creek nr Pilot Rock
Annual Means
150000
100000
50000
0
Acre-feet
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
Years

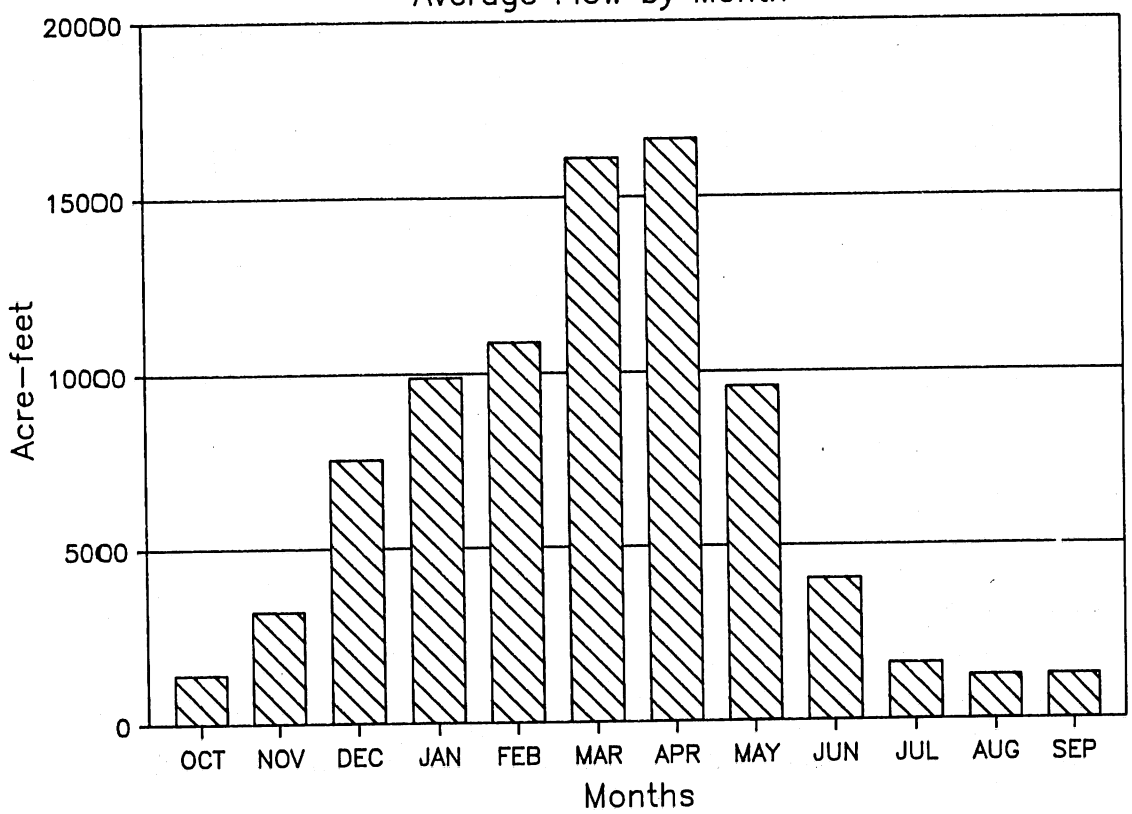
#14022500 McKay Creek nr Pilot Rock

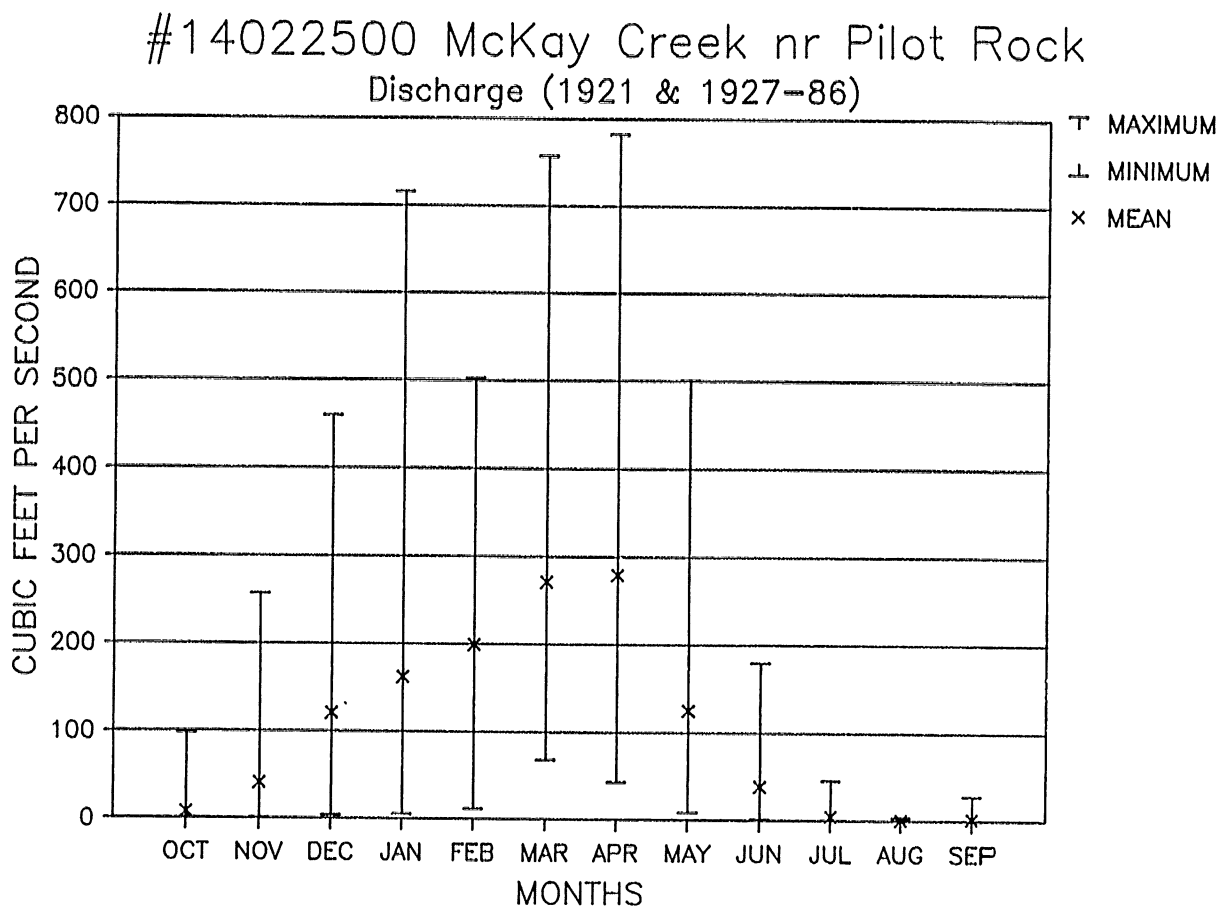
Discharge (1921 & 1927–86)

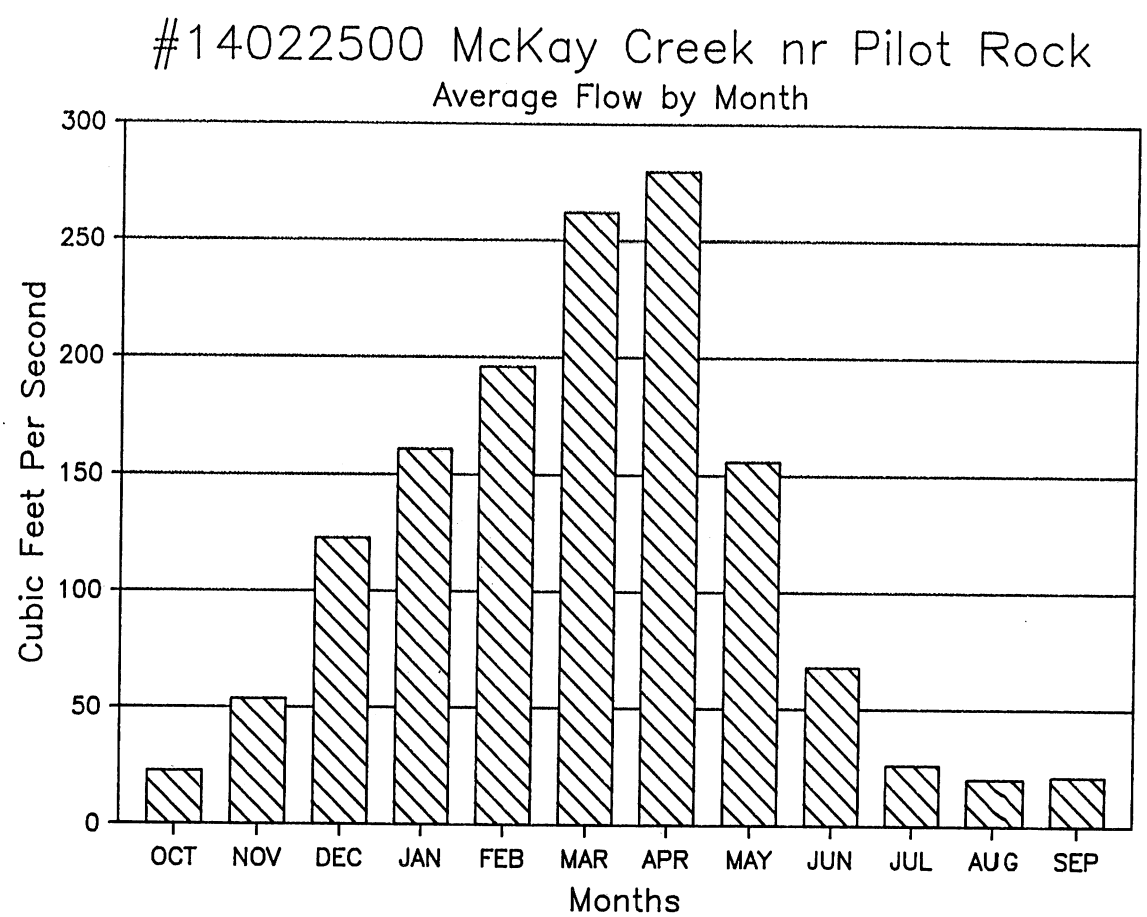


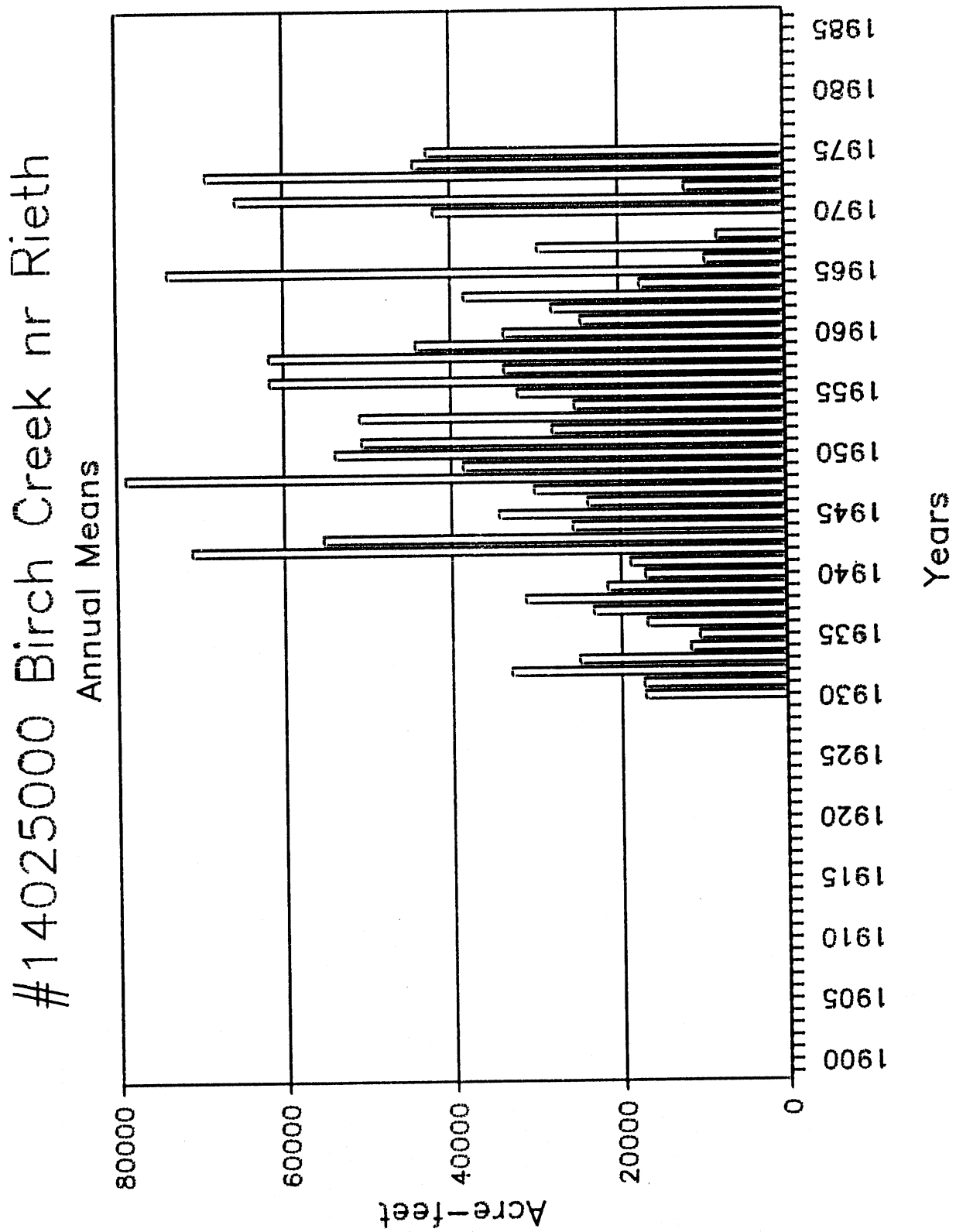
#14022500 McKay Creek nr Pilot Rock

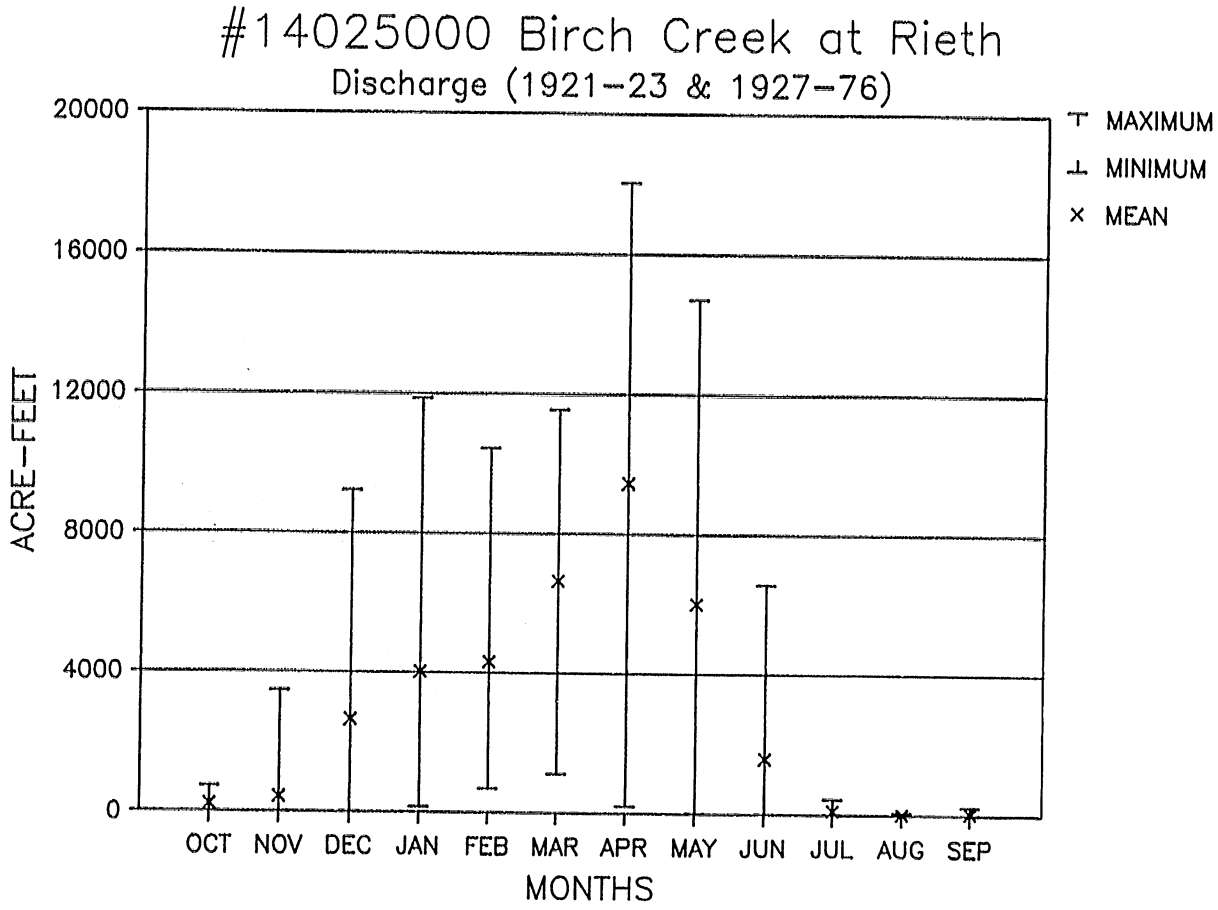
Average Flow by Month

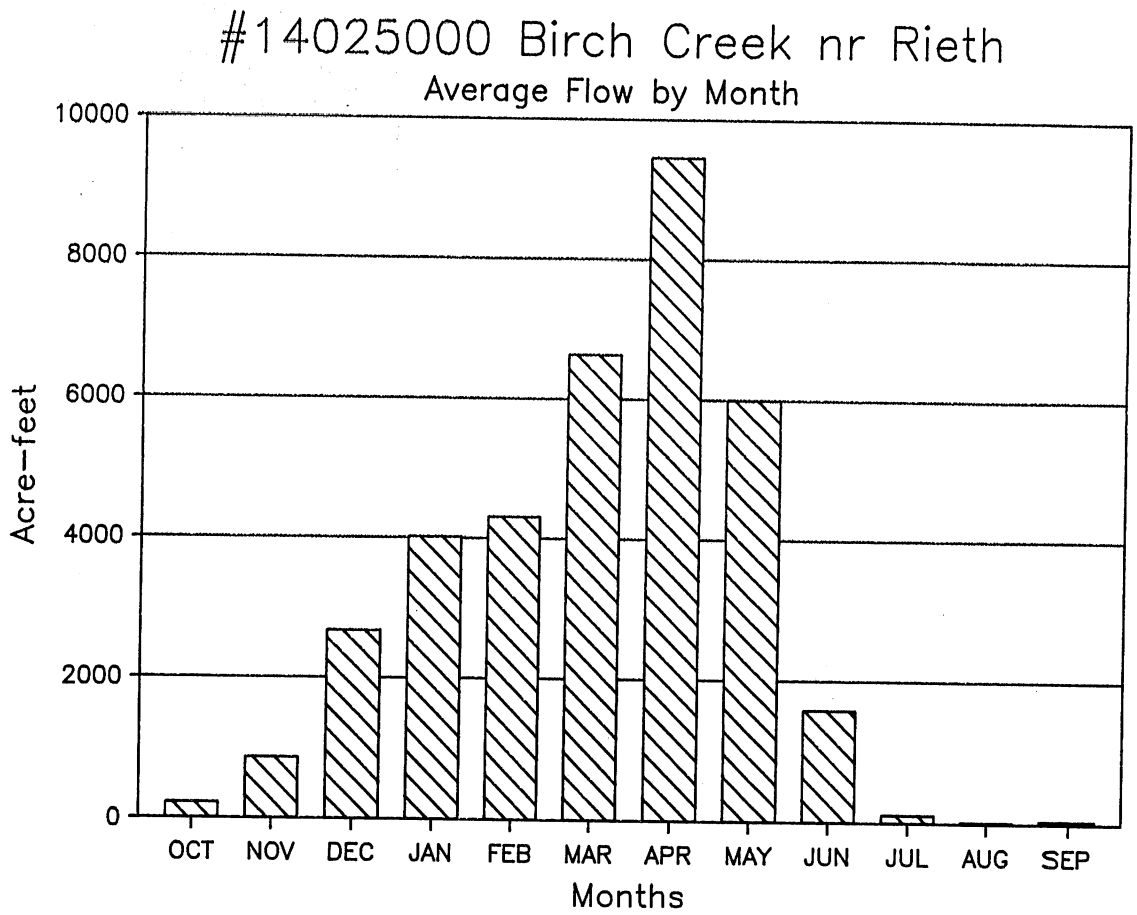



#14022500 McKay Creek nr Pilot Rock
Discharge (1921 & 1927-86)
CUBIC FEET PER SECOND
800
700
600
500
400
300
200
100
0
MAXIMUM
MINIMUM
MEAN
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
MONTHS


#14022500 McKay Creek nr Pilot Rock
Average Flow by Month
Cubic Feet Per Second
300
250
200
150
100
50
0
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
Months

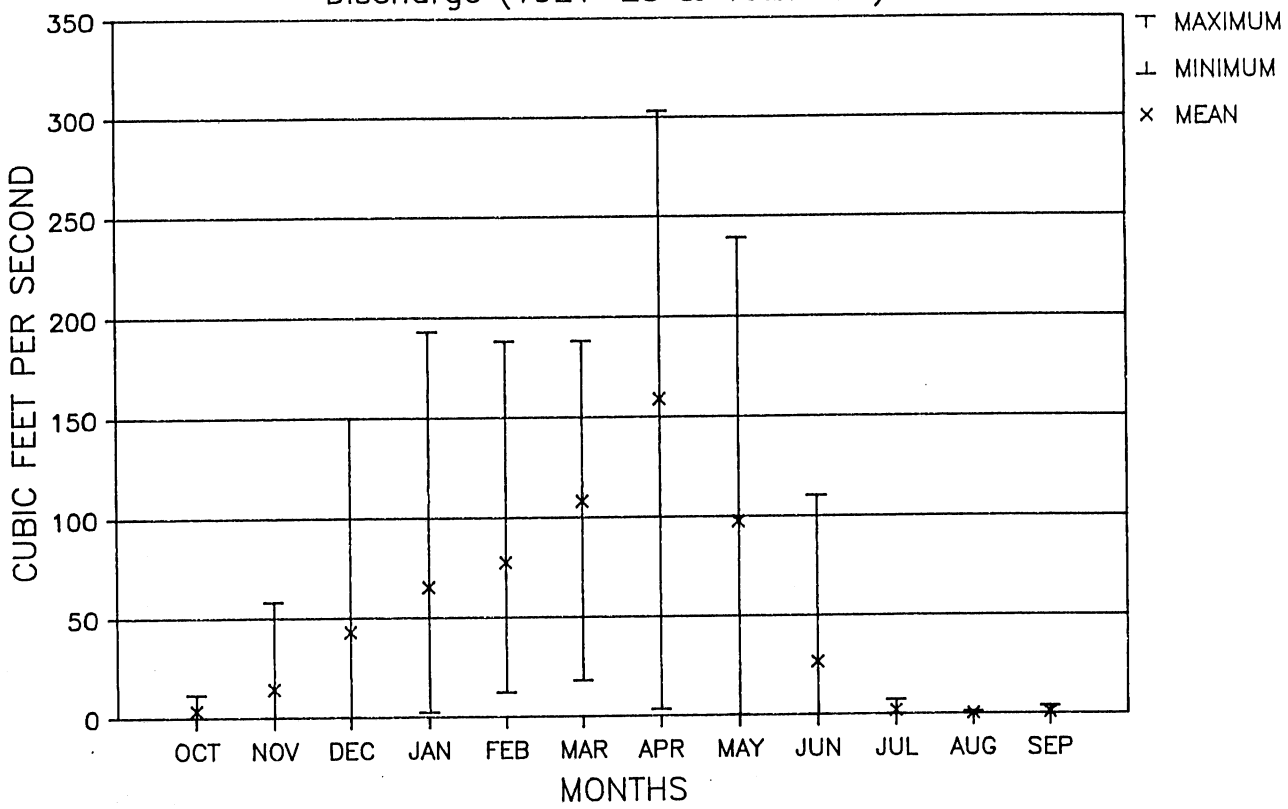

#14025000 Birch Creek nr Rieth
Annual Means
Acre-feet
80000
60000
40000
20000
0
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
Years


#14025000 Birch Creek at Rieth
Discharge (1921–23 & 1927–76)
MAXIMUM
MINIMUM
MEAN
20000
16000
12000
8000
4000
0
ACRE-FEET
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
MONTHS


#14025000 Birch Creek nr Rieth
Average Flow by Month
10000
8000
6000
4000
2000
0
Acre-feet
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
Months

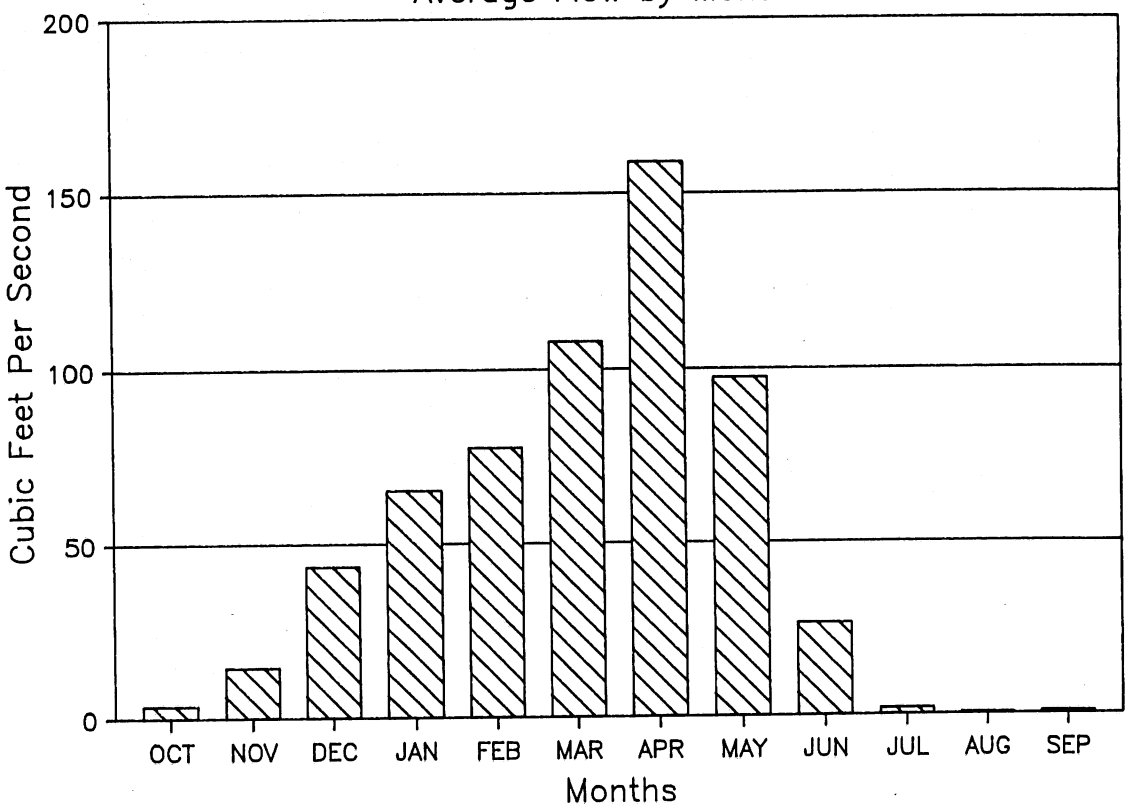
#14025000 Birch Creek at Rieth

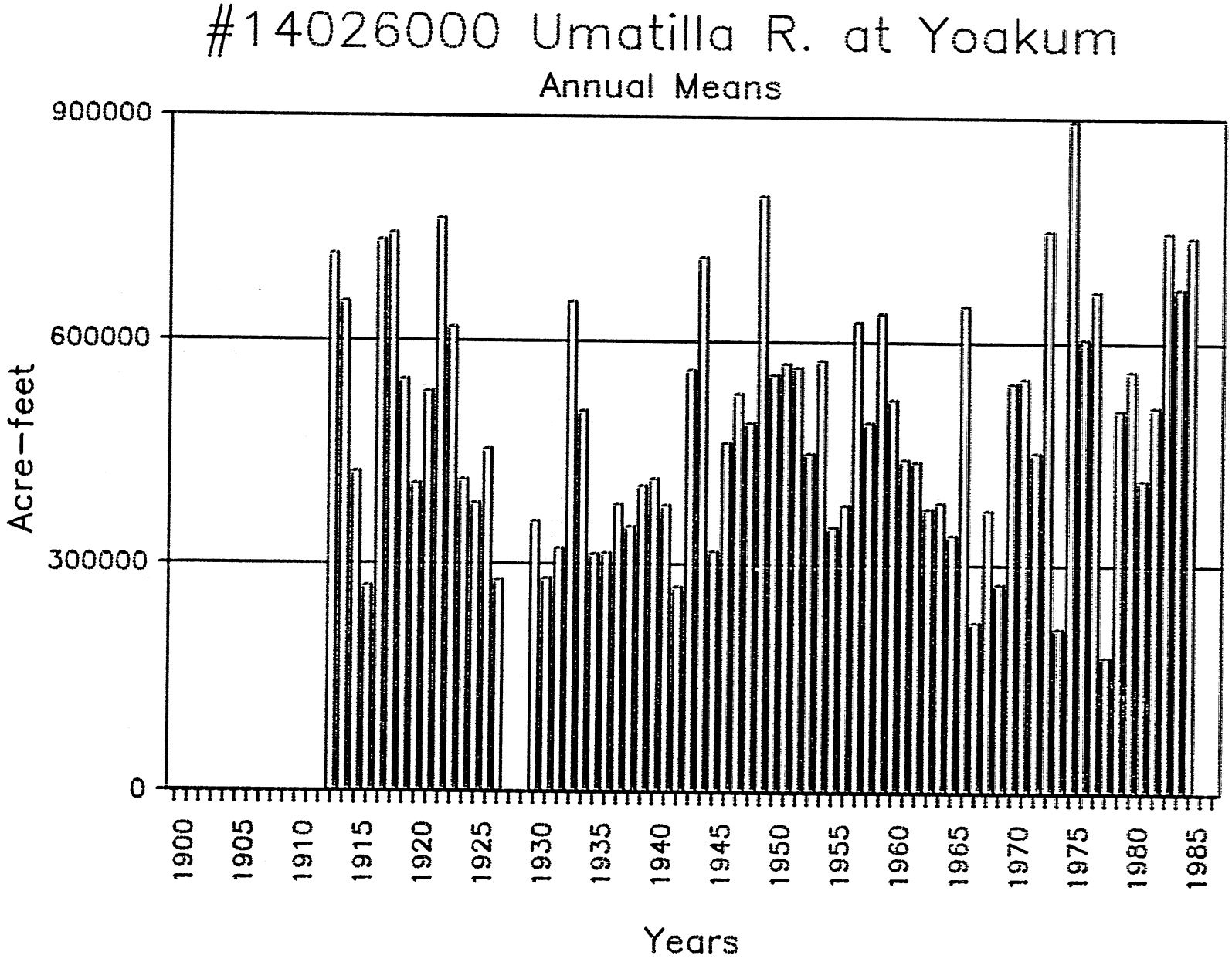
Discharge (1921–23 & 1927–76)



#14025000 Birch Creek nr Rieth

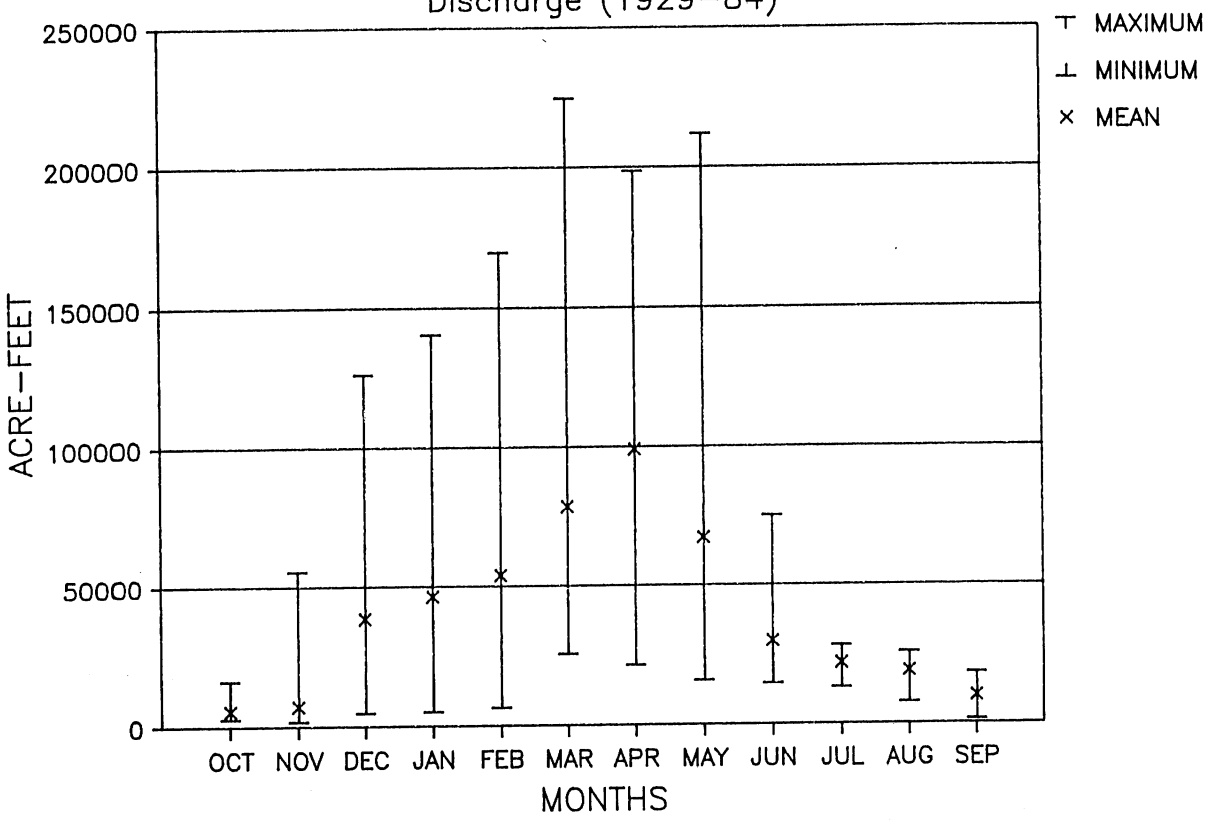
Average Flow by Month




#14026000 Umatilla R. at Yoakum
Annual Means
900000
600000
300000
0
Acre-feet
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
Years

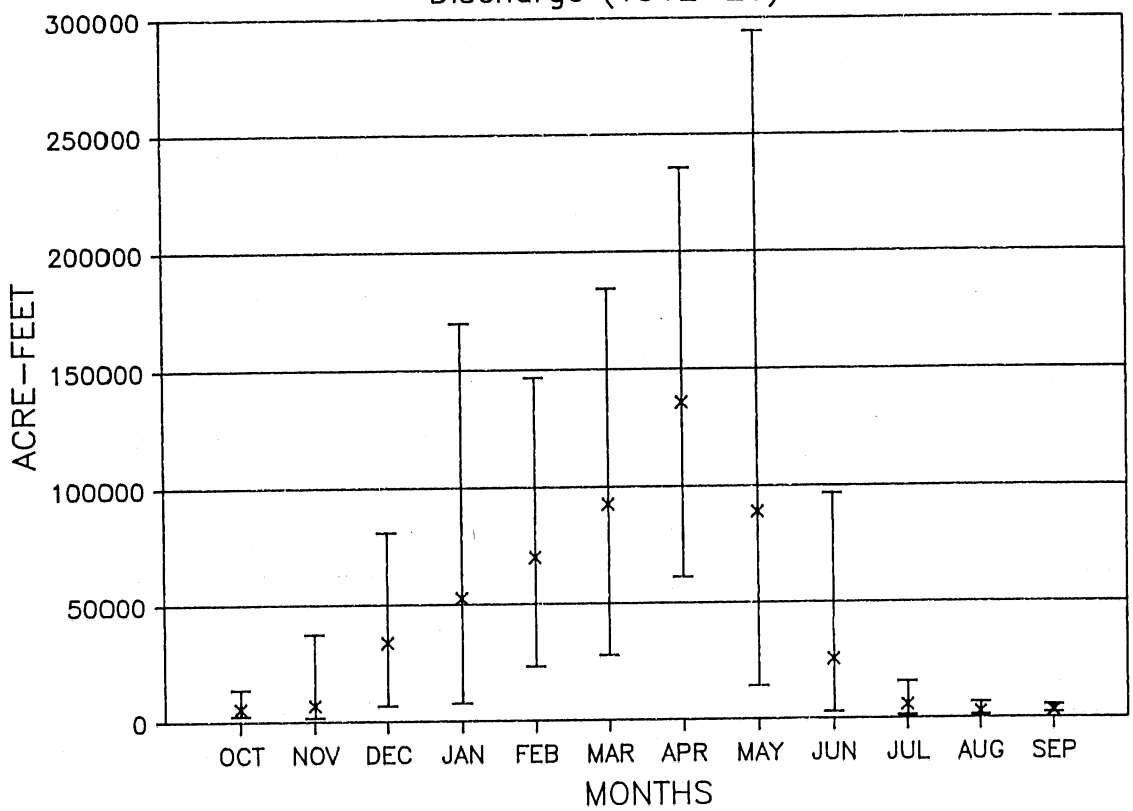
#14026000 Umatilla River at Yoakum

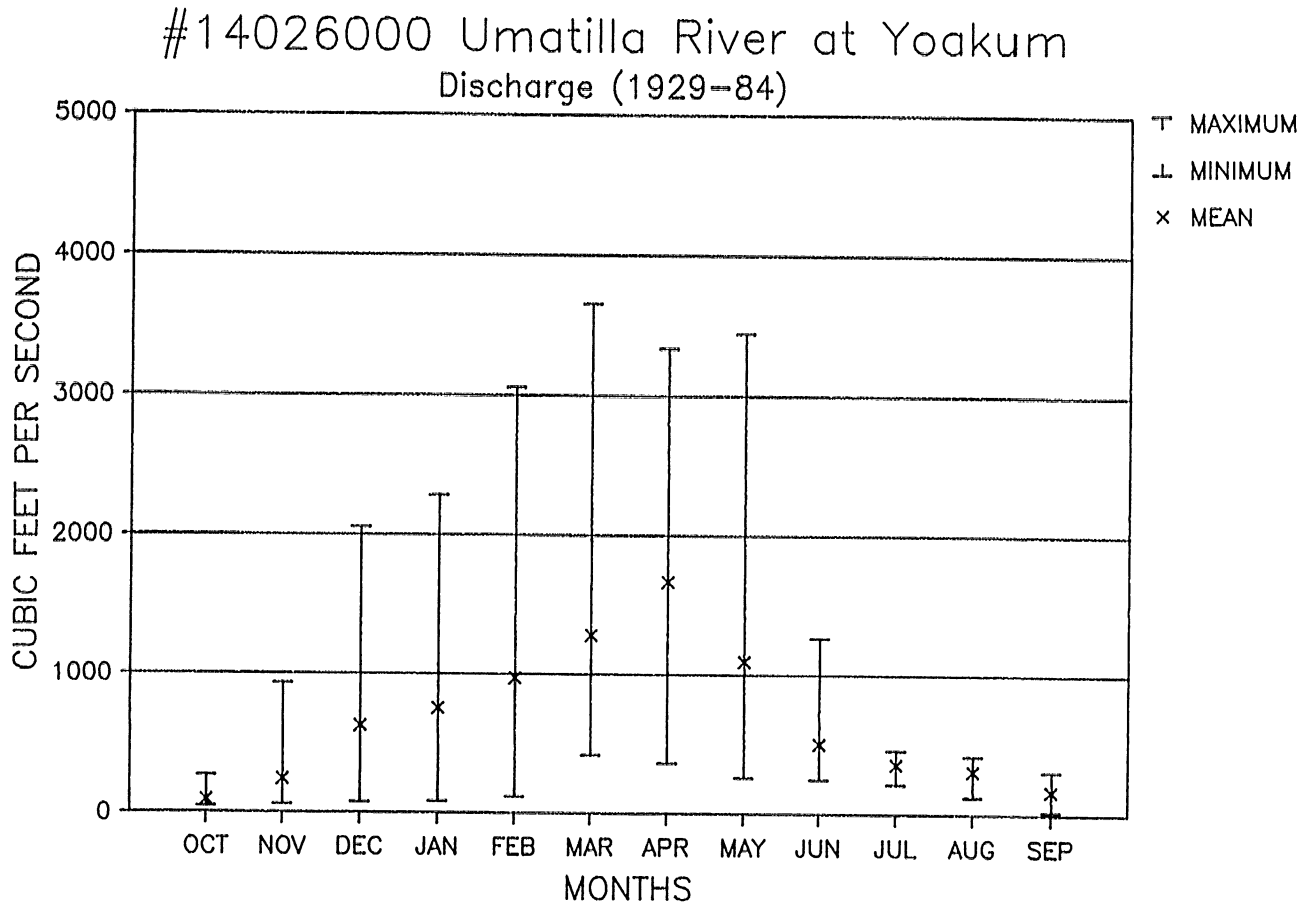
Discharge (1929–84)

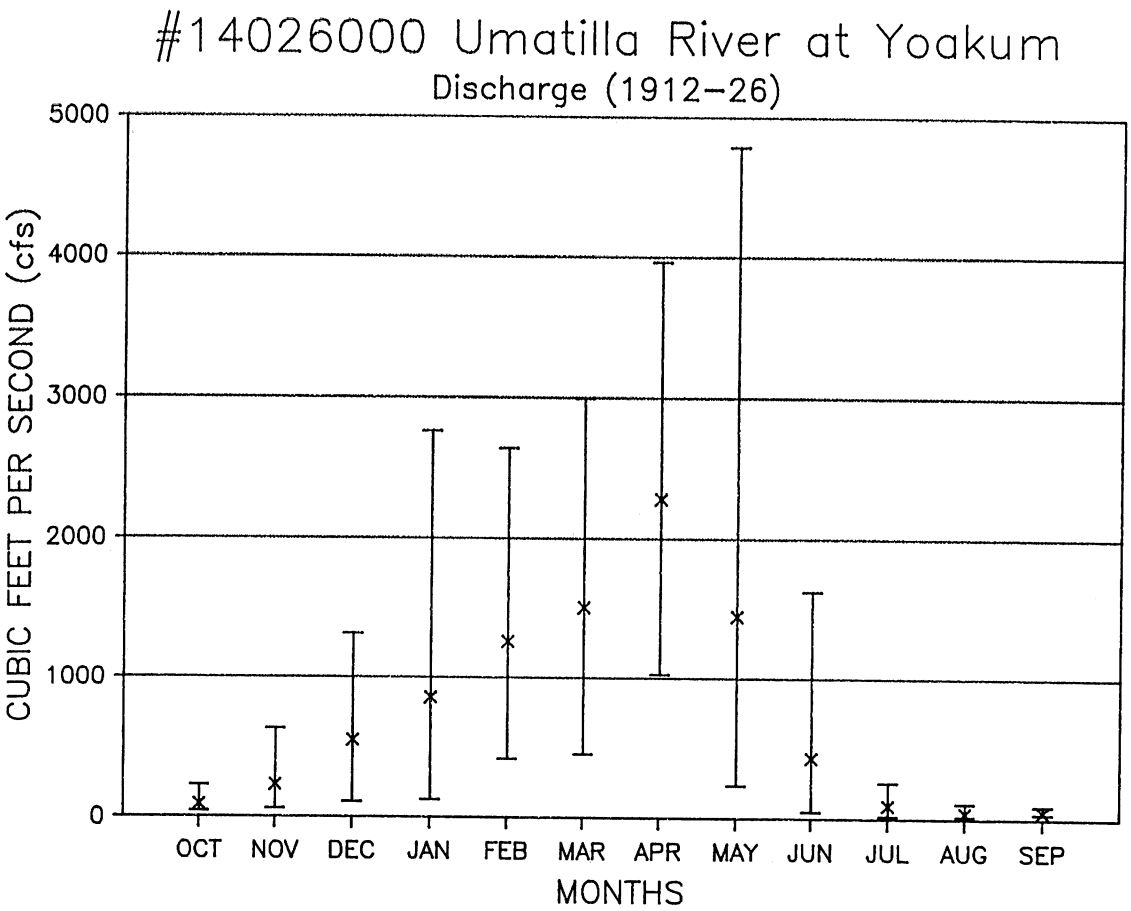


#14026000 Umatilla River at Yoakum

Discharge (1912–26)

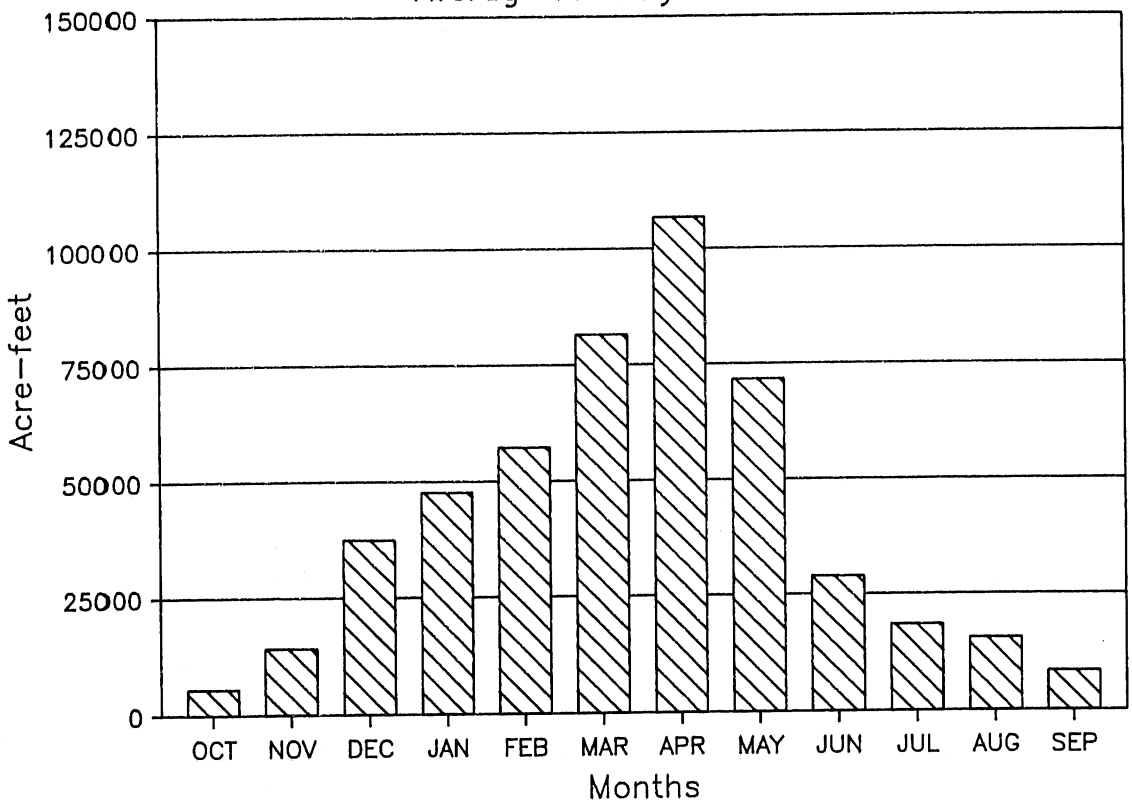



#14026000 Umatilla River at Yoakum
Discharge (1929–84)
MAXIMUM
MINIMUM
MEAN
CUBIC FEET PER SECOND
5000
4000
3000
2000
1000
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
MONTHS


#14026000 Umatilla River at Yoakum
Discharge (1912–26)
CUBIC FEET PER SECOND (cfs)
5000
4000
3000
2000
1000
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
MONTHS

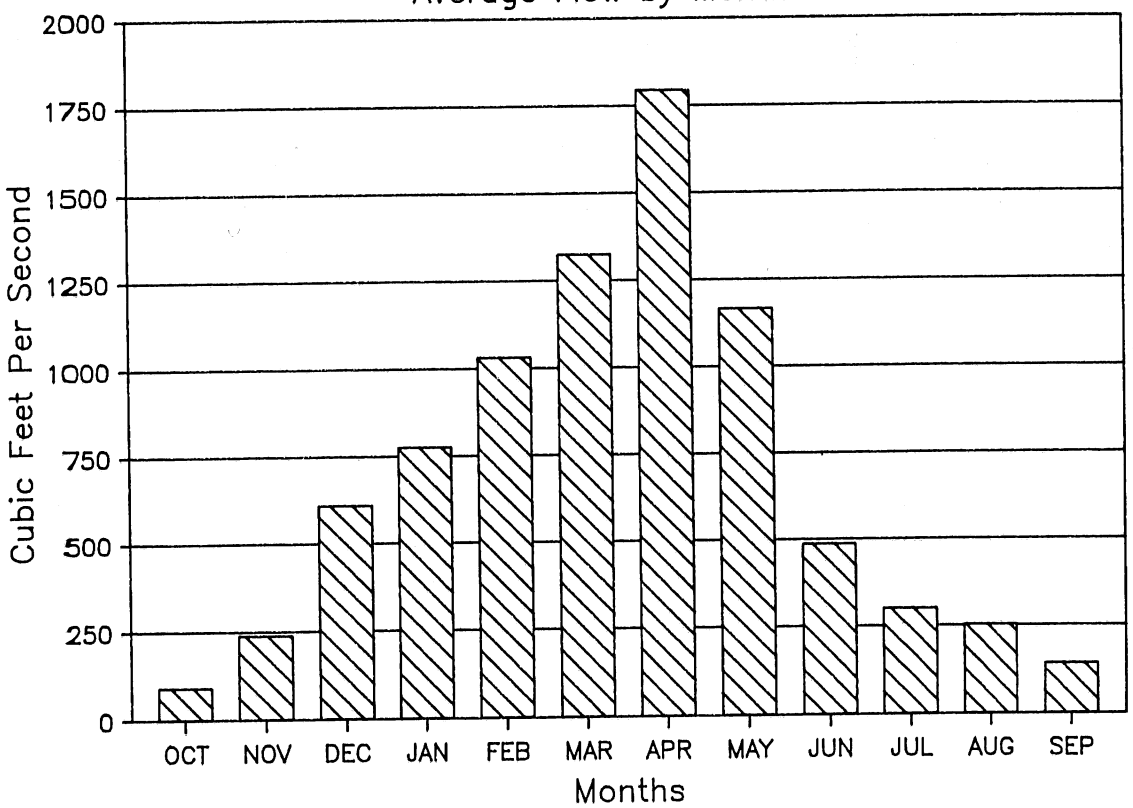
#14026000 Umatilla R. at Yoakum

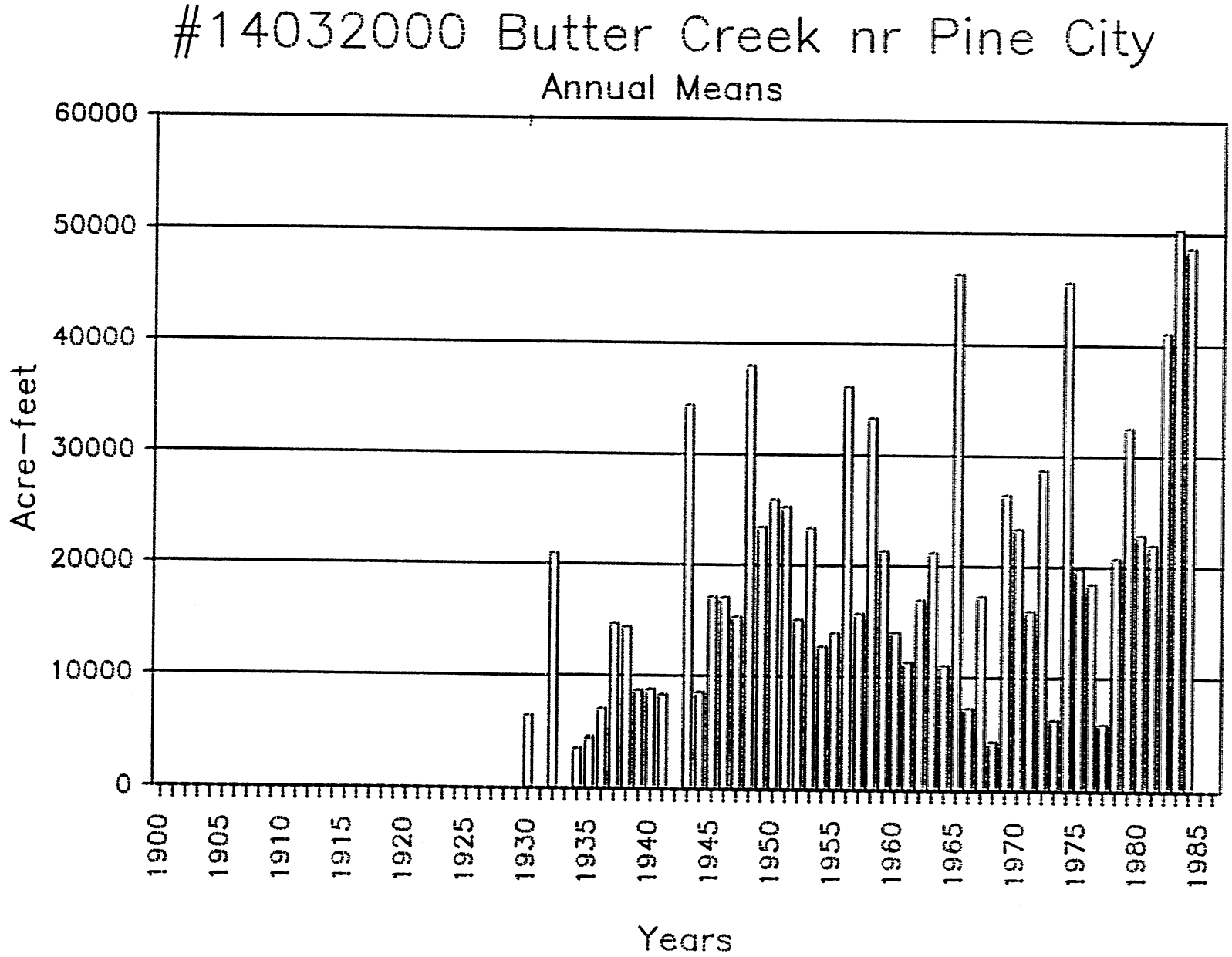
Average Flow by Month



#14026000 Umatilla R. at Yoakum

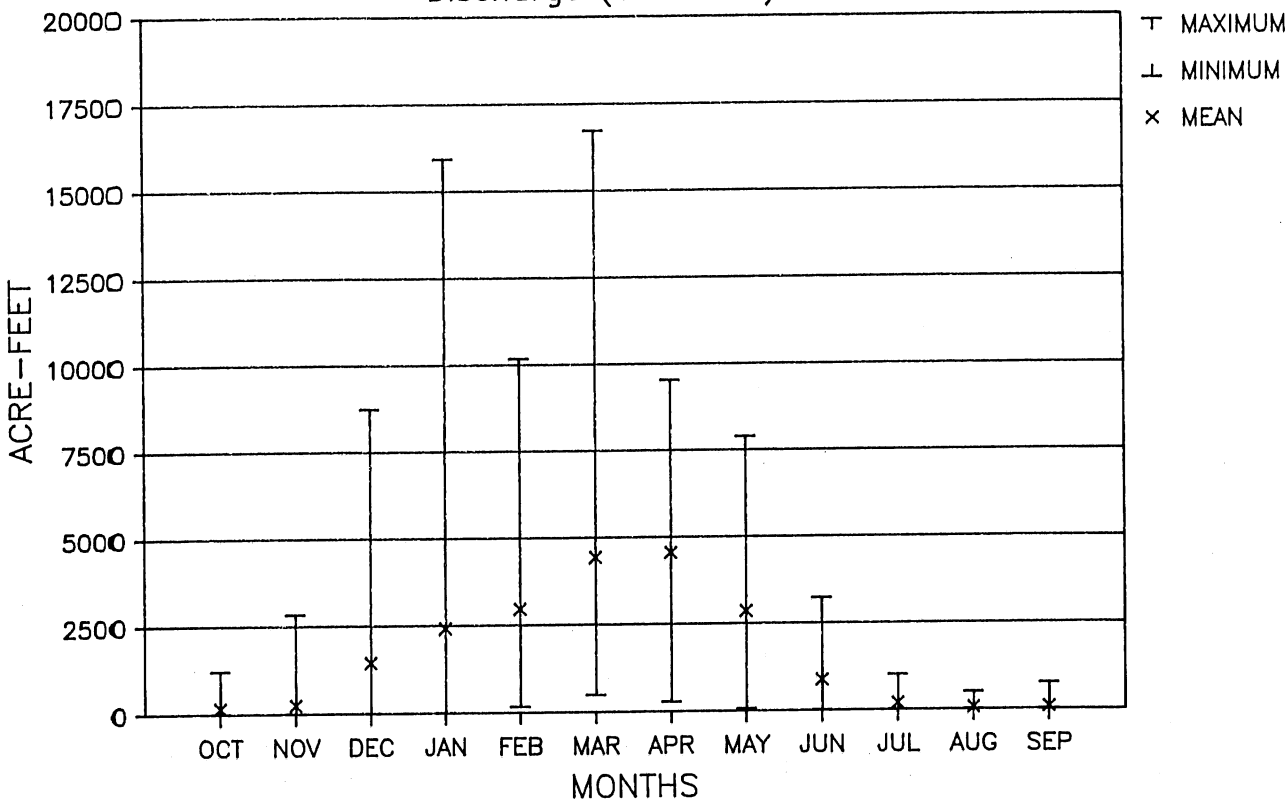
Average Flow by Month




#14032000 Butter Creek nr Pine City
Annual Means
60000
50000
40000
30000
20000
10000
0
Acre-feet
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
Years

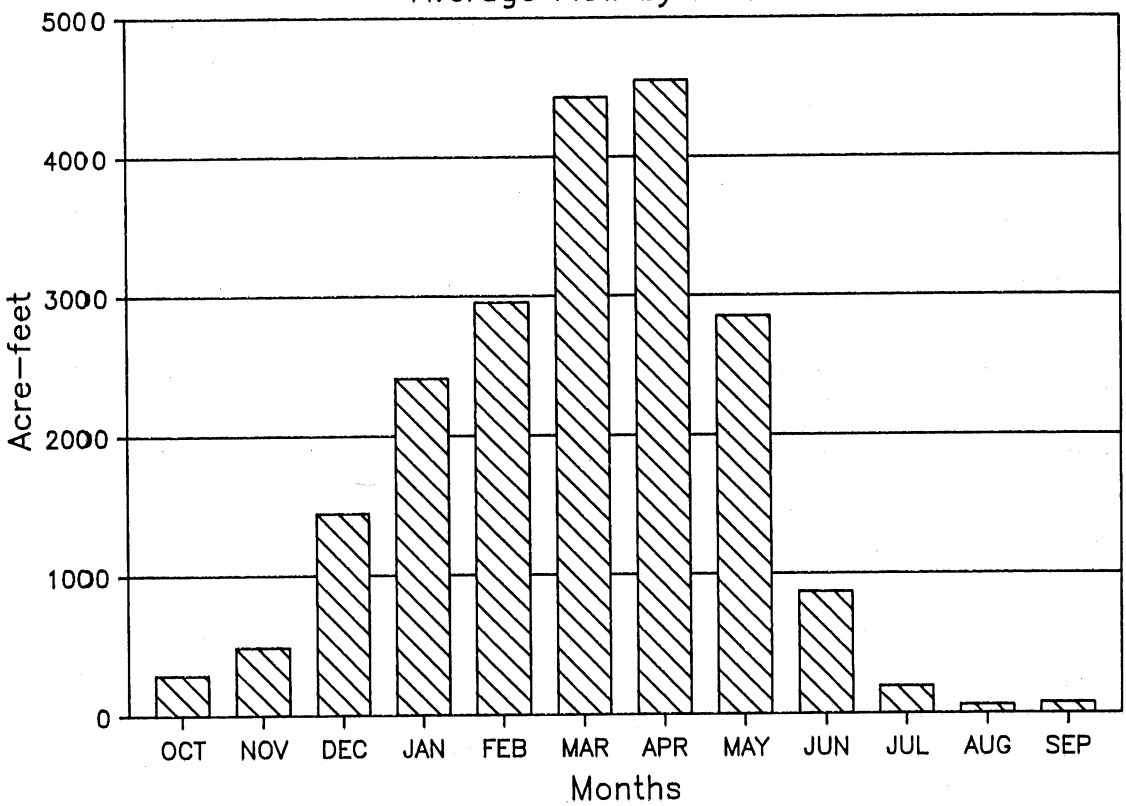
#14032000 Butter Creek nr Pine City

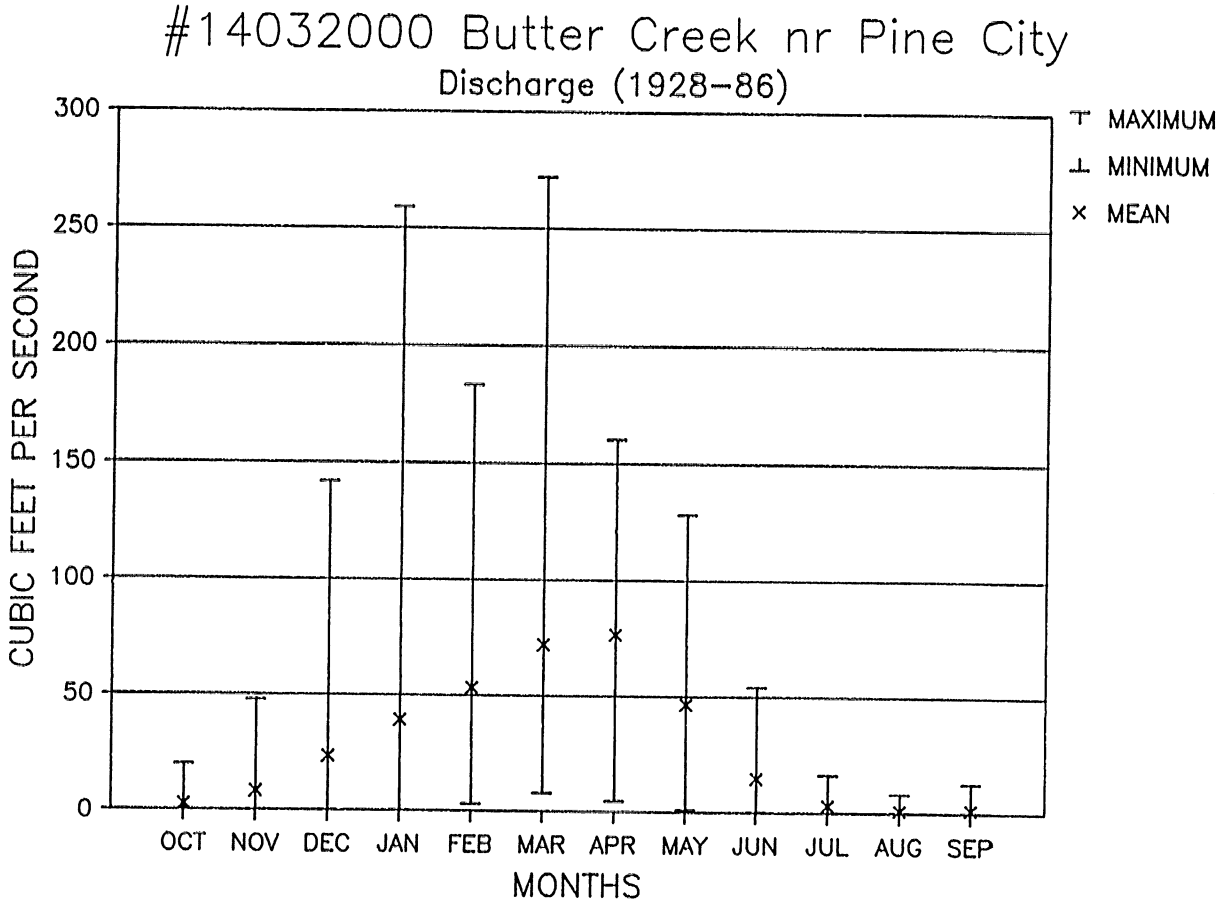
Discharge (1928–86)

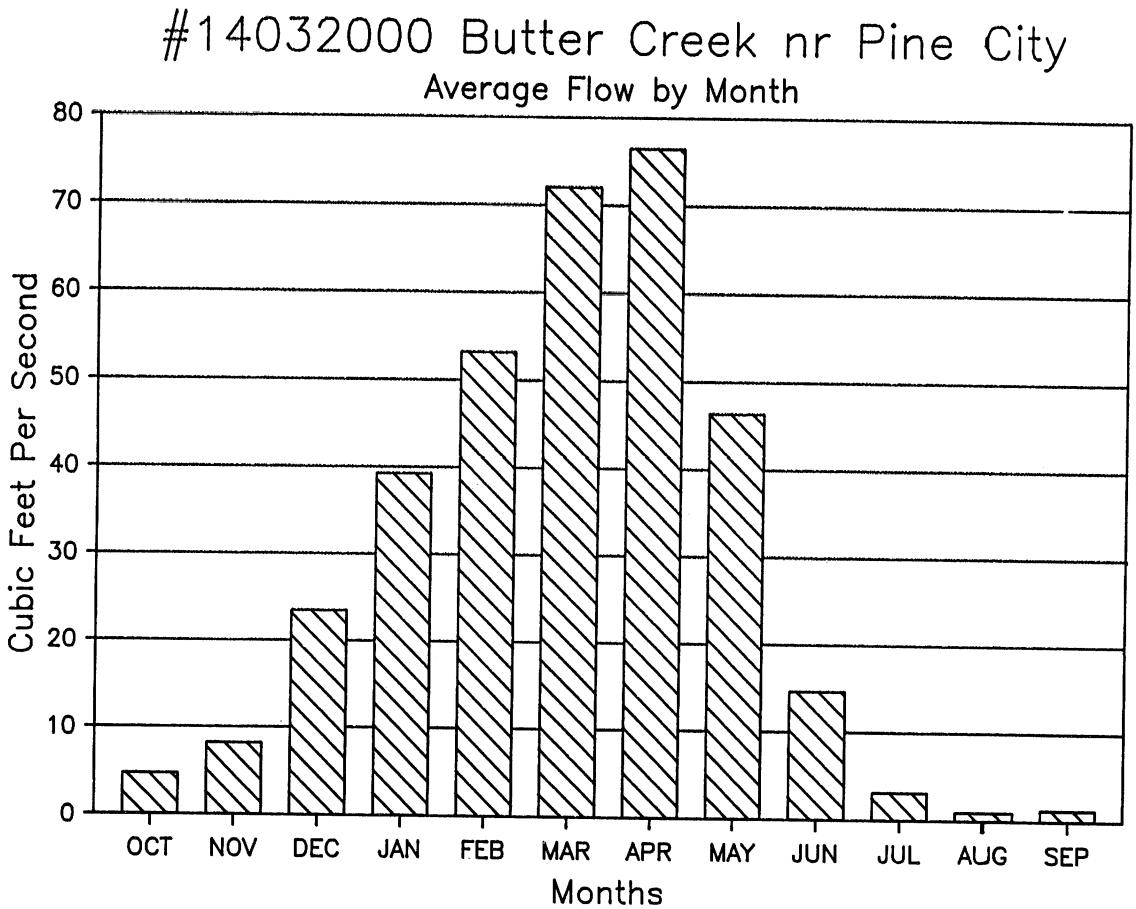


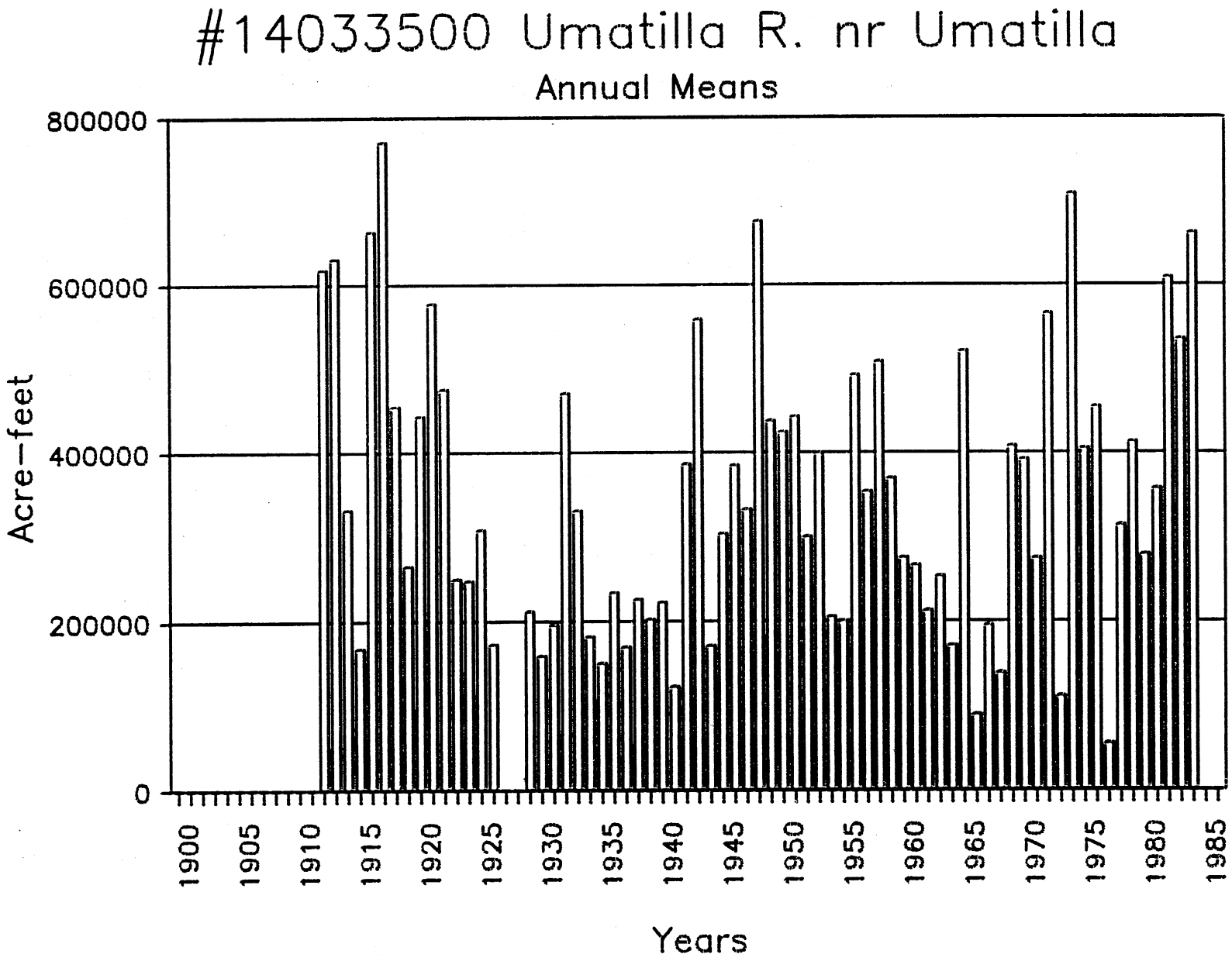
#14032000 Butter Creek nr Pine City

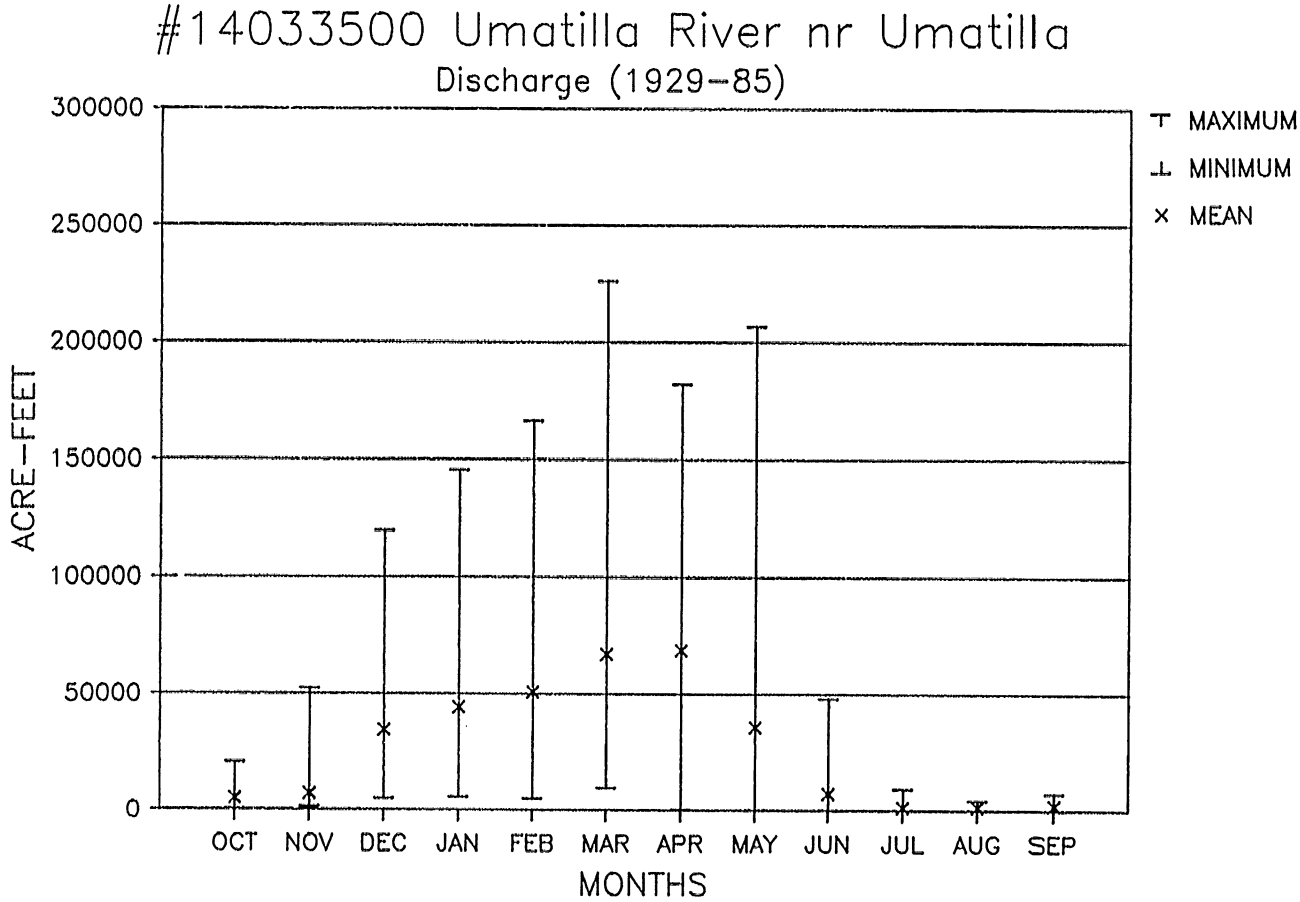
Average Flow by Month

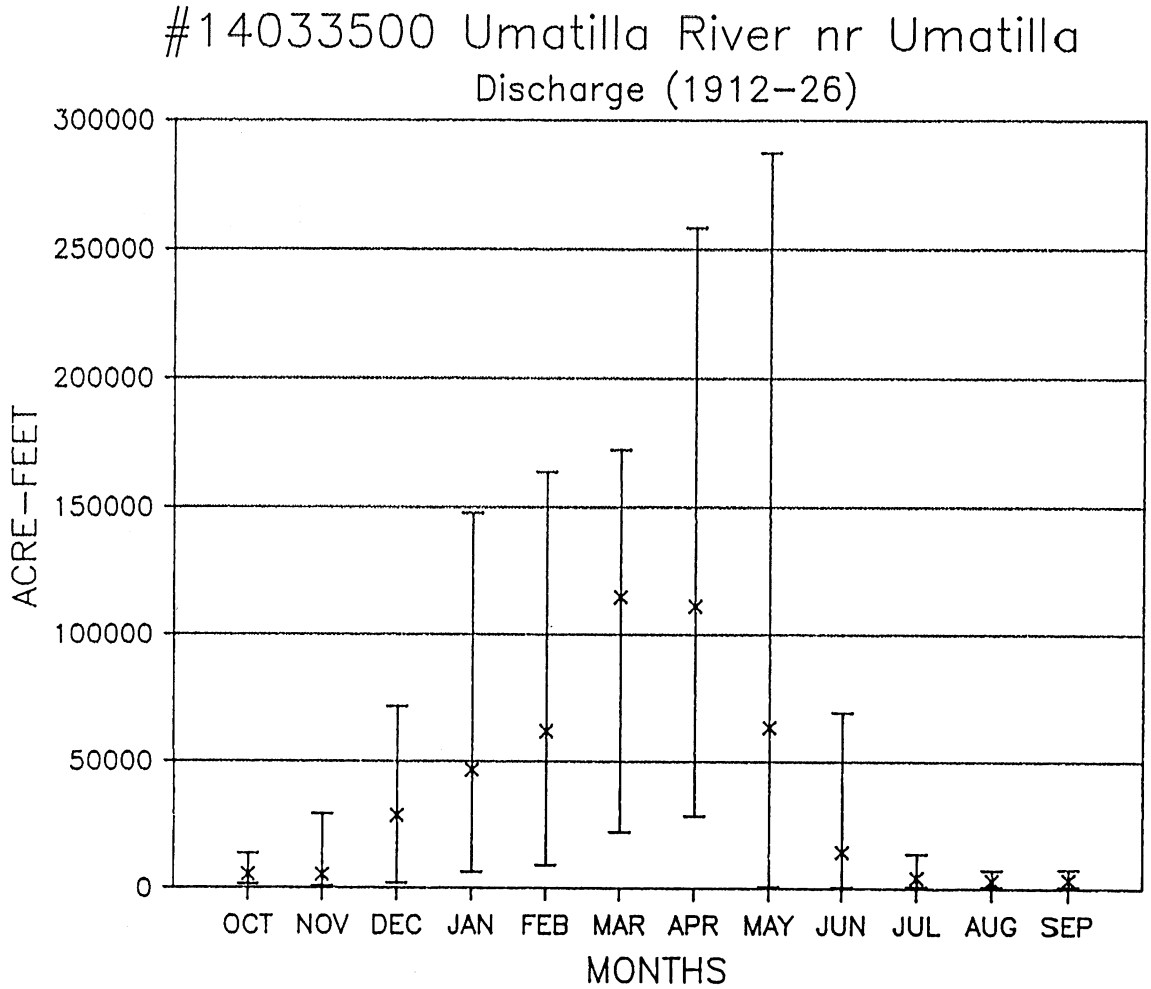



#14032000 Butter Creek nr Pine City
Discharge (1928-86)
MAXIMUM
MINIMUM
MEAN
CUBIC FEET PER SECOND
300
250
200
150
100
50
0
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
MONTHS


#14032000 Butter Creek nr Pine City
Average Flow by Month
Cubic Feet Per Second
80
70
60
50
40
30
20
10
0
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
Months

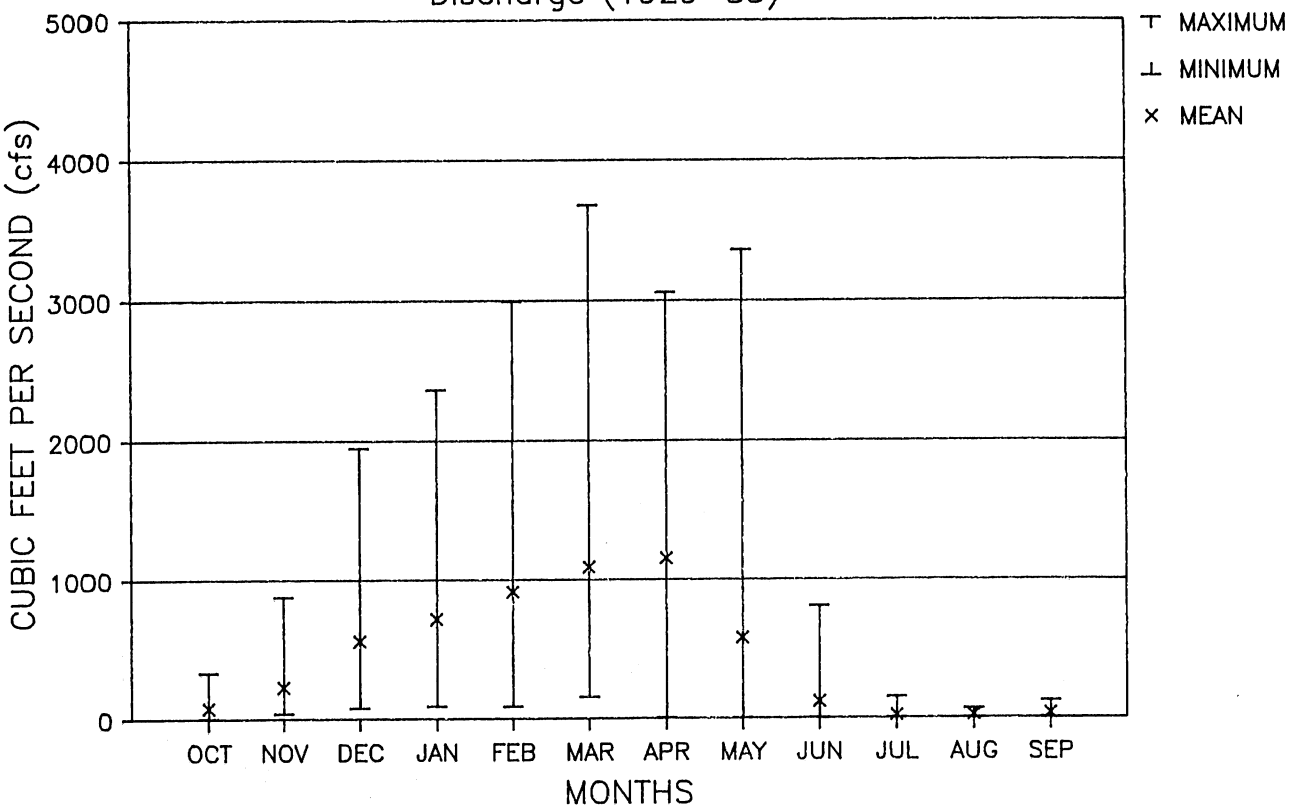

#14033500 Umatilla R. nr Umatilla
Annual Means
800000
600000
400000
200000
0
Acre-feet
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
Years


#14033500 Umatilla River nr Umatilla
Discharge (1929–85)
300000
250000
200000
150000
100000
50000
0
ACRE–FEET
MAXIMUM
MINIMUM
MEAN
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
MONTHS


#14033500 Umatilla River nr Umatilla
Discharge (1912–26)
300000
250000
200000
150000
100000
50000
0
ACRE–FEET
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
MONTHS

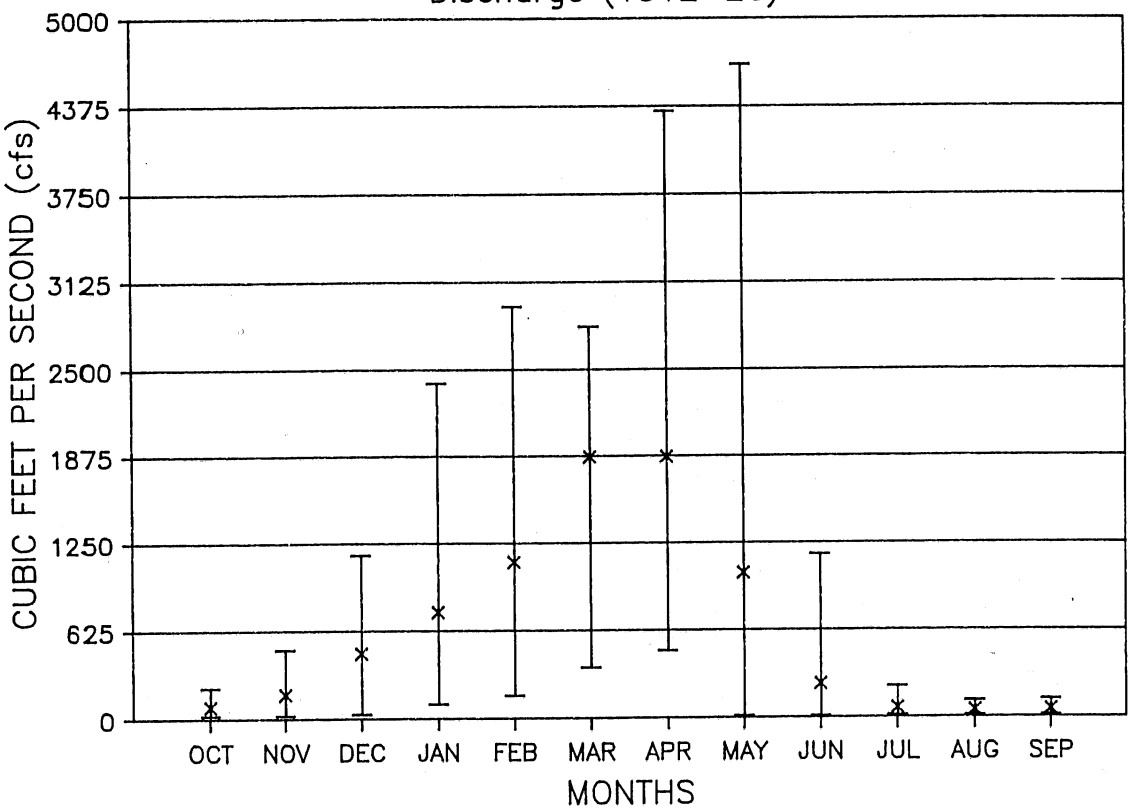
#14033500 Umatilla River nr Umatilla

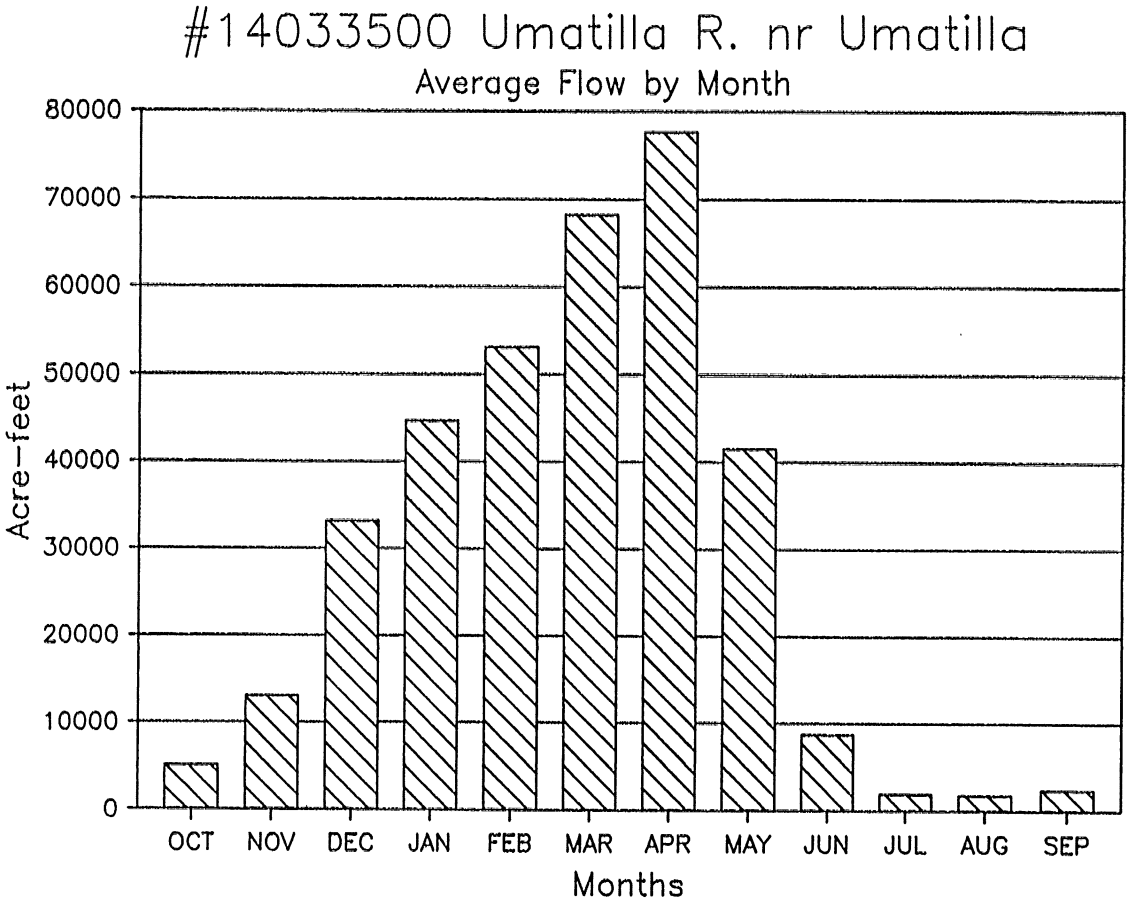
Discharge (1929–85)

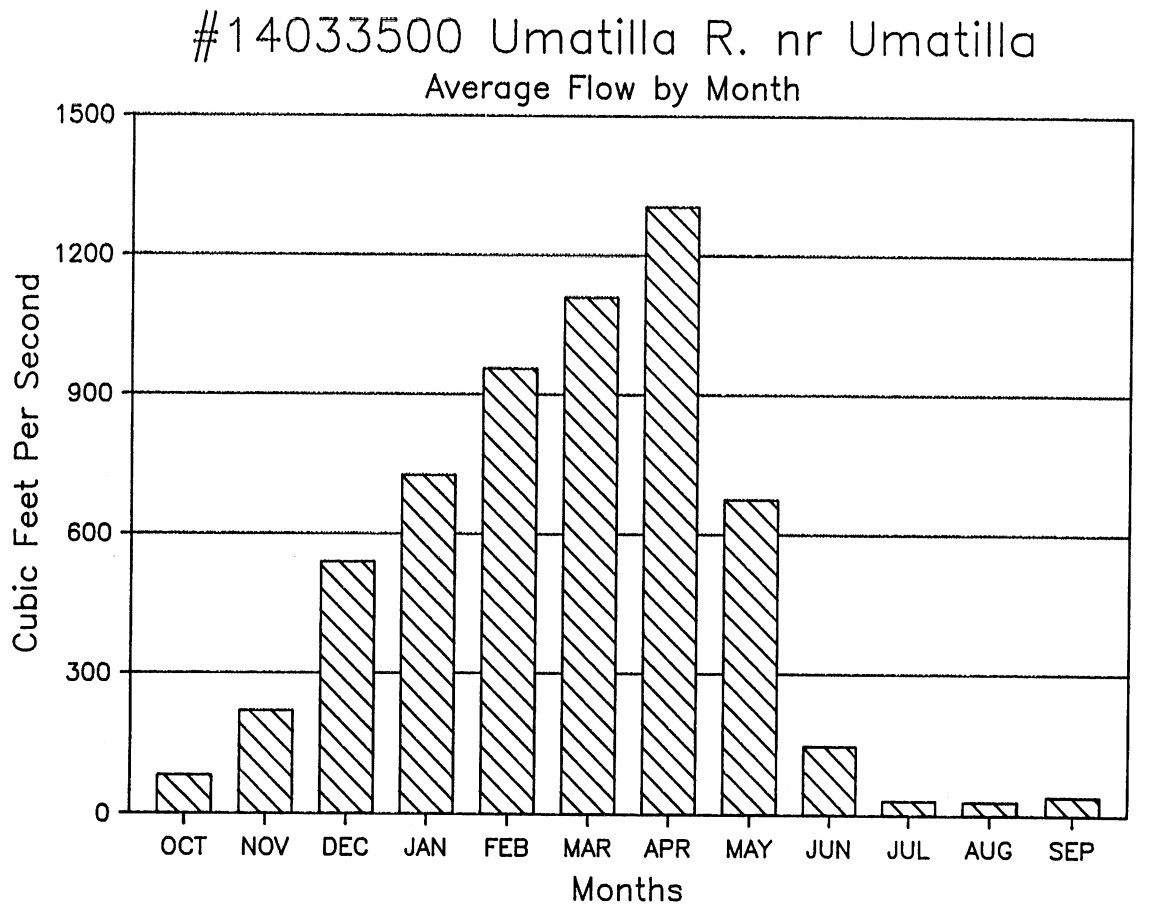


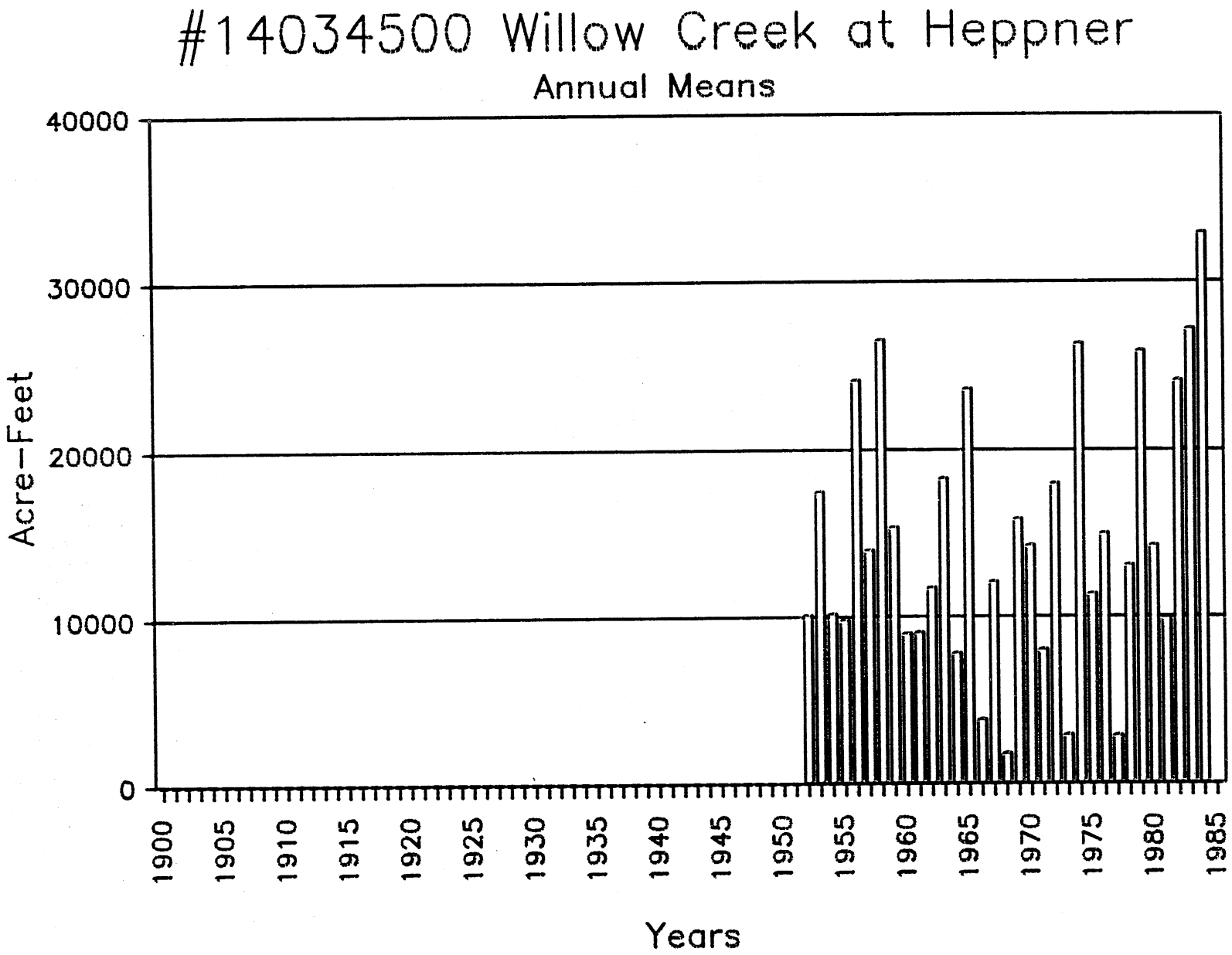
#14033500 Umatilla River nr Umatilla

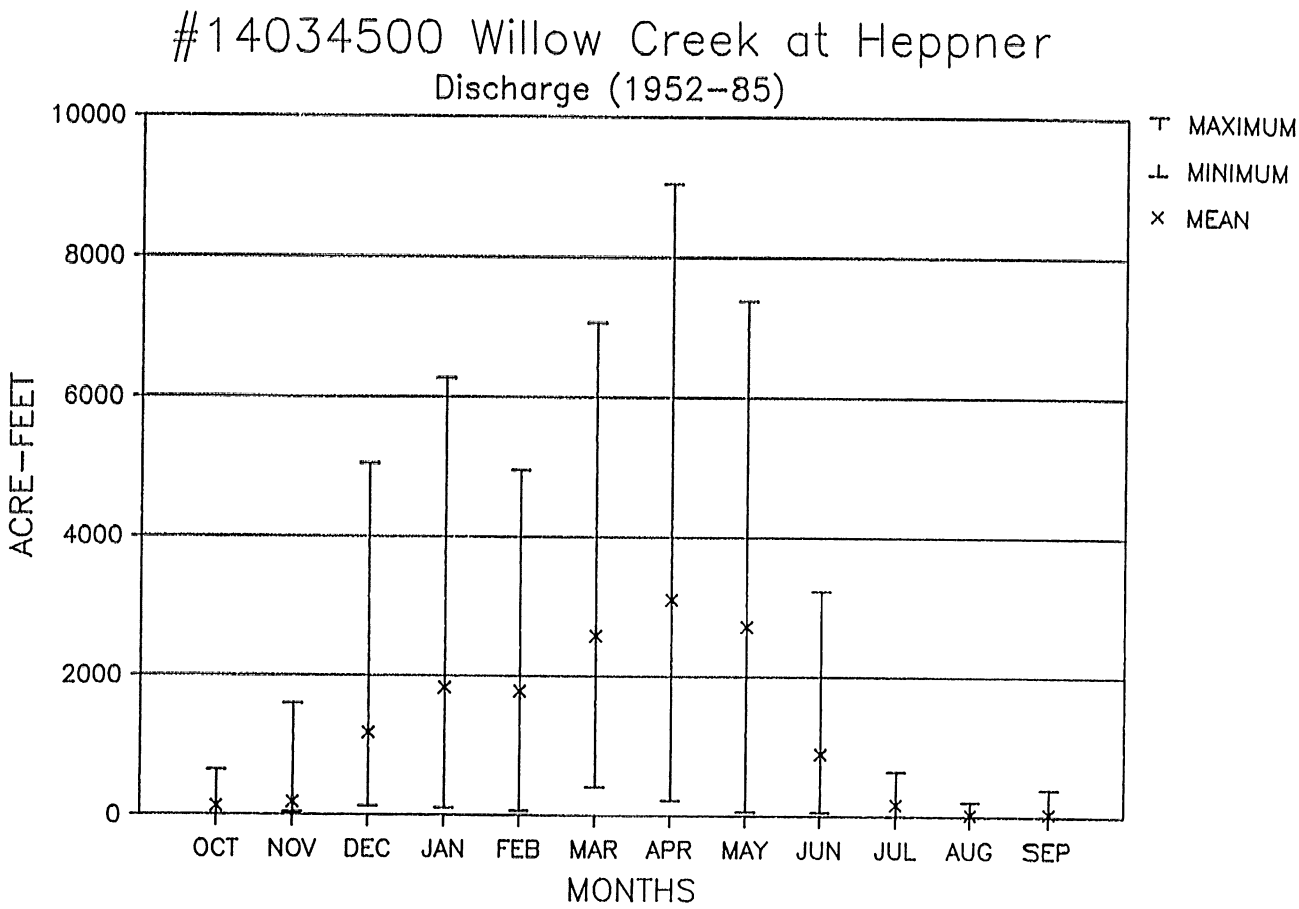
Discharge (1912–26)

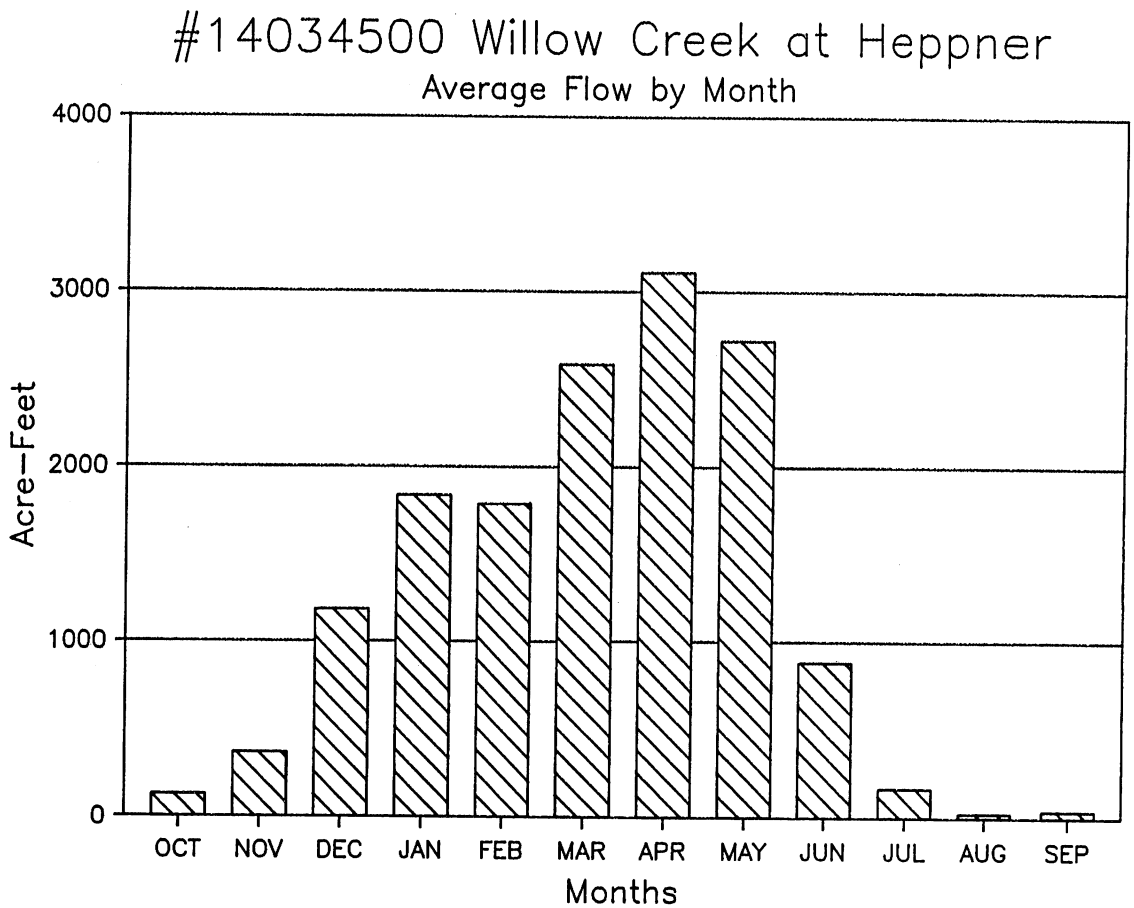



#14033500 Umatilla R. nr Umatilla
Average Flow by Month
Acre-feet
80000
70000
60000
50000
40000
30000
20000
10000
0
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
Months


#14033500 Umatilla R. nr Umatilla
Average Flow by Month
Cubic Feet Per Second
1500
1200
900
600
300
0
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
Months

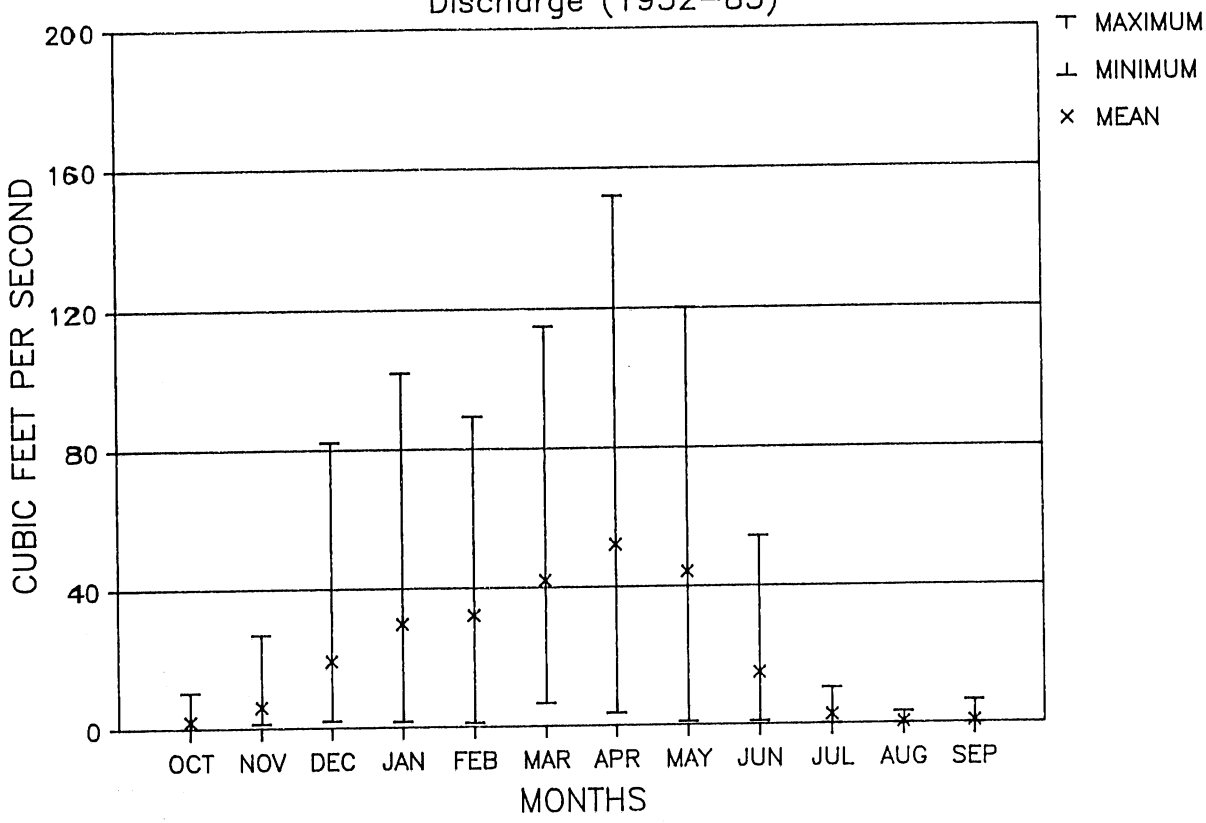

#14034500 Willow Creek at Heppner
Annual Means
40000
30000
20000
10000
0
Acre-Feet
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
Years


#14034500 Willow Creek at Heppner
Discharge (1952–85)
MAXIMUM
MINIMUM
MEAN
ACRE–FEET
10000
8000
6000
4000
2000
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
MONTHS


#14034500 Willow Creek at Heppner
Average Flow by Month
Acre–Feet
4000
3000
2000
1000
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
Months

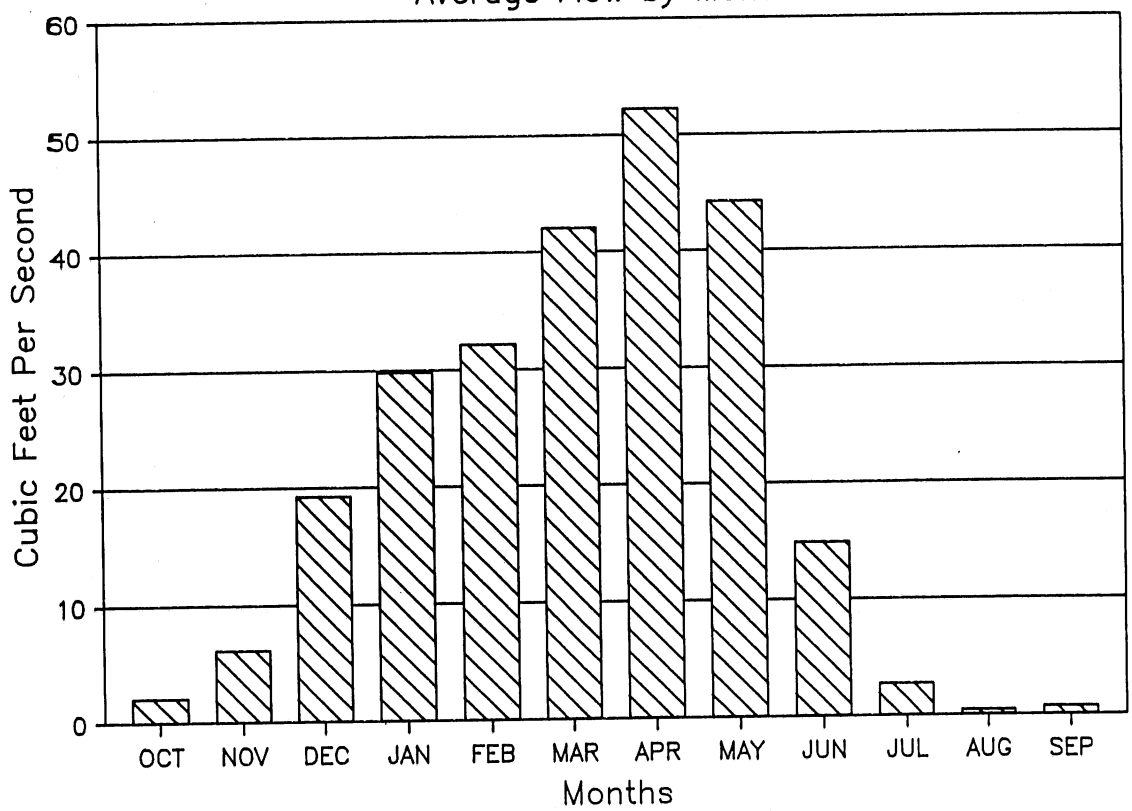
#14034500 Willow Creek at Heppner

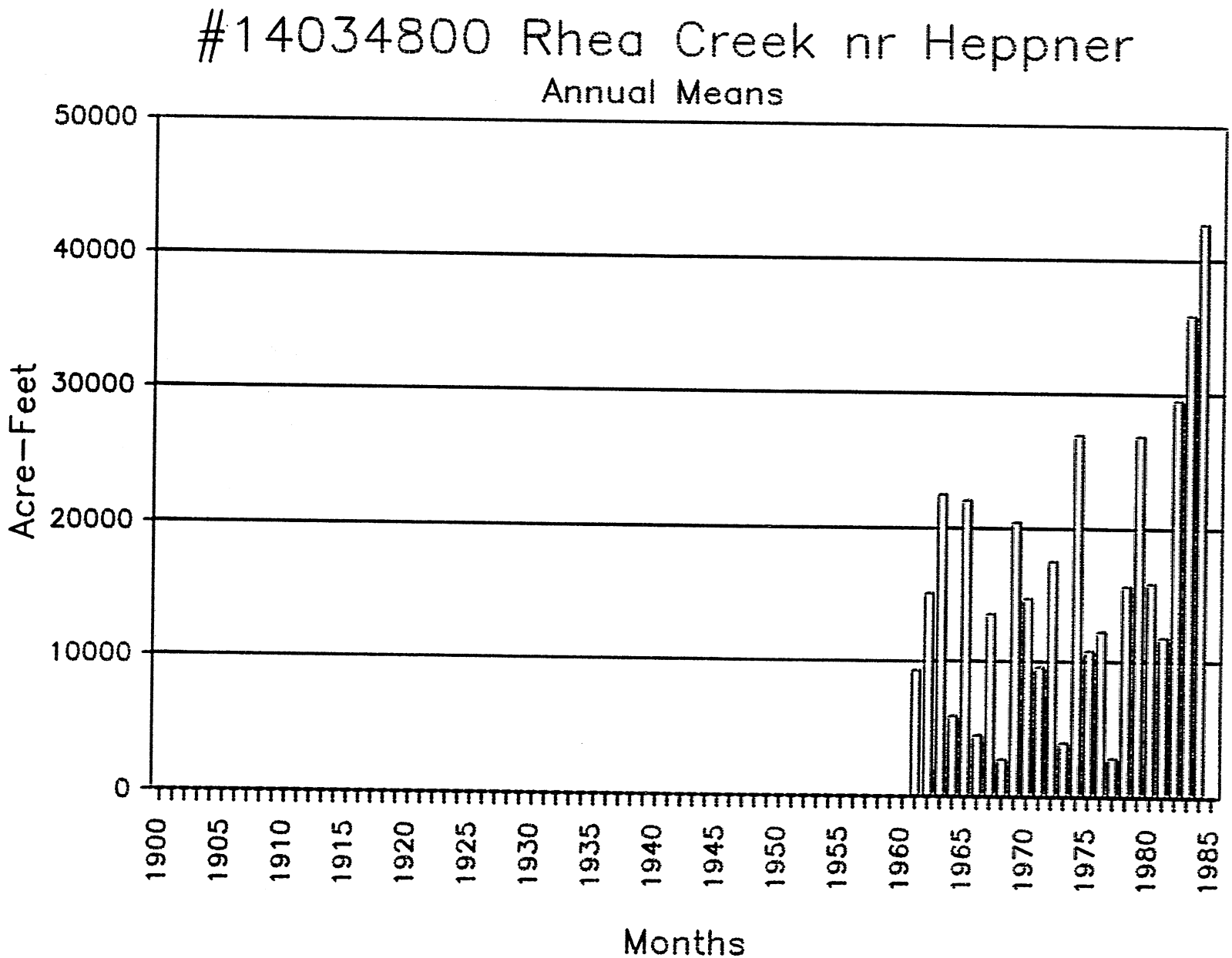
Discharge (1952–85)

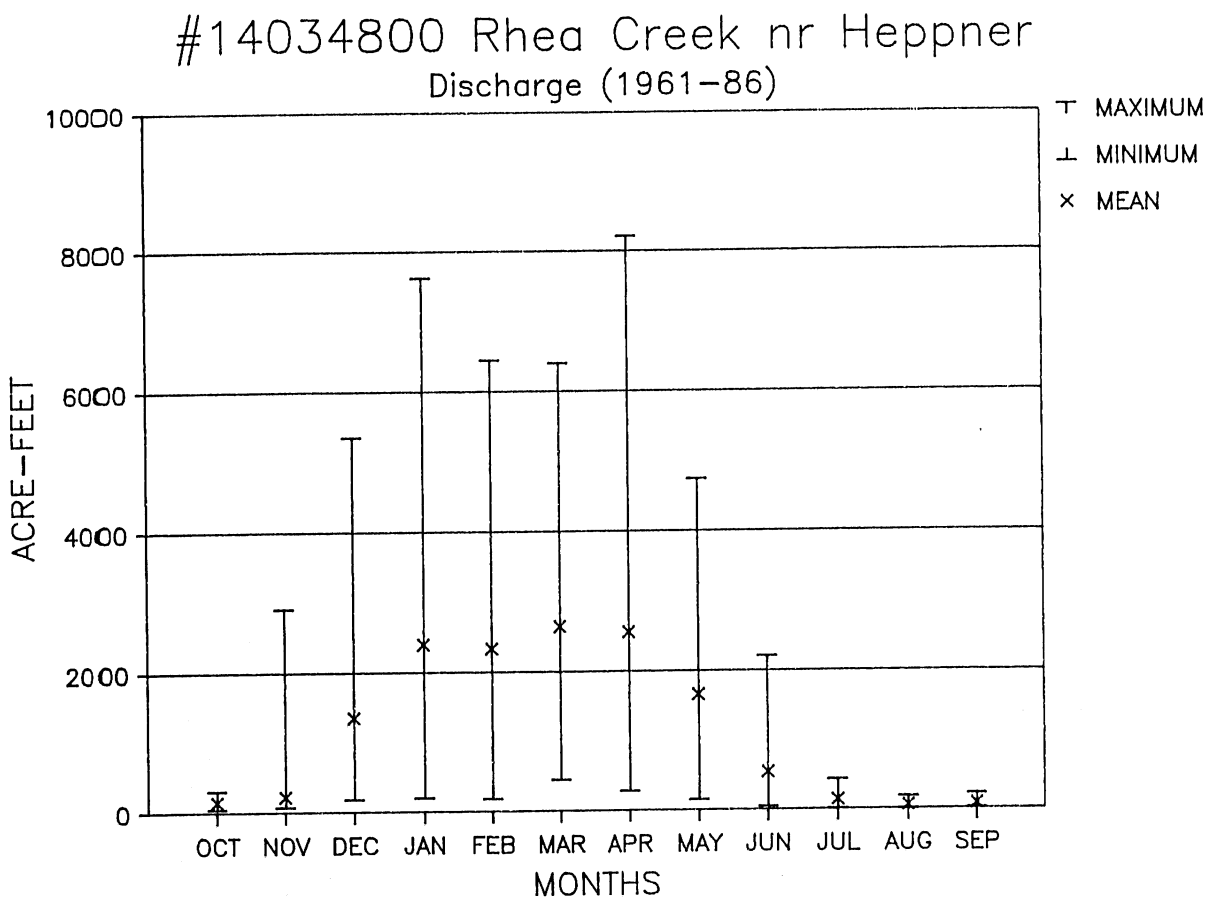


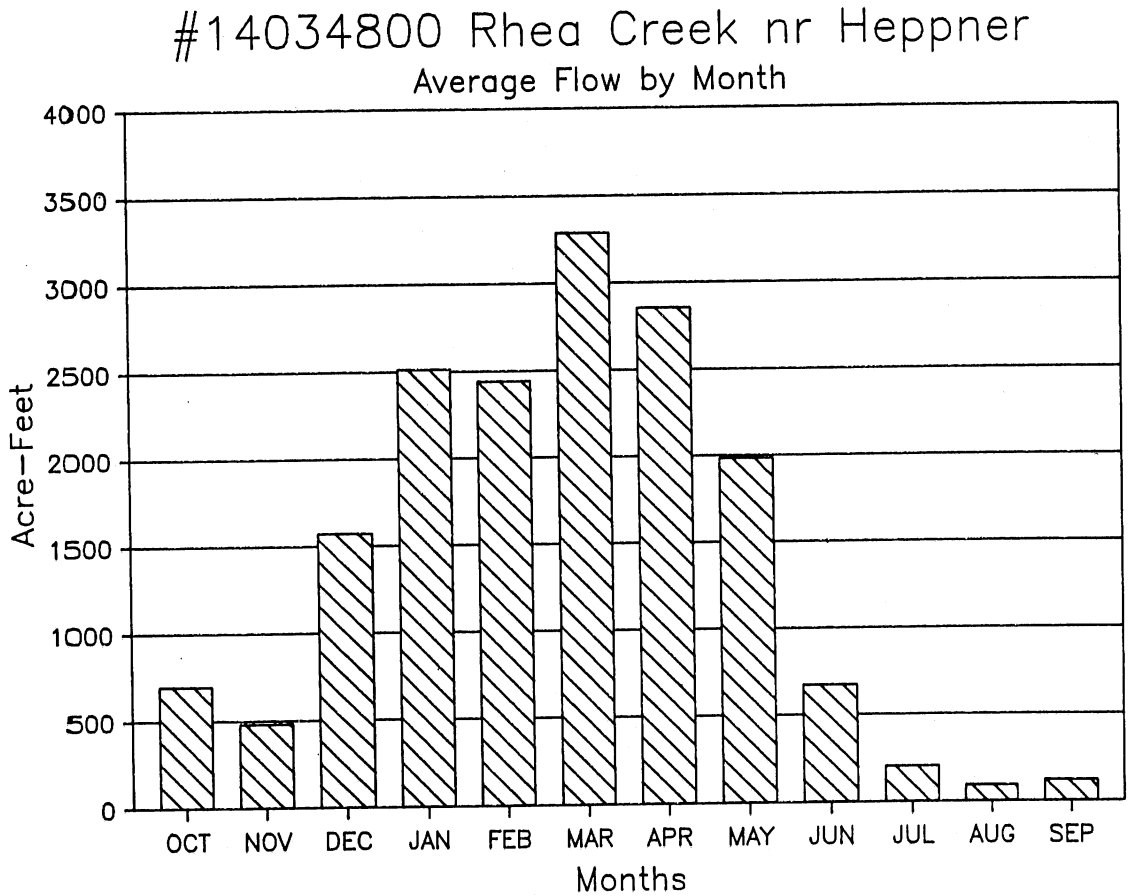
#14034500 Willow Creek at Heppner

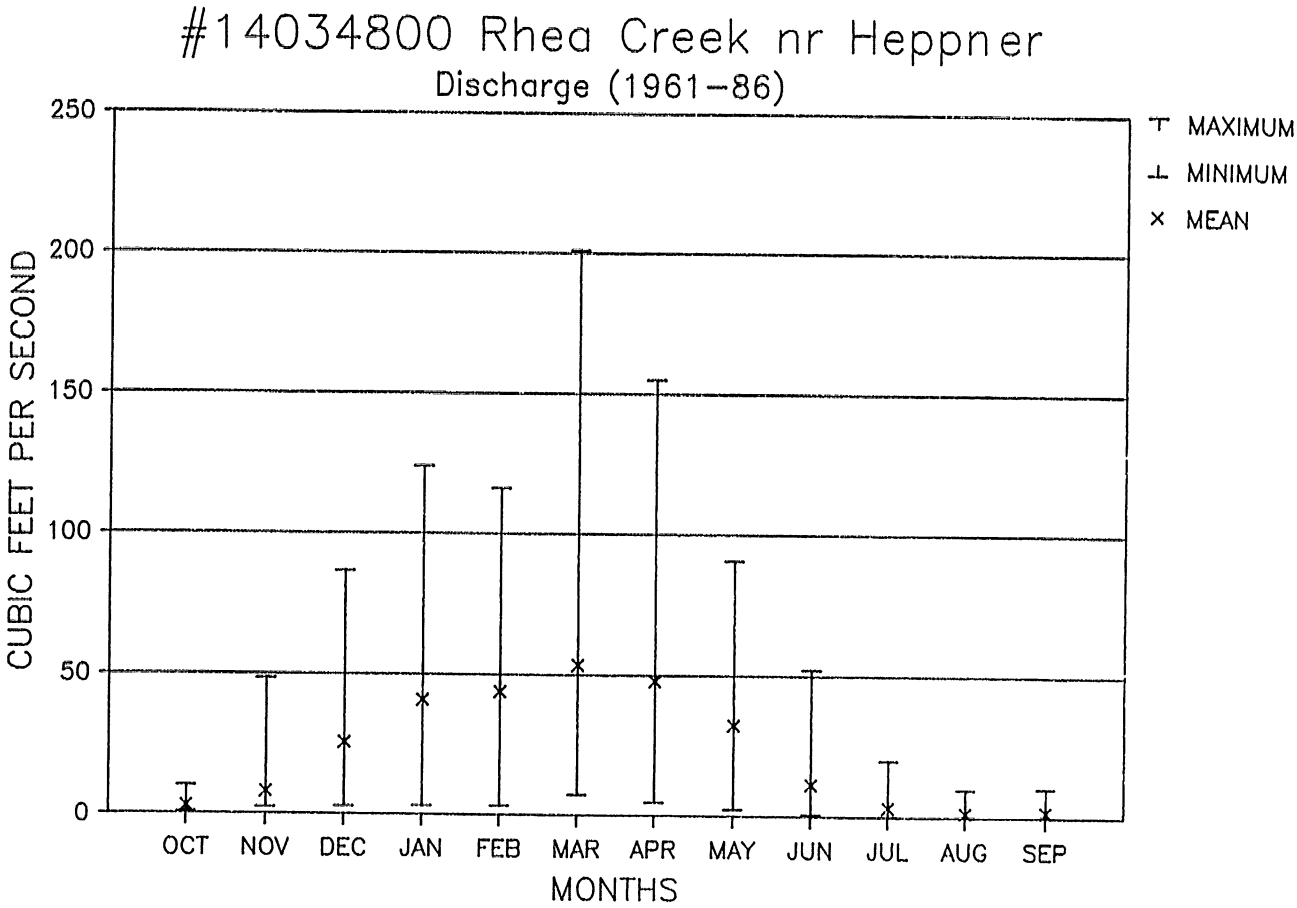
Average Flow by Month

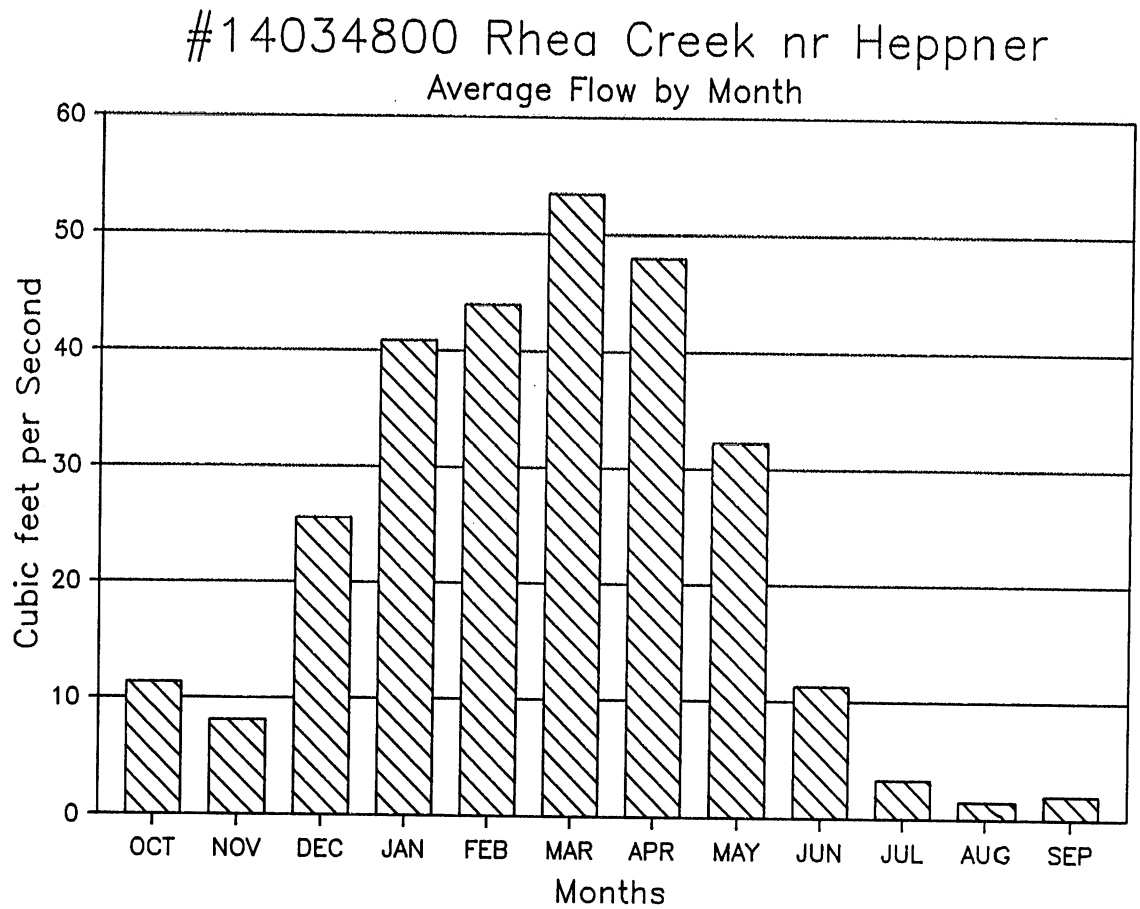


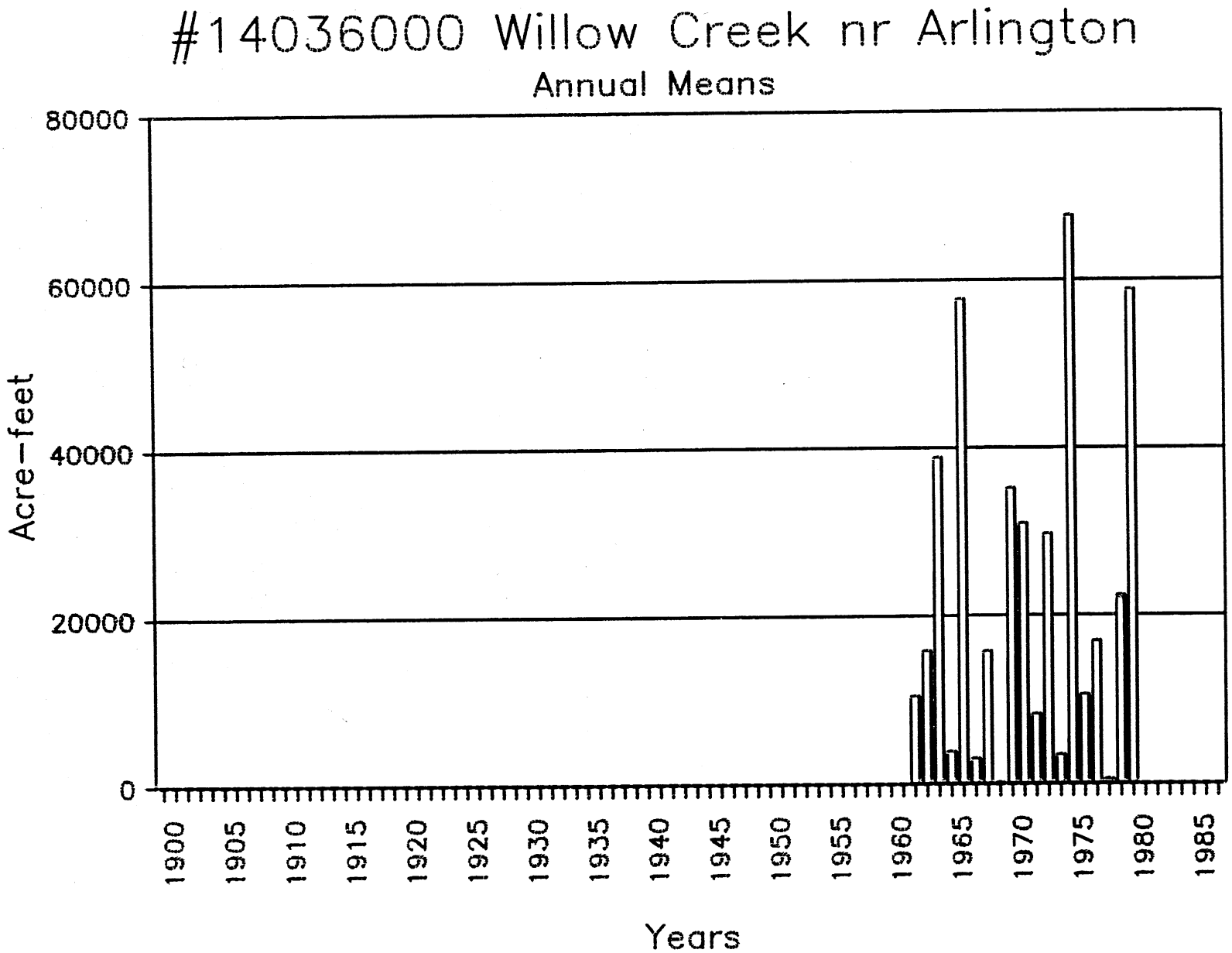

#14034800 Rhea Creek nr Heppner
Annual Means
Acre-Feet
50000
40000
30000
20000
10000
0
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
Months

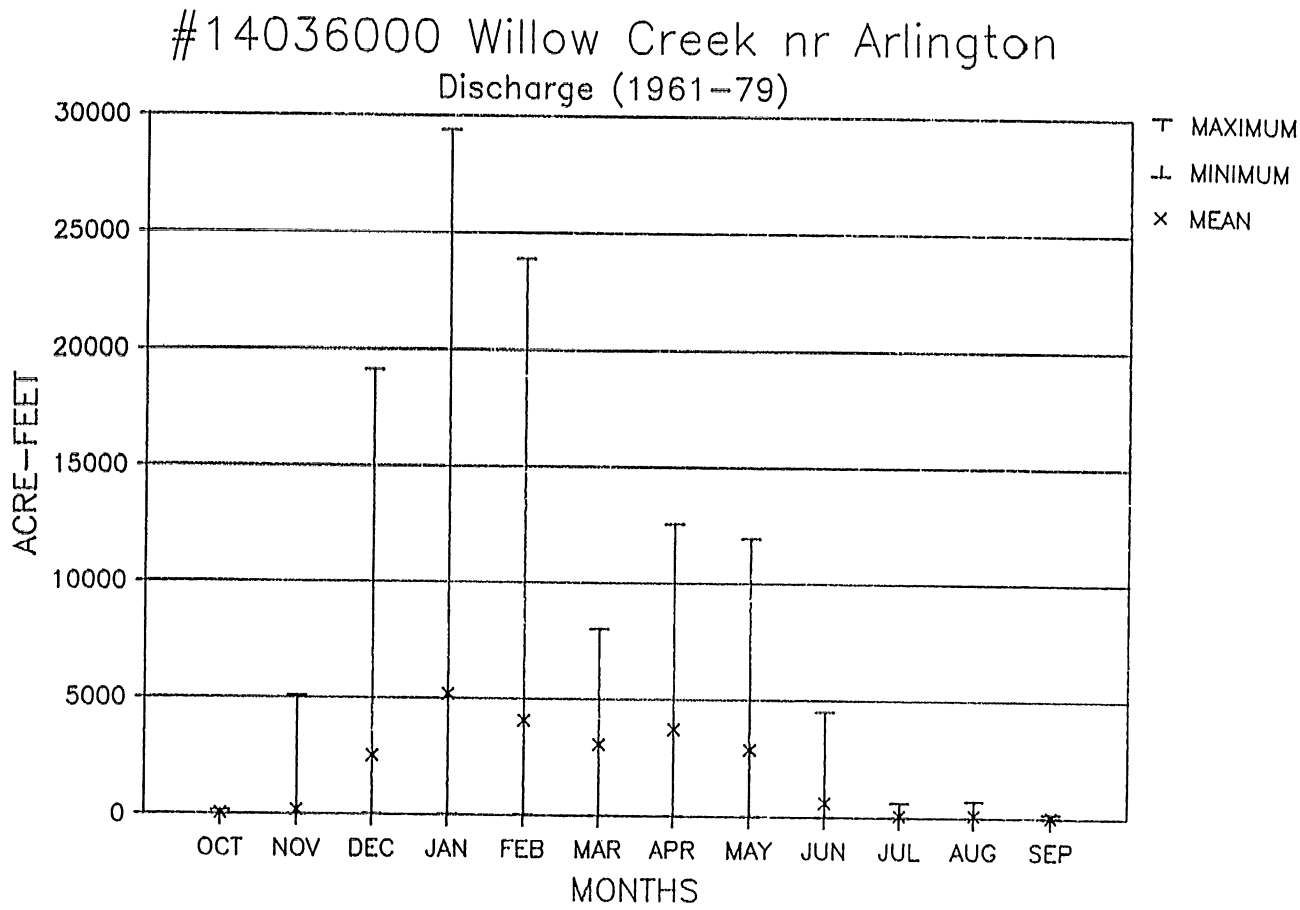

#14034800 Rhea Creek nr Heppner
Discharge (1961–86)
MAXIMUM
MINIMUM
MEAN
ACRE–FEET
10000
8000
6000
4000
2000
0
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
MONTHS

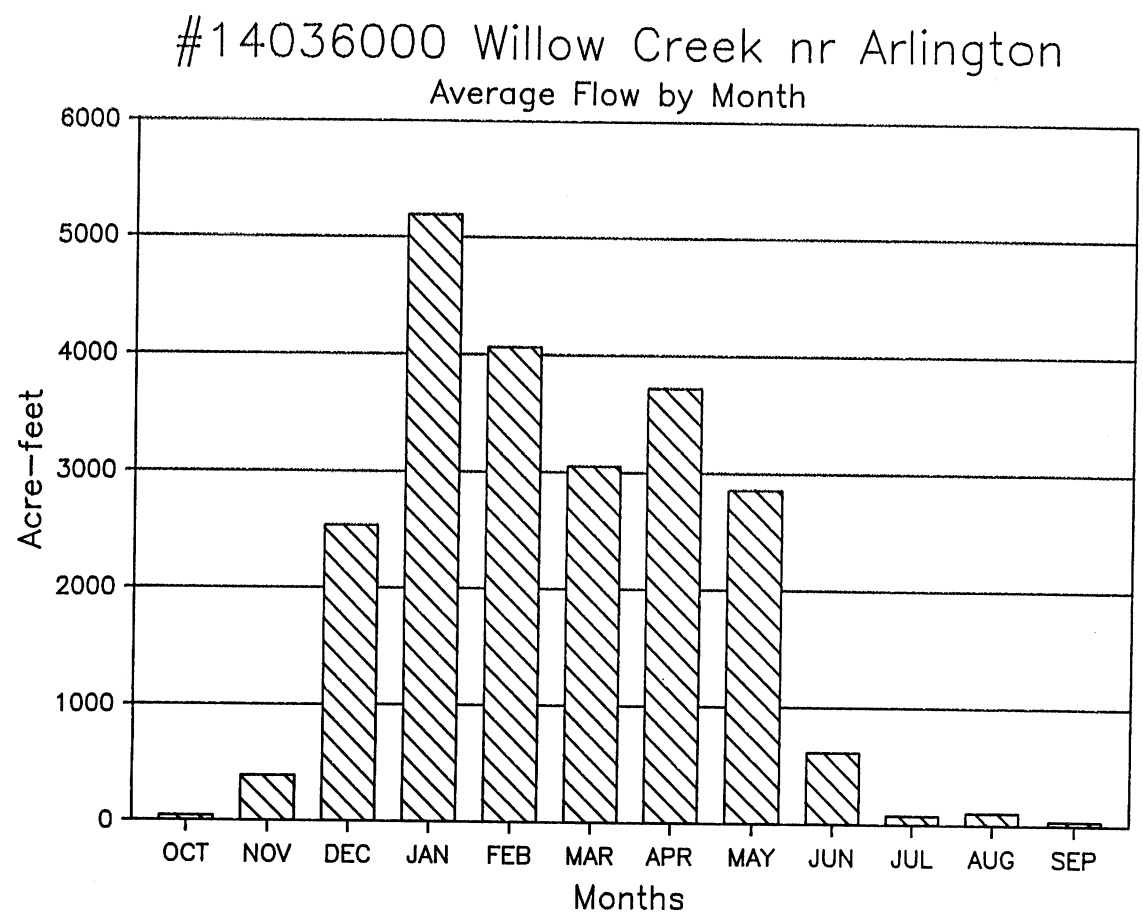

#14034800 Rhea Creek nr Heppner
Average Flow by Month
Acre–Feet
4000
3500
3000
2500
2000
1500
1000
500
0
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
Months


#14034800 Rhea Creek nr Heppner
Discharge (1961–86)
MAXIMUM
MINIMUM
MEAN
CUBIC FEET PER SECOND
250
200
150
100
50
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
MONTHS


#14034800 Rhea Creek nr Heppner
Average Flow by Month
Cubic feet per Second
60
50
40
30
20
10
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
Months

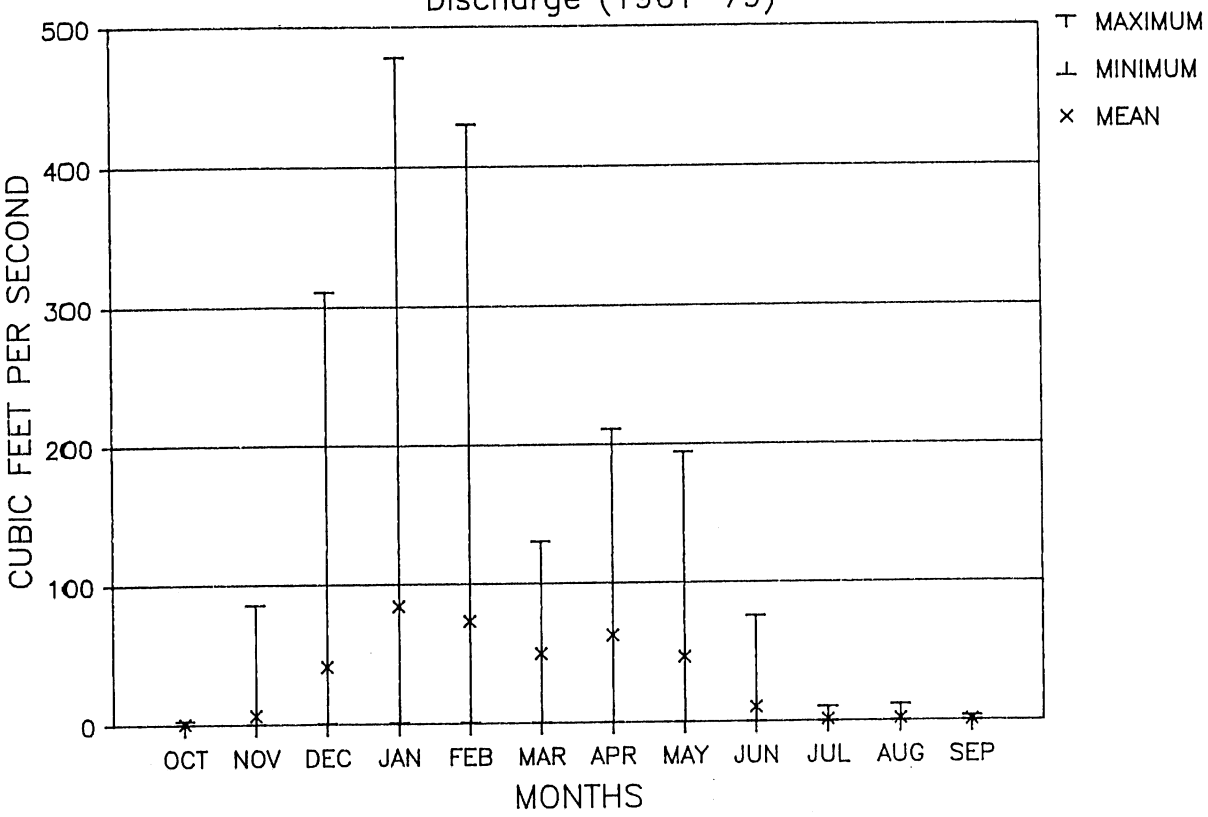

#14036000 Willow Creek nr Arlington
Annual Means
80000
60000
40000
20000
0
Acre-feet
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
Years


#14036000 Willow Creek nr Arlington
Discharge (1961-79)
MAXIMUM
MINIMUM
MEAN
ACRE-FEET
30000
25000
20000
15000
10000
5000
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
MONTHS


#14036000 Willow Creek nr Arlington
Average Flow by Month
Acre-feet
6000
5000
4000
3000
2000
1000
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
Months

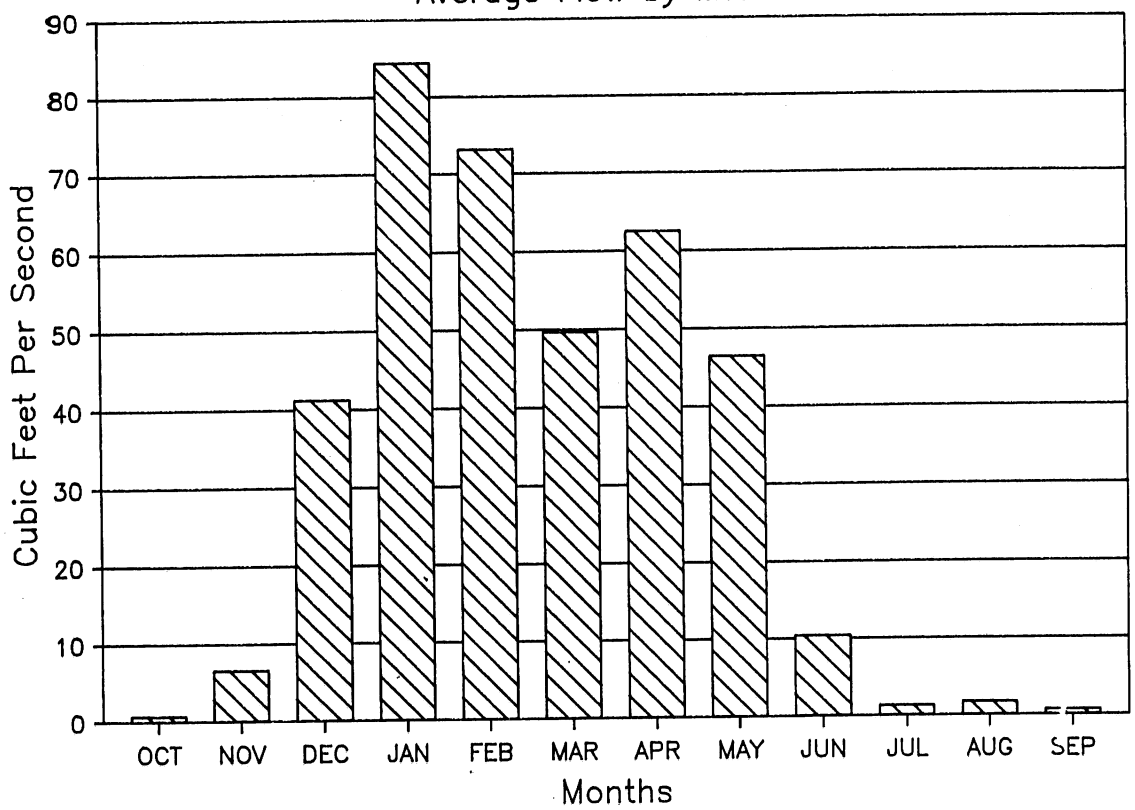
#14036000 Willow Creek nr Arlington

Discharge (1961–79)



#14036000 Willow Creek nr Arlington

Average Flow by Month



APPENDIX C

WATER QUALITY STANDARDS

Umatilla Basin

Beneficial Water Uses to be Protected

340-41-642 Water quality in the Umatilla River Basin (see Figures 1 and 12) shall be managed to protect the recognized beneficial uses as indicated in Table 11.

Stat. Auth.: ORS Ch. 468
Hist.: DEQ 128, f. & ef. 1-21-77

Water Quality Standards Not to be Exceeded (To be Adopted Pursuant to ORS 468.735 and Enforceable Pursuant to ORS 468.720, 468.990, and 468.992)

340-41-645 (1) Notwithstanding the water quality standards contained below, the highest and best practicable treatment and/ or control of wastes, activities, and flows shall in every case be provided so as to maintain dissolved oxygen and overall water quality at the highest possible levels and water temperatures, coliform bacterial concentrations, dissolved chemical substances, toxic materials, radioactivity, turbidities, color, odor, and other deleterious factors at the lowest possible levels.

(2) No wastes shall be discharged and no activities shall be conducted which either alone or in combination with other wastes or activities will cause violation of the following standards in the waters of the Umatilla River Basin:

(a) Dissolved oxygen (DO):

(A) Main Stem Columbia River (river miles 247 to 309): The DO concentration shall not be less than 90% of saturation.

(B) All other Basin waters: DO concentrations shall not be less than 75 percent of saturation at the seasonal low, or less than 95 percent of saturation in spawning areas during spawning, incubation, hatching, and fry stages of salmonid fishes.

(b) Temperature: No measurable increases shall be allowed outside of the assigned mixing zone, as measured relative to a control point immediately upstream from a discharge when stream temperatures are 68° F. or greater; or more than 0.5° F. increase due to a single-source discharge when receiving water temperatures are 67.5° F. or less; or more than 2° F. increase due to all sources combined when stream temperatures are 66° F. or less, except for specifically limited duration activities which may be authorized by DEQ under such conditions as DEQ and the Department of Fish and Wildlife may prescribe and which are necessary to accommodate legitimate uses or activities where temperatures in excess of this standard are unavoidable and all practical preventive techniques have been applied to minimize temperature rises. The Director shall hold a public hearing when a request for an exception to the temperature standard for a planned activity or discharge will in all probability adversely affect the beneficial uses.

(c) Turbidity (Jackson Turbidity Units, JTU): No more than a 10 percent cumulative increase in natural stream turbidities shall be allowed, as measured relative to a control point immediately upstream of the turbidity causing activity. However, limited duration activities necessary to address an emergency or to accommodate essential dredging, construction or other legitimate activities and which cause the standard to be exceeded may be authorized provided all practicable turbidity control techniques have been applied and one of the following has been granted:

(A) Emergency activities: Approval coordinated by DEQ with the Department of Fish and Wildlife under conditions they may prescribe to accommodate response to emergencies or to protect public health and welfare.

(B) Dredging, Construction or other Legitimate Activities: Permit or certification authorized under terms of Section 401 or 404 (Permits and Licenses, Federal Water Pollution Control Act) or OAR 141-85-100 et seq. (Removal and Fill Permits, Division of State Lands), with limitations and conditions governing the activity set forth in the permit or certificate.

(d) pH (hydrogen ion concentration): pH values shall not fall outside the following ranges:

(A) Columbia River (river miles 247 to 309): 7.0 to 8.5.

(B) All other Basin streams: 6.5 to 8.5.

(e) Organisms of the coliform group where associated with fecal sources (MPN or equivalent MF using a representative number of samples): A log mean of 200 fecal coliform per 100 milliliters based on a minimum of 5 samples in a 30-day period with no more than 10 percent of the samples in the 30-day period exceeding 400 per 100 ml.

(f) Bacterial pollution or other conditions deleterious to waters used for domestic purposes, livestock watering, irrigation, or bathing, or otherwise injurious to public health shall not be allowed.

(g) The liberation of dissolved gases, such as carbon dioxide, hydrogen sulfide, or other gases in sufficient quantities to cause objectionable odors or to be deleterious to fish or other aquatic life, navigation, recreation, or other reasonable uses made of such waters shall not be allowed.

(h) The development of fungi or other growths having a deleterious effect on stream bottoms, fish or other aquatic life, or which are injurious to health, recreation, or industry shall not be allowed.

(i) The creation of tastes or odors or toxic or other conditions that are deleterious to fish or other aquatic life or affect the potability of drinking water or the palatability of fish or shellfish shall not be allowed.

(j) The formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry shall not be allowed.

(k) Objectionable discoloration, scum, oily sleek or floating solids, or coating of aquatic life with oil films shall not be allowed.

(l) Aesthetic conditions offensive to the human senses of sight, taste, smell, or touch shall not be allowed.

(m) Radioisotope concentrations shall not exceed maximum permissible concentrations (MPC's) in drinking water, edible fishes or shellfishes, wildlife, irrigated crops, livestock and dairy products, or pose an external radiation hazard.

(n) The concentration of total dissolved gas relative to atmospheric pressure at the point of sample collection shall not exceed one hundred and ten percent (110%) of saturation, except when stream flow exceeds the 10-year, 7-day average flood. However, for Hatchery receiving waters and waters of less than 2 feet in depth, the concentration of total dissolved gas relative to atmospheric pressure at the point of sample collection shall not exceed one hundred and five percent (105%) of saturation.

(o) Total Dissolved Solids: Guide concentrations listed below shall not be exceeded unless otherwise specifically authorized by DEQ upon such conditions as it may deem necessary to carry out the general intent of this plan and to protect the beneficial uses set forth in rule 340-41-642: Columbia River – 200.0 mg/l.

(p) Toxic Substances:

(A) Toxic substances shall not be introduced above natural background levels in the waters of the state in amounts, concentrations, or combinations which may be harmful, may chemically change to harmful forms in the environment, or may bioaccumulate to levels that adversely affect public health, safety, or welfare; aquatic life; or other designated beneficial uses.

(B) Levels of toxic substances shall not exceed the most recent criteria values for organic and inorganic pollutants established by EPA and published in **Quality Criteria for Water** (1986). A list of the criteria is presented in Table 20.

(C) The criteria in paragraph (B) of this subsection shall apply unless data from scientifically valid studies demonstrate that the most sensitive designated beneficial uses will not be adversely affected by exceeding a criterion or that a more restrictive criterion is warranted to protect beneficial uses, as accepted by the Department on a site specific basis. Where no published EPA criteria exist for a toxic substance, public health advisories and other published scientific literature may be considered and used, if appropriate, to set guidance values.

(D) Bio-assessment studies such as laboratory bioassays or instream measurements of indigenous biological communities, shall be conducted, as the Department deems necessary, to monitor the toxicity of complex effluents, other suspected discharges or chemical substances without numeric criteria, to aquatic life. These studies, properly conducted in accordance with standard testing procedures, may be considered as scientifically valid data for the purposes of paragraph (C) of this subsection. If toxicity occurs, the Department shall evaluate and implement measur necessary to reduce toxicity on a case-by-case basis.

(3) Where the natural quality parameters of waters of the Umatilla Basin are outside the numerical limits of the above assigned water quality standards, the natural water quality shall be the standard.

(4) Mixing zones:

(a) The Department may allow a designated portion of a receiving water to serve as a zone of initial dilution for waste waters and receiving waters to mix thoroughly and this zone will be defined as a mixing zone.

(b) The Department may suspend all or part of the water quality standards, or set less restrictive standards, in the defined mixing zone, provided that the following conditions are met:

(A) The water within the mixing zone shall be free of:

(i) Materials in concentrations that will cause acute (96HLC50) toxicity to aquatic life. Acute toxicity is measured as the lethal concentration that causes 50 percent mortality of organisms within a 96-hour test period.

(ii) Materials that will settle to form objectionable deposits.

(iii) Floating debris, oil, scum, or other materials that cause nuisance conditions.

(iv) Substances in concentrations that produce deleterious amounts of fungal or bacterial growths.

(B) The water outside the boundary of the mixing zone shall:

(i) Be free of materials in concentrations that will cause chronic (sublethal) toxicity. Chronic toxicity is measured as the concentration that causes long-term sublethal effec such as significantly impaired growth or reproduction aquatic organisms, during a testing period based on test species life cycle. Procedures and end points will be specified by the Department in waste water discharge permits.

(ii) Meet all other water quality standards under normal annual low flow conditions.

(c) The limits of the mixing zone shall be described in the waste water discharge permit. In determining the location, surface area, and volume of a mixing zone area, the Department may use appropriate mixing zone guidelines to assess the biological, physical, and chemical character of receiving waters, and effluent, and the most appropriate placement of the outfall, to protect instream water quality, public health, and other beneficial uses. Based on receiving water and effluent characteristics, the Department shall define a mixing zone in the immediate area of a waste discharge to:

(A) Be as small as feasible;

(B) Avoid overlap with any other mixing zones to the extent possible and be less than the total stream width as necessary to allow passage of fish and other aquatic organisms;

(C) Minimize adverse effects on the indigenous biological community especially when species are present that warrant special protection for their economic importance, tribal significance, ecological uniqueness, or for other similar reasons as determined by the Department;

(D) Not threaten public health;

(E) Minimize adverse effects on other designated beneficial uses outside the mixing zone.

(d) The Department may request the applicant of permitted discharge for which a mixing zone is required, to

bmit all information necessary to define a mixing zone, such as:

(A) Type of operation to be conducted;

(B) Characteristics of effluent flow rates and composition;

(C) Characteristics of low flows of receiving waters;

(D) Description of potential environmental effects;

(E) Proposed design for outfall structures.

(e) The Department may, as necessary, require mixing zone monitoring studies and/or bioassays to be conducted to evaluate water quality or biological status within and outside the mixing zone boundary.

(f) The Department may change mixing zone limits or require the relocation of an outfall if it determines that the water quality within the mixing zone adversely affects any existing beneficial uses in the receiving waters.

(5) Testing methods: The analytical testing methods for determining compliance with the water quality standards contained in this rule shall be in accordance with the most recent edition **of Standard Methods for the Examination of Water and Waste Water published jointly by the American Public Health Association, American Water Works Association, and Water Pollution Control Federation,** unless the Department has published an applicable superseding method, in which case testing shall be in accordance with the superseding method; provided, however, that testing in accordance with an alternative method shall comply with this rule if the Department has published the method or has approved the method in writing.

[**Publications:** The publication(s) referred to or incorporated by reference this rule are available from the office of the Department of Environmental ality.]

Stat. Auth.: ORS Ch. 468
Hist.: DEQ 128, f. & ef. 1-21-77; DEQ 1-1980, f. & ef. 1-9-80; DEQ 18-1987, f. & ef. 9-4-87

Minimum Design Criteria for Treatment and Control of Wastes

340-41-655 Subject to the implementation program set forth in rule 340-41-120, prior to discharge of any wastes from any new or modified facility to any waters of the Umatilla River Basin, such wastes shall be treated and controlled in facilities designed in accordance with the following minimum criteria (In designing treatment facilities, average conditions, and a normal range of variability are generally used in establishing design criteria. A facility once completed and placed in operation should operate at or near the design limit most of the time but may operate below the design criteria limit at times due to variables which are unpredictable or uncontrollable. This is particularly true for biological treatment facilities. The actual operating limits are intended to be established by permit pursuant to ORS 468.740 and recognize that the actual performance level may at times be less than the design criteria.):

(1) Sewage wastes:

(a) During periods of low stream flows (approximately May 1 to October 31): Treatment resulting in monthly average effluent concentrations not to exceed 20 mg/l of BOD and 20 mg/l of SS or equivalent control.

(b) During the period of high stream flows (approximately November 1 to April 30): A minimum of secondary eatment or equivalent control and unless otherwise specifically authorized by the Department, operation of all waste treatment and control facilities at maximum practicable efficiency and effectiveness so as to minimize waste discharges to public waters.

(c) Effluent BOD concentrations in mg/l, divided by the dilution factor (ratio of receiving stream flow to effluent flow) shall not exceed one (1) unless otherwise approved by the EQC.

(d) Sewage wastes shall be disinfected, after treatment, equivalent to thorough mixing with sufficient chlorine to provide a residual of at least 1 part per million after 60 minutes of contact time unless otherwise specifically authorized by permit.

(e) Positive protection shall be provided to prevent bypassing raw or inadequately treated sewage to public waters unless otherwise approved by the Department where elimination of inflow and infiltration would be necessary but not presently practicable.

(f) More stringent waste treatment and control requirements may be imposed where special conditions may require.

(2) Industrial wastes:

(a) After maximum practicable inplant control, a minimum of secondary treatment or equivalent control (reduction of suspended solids and organic material where present in significant quantities, effective disinfection where bacterial organisms of public health significance are present, and control of toxic or other deleterious substances).

(b) Specific industrial waste treatment requirements shall be determined on an individual basis in accordance with the provisions of this plan, applicable federal requirements, and the following:

(A) The uses which are or may likely be made of the receiving stream;

(B) The size and nature of flow of the receiving stream;

(C) The quantity and quality of wastes to be treated; and

(D) The presence or absence of other sources of pollution on the same watershed.

(c) Where industrial, commercial, or agricultural effluents contain significant quantities of potentially toxic elements, treatment requirements shall be determined utilizing appropriate bioassays.

(d) Industrial cooling waters containing significant heat loads shall be subjected to offstream cooling or heat recovery prior to discharge to public waters.

(e) Positive protection shall be provided to prevent bypassing of raw or inadequately treated industrial wastes to any public waters.

(f) Facilities shall be provided to prevent and contain spills of potentially toxic or hazardous materials and a positive program for containment and cleanup of such spills should they occur shall be developed and maintained.

Stat. Auth.: ORS Ch. 468
Hist.: DEQ 128, f. & ef. 1-21-77

Walla Walla Basin

Beneficial Water Uses to be Protected

340-41-682 Water quality in the Walla Walla River Basin (see Figures 1 and 13) shall be managed to protect the recognized beneficial uses as indicated in Table 12.

Stat. Auth.: ORS Ch. 468
Hist.: DEQ 128, f. & ef. 1-21-77; DEQ 9-1985, f. & ef. 8-6-85

Water Quality Standards Not to be Exceeded (To be Adopted Pursuant to ORS 468.735 and Enforceable Pursuant to ORS 468.720, 468.990, and 468.992)

340-41-685 (1) Notwithstanding the water quality standards contained below, the highest and best practicable treatment and/ or control of wastes, activities, and flows shall in every case be provided so as to maintain dissolved oxygen and overall water quality at the highest possible levels and water temperatures, coliform bacteria concentrations, dissolved chemical substances, toxic materials, radioactivity, turbidities, color, odor, and other deleterious factors at the lowest possible levels.

(2) No wastes shall be discharged and no activities shall be conducted which either alone or in combination with other wastes or activities will cause violation of the following standards in the waters of the Walla Walla River Basin:

(a) Dissolved oxygen (DO): DO concentrations shall not be less than 75 percent of saturation at the seasonal low, or less than 95 percent of saturation in spawning areas during spawning, incubation, hatching, and fry stages of salmonid fishes.

(b) Turbidity (Jackson Turbidity Units, JTU): No more than a 10 percent cumulative increase in natural stream turbidities shall be allowed, as measured relative to a control point immediately upstream of the turbidity causing activity. However, limited duration activities necessary to address an emergency or to accommodate essential dredging, construction or other legitimate activities and which cause the standard to be exceeded may be authorized provided all practicable turbidity control techniques have been applied and one of the following has been granted:

(A) Emergency activities: Approval coordinated by DEQ with the Department of Fish and Wildlife under conditions they may prescribe to accommodate response to emergencies or to protect public health and welfare.

(B) Dredging, Construction or other Legitimate Activities: Permit or certification authorized under terms of Section 401 or 404 (Permits and Licenses, Federal Water Pollution Control Act) or OAR 141-85-100 et seq. (Removal and Fill Permits, Division of State Lands), with limitations and conditions governing the activity set forth in the permit or certificate.

(c) pH (hydrogen ion concentration): pH values shall not fall outside the range of 6.5 to 8.5.

(d) Organisms of the coliform group where associated with fecal sources (MPN or equivalent MF using a representative number of samples): Main stem Walla Walla River: Organisms of the coliform group where associated with fecal sources (MPN or equivalent MF using a representative number of samples): A log mean of 200 fecal coliform per 100 milliliters based on a minimum of 5 samples in a 30-day period with no more than 10 percent of the samples in the 30-day period exceeding 400 per 100 ml.

(e) Bacterial pollution or other conditions deleterious to waters used for domestic purposes, livestock watering, irrigation, bathing, or shellfish propagation, or otherwise injurious to public health shall not be allowed.

(f) The liberation of dissolved gases, such as carbon dioxide, hydrogen sulfide, or other gases in sufficient quantities to cause objectionable odors or to be deleterious to fish or other aquatic life, navigation, recreation, or other reasonable uses made of such waters shall not be allowed.

(g) The development of fungi or other growths having a deleterious effect on stream bottoms, fish or other aquatic life, or which are injurious to health, recreation, or industry shall not be allowed.

(h) The creation of tastes or odors or toxic or other conditions that are deleterious to fish or other aquatic life or affect the potability of drinking water or the palatability of fish or shellfish shall not be allowed.

(i) The formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry shall not be allowed.

(j) Objectionable discoloration, scum, oily sleek or floating solids, or coating of aquatic life with oil films shall not be allowed.

(k) Aesthetic conditions offensive to the human senses of sight, taste, smell, or touch shall not be allowed.

(l) Radioisotope concentrations shall not exceed maximum permissible concentrations (MPC's) in drinking water, edible fishes or shellfishes, wildlife, irrigated crops, livestock and dairy products, or pose an external radiation hazard.

(m) The concentration of total dissolved gas relative to atmospheric pressure at the point of sample collection shall not exceed one hundred and ten percent (110%) of saturation, except when stream flow exceeds the 10-year, 7-day average flood. However, for Hatchery receiving waters and waters of less than 2 feet in depth, the concentration of total dissolved gas relative to atmospheric pressure at the point of sample collection shall not exceed one hundred and five percent (105%) of saturation.

(n) Total Dissolved Solids: Guide concentrations listed below shall not be exceeded unless otherwise specifically authorized by DEQ upon such conditions as it may deem necessary to carry out the general intent of this plan and to protect the beneficial uses set forth in rule 340-41-682: 200.0 mg/l.

(o) Temperature: No measureable increase when river temperatures are 68° F. or greater; or more than 0.5° F. due to a single-source discharge when receiving waters are 67.5° F. or less; or more than 2° F. increase due to all sources combined when river temperatures are 66° F. or less.

(p) Toxic Substances:

(A) Toxic substances shall not be introduced above natural background levels in the waters of the state in amounts, concentrations, or combinations which may be harmful, may chemically change to harmful forms in the environment, or may bioaccumulate to levels that adversely affect public health, safety, or welfare; aquatic life; or other designated beneficial uses.

(B) Levels of toxic substances shall not exceed the most recent criteria values for organic and inorganic pollutants established by EPA and published in **Quality Criteria for Water**(1986). A list of the criteria is presented in Table 20.

(C) The criteria in paragraph (B) of this subsection shall apply unless data from scientifically valid studies demonstrate that the most sensitive designated beneficial uses will not be adversely affected by exceeding a criterion or that a more restrictive criterion is warranted to protect beneficial uses, as accepted by the Department on a site specific basis. Where no published EPA criteria exist for a toxic substance, public health advisories and other published scientific literature may be considered and used, if appropriate, to set guidance values.

(D) Bio-assessment studies such as laboratory bioassays or instream measurements of indigenous biological communities shall be conducted, as the Department deems necessary, to monitor the toxicity of complex effluents, other suspected discharges or chemical substances without numeric criteria, to aquatic life. These studies, properly conducted in accordance with standard testing procedures, may be considered as scientifically valid data for the purposes of paragraph (C) of this subsection. If toxicity occurs, the Department shall evaluate and implement measures necessary to reduce toxicity on a case-by-case basis.

(3) Where the natural quality parameters of waters of the Walla Walla River Basin are outside the numerical limits of the above assigned water quality standards, the natural water quality shall be the standard.

(4) Mixing zones:

(a) The Department may allow a designated portion of a receiving water to serve as a zone of initial dilution for waste waters and receiving waters to mix thoroughly and this zone will be defined as a mixing zone.

(b) The Department may suspend all or part of the water quality standards, or set less restrictive standards, in the defined mixing zone, provided that the following conditions are met:

(A) The water within the mixing zone shall be free of:

(i) Materials in concentrations that will cause acute (96HLC50) toxicity to aquatic life. Acute toxicity is measured as the lethal concentration that causes 50 percent mortality of organisms within a 96-hour test period.

(ii) Materials that will settle to form objectionable deposits.

(iii) Floating debris, oil, scum, or other materials that cause nuisance conditions.

(iv) Substances in concentrations that produce deleterious amounts of fungal or bacterial growths.

(B) The water outside the boundary of the mixing zone shall:

(i) Be free of materials in concentrations that will cause chronic (sublethal) toxicity. Chronic toxicity is measured as the concentration that causes long-term sublethal effects, such as significantly impaired growth or reproduction in aquatic organisms, during a testing period based on test species life cycle. Procedures and end points will be specified by the Department in waste water discharge permits.

(ii) Meet all other water quality standards under normal annual low flow conditions.

(c) The limits of the mixing zone shall be described in the waste water discharge permit. In determining the location, surface area, and volume of a mixing zone area, the Department may use appropriate mixing zone guidelines to assess the biological, physical, and chemical character of receiving waters, and effluent, and the most appropriate placement of the outfall, to protect instream water quality, public health, and other beneficial uses. Based on receiving water and effluent characteristics, the Department shall define a mixing zone in the immediate area of a waste water discharge to:

(A) Be as small as feasible;

(B) Avoid overlap with any other mixing zones to the extent possible and be less than the total stream width as necessary to allow passage of fish and other aquatic organisms;

(C) Minimize adverse effects on the indigenous biological community especially when species are present that warrant special protection for their economic importance, tribal significance, ecological uniqueness, or for other similar reasons as determined by the Department;

(D) Not threaten public health;

(E) Minimize adverse effects on other designated beneficial uses outside the mixing zone.

(d) The Department may request the applicant of a permitted discharge for which a mixing zone is required, to submit all information necessary to define a mixing zone, such as:

(A) Type of operation to be conducted;

(B) Characteristics of effluent flow rates and composition;

(C) Characteristics of low flows of receiving waters;

(D) Description of potential environmental effects;

(E) Proposed design for outfall structures.

(e) The Department may, as necessary, require mixing zone monitoring studies and/or bioassays to be conducted to evaluate water quality or biological status within and outside the mixing zone boundary.

(f) The Department may change mixing zone limits or require the relocation of an outfall if it determines that the water quality within the mixing zone adversely affects any existing beneficial uses in the receiving waters.

(5) Testing methods: The analytical testing methods for determining compliance with the water quality standards contained in this rule shall be in accordance with the most recent edition of **Standard Methods for the Examination of Water and Waste Water published jointly by the American Public Health Association, American Water Works Association, and Water Pollution Control Federation**, unless the Department has published an applicable superseding method, in which case testing shall be in accordance with the superseding method; provided, however, that testing in accordance with an alternative method shall comply with this rule if the Department has published the method or has approved the method in writing.

[**Publications:** The publication(s) referred to or incorporated by reference in this rule are available from the office of the Department of Environmental Quality.]

Stat. Auth.: ORS Ch. 468
Hist.: DEQ 128, f. & ef. 1-21-77; DEQ 1-1980, f. & ef. 1-9-80; DEQ 18-1987, f. & ef. 9-4-87

Minimum Design Criteria for Treatment and Control of Wastes

340-41-695 Subject to the implementation program set forth in rule 340-41-120, prior to discharge of any wastes from any new or modified facility to any waters of the Walla Walla River Basin, such wastes shall be treated and controlled in facilities designed in accordance with the following minimum criteria (In designing treatment facilities, average conditions and a normal range of variability are generally used in establishing design criteria. A facility once completed and placed in operation should operate at or near the design limit most of the time but may operate below the design criteria limit at times due to variables which are unpredictable or uncontrollable. This is particularly true for biological treatment facilities. The actual operating limits are intended to be established by permit pursuant to ORS 468.740 and

recognize that the actual performance level may at times be less than the design criteria.):

(1) Sewage wastes:

(a) During periods of low stream flows (approximately April 1 to October 31): Treatment resulting in monthly average effluent concentrations not to exceed 20 mg/l of BOD and 20 mg/l of suspended solids or equivalent control.

(b) During the period of high stream flows (approximately November 1 to March 31): A minimum of secondary treatment or equivalent control and unless otherwise specifically authorized by the Department, operation of all waste treatment and control facilities at maximum practicable efficiency and effectiveness so as to minimize waste discharges to public waters.

(c) Effluent BOD concentrations in mg/l, divided by the dilution factor (ratio of receiving stream flow to effluent flow) shall not exceed one (1) unless otherwise approved by the EQC.

(d) Sewage wastes shall be disinfected, after treatment, equivalent to thorough mixing with sufficient chlorine to provide a residual of at least 1 part per million after 60 minutes of contact time unless otherwise specifically authorized by permit.

(e) Positive protection shall be provided to prevent bypassing raw or inadequately treated sewage to public waters unless otherwise approved by the Department where elimination of inflow and infiltration would be necessary but not presently practicable.

(f) More stringent waste treatment and control requirements may be imposed where special conditions may require.

(2) Industrial wastes:

(a) After maximum practicable inplant control, a minimum of secondary treatment or equivalent control (reduction of suspended solids and organic material where present in significant quantities, effective disinfection where bacterial organisms of public health significance are present, and control of toxic or other deleterious substances).

(b) Specific industrial waste treatment requirements shall be determined on an individual basis in accordance with the provisions of this plan, applicable federal requirements, and the following:

(A) The uses which are or may likely be made of the receiving stream;

(B) The size and nature of flow of the receiving stream;

(C) The quantity and quality of wastes to be treated; and

(D) The presence or absence of other sources of pollution on the same watershed.

(c) Where industrial, commercial, or agricultural effluents contain significant quantities of potentially toxic elements, treatment requirements shall be determined utilizing appropriate bioassays.

(d) Industrial cooling waters containing significant heat loads shall be subjected to offstream cooling or heat recovery prior to discharge to public waters.

(e) Positive protection shall be provided to prevent bypassing of raw or inadequately treated industrial wastes to any public waters.

(f) Facilities shall be provided to prevent and contain spills of potentially toxic or hazardous materials and a positive program for containment and cleanup of such spills should they occur shall be developed and maintained.

(November, 1987)

Stat. Auth.: ORS Ch. 468
Hist.: DEQ 128, f. & ef. 1-21-77

APPENDIX D

BEST MANAGEMENT PRACTICES

SUMMARY OF BEST MANAGEMENT PRACTICES

BMP	Definition	Purpose	Estimated cost-1978 base
Brush Management	Management and manipulation of stands of brush by mechanical, chemical, or biological means, or by controlled burning on range-and, native pasture, pasture-land, recreation-land andwildlife land.	To reduce competition from undesirable brush species so that a desirable protective cover of grass can be established or existing stand can be improved The improved stand will reduce runoff and possible sedimentation.	$5.25-$8.00/AC
Chiseling and Subsoiling	Loosening the soil without inverting, with a minimum of mixing the surface soil, to shatter restrictive layers below normal plow depth that inhibit water movement or root development.	To improve water and root penetration and aeration by breaking up tillage pans or other restrictive layers that impede water movement into the soil and increase runoff.	$20.00-$35.00/AC
Conservation Cropping System	Growing crops in combination with needed cultural and management measures. Cropping systems include rotations that contain grasses and legumes as well as rotations in which the desired benefits are achieved without the use of such crops. Such management measures as the use of deep furrow drills, need for early seeding where possible, cross slope tillage, and the use of permanent or winter annual cover crops are included.	Two basic purposes are for improvement and maintenance of a good physical condition in the soil and to protect the soil during critical periods when erosion usually occurs.	$25.00/AC
Contour Farming	Farming sloping land in such a way that plowing, preparing land, planting and cultivating are done on the contour.	Contour tillage leaves marks that slow runoff and allow more moisture to move into the soil. Lower runoff velocity also reduces the capacity of erosion.	$6.00/AC

BMP	Definition	Purpose	Estimated cost-1978 base
Control Weed Spraying	Limit weed spraying to the minimum area needed to control undesirable weeds.	To minimize weed and other vegetation kill on erodible slopes so as to reduce the area of bare soil exposed to erosion.	N/A
Critical Area Planting	Planting vegetation such as trees, shrubs, vines, grasses, or legumes on critical areas.	To establish a protective vegetative cover on sediment-producing, highly erodible or severely eroded areas such as dams, dikes, mine spoil, surface mined areas, cuts, fills, levees, roads, skid trails, landings, and denuded or gullied areas where vegetation is difficult to establish with usual seeding and planting methods.	$44.00-$59.00/AC
Crop Residue Use	Using plant residues to protect cultivated fields during critical erosion periods. Includes stubble mulching. It may be necessary to grow long-strawed grain varieties to produce adequate residues for mulching. The need for occasional mold board plowing is recognized with this practice.	To break the impact of raindrops on the soil surface which helps prevent soil erosion, slows runoff allowing more water to move into the soil, and filters sediment out of the runoff. Also very effective in wind erosion control.	$7.50-$20.00/AC
Culvert Sizing and Location	Selecting and placing enough culverts of adequate size and capacity in road construction applications.	To provide adequate culvert capacity to pass critical flows, avoid washouts, and minimize streambed erosion at the outfall.	N/A
Dam - Multi-Purpose	A structure built across a stream or natural watercourse with designed reservoir capacity for two or or more purposes such as floodwater retention irrigation supply, municipal supply, recreation, etc.	To store excess runoff and avoid adverse impacts of high flows and release water during runoff to supplement water supplies and instream flows.	N/A

BMP	Definition	Purpose	Estimated cost-1978 base
Debris Basin	A barrier or dam constructed across a waterway or at other suitable locations to form a silt or sediment basin.	To collect runoff and allow sediment to settle out. Basins help keep sediment on the land where it originates.	$300-400/ basin
Deferred Grazing	Postponing grazing or resting grazing ground for a prescribed period.	To help insure a vigorous grass stand to help reduce runoff and sedimentation.	$0.50/AC
Diversion	A channel with a supporting ridge on the lower side constructed across the slope. Normally installed as a single structure to intercept runoff before it damages cropland, pastures, farmsteads, or other conservation measures.	To reduce excessive erosion and sedimentation by intercepting runoff from higher areas and diverting it to safe, nonerosive outlets before it reaches more erosive areas.	$20.00-$50.00/AC
Emergency Tillage	Roughening the soil surface by such methods as listerring, ridging, chiseling, using a duckfoot sweep, or other means. Usually done during critical wind erosion periods.	To provide temporary protection to tilled land in danger of being eroded by wind because of in sufficient residue, or cloddiness	$4.80/AC
Fencing	Enclosing or dividing an area of land with a suitable, permanent, structure that acts as a barrier to livestock, big game, or people.	To achieve more even livestock distribution on the range. To exclude grazing or other activity in critical erosion areas such as streambanks. To allow more vegetative growth for bank protection.	$2,500/MI
Field Windbreak	A strip or belt of trees or shrubs established within or adjacent to a field.	To reduce soil blowing, control snow drifting, conserve moisure, protect crops, orchards, livestock, and wildlife.	$0.50/FT

BMP	Definition	Purpose	Estimated cost-1978 base
Filter Strip	A strip or area of vegetation for removing sediment, organic matter, and other pollutants from runoff.	To remove sediment and other pollutants from runoff by filtration, infiltration, absorption, adsorption, decomposition, and volitilization.	$0.25-$2.00/AC
Flatten Cut and Fill Slopes	Laying back cut and fill slopes to reduce their steepness and erosion potential.	To improve the chance of stabilizing a slope through seeding and reduce the likelihood of soil sluffing when saturated with water.	N/A
Grade Stabilization Structure	A structure to stabilize the grade or to control head cutting in natural or artificial channels, or prevent the formation or variance of gullies.	To stabilize the grade in channels or to control gully erosion where flow concentration or flow velocity poses the potential for erosion.	$600-$1,000/structure
Grassed Waterway or Outlet	A natural or constructed waterway or outlet shaped, graded and vegetated to safely dispose of runoff from a field, diversion, terrace or other structure.	To reduce velocities of concentrated runoff to minimize erosion and filter sediment from runoff.	$92.00-$300/AC
Graveling Roads	Graveling and grading dirt roads.	To minimize soil erosion from dirt roads by protecting roads from runoff, gullying and rutting from vehicle travel on a soft road bed.	N/A
Irrigation System: Drip, Sprinkler Surface and Subsurface	A planned irrigation system where all necessary facilities have been installed for the efficient application of water.	To apply irrigation water efficiently while minimizing runoff and erosion.	$200.00-$400/AC
Irrigation Water Management	Determining and controlling the rate, amount and timing of water application to soils for crop water needs.	To reduce irrigation water runoff, field erosion and sedimentation. To apply irrigation water more efficiently to meet crop soil moisture needs and holding capacity.	$28.00/AC

BMP	Definition	Purpose	Estimated cost-1978 base
Livestock Exclusion	Excluding livestock from an area where grazing is not wanted.	To protect existing vetetation from grazing, protect new seeding from grazing so it can establish itself, protect critical soil areas from grazing and trailing and protect water supplies from direct pollution.	
Minimum Tillage	Limiting the number of cultural operations to those that are properly timed and essential to a crop and prevent soil damage.	To retard deterioration of soil structure, reduce soil compaction and formation of tillage pans and to improve soil aeration, permeability, and tilth.	$7.50-$20.00/AC
Mulching	Applying plant surface residues or other suitable materials not produced on the site to the soil surface.	To conserve moisture, prevent surface compaction or crusting, reduce runoff and erosion, control weeds, and help establish plant cover.	$100.00/AC
Pasture and Hayland Planting	Establishing or re-establishing long-term stands of adapted species of perennial, biennial, or reseeding forage plants.	To insure adequate vegetative cover is provided for both soil protection and forage production on land currently in pasture and hay production or on land being converted from an annual cropping pattern.	$44.00-$59.00/AC
Pipeline	Pipe installed to convey water for livestock or recreational use.	To convey water efficiently without erosion and for reasons of sanitation.	$0.75/FT
Planned Grazing System	A system in which two or more grazing units are alternately rested from grazing in a planned sequence over a period of years. The rest period may be throughout the year or during the growing season of the key plants.	To maintain or accelerate improvement in plant cover in all grazing units. Improved cover will reduce runoff and sedimentation.	$0.50/AC

BMP	Definition	Purpose	Estimated cost-1978 base
Proper Grazing Use	Grazing at an intensity which will maintain enough cover to protect the soil and maintain or improve the quantity and quality of desirable vegetation.	To increase the vigor and reproduction of key plants, accumulate litter and mulch needed to conserve soil and water, and reduce the fire hazard on forestlands.	$0.50/AC
Range Seeding	Establishing adapted plants by seeding on rangeland.	To establish or re-establish adapted plants on range areas where the vegetative cover is so depleted that it is neither providing adequate forage or adequate soil erosion protection.	$16.80/AC
Road Closure	Installing traffic control devices to keep traffic off the road during critical months.	To avoid erosion caused by rutting, potholing, and other damage to the road, road shoulders, and roadside ditches from traffic use during periods of heavy precipitation.	N/A
Road Location	Selecting road routes to avoid unstable soils, minimize impacts on streams, and reduce opportunities for the road location to be a source of erosion or sedimentation.	To minimize the chances of slumping, washouts, gullying, and other types of erosion that occur on roads, and road cuts and fills that contribute to turbidity and sedimentation in streams	N/A
Salting	A range practice in which salt blocks or other form of salt are placed away from the water source.	To help achieve more even livestock distribution by causing livestock to travel from water to the salt, grazing the pasture more evenly and reducing livestock impacts on riparian areas.	N/A
Spring Development	Improving springs and seeps by excavating, cleaning, capping or providing collection and storage facilities.	To develop a source of livestock water to improve the distri bution of grazing. Better livestock distribution reduces the possibility of overgrazing a portion of the grazing unit and creating an erosion hazard.	$300.00-$500.00/ development.

BMP	Definition	Purpose	Estimated cost-1978 base
Stock Trails and Walkways	A trail or walkway for livestock to improve the grazing distribution and access to forrage and water.	To provide or improve access to forage and water, reduce livestock concentrations, and control livestock to permit grazing use and planned grazing systems. To reduce over-grazing and creation of erosion hazards.	$0.22/FT
Streambank Protection	Stabilizing and protecting banks of streams, lakes, estuaries, or excavated channels against scour and erosion by use of vegetative or structural means.	To protect eroding banks from further erosive activity by installing either mechanical or vegetative controls and devices singly or in combination.	$37,000/ bank mile for rock riprap.
Stripcropping (Contour or Field)	Growing crops in a systematic arrangement of strips or bands on the contour or across the slope. The crops are arranged so that a strip of grass or close growing crop is alternated with a strip of clean-tilled crop or fallow.	To reduce soil erosion on sloping fields by reducing the length of run of runoff water through clean-tilled soil slowing the velocity of water and trapping sediment as the water passes through the grass strips.	$6.00/AC
Stripcropping, Wind	Growing wind resisting crops in strips alternating with row crops or fallow and arranged at angles to offset adverse wind effects.	To reduce soil blowing. Most effective when used in combination with plant residues, surface roughness, and field windbreaks.	N/A
Structures for Water Control	A structure in an irrigation, drainage, or other water management system that conveys water, controls the direction or rate of flow, or maintains a desired water surface elevation. Structures may also be for the protection of fish and wildlife.	To control the stage, discharge, distribution, delivery, or direction of flow of water in open channels or water use areas in such manner as to avoid erosion and the resulting sedimentation.	$10.00/AC

BMP	Definition	Purpose	Estimated cost-1978 base
Stubble Mulching	Managing plant residues on a year-round basis. Harvesting, tilling, planting, cultivating operations are performed in such a way that protective amounts of vegetation remain on the soil surface.	To reduce soil loss from wind and water, improve water infiltration, and improve the physical condition of the soil.	$0.50-$2.50/AC
Terrace	An earth embankment, a channel, or a ridge and channel constructed across the slope.	To: reduce slope length, erosion, sediment content in runoff water; intercept and conduct runoff at a safe velocity to a stable outlet; retain runoff for moisture conservation; prevent gully development; reform the land surface; improve farmability, and reduce flooding.	$0.35-$1.50/FT
Trough or Tank	A trough or tank with needed devices for water control and waste water disposal, installed to provide drinking water for livestock.	Used in conjunction with spring, pond or pipeline development to improve livestock distribution and reduce overgrazing and the resulting erosion.	$100.00-$125.00/unit.
Winterizing Roads	The use of water bars (small ditches built across the road to intercept water), crowning or shaping the road surface.	To prevent the concentration of water and its erosive effects on the road surface, shoulders, and roadside ditches.	N/A

N/A = not available