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WASHINGTON PUBLIC POWER SUPPLY SYSTEM

P.O. Box 968 • 3000 George Washington Way • Richland, Washington 99352-0968 • (509) 372-5000

April 30, 1996
GO2-96-093

Mr. Jason J. Zeller, Manager
Energy Facility Site Evaluation Council
P.O. Box 43172
Olympia, WA 98501-3172

Dear Mr. Zeller:

Subject: **SUPPLY SYSTEM NUCLEAR PLANT NO. 2**
ECOLOGICAL MONITORING PROGRAM ANNUAL REPORT FOR 1995

Reference: Letter dated March 27, 1996, JV Parrish (Supply System) to JJ Zeller (EFSEC), "Nonradiological Environmental Monitoring Program"

Enclosed, please find five (5) copies of the subject report which is submitted per Council Resolution No. 266. In the referenced letter the Supply System proposed to discontinue the monitoring activities because ten years of data have not disclosed any environmental impact attributable to plant operation. If you have questions concerning the report or the monitoring program, please contact W.A. Kiel at (509) 377-4490.

Sincerely,

R.L. Webring (Mail Drop PE08)
Vice President, Operations Support/PIO

Enclosures

cc (w/encl):
L Russell (WDOE-Kenn)
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SUBJECT: SEMIANNUAL RADIOACTIVE EFFLUENT RELEASE REPORT FOR PALO VERDE NUCLEAR GENERATING STATION AND WPPSS NUCLEAR PROJECT, UNIT 2

The following documents concerning our review of the subject facility are transmitted for your information.

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	PALO VERDE 1,2,3 EFFLUENT RELEASE REPORT FOR JAN-JUNE transmitted by Letter	8/31/94
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Office of Nuclear Reactor Regulation

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July 29, 1994

DOCKET NO(S): 50-397

Mr. Jerry Leitch
Radiation Program Manager, Region 10
Environmental Protection Agency
1200 Eisth Avenue
Seattle, WA 98101

SUBJECT: WNP-2 Operational Ecological Monitoring Program Annual Report and Radiological Environ Monitoring Program Annual Report

The following documents concerning our review of the subject facility are transmitted for your information.

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March 24, 1994

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Dr. William C. Cunningham
FDA Research Chemist
NIST Building 235/B125
Gaithersburg, MD 20899

SUBJECT: WASHINGTON PUBLIC POWER SUPPLY SYSTEM

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March 24, 1994

DOCKET NO(S). 50-397

Chief, Branch of Federal Activities
Division of Habitat Conservation
400 ARLSQ
U.S. Fish and Wildlife Service
1849 C Street, N.W.
Washington, D.C. 20240

SUBJECT: WASHINGTON PUBLIC POWER SUPPLY SYSTEM

The following documents concerning our review of the subject facility are transmitted for your information.

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March 23, 1994

DOCKET NO(S). 50-397

Mr. Jerry Leitch
Radiation Program Manager, Region 9
(A1-082)
Environmental Protection Agency
1200 Sixth Avenue
Seattle, WA 98101

SUBJECT: TRANSMITTAL OF ANNUAL REPORTS FOR WPPSS NUCLEAR PROJECT, UNIT 2

The following documents concerning our review of the subject facility are transmitted for your information.

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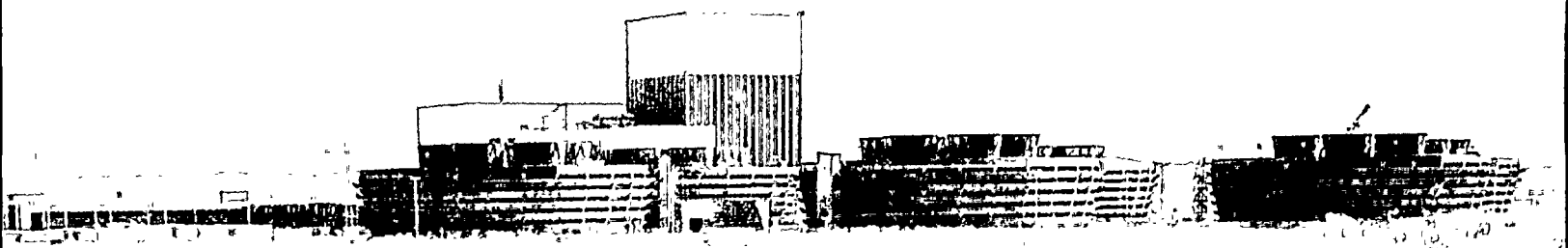
Washington Public Power Supply System



1995 Annual Report

Prepared by Environmental Sciences Department

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EXECUTIVE SUMMARY

The Ecological Monitoring Program is comprised of several elements which are intended to determine the effects of the operation of the Supply System's Nuclear Plant No. 2 on the environment. These program elements include: plant effluent and Columbia River water quality; vegetation cover and phytomass in selected plots; and soil chemistry at established sampling locations. The results of the 1995 monitoring efforts may be summarized as follows:

- Plant cooling water discharges had no discernible effect on Columbia River water quality.

- No measurable effects of plant cooling tower drift were observed on vegetation cover, phytomass, or soil chemistry. A dramatic increase in cover and phytomass was observed at most stations. This is in direct correlation with the record precipitation recorded during the growing season.

ACKNOWLEDGEMENTS

This report, prepared by the Washington Public Power Supply System, describes the soil and vegetation studies, and water quality programs for WNP-2.

Project Team

Terry E. Northstrom	Supervisor, Environmental Sciences
Deborah C. Singleton	Environmental Scientist
Richard E. Welch	Environmental Scientist

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1.0 INTRODUCTION

1.1 BACKGROUND

The Site Certification Agreement (SCA) for WNP-2 was approved on May 17, 1972, by the State of Washington and the Washington Public Power Supply System (Supply System). The SCA requires that environmental monitoring be conducted during the preoperational and operational phases of site development and use. The objective of the monitoring program is to provide an environmental measurement history for evaluation by the Supply System and the Washington State Energy Facility Site Evaluation Council (EFSEC) and to identify significant effects of plant operation on the environment. Since 1972, several revisions of the monitoring program have been approved by EFSEC in the form of SCA attachments and EFSEC resolutions Nos. 193, 194, 214, 239, and 266.

Most of the studies, analyses, and reports for the preoperational (1973-1984) environmental program of the SCA were performed by outside laboratories for the Supply System. The aquatic studies were in reports by Battelle Pacific Northwest Laboratories for the period of September 1974 through August 1978 (Battelle 1976, 1977, 1978, 1979a, 1979b) and by Beak Consultants, Inc. for the period of August 1978 through March 1980 (Beak 1980). The terrestrial program was performed and reports were prepared by Battelle from 1974 until 1979 (Rickard 1976, 1977, 1979a, 1979b) and then by Beak from 1980 to 1982 (Beak 1981, 1982a, 1982b).

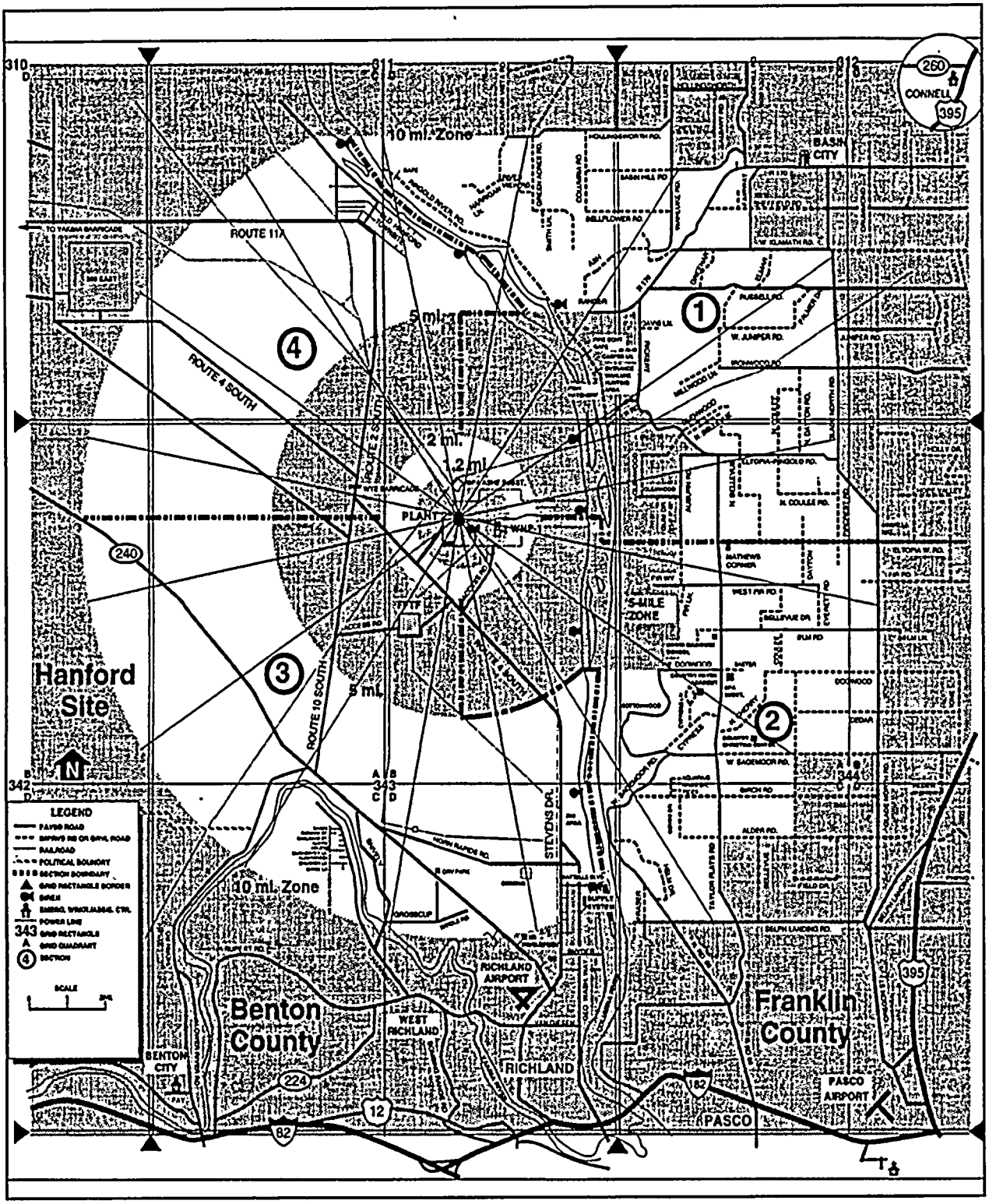
Since 1983, Supply System scientists have been responsible for the entire operational environmental monitoring program. Using the data acquired during 1984, the first comprehensive operational environmental annual report was prepared by Supply System scientists (Supply System 1985) and has since continued annually (Supply System 1986 through 1994). A few studies and reports were completed by Supply System personnel prior to the annual reports, including animal studies (Schleder 1982, 1983, 1984) and terrestrial monitoring (Northstrom 1984).

This report presents the results of the Ecological Monitoring Program for the period of January through December 1995.

1.2 THE SITE

The Supply System leases the WNP-2 site (441 hectares or 1089 acres) from the U. S. Department of Energy. WNP-2 lies within the boundaries of the Columbia Basin between the Cascade Range in Washington and Blue Mountains in Oregon and comprises approximately two-thirds of the area lying east of the Cascades. Approximately 5 km (3.25 miles) to the east, the site is bounded by the Columbia River. The plant communities within the region are described as shrub-steppe communities consisting of various layers of perennial grasses overlaid by a discontinuous layer of shrubs. In general, moisture relations do not support arborescent species, except along streambanks. In August 1984, a range fire destroyed much of the shrub cover on the Hanford site and temporarily modified the shrub-steppe associations which were formerly present.

Figure 1-1 WNP-2 Location Map



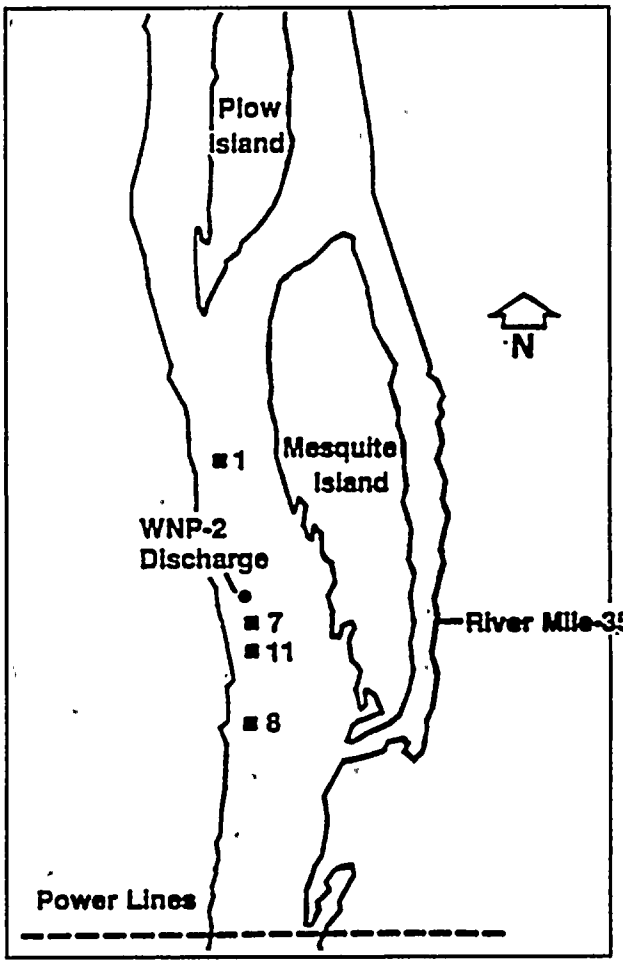
2.0 WATER QUALITY

2.1 INTRODUCTION

The water quality sampling stations are located near the west bank of the Columbia River at river mile 352. Sampling was limited to the main channel on the Benton County side. Near the site, the river averages 370 meters (1200 feet) wide with a water surface elevation of 105 meters (345 feet) above sea level and ranges to 7.3 meters (24 feet) deep. Sampling stations have been established in the river both upstream and downstream from the plant intake and discharge structures. The river level in this area fluctuates considerably during a 24-hour period and from day to day in response to release patterns at the Priest Rapids Dam (river mile 397).

2.2 MATERIALS AND METHODS

Figure 2-1. Location of Sampling Stations



Columbia River Surface water was sampled monthly from January through December 1995. Samples were collected near river mile 352 from four stations numbered 1, 7, 11, and 8 (Figures 2-1 and 2-2). Station 1 is upstream of the WNP-2 intake and discharge and represents the control. Station 7 is in the center of the mixing zone approximately 45 meters (150 feet) downstream of the discharge and provides a measure of near field blowdown effects. Station 11, at 91 meters (300 feet) downstream from the discharge, represents the extremity of the mixing zone. Substations 11M and 11B sample water from middle and bottom depths, respectively. Station 8 is approximately 568 meters (1870 feet) downstream from the discharge and represents a location where the blowdown is well mixed in the Columbia River. With the exception of Substations 11M and 11B, Columbia River samples were analyzed for temperature, dissolved oxygen (DO), pH, conductivity, turbidity, total alkalinity, total hardness, total phosphorus, inorganic phosphate, sulfate, total copper, total iron, total zinc, total nickel, total lead, total cadmium and total chromium. The samples from substations (11M and 11B) were analyzed for total copper only.

Plant blowdown was sampled monthly during 1995. Blowdown samples were analyzed for temperature, pH, conductivity, turbidity, total phosphorus, inorganic phosphate, sulfate, oil and grease, total copper, total iron, total zinc, total nickel, total lead, total cadmium, and total chromium. Volatile organic compounds (VOCs) and semi-volatile organic compounds were analyzed on a quarterly basis.

The evaporation/percolation pond (storm drain pond) is located approximately 1500 feet northeast of the plant. The pond is a collection point for water from various locations within the controlled area. Water and sediment were sampled monthly and semiannually, respectively. Monthly water samples were analyzed for pH, conductivity, total iron, total copper, total nickel, total zinc, total lead, total cadmium, total chromium, and oil and grease. In addition, quarterly water samples were analyzed for total dissolved solids and VOCs and semi-VOCs. Semiannual sediment samples were analyzed for the same total metals as the monthly water samples, excluding iron. A summary of water quality parameters, stations and sampling frequencies is presented in Table 2-1.

Table 2-1. Summary of Water Quality Parameters, Stations, and Sampling Frequencies , 1995

Parameter	1	7**	11**	11M &11B**	8**	Plant Blowdown	Pond
Temperature	M	M	M	—	M	M	—
Dissolved Oxygen	M	M	M	—	M	—	—
pH	M	M	M	—	M	M	M
Turbidity	M	M	M	—	M	M	—
Total Alkalinity	M	M	M	—	M	—	—
Filterable Residue (TDS)	—	—	—	—	—	—	Q
Conductivity	M	M	M	—	—	M	M
Iron (Total)	M	M	M	—	M	M	M
Copper (Total)	M	M	M	M	M	M	M
Nickel (Total)	M	M	M	—	M	M	M
Zinc (Total)	M	M	M	—	M	M	M
Lead (Total)	M	M	M	—	M	M	M
Cadmium (Total)	M	M	M	—	M	M	M
Chromium (Total)	M	M	M	—	M	M	M
Sulfate	M	M	M	—	M	M	—
Orthophosphorus	M	M	M	—	M	M	—
Total Phosphorus	M	M	M	—	M	M	—
Oil and Grease	—	—	—	—	M	M	M
Hardness	M	M	M	—	M	—	—
Organics (VOCs and semi-Vocs)	—	—	—	—	—	Q	Q

Symbols Key

Q= Quarterly
M= Monthly
**= Samples collected only if the plant is operating

2.2.1 Sample Collection

Columbia River water samples were collected by boat approximately 300 feet from the Benton County shore. Temperature was determined in situ with portable instruments. Water for total metal, conductivity, pH, sulfate, total phosphorus, inorganic phosphate, turbidity, total alkalinity and total hardness analyses was collected in 2.8 liter polypropylene cubitainers and stored in a cooler until delivered to the Supply System's Environmental and Analytical Support Laboratory (EASL). Water for total copper analysis from substations 11M and 11B was collected in one-liter polypropylene cubitainers with an all-Teflon pump and Tygon tubing. Water for dissolved oxygen measurements was collected in 300 ml (Biological Oxygen Demand) bottles.

Blowdown temperature was determined in situ. Water for pH, conductivity, turbidity, total phophorus, inorganic phosphate and total metals analysis was collected in 2.8 liter polypropylene cubitainers. Water for oil and grease and semivolatile organics anlsysis was collected in one-liter clear and amber glass bottles, respectively. Water for volatile organics analysis was collected in 40 ml glass bottles.

Evaporation/percolation pond water for pH, conductivity and total metals was collected in 2.8 liter polypropylene cubitainers. Water for total dissolved solids analysis was collected in 500 ml plastic bottles. Water for oil and grease, VOCs and semi-VOCs was collected as described under blowdown sampling. All samples were stored in a cooler until delivered to the laboratory for analysis.

River water quality samples collected during the annual plant maintenance outage (April through June) consisted of station 1 (control) samples only.

2.2.2 Analysis Methods

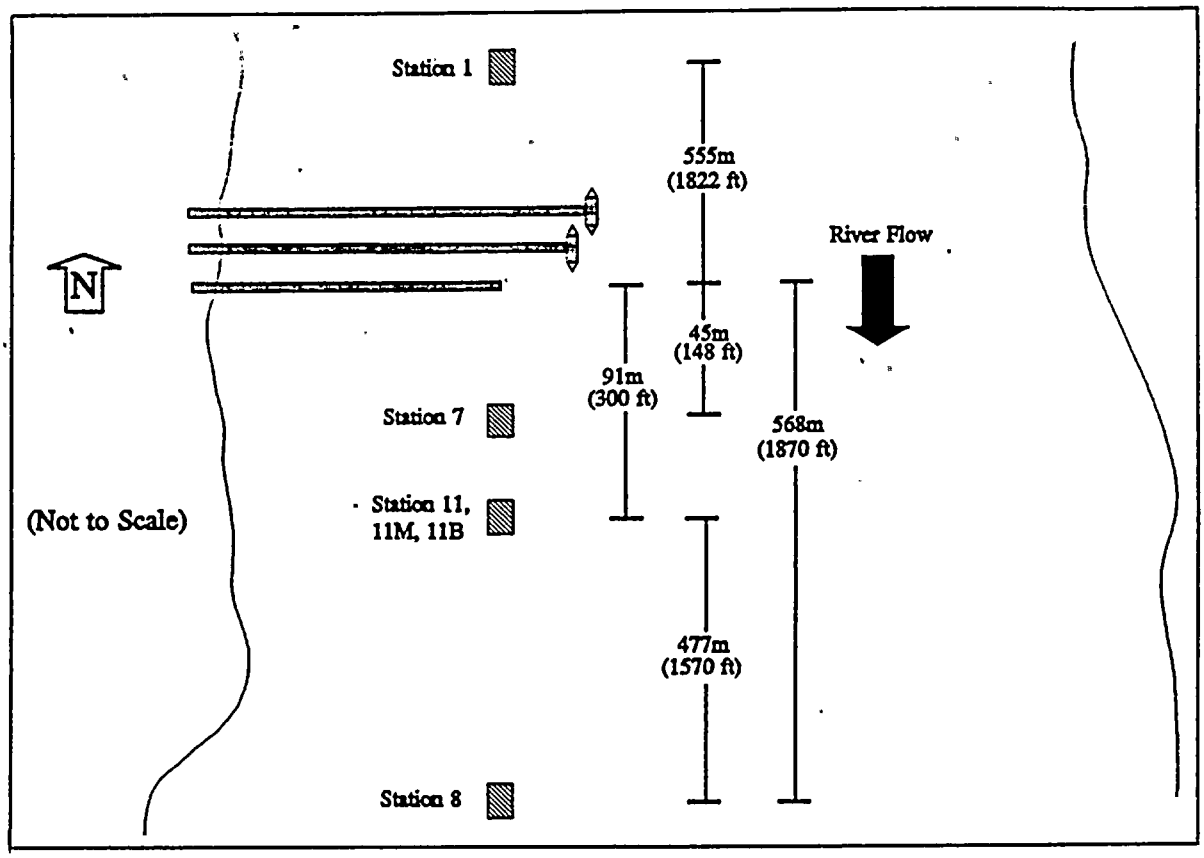
Field temperature measurements were made using a Fisher NIST-traceable thermometer. Temperature was recorded to within 0.1 °C after the probe had been allowed to equilibrate for a minimum of one minute.

Total metals, sulfate, conductivity, pH, dissolved oxygen, inorganic phosphate, turbidity, total alkalinity, total hardness, VOCs and semi-VOCs, total phosphorus, and oil and grease, were determined by Supply System laboratory personnel. Analyses for total dissolved solids and some total metals were performed by an offsite laboratory. Sample holding times followed those recommended by the U.S. Environmental Protection Agency (EPA 1983). Table 2-2 lists the approved EPA and Standard Methods used.

Table 2-2. Summary of Water Quality Parameters, EPA and Standard Method Method Numbers

Parameter	EPA Method Number	Standard Methods Method Number
Water Temperature (°C)	170.1	
Turbidity (NTU)	180.1	
Conductivity (μS/cm) at 25°C	120.1	
Disssolved Oxygen (mg/L) Probe	360.1	
Dissolved Oxygen (mg/L) Modified Winkler	360.2	
pH (Standard Unit)	150.1	
Total Alkalinity (mg/L as $CaCO_3$)	310.1	
Total Hardness (mg/L as $CaCO_3$)	130.2, 6010	2340B
Oil and Grease (mg/L)	412.2	
Total Phosphorus (mg/L as P)	365.2	4500-P
Inorganic Phosphate (mg/L as P)	300, 365.2	
Sulfate (mg/L as SO_4)	300, 375.4	
Total Copper (μg/L as Cu)	200.7, 220.1, 220.2	
Total Iron (μg/L as Fe)	200.7, 236.1, 236.2	
Total Nickel (μg/L asNi)	200.7, 249.1, 249.2	
Total Zinc (μg/L as Zn)	200.7, 289.1, 289.2	
Total Lead (μg/L as Pb)	200.7, 239.1, 239.2	
Total Cadmium (μg/L as Cd)	200.7, 212.1, 212.2	
Total Chromium (μg/L as Cr)	200.7, 218.1, 218.2	
Filterable Residue: TDS (mg/L)	160.1	
Volatile Organics (μg/L)	8240	
Semivolatile Organics (μg/L)	8270	

Figure 2-2. Schematic of River Sample Locations for Water Quality



2.3 RESULTS AND DISCUSSION

The evaporation/percolation pond is a discharge to ground and is not related to potential effects of the blowdown on the Columbia River. There was no plant blowdown during the February sampling event. For all sampling periods, significant interstation differences could not be detected for any of the measured parameters. The water quality monitoring results for both the river and the pond are presented in the following subsections.

2.3.1 Temperature

Columbia River surface temperatures varied seasonally with a temperature of 3.2°C at all stations on January 30 and a maximum of 19.8°C at station 1 on September 19 (Table 2-3). Blowdown temperatures ranged from 19.8°C in January to 41.7°C in July.

Table 2-3. Summary of Temperature (°C) Measurements for 1995

Sample Date	1	7	11	8	Plant Blowdown
01/30/95	3.2	3.2	3.2	3.2	19.8
02/28/95	3.5	3.5	3.5	3.5	--
03/30/95	5.5	5.5	5.5	5.5	37.1*
04/26/95	8.6	--	--	--	--
05/30/95	13.1	--	--	--	--
06/29/95	16.0	--	--	--	--
07/25/95	18.5	18.5	18.5	18.5	41.7*
08/31/95	19.0	19.0	19.0	19.0	40.6*
09/19/95	19.8	19.7	19.7	19.7	39.1*
10/24/95	13.8	13.8	13.8	13.8	35.5*
11/09/95	11.7	11.7	11.6	11.7	34.0*
12/20/95	6.8	6.8	6.8	6.8	24.2*

*Measurements taken from cooling tower 2B- top deck.

2.3.2 Dissolved Oxygen (DO)

DO measurements for each sample station are presented in Table 2-4. Columbia River DO concentrations ranged from 9.4 mg/L at Stations 1, 7 and 11 in September to 14.0 mg/L at Station 1 in February.

Table 2-4. Summary of Dissolved Oxygen (mg/L) Measurements

Sample Date	1	7	11	8
01/30/95	13.6	13.6	13.5	13.5
02/28/95	14.0	13.9	13.9	13.9
03/30/95	13.4	13.4	13.5	13.4
04/26/95	13.5	--	--	--
05/30/95	11.9	--	--	--
06/29/95	10.8	--	--	--
07/28/95	10.1	10.2	10.2	10.2
08/31/95	10.0	10.0	9.9	10.0
09/19/95	9.4	9.4	9.4	9.5
10/24/95	10.2	10.5	10.1	10.3
11/09/95	11.0	10.8	10.9	10.8
12/20/95	12.1	12.1	12.0	12.2

DO concentrations were inversely related to river temperature as would be expected from solubility laws. DO levels were never below the water quality standard for Class A waters (WDOE 1992) indicating good water quality with respect to dissolved oxygen throughout the year.

2.3.3 pH and Alkalinity

Columbia River pH values ranged from 7.47 at Station 1 in January to 8.12 at Station 1 in May. The pH water quality standard for Class A waters is from 6.5 to 8.5 (WDOE 1992). Blowdown pH values ranged from 7.86 in December, to 8.47 in September. Pond pH values ranged from 7.09 in January to 9.19 in April. Columbia River alkalinities ranged from 49 to 62 mg/L as calcium carbonate. Results for pH and alkalinity are listed in Tables 2-5 and 2-6.

Table 2-5. Summary of pH Measurements

Sample Date	1	7	11	8	Plant Blowdown	Pond
01/30/95	7.47	7.51	7.48	7.48	8.11	7.09
02/28/95	7.57	7.53	7.59	7.65	--	7.92
03/30/95	7.48	7.52	7.54	7.53	8.15	8.12
04/26/95	8.01	--	--	--	--	9.19
05/30/95	8.12	--	--	--	--	7.81
06/29/95	7.94	--	--	--	--	8.09
07/25/95	7.83	7.76	7.81	7.82	8.32	7.92
08/31/95	7.94	7.78	8.07	7.91	8.46	8.09
09/19/95	7.87	7.92	7.97	7.85	8.47	8.07
10/24/95	7.62	7.71	7.63	7.73	8.21	8.16
11/09/95	7.64	7.64	7.65	7.64	8.37	8.04
12/20/95	7.71	7.65	7.87	7.62	7.86	8.13

Table 2-6. Summary of Alkalinity Measurements

Sample Date	1	7	11	6
01/30/95	61	62	62	62
02/28/95	57	60	58	57
03/30/95	55	55	56	55
04/26/95	57	--	--	--
05/30/95	57	--	--	--
06/29/95	49	--	--	--
07/25/95	54	55	55	55
08/31/95	57	58	58	58
09/19/95	57	57	56	57
10/24/95	54	54	54	54
11/09/95	56	56	55	56
12/20/95	61	60	61	61

2.3.4 Hardness

Hardness ranged from 55 to 85 mg/L as calcium carbonate. This data is presented in Table 2-7.

Table 2-7. Summary of Total Hardness Mesurements

Sample Date	1	7	11	6
01/30/95	72	74	72	73
02/28/95	72	73	73	72
03/30/95	71	72	71	71
04/26/95	85	--	--	--
05/30/95	58	--	--	--
06/29/95	55	--	--	--
07/25/95	59	60	61	60
08/31/95	66	65	66	67
09/19/95	65	64	63	65
10/24/95	63	64	63	63
11/09/95	67	69	67	66
12/20/95	71	70	69	71

2.3.5 Conductivity

Columbia River conductivity measurements ranged from 112 μS/cm at 25°C at station 1 in June to 153 μS/cm at 25°C at station 7 in January and February. Blowdown measurements ranged from 1060 μS/cm at 25°C to 1570 μS/cm at 25°C. Storm drain pond values ranged from 68 to 575 μS/cm at 25°C. Conductivity measurements are listed in Table 2-8.

Table 2-8. Summary of Conductivity Measurements

Sample Date	1	7	11	8	Plant Blowdown	Pond
01/30/95	151	153	151	152	1140	68
02/28/95	150	153	148	148	--	575
03/30/95	149	150	149	149	1270	431
04/26/95	146	--	--	--	--	326
05/30/95	148	--	--	--	--	273
06/29/95	112	--	--	--	--	198
07/25/95	128	127	127	130	1480	223
08/31/95	138	140	140	140	1550	226
09/19/95	138	138	138	139	1570	305
10/24/95	125	124	131	133	1340	455
11/09/95	127	129	128	129	1320	433
12/20/95	146	147	147	147	1060	421

2.2.7 Turbidity

In the Columbia River, measured turbidities were low and ranged from 1.0 nephlometric turbidity units (NTU) to 4.5 NTU. Blowdown values ranged from 9 to 40 NTU. Turbidity results are listed in Table 2-9.

Table 2-9. Summary of Turbidity Measurements

Sample Date	1	7	11	8	Plant Blowdown
01/30/95	1.5	1.1	1.4	1.0	10
02/28/95	4.0	4.3	4.3	4.2	--
03/30/95	3.6	3.8	3.5	3.6	40
04/26/95	4.5	--	--	--	--
05/30/95	4.5	--	--	--	--
06/29/95	1.0	--	--	--	--
07/25/95	2.0	2.0	1.9	1.8	9
08/31/95	1.3	1.5	1.4	1.6	12
09/19/95	1.6	1.6	1.7	1.5	16
10/24/95	2.0	1.9	1.9	2.1	15
11/09/95	1.4	1.5	1.5	1.3	25
12/20/95	2.3	2.4	2.2	2.4	38

2.3.7 Metals (Total)

Columbia River cadmium concentrations were below the respective method detection limit (1.4μg/L) at all stations during all periods. River copper concentrations ranged from <1.9 μg/L to 4.6 μg/L. Zinc concentrations ranged from <5.0 μg/L to 14.4 μg/L and iron concentrations ranged from 33 μg/L to 218 μg/L. Nickel concentrations were generally below the detection limit of 2.0 μg/L. The highest nickel reading of 2.6 μg/L was recorded at station 7 in January.

Blowdown cadmium concentrations were below the detection limit for all stations and periods, except October (5.1 μg/L). Nickel and lead concentrations were fairly low, ranging from <2.0 μg/L to 7.0 μg/L and < 1.0 μg/L to 4.7 μg/L, respectively. Blowdown copper, zinc and iron concentrations were substantially higher than river concentrations and ranged from 45 μg/L to 110 μg/L, 47 μg/L to 108 μg/L, and 360 μg/L to 2010 μg/L, respectively. Chromium concentrations ranged from <0.5 μg/L to 5.0 μg/L.

Evaporation/percolation pond water cadmium and nickel concentrations were below their respective detection limits for all periods. Lead concentrations ranged from <1.0 μg/L to 19.0 μg/L. Chromium concentrations ranged from <0.5 μg/L to 1.6 μg/L. Copper concentrations ranged from <1.9 μg/L to 35 μg/L and zinc concentrations ranged from 27 μg/L to 774 μg/L. Iron concentrations ranged from a low of 20 μg/L in November to a high of 196 μg/L in January. With the exception of lead and nickel, measurable levels for all other metal constituents were observed in the storm drain pond sediment samples.

Total metal results are listed in Tables 2-10 through 2-16.

Table 2-10. Summary of Copper (μg/L) Measurements

Sample Date	1	7	11	11M	11B	8	Plant Blowdown	Pond	Pond Sediment (μg/g)
01/30/95	<1.9	2.1	<1.9	<1.9	<1.9	<1.9	54	8.5	–
02/28/95	<1.9	2.4	2.4	<1.9	<1.9	2.1	–	2.4	–
03/30/95	<1.9	2.0	<1.9	<1.9	<1.9	<1.9	51	<1.9	–
04/26/95	<1.9	–	–	–	–	–	–	35	–
05/30/95	2.6	–	–	–	–	–	–	17	–
06/29/95	2.9	–	–	–	–	–	–	13	71.4
07/25/95	2.0	3.0	2.0	4.6	2.4	2.0	110	6.0	–
08/31/95	<1.9	2.0	2.0	<1.9	<1.9	2.0	58	5.0	–
09/19/95	2.0	<1.9	<1.9	<1.9	<1.9	<1.9	45	8.0	–
10/24/95	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	54	<1.9	–
11/09/95	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	69	3.0	–
12/20/95	<1.9	<1.9	<1.9	<1.9	<1.9	<1.9	57	2.0	101

Table 2-11. Summary of Nickel (μg/L) Measurements

Sample Date	1	7	11	8	Plant Blowdown	Pond	Pond Sediment (μg/g)
01/30/95	<2.0	2.6	<2.0	<2.0	4.2	<2.0	—
02/28/95	<2.0	<2.0	<2.0	<2.0	—	<2.0	—
03/30/95	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	—
04/26/95	<2.0	—	—	—	—	<2.0	—
05/30/95	<2.0	—	—	—	—	<2.0	—
06/29/95	<2.0	—	—	—	—	<2.0	<0.4
07/25/95	<2.0	<2.0	<2.0	<2.0	3.0	<2.0	—
08/31/95	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	—
09/19/95	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	—
10/24/95	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	—
11/09/95	<2.0	<2.0	<2.0	<2.0	5.0	<2.0	—
12/20/95	<2.0	<2.0	<2.0	<2.0	7.0	<2.0	<0.4

Table 2-12. Summary of Zinc (μg/L) Measurements

Sample Date	1	7	11	8	Plant Blowdown	Pond	Pond Sediment (μg/g)
01/30/95	6.9	7.5	<5.0	8.7	54	124	–
02/28/95	6.2	7.8	9.4	8.4	–	27	–
03/30/95	<5.0	<5.0	<5.0	<5.0	47	53	–
04/26/95	14.1	–	–	–	–	67	–
05/30/95	7.7	–	–	–	–	262	–
06/29/95	6.8	–	–	–	–	75	258
07/25/95	6.0	6.9	7.4	7.0	108	134	–
08/31/95	5.9	6.0	8.4	5.7	68	435	–
09/19/95	<5.0	8.6	<5.0	<5.0	53	774	–
10/24/95	5.4	5.4	6.0	5.4	65	41	–
11/09/95	<5.0	<5.0	<5.0	<5.0	57	44	–
12/20/95	6.6	7.2	5.4	5.0	68	62	740

Table 2-13. Summary of Iron (μg/L) Measurements

Sample Date	1	7	11	8	Plant Blowdown	Pond
01/30/95	41	44	46	49	906	196
02/28/95	207	206	216	218	--	29
03/30/95	35	33	37	33	360	67
04/26/95	241	--	--	--	--	186
05/30/95	149	--	--	--	--	70
06/29/95	196	--	--	--	--	144
07/25/95	103	101	107	100	435	--
08/31/95	70	73	72	71	603	38
09/19/95	56	70	69	61	589	71
10/24/95	83	87	69	75	624	24
11/09/95	74	87	83	75	1250	20
12/20/95	135	134	131	124	2010	28

Table 2-14. Summary of Lead (μg/L) Measurements

Sample Date	1	7	11	8	Plant Blowdown	Pond	Pond Sediment (μg/g)
01/30/95	2.7	<1.0	<1.0	<1.0	<.9	<1.0	--
02/28/95	<1.0	3.3	<1.0	<1.0	--	<1.0	--
03/30/95	<1.0	<1.0	<1.0	<1.0	4.7	<1.0	--
04/26/95	<1.0	--	--	--	--	<1.0	--
05/30/95	<1.0	--	--	--	--	19	--
06/29/95	<1.0	--	--	--	--	14	<0.14*
07/25/95	2.0	8.0	2.0	4.0	1.0	2.0	--
08/31/95	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--
09/19/95	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--
10/24/95	<1.0	<1.0	<1.0	<1.0	1.0	<1.0	--
11/09/95	1.0	<1.0	<1.0	<1.0	2.0	<1.0	--
12/20/95	<1.0	<1.0	<1.0	<1.0	2.0	<1.0	14.2

*Detection limit for solid sample.

Table 2-15. Summary of Cadmium (μg/L) Measurements

Sample Date	1	7	11	9	Plant Blowdown	Pond	Pond Sediment (μg/g)
01/30/95	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	--
02/28/95	<1.4	<1.4	<1.4	<1.4	--	<1.4	--
03/30/95	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	--
04/26/95	<1.4	--	--	--	--	<1.4	--
05/30/95	<1.4	--	--	--	--	<1.4	--
06/29/95	<1.4	--	--	--	--	<1.4	3.6
07/25/95	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	--
08/31/95	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	--
09/19/95	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	--
10/24/95	<1.4	<1.4	<1.4	<1.4	5.1	<1.4	--
11/09/95	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	--
12/20/95	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	10.4

Table 2-16. Summary of Chromium (μg/L) Measurements

Sample Date	1	7	11	8	Plant Blowdown	Pond	Pond Sediment (μg/g)
01/30/95	<0.5	<0.5	<0.5	<0.5	1.1	<0.5	--
02/28/95	<0.5	<0.5	<0.5	<0.5	--	<0.5	--
03/30/95	<0.5	<0.5	<0.5	<0.5	5.0	<0.5	--
04/26/95	<0.5	--	--	--	--	<0.5	--
05/30/95	<0.5	--	--	--	--	<0.5	--
06/29/95	<0.5	--	--	--	--	<0.5	8.8
07/25/95	0.8	0.9	0.8	0.9	2.5	0.8	--
08/31/95	<0.5	<0.5	<0.5	<0.5	<0.5	1.6	--
09/19/95	<0.5	<0.5	<0.5	<0.5	2.1	<0.5	--
10/24/95	<0.5	<0.5	<0.5	<0.5	1.5	<0.5	--
11/09/95	0.8	0.8	0.7	0.9	2.8	0.9	--
12/20/95	0.9	1.0	1.0	0.9	5.0	0.9	11.2

2.3.8 Oil and Grease

Blowdown and pond oil and grease values were below the detection limit of 1.0 mg/L for all periods sampled. Oil and grease measurements are summarized in the following table.

Table 2-17. Summary of Oil and Grease (mg/L) Measurements

Sample Date	Plant Blowdown	Pond
01/30/95	<1.0	<1.0
02/28/95	--	<1.0
03/30/95	<1.0	<1.0
04/26/95	--	<1.0
05/30/95	--	<1.0
06/29/95	--	<1.0
07/29/95	<1.0	<1.0
08/31/95	<1.0	<1.0
09/19/95	<1.0	<1.0
10/24/95	<1.0	<1.0
11/09/95	<1.0	<1.0
12/20/95	<1.0	<1.0

2.3.9 Total Phosphorus and Inorganic Phosphate

Columbia River total phosphorus concentrations ranged from <0.01 to 0.02 mg/L as P. Blowdown values ranged from 2.4 to 4.7 mg/L as P. Columbia River inorganic phosphate concentrations were at or below 0.1 mg/L for all stations and periods, except Station II in March (0.2 mg/L).. Blowdown inorganic phosphate measurements ranged from 0.8 to 1.6 mg/L as P. Total phosphorus and inorganic phosphate measurements are summarized in Tables 2-18 and 2-19.

Table 2-18. Summary of Total Phosphorus (mg/L as P) Measurements

Sample Date	1	7	11	8	Plant Blowdown
01/30/95	0.02	0.02	0.02	0.01	2.4
02/28/95	0.02	0.02	0.02	0.02	--
03/30/95	0.03	0.02	0.02	0.02	4.1
04/26/95	0.02	--	--	--	--
05/30/95	0.01	--	--	--	--
06/29/95	<0.01	--	--	--	--
07/25/95	0.01	0.01	0.01	0.01	4.4
08/31/95	0.01	0.01	0.01	0.01	4.4
09/19/95	0.01	0.02	0.02	0.02	4.4
10/24/95	0.01	0.02	0.02	0.02	4.1
11/09/95	0.01	0.02	0.01	0.01	4.7
12/20/95	0.03	0.02	0.02	0.02	3.3

Table 2-19. Summary of Inorganic Phosphate (mg/L as P) Measurements

Sample Date	1	7	11	8	Plant Blowdown
01/30/95	<0.1	<0.1	<0.1	<0.1	1.0
02/28/95	<0.1	<0.1	0.1	<0.1	--
03/30/95	<0.1	<0.1	0.2	<0.1	1.0
04/26/95	<0.1	--	--	--	--
05/30/95	<0.1	--	--	--	--
06/29/95	<0.1	--	--	--	--
07/25/95	<0.1	<0.1	<0.1	<0.1	0.8
08/31/95	<0.1	<0.1	<0.1	<0.1	0.9
09/19/95	<0.1	<0.1	<0.1	<0.1	0.8
10/24/95	<0.1	<0.1	<0.1	<0.1	1.3
11/09/95	<0.1	<0.1	<0.1	<0.1	1.2
12/20/95	<0.1	<0.1	<0.1	<0.1	1.6

2.3.10 Sulfate

Individual Columbia River sulfate measurements ranged from 9.3 to 10.8 mg/L. Blowdown measurements ranged from 419 to 775 mg/L. The results are presented in Table 2-20.

Table 2-20. Summary of Sulfate (mg/L) Measurements

Sample Date	1	7	11	8	Plant Blowdown
01/30/95	10.1	10.8	10.2	10.1	471
02/28/95	10.2	10.2	10.2	10.2	—
03/30/95	10.5	10.6	10.6	10.5	443
04/26/95	10.3	—	—	—	—
05/30/95	8.6	—	—	—	—
06/29/95	7.3	—	—	—	—
07/25/95	9.0	9.0	9.2	9.0	660
08/31/95	8.9	8.9	8.8	8.8	700
09/19/95	9.1	9.1	9.1	9.1	775
10/24/95	9.2	9.4	9.2	9.2	595
11/09/95	9.3	10.5	10.1	9.3	525
12/20/95	9.2	9.2	9.2	9.2	419

2.3.11 Total Dissolved Solids

The quarterly total dissolved solids (TDS) measurements of the pond ranged from 130 mg/L to 260 mg/L. This data is presented in Table 2-21.

Table 2-21. Summary of Quarterly Total Dissolved Solid (mg/L) Measurements

Sample Date	Conc.
03/30/95	250
06/29/95	130
09/19/95	230
12/20/95	260

2.3.12 VOCs and Semi-VOCs

Blowdown volatile and semivolatile concentrations were below their respective detection limits for all compounds during all periods.

Evaporation/percolation pond semivolatile organic compound concentrations were below their respective detection limits for all compounds during all periods, except bis (2-ethylhexyl) phthalate in March (480 μg/L) and September (24 μg/L). Limit of detection for bis(2-ethylhexyl) phthalate is 10 μg/L. Volatile organic concentrations were below their respective detection limits for all compounds during all periods, except freon 113 in September (24 μg/L) and December (88 μg/L) and chloroform in December (11 μg/L). Limits of detection for freon 113 and chloroform are 10 μg/L and 5 μg/L, respectively. A list of the volatile and semivolatile organic compounds analyzed are presented in Tables 2-22 and 2-23, respectively.

Table 2-22. Summary of Volatile Organic Compounds

Chloromethane	Vinyl chloride	trans-1,3-Dichloropropene
Trichlorofluoromethane	Bromomethane	Dibromochloromethane
Freon 113	Chloroethane	Toluene
1,1-Dichloroethene	Carbon disulfide	2-Hexanone
Acetone	Methylene chloride	Ethylbenzene
cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Styrene
1,1-Dichloroethane	Chloroform	1,4-Dichlorobenzene
1,2-Dichloroethane	2-Butanone	1,1,2,2-Tetrachloroethane
1,1,1-Trichloroethane	Carbon tetrachloride	Bromoform
Benzene	Trichloroethene	4-Methyl-2-pentanone
1,2-Dichloropropane	Vinyl acetate	Tetrachloroethene
Bromodichloromethane	2-Chloroethylvinylether	Chlorobenzene
cis 1,3-Dichloropropene	1,1,2-Trichloroethane	Total Xylenes
1,3-Dichlorobenzene	1,2-Dichlorobenzene	

Table 2-23. Summary of Semivolatile Organic Compounds

Acids	Base Neutrals	
Phenol	2-Chloronaphthalene	2,4-Dinitrotoluene
2-Chlorophenol	2-Nitroaniline	Diethylphthalate
2-Methylphenol	Dimethylphthalate	Fluorene
4-Methylphenol	Acenaphthalene	4-Chlorophenyl-phenylether
2-Nitrophenol	2,6-Dinitrotoluene	4-Nitroaniline
2,4-Dimethylphenol	3-Nitroaniline	n-Nitrosodiphenylamine
2,4-Dichlorophenol	Acenaphthene	4-Bromophenyl-phenylether
Benzoic Acid	Dibenzofuran	Hexachlorobenzene
4-Chloro-3-methylphenol	Phenanthrene	bis (2-Chloroethyl)ether
2,4,6-Trichlorophenol	1,3-Dichlorobenzene	Anthracene
2,4,5-Trichlorophenol	1,4-Dichlorobenzene	Di-n-butylphthalate
2,4-Dinitrophenol	Benzyl Alcohol	Fluoranthene
4-Nitrophenol	1,2-Dichlorobenzene	Pyrene

Table 3-23. Summary of Semivolatile Organic Compounds

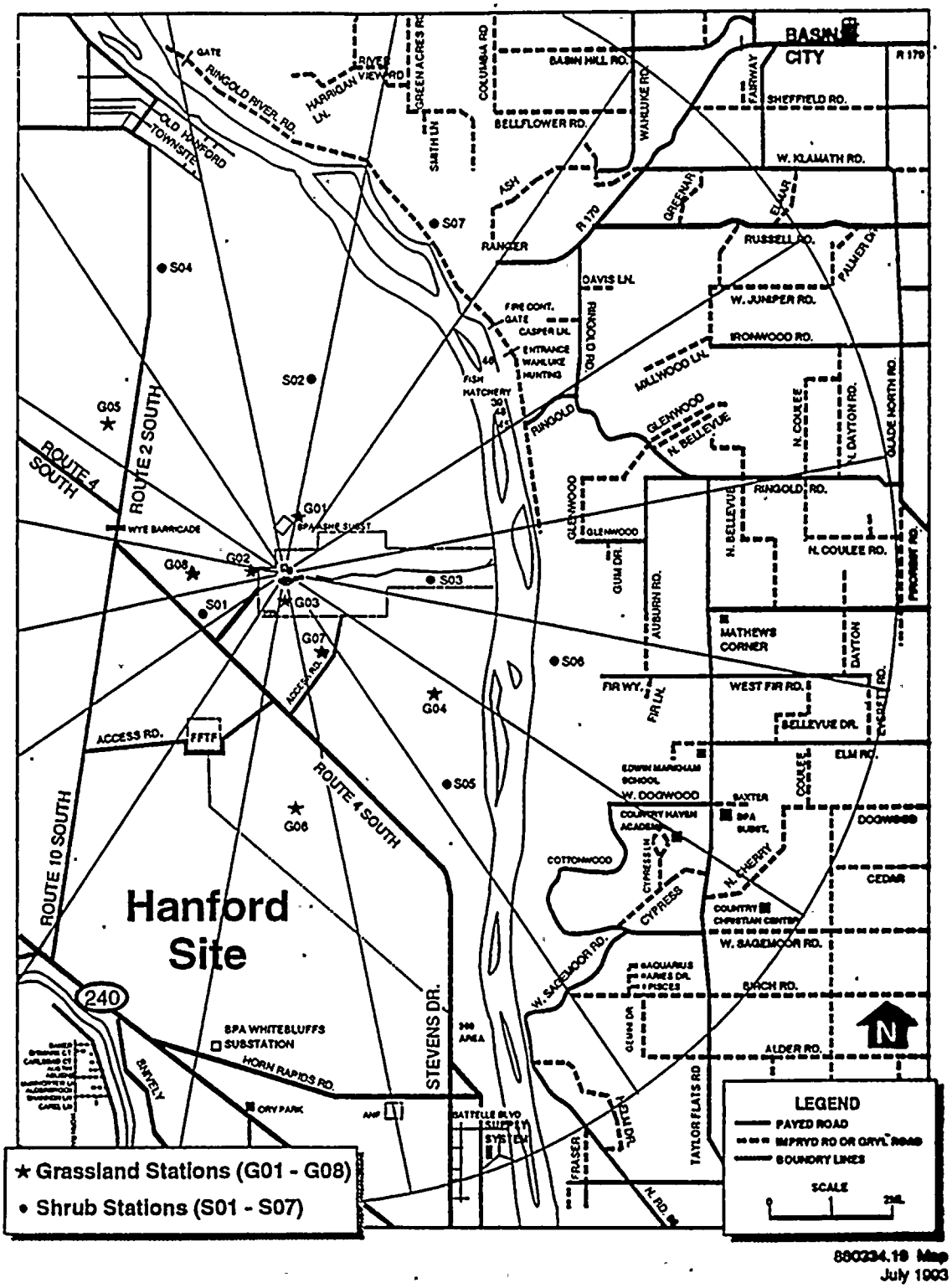
Acids	Base Neutrals	
Pentachlorophenol	n-Nitroso-di-n-propylamine	Benzo[a]anthracene
	Hexachloroethane	Nitrobenzene
	Isophorone	bis (2-Chloroethoxy)methane
	1,2,4-Trichlorobenzene	Naphthalene
	4-Chloroaniline	Dibenzo[a,h]anthracene
	Benzo[g,h,i]perylene	Hexachlorobutadiene
	2-Methylnaphthalene	Hexachlorocyclopentadiene
	Benzo[b]fluoranthene	3,3-Dichlorobenzidine
	Benzo[k]fluoranthene	Chrysene
	Benzo[a]pyrene	bis (2-Ethylhexyl)phthalate
	Indeno[1,2,3-cd]pyrene	

3.0 SOIL AND VEGETATION STUDIES

3.1 INTRODUCTION

The objective of the soil and vegetation studies is to identify any significant effects or impacts of plant cooling tower operation upon the plant communities surrounding WNP-2. Vegetation and soil sampling is conducted at the peak of the cheatgrass growth cycle known as the purple stage (Klemmedson 1964). Cheatgrass *(Bromus tectorum)* is the predominant species within all fifteen of the sampling plots with a mean frequency >98% and cover often approaching 50%. Cheatgrass fruits turn purple shortly after reaching viability and then brown when mature. The purple stage of development correlates well with the peak productivity of many associated species and serves as a marker for initiation of annual sampling and comparison of phytomass productivity between years. The program includes the measurement of herbaceous canopy cover, herbaceous phytomass and soil chemistry. Soil chemical parameters measured include pH, carbonate, bicarbonate, sulfate, chloride, sodium, copper, zinc and conductivity. Fifteen sampling stations are located within a five mile radius of the plant. The stations consist of eight grassland (G01-G08) and seven shrub sites (S01-S07). The location of each station is illustrated in Figure 3-1.

Figure 3-1. Soil and Vegetation Sampling Location Map



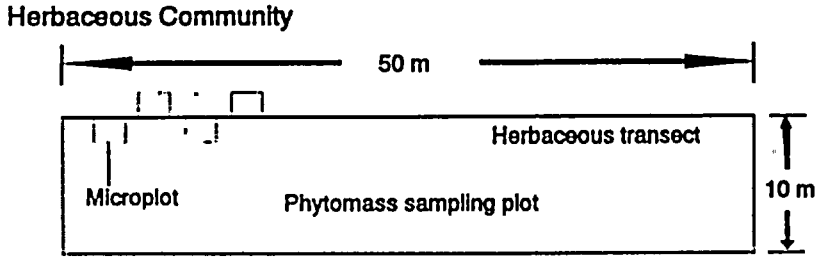
880234.19 Map
July 1993

3.2 MATERIALS AND METHODS

3.2.1 Herbaceous Canopy Cover

At each of the fifteen stations fifty microplots (20 cm x 50 cm) were placed at 1-meter intervals on alternate sides of the herbaceous transect (fig. 3-2). Canopy cover was estimated for each species occurring within a microplot using Daubenmire's (1968) cover classes. Data were recorded on standard data sheets. To assure the quality of the sampling, three randomly selected microplots were sampled twice. The entire transect was resampled if cover estimates for any major species (>50% frequency) differed by more than one cover class.

Figure 3-2. Layout of Vegetation and Soil Sampling Plots



3.2.2 Herbaceous Phytomass

Phytomass sampling was conducted concurrently with cover sampling. Phytomass sampling plots were randomly located within an area adjacent to the permanent transects or plots (Figure 3-2). At each station, all live herbaceous vegetation rooted in the designated microplot (20 x 50 cm) was clipped to ground level and placed in paper bags. Each bag was stapled shut and labeled with station code, plot number, date and personnel initials.

Sampling bags were transported to the laboratory, opened, and placed in a drying oven until a consistent weight was obtained. Following drying, the bags were removed singularly from the oven and their contents immediately weighed to the nearest 0.1 g. Laboratory quality assurance consisted of independently reworking 10 percent of the phytomass samples to assess data validity and reliability.

3.2.3 Soil Chemistry

At each of the fifteen grassland and shrub stations, two soil samples were collected from the top 15 cm of soil with a clean stainless steel trowel. The soil samples are randomly selected and taken from the phytomass sampling plot. The samples were placed in 250 ml sterile plastic cups with lids, labeled and refrigerated at 4°C. Nine parameters were analyzed in each sample, including pH, bicarbonate, carbonate, conductivity, sulfate, chloride, copper, zinc, and sodium. Aliquots of soil for trace metal analysis were microwave digested according to Gilman (1989). Preservation times and conditions, when applicable, followed EPA procedures (1983).

Laboratory quality control comprised 10-20% of the sample analysis load. Routine quality control samples included internal laboratory check standards, reagent blanks, and prepared EPA or NIST controls.

3.3 RESULTS AND DISCUSSION

During the 1995 season, 62 plant taxa were observed in the study areas. Table 3-1 lists the vascular plants observed during 1995 field studies.

Table 3-1. Vascular Plants Observed During 1995

Scientific Name	Common Name
APIACEAE	Pasley Family
Cymopterus terebinthinus (Hook.) T.&G. var. *terebinthinus*	Turpentine cymopterus
ASTERACEAE	Aster Family
Achillea millefolium L.	Yarrow
Antennaria dimorpha (Nutt.) T.& G.	Low pussy-toes
Artemisia tridentata Nutt.	Big Sagebrush
Balsamorhiza careyana Gray	Carey's balsamroot
Chrysothamnus nauseosus (Pall.) Britt	Gray rabbitbrush
Chrysothamnus viscidiflorus (Hook.) Nutt	Green rabbitbrush
Crepis atrabarba Heller	Slender hawksbeard
Franseria acanthicarpa Hook.	Bur ragweed
Layia glandulosa (Hook.) H & A	White daisy tidytips
Tragopogon dubius Scop.	Yellow salsify
Aster canescens Pursh	Hoary aster
BORAGINACEAE	Borage Family
Amsinckia lycopsoides Lehm.	Tarweed fiddleneck
Cryptantha circumscissa (H&A) Johnst.	Matted cryptantha
Cryptantha leucophaea (Dougl.) Pays	NA
Cryptantha pterocarya (Torr.) Greene	Winged cryptantha
BRASSICAEAE	Mustard Family
Descurainia pinnata (Walt.) Britt.	Western tansymustard
Draba verna L.	Spring draba
Erysimum asperum (Nutt.) DC.	Prairie rocket
Sisymbrium altissimum L.	Tumblemustard
CACTACEAE	Cactus Family
Opuntia polycantha Haw.	Starvation cactus

Table 3-1. Vascular Plants Observed During 1995 (Continued)

Scientific Name	Common Name
CARYOPHYLLACEAE	Pink Family
Arenaria franklinii Dougl. var *franklinii*	Franklin's sandwort
Holosteum umbellatum L.	Jagged chickweed
CHENOPODIACEAE	Chenopod Family
Chenopodium leptophyllum (MOQ.) Wats.	Slimleaf goosefoot
Grayia spinosa (Hook.) MOQ.	
Salsola kali L.	Russian thistle
FABACEAE	Pea Family
Astragalus purshii Dougl.	Wooly-pod milk-vetch
Astragalus sclerocarpus Gray	Stalked-pod milk-vetch
Psoralea lanceolata Pursh	Lance-leaf scurf-pea
GERANIACEAE	Geranium Family
Erodium cicutarium (L.) L'Her.	Filaree, storks-bill
HYDROPHYLLACEAE	Waterleaf Family
Phacelia hastata Dougl.	Whiteleaf phacelia
Phacelia linearis (Pursh) Holz.	Threadleaf phacelia
LILIACEAE	Lily Family
Brodiaea douglasii Wats.	Douglas' brodiaea
Calochortus macrocarpus Dougl.	Sego lily
Fritillaria pudica (Pursh) Spreng.	Chocolate lily
LOASACEAE	Blasing-star Family
Mentzelia albicaulis Dougl. Ex Hook.	White-stemmed mentzelia
MALVACEAE	Mallow Family
Sphaeralcea munroana (Dougl.) Spach Ex Gray	White-stemmed globe-mallow
ONAGRACEAE	Evening-primrose Family
Oenothera pallida Lindl. var. *pallida*	White-stemmed evening-primrose
PLANTAGINACEAE	Plantain Family
Plantago patagonica Jacq.	Indian-wheat

Table 3-1. Vascular Plants Observed During 1995 (Continued)

Scientific Name	Common Name
POACEAE	Grass Family
Agropyron cristatum (L.) Gaertn.	Crested wheatgrass
Agropyron dasystachyum (Hook.) Scribn.	Thick-spiked wheatgrass
Agropyron spicatum (Pursh) Scribn. & Smith	Bluebunch wheatgrass
Bromus tectorum L.	Cheatgrass
Festuca octoflora Walt.	Six-weeks fescue
Koeleria cristata Pers.	Prairie Junegrass
Oryzopsis hymenoides (R&S) Ricker	Indian ricegrass
Poa sandbergii Vasey	Sandberg's bluegrass
Sitanion hystrix (Nutt.) Smith	Bottlebrush squirreltail
Stipa comata Trin. & Rupr.	Needle-and-thread
POLEMONIACEAE	Phlox Family
Gilia minutiflora Benth.	Gilia
Gilia sinuata Dougl.	Shy gilia
Leptodactylon pungens (Torr.) Nutt.	Granite gilia
Microsteris gracilis (Hook.) Greene var. *humilior* (Hook.) Cronq.	Pink microsteris
Phlox longifolia Nutt.	Long-leaf phlox
POLYGONACEAE	Buckwheat Family
Eriogonuum niveum Dougl.	Snow buckwheat
Rumex venosus Pursh	Wild begonia
RANUNCULACEAE	Buttercup Family
Delphinium nuttallianum Pritz. ex Walpers	Larkspur
ROSACEAE	Rose Family
Purshia tridentata (Pursh) DC	Antelope Bitterbrush
SANTALACEAE	Sandalwood Family
Comandra umbellata (L.) Nutt.	Bastard toad-flax
SAXIFRAGACEAE	Saxifrage Family
Ribes aureum Pursh	Golden current
SCROPHULARIACEAE	Figwort Family
Penstemon acuminatus Dougl.	Sand-dune penstemon

Table 3-1. Vascular Plants Observed During 1995 (Continued)

Scientific Name	Common Name
VALERIANACEAE	Valerian Family
Plectritis macrocera T&G	Longhorn plectritis

3.3.1 Herbaceous Cover

Total herbaceous cover averaged 92.39% in 1995 which represents an increase of 105% from 1994 (45.05). With the exception of station GO6, all other stations showed an increase of 45% or greater in total herbaceous cover. *Bromus tectorum* continues to be the dominant annual grass with an average cover of 34.42%, an increase of 35.25%. Total perennial grass cover was 27.60%, an increase of 212%. As in previous years, the dominant perennial grass was *Poa sandbergii* with an average cover of 19.69%. The most significant change in cover occurred in the annual forbs. Total annual forb cover increased 395% from last year. *Sisymbrium altissimum* had an average cover of 7.44% compared to 0.54 % last year. *Draba verna* with a previous cover of 0.88% increased 509% with an average cover of 5.36% for 1995. The total perennial forb cover was 3.5%.

Frequency values (%) increased at eight of the fifteen stations. The most significant increase in frequency values was seen in annual forbs. Only two stations (SO2 and SO4) showed a decrease in the number of annual forb species per site. Station GO5 had an increase of six annual forb species. The total species per site for station GO5 increased from 14 to 21. Station SO6 increased from 7 to 14 in total species per site. Table 3-3 shows mean frequency values (%) by species for each sampling station.

Table 3-2. Herbaceous Cover for Fifteen Sampling Stations (%)

	GO1	GO2	GO3	GO4	GO5	GO6	GO7	GO8	SO1	SO2	SO3	SO4	SO5	SO6	SO7	AVG. GO1-SO7
Annual Grasses																
Bromus tectorum	78.65	70.60	55.50	4.80	10.50	27.60	53.65	60.20	31.80	9.25	25.80	36.15	46.75	4.00	1.10	34.42
Festuca octoflora	0.00	0.00	0.00	0.00	0.60	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Total Annual Grass Cover	**78.65**	**70.60**	**55.50**	**4.80**	**11.10**	**27.65**	**53.65**	**60.20**	**31.80**	**9.25**	**25.80**	**36.15**	**46.25**	**4.00**	**1.10**	**34.47**
Perennial Grasses																
Agropyron spicatum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.02
Oryzopis hymenoides	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.60	0.00	0.00	0.00	2.30	0.00	0.33
Poa sandbergii	10.15	18.00	4.00	38.25	47.45	1.95	16.75	16.25	17.60	21.80	30.00	8.64	0.00	51.85	12.65	19.69
Stipa comata	0.00	0.00	0.00	26.60	0.00	2.45	0.00	6.65	0.00	14.40	0.00	0.00	2.00	0.40	0.00	7.50
Total Perennial Grass Cover	**10.15**	**18.00**	**4.00**	**64.85**	**47.45**	**4.40**	**16.75**	**22.90**	**17.60**	**98.80**	**30.00**	**8.64**	**2.30**	**55.55**	**12.65**	**27.60**
Annual Forbs																
Amsinckia tycopsoides	0.05	0.10	9.50	0.05	0.50	0.05	11.20	0.05	4.15	0.35	0.00	0.00	3.30	0.10	2.35	2.12
Brodiaea douglasii	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Cryptantha circumscissa	0.00	0.00	0.00	0.05	0.05	0.15	0.00	0.00	0.15	0.00	0.00	0.00	0.15	0.00	0.00	0.04
Descurainia pinnata	0.00	0.10	0.10	0.00	0.05	0.00	1.70	0.00	0.55	0.00	0.00	0.00	0.00	1.85	57.80	4.14
Draba verna	16.55	15.15	3.65	3.30	14.00	0.05	5.55	8.15	4.45	0.00	4.60	2.00	2.00	0.90	0.10	5.36
Erodium cicutarium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.85	0.00	0.00	0.06
Franseria acanthicarpa	0.00	0.00	3.15	0.10	0.10	0.40	1.40	0.05	0.95	0.00	0.00	0.00	0.30	0.05	0.00	0.43
Gilia minutiflora	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00
Holosteum umbellatum	2.30	8.65	2.75	3.70	9.30	0.35	4.60	9.10	7.10	5.70	6.55	2.60	2.90	0.00	0.60	4.41
Mentzelia albicaulis	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.05	0.00	0.10	0.00	0.00	0.00	0.01
Microsteris gracilis	0.15	0.00	3.80	0.15	0.60	2.30	2.45	0.20	7.60	0.00	9.50	0.00	1.20	0.00	0.00	1.29
Phacelia linearia	0.00	0.00	0.05	0.05	0.10	0.10	0.00	0.00	0.10	0.00	0.00	0.00	0.20	0.00	0.00	0.04
[illegible]tago patagonica	0.40	1.15	0.00	1.70	0.00	0.00	0.00	0.40	0.00	0.00	5.00	0.00	1.45	0.00	0.50	0.71
[illegible] kali	1.35	0.15	0.15	0.10	1.45	0.20	0.05	0.05	5.40	0.45	0.00	0.45	0.65	0.05	0.00	0.70
[illegible]rium altissimum	2.95	1.90	0.30	0.00	0.10	0.15	3.85	2.60	1.00	1.10	0.65	44.47	1.70	11.15	40.75	7.44
Total Annual Forb Cover	**23.75**	**27.50**	**23.35**	**9.65**	**26.25**	**3.75**	**30.85**	**20.65**	**31.45**	**6.65**	**17.75**	**49.62**	**14.75**	**14.30**	**102.1**	**26.82**
Perrenial Forbs																
Achillea millefolium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	1.30	0.00	0.10
Aster canescens	0.00	0.00	0.10	0.00	0.00	0.00	0.05	0.00	1.75	0.00	0.00	0.30	0.00	0.00	0.00	0.88
Astragalus sclerocarpus	0.00	0.00	0.00	0.00	0.00	1.30	0.00	0.00	0.00	0.00	0.00	1.05	0.30	0.00	0.00	0.09
Balsamorhiza careyana	0.00	0.00	0.00	0.00	3.40	0.05	0.00	0.00	0.00	0.00	0.00	2.30	1.70	0.00	0.00	0.43
Comandra umbellata	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Crepis atrabarba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.40	0.00	0.00	0.00	0.00	0.16
Cymopterus terebinthinus	0.00	0.60	0.00	0.00	0.00	0.00	4.15	0.05	0.00	0.00	6.95	0.00	0.00	0.00	6.45	1.51
Eriogonum niveum	0.00	0.00	0.00	0.00	1.40	0.00	0.00	0.00	0.05	0.00	0.00	0.00	6.75	0.00	0.00	0.55
Oenothera pallida	0.00	0.00	0.20	0.20	0.85	0.15	0.00	0.00	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.12
Phlox longifolia	0.10	0.05	0.05	0.50	0.90	0.00	0.05	2.80	0.30	0.35	0.00	0.00	0.00	3.00	0.00	0.42
Rumex venosus	0.05	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Total Perennial Forb Cover	**0.15**	**0.65**	**0.45**	**0.25**	**7.15**	**5.65**	**0.15**	**2.80**	**2.25**	**7.40**	**2.40**	**3.65**	**8.48**	**4.60**	**6.45**	**3.50**
Total Herbaceous Cover	**112.7**	**116.8**	**85.30**	**79.55**	**91.95**	**41.45**	**101.4**	**106.6**	**83.10**	**122.1**	**75.95**	**98.06**	**72.28**	**78.45**	**122.3**	**92.39**

Table 3-3. Mean Frequency Values (%) by Species for Each Sampling Station

	GO1	GO2	GO3	GO4	GO5	GO6	GO7	GO8	SO1	SO2	SO3	SO4	SO5	SO6	SO7
Annual Grasses															
Bromus tectorum	100	100	100	76	96	98	96	96	100	52	90	100	100	34	34
Festuca octoflora					14	2						4			
Perennial Grasses															
Agropyron spicatum													2		
Oryzopis hymenoides										10				14	
Poa sandbergii	86	82	8	96	94	10	48	56	38	52	100	30		86	80
Stipa comata				74		4		12		50			4	6	
Annual Forbs															
Amsinckia lycopsoides	2	4	44	2	10	2	56	2	40	4			26	4	16
Chenopodium leptophyllum													6		
Cryptantha circumscissa				2	2	4			6						
Cryptantha pterocarya									6						
Descurainia pinnata		4	4		2		2		12					36	96
Draba verna	94	98	98	82	98	2	92	98	88		94	60	70	26	4
Erodium cicutarium													2		
Franseria acanthacarpa			66	4	4	16	36	2	18				12	2	
Gilia sinuata					2					2					
Holosteum umbellatum	62	98	90	52	98	4	74	96	94	58	94	54	76		14
Layia glandulosa					2										
Mentzelia albicaulis							2			2		4			
Microsteris gracilis	6		72	6	14	62	20	8	68		28		28		
Phacelia linearis			2	2	4				4	4	22		8		
Plantago pategonica	16	26		48				6			74		28		10
Salsola kali	54	6	6	4	38	8	2	2	62	18		18	26	2	
Sisymbrium altissimum	30	26	12		4	6	20	16	20	4	26	86	20	52	78
Tragopogon dubius												2			
Perennial Forbs															
Achillea millifolium														4	
Aster canescens			4				2						2		
Astragalus purshii															
Astragalus sclerocarpus						4						4		2	
Balsamorhiza careyana					4	2						6	2		
Brodiaea douglasii					2			2	2						
Comandra umbellata					4										
Crepis atrabarba															
Cymopterus terebinthinus		4				22									
Eriogonum niveum					6				8				20		
Oenothera pallida			8	8	14	6			2	2		4	40		
Phlox longifolia	4	2	2	10	8		2	32	2	4			6	6	
Rumex venosus	2		4						4						
Total Species per Site	11	11	15	14	21	16	13	13	18	11	9	10	19	14	8

Table 3-3. Mean Herbaceous Cover for 1975 through 1995

CLASS	YEAR	S01	S02	S03	S04	S05	X S01-5	S06	S07	XS	G01	G02	G03	G04	X G01-4	G05	G06	G07	G08	XG	XSG	G01-4, S01-5
AG	1975	49.90	35.30	43 80						43 00	43 90	43 00								43.45	43.18	43 18
PG	1975	0.60	2.00	4 50						2.37	3.70	5.50								4 60	3 26	3 26
AF	1975	14 60	11.70	11.70						12.67	29.50	13 00								21.25	16.10	16 10
PF	1975	4 30	0 90	1.80						2.33	1.50	2.10								1 80	2.12	2.12
ALL	1975	69.40	49.90	61 80						60.37	78.60	63.60								71.10	64 66	64 66
AG	1976	50.70	40.90	34.30						41.97	71.20	51.60								61.40	49.74	49.74
PG	1976	0 40	10.50	10 30						7 07	4 40	3.10								3.75	5.74	5.74
AF	1976	5.50	5.30	7.20						6 00	11.90	8 50								10.20	7 68	7 68
PF	1976	0 00	0 50	0 20						0 23	0 00	0.20								0 10	0.18	0 18
ALL	1976	56 60	57.20	52 00						55.27	87.50	63.40								75.45	63 34	63 34
AG	1977	1.35	0 65	1.90						1.30	5.20	1.45								3 33	2 11	2.11
PG	1977	0 35	11 30	8 28						6 64	3 25	2.90								3 08	5 22	5.22
AF	1977	0 25	0 05	0 90						0 40	2 40	9.35								5.88	2 59	2.59
PF	1977	0 55	0 60	1 42						0 86	0 05	6.30								3 18	1.78	1.78
ALL	1977	2 50	12 60	12.50						9.20	10.90	20.00								15.45	11.70	11.70
AG	1978	51 00	67.00	51 00						56.33	68.00	42.00								55 00	55 80	55.80
PG	1978	3 00	18 00	11 00						10 67	8 00	7.00								7.50	9 40	9 40
AF	1978	38 00	10 00	33 00						27.00	23 00	25.00								24.00	25 80	25 80
PF	1978	8 00	0 00	5 00						4 33	2 00	3.00								2 50	3 60	3 60
ALL	1978	100 00	95.00	100 00						98.33	101.00	77.00								89.00	97.60	94 60
AG	1979	25 00	29 00	9 00						21.00	31.00	10 00								20 50	20 80	20 80
PG	1979	1.00	18 00	11.00						10.00	7.00	5.00								6 00	8 40	8 40
AF	1979	2 00	4 00	10.00						5.33	43 00	33 00								38 00	18 40	18 40
PF	1979	11.00	0 00	3 00						4.67	0 00	7.00								3 50	4 20	4.20
ALL	1979	39.00	51.00	33.00						41.00	81 00	55.00								68 00	51.80	51.80
AG	1980	50.40	51 80	24.30	56.20	56.40	47.82			47.82	64.30	77.80	73.80	12.30	57.05					57.05	51.92	51 92
PG	1980	1.00	7.20	23.30	10.90	0.10	8.50			8.50	28 30	64.00	0.10	26.60	29.75					29.75	17.94	17.94
AF	1980	7.60	4.20	22.50	3.40	14.10	10.36			10.36	7.30	5.00	28.70	4.90	11.48					11.48	10 86	10 86
PF	1980	2.20	2.20	4.70	4.60	1.80	3.10			3.10	0.40	0 00	0 00	4 60	1.25					1 25	2 28	2.28
ALL	1980	61.20	65.40	74 80	75.10	72.40	69.78			69.78	100.30	146 80	102.60	48.40	99.53					99.53	83.00	83 00
AG	1981	74 80	54.60	66.50	69.80	76.20	64.38			64.38	77.40	84 00	88.40	48.90	74 68					74 68	68 96	68 96
PG	1981	0.10	4.70	14.30	5.80	0 00	4.98			4.98	19 60	25.90	0.00	36.70	20.55					20 55	11.90	11.90
AF	1981	5.30	3 50	18 20	1.20	12.50	8.14			8.14	15.90	11.90	17.50	5.90	12.80					12 80	10 21	10 21
PF	1981	0 00	3.20	0.70	4 90	0.50	1.86			1 86	0 20	0.00	0.00	1.90	0.53					0.53	1.27	1.27
ALL	1981	80 20	66.00	99.70	61.70	89 20	79.36			79.36	113.10	121.80	105.90	93.40	108.55					108.55	92.33	92.33
AG	1982	51.50	25.80	36.60	32.70	20 00	33.32			33.32	42 20	45.50	51 00	22.90	40.40					40.40	36.47	36 47
PG	1982	0 40	6.40	17.90	4.30	0 80	5.96			5 96	11.20	11.60	0.10	31.30	13 55					13.55	9 33	9 33
AF	1982	4 60	4.20	7.50	1 60	17.30	7 04			7.04	9.70	4.60	4.60	4.10	5.75					5.75	6.47	6 47
PF	1982	0.20	4.30	0.70	6.20	1 00	2.48			2.48	0.30	0 00	1.30	3 80	1 35					1.35	1 98	1.98
ALL	1982	56.70	40.70	62.70	44 80	39.10	48 80			48 80	63.40	61.70	57.00	62.10	61 05					61 05	54 24	54 24

Table 3-3. Mean Herbaceous Cover for 1975 through 1995 (continued)

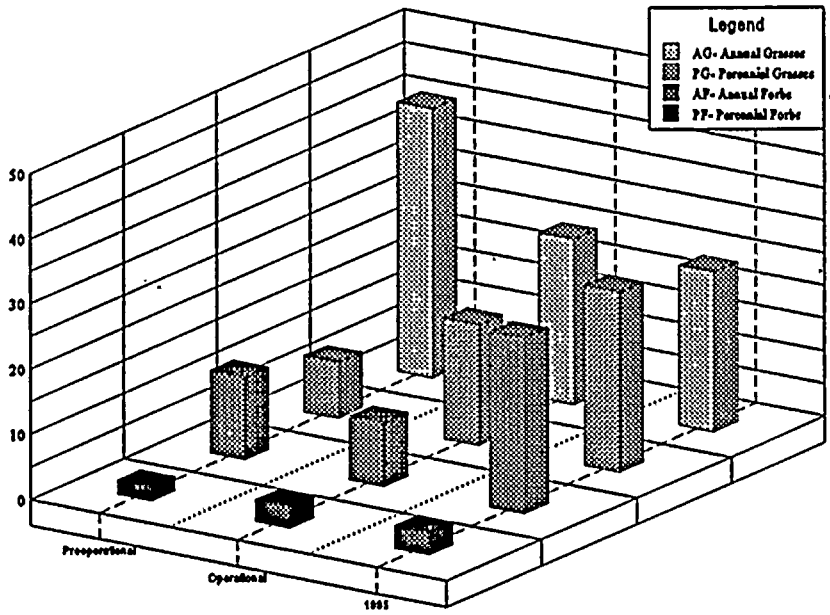
CLASS	YEAR	S01	S02	S03	S04	S05	X S01-5	S06	S07	XS	G01	G02	G03	G04	X G01-4	G05	G06	G07	G08	XG	XSG	G01-4, S01-5
AG	1983	53 80	37.60	33 65	36.75	31 85	38.73			38.73	49.50	39.55	62.75	17.55	42.35					42.34	40.33	40 33
PG	1983	2.15	7.70	14.45	6.40	1.29	6 40			6.40	2.10	15.75	0 00	25.50	10.84					10.84	8.37	8 37
AF	1983	8 20	7.85	12.55	3 45	22.35	10 88			10 88	18.70	8.85	8 65	6 65	10.71					10.71	10 81	10 81
PF	1983	0.70	3.10	1 05	4.40	1.95	2.24			2.24	0.65	0.05	2.10	4.00	1.70					1.70	2.00	2 00
ALL	1983	64.85	56.25	61.70	51.00	57.44	58.25			58.25	70.95	64.20	73.50	53.70	65.59					65.59	61.51	61.51
AG	1984	41.50	32.75	39.35	36 30	36.50	37.28			37.28	60 85	71.30	60 85	9.60	50.65					50 65	43 22	43 22
PG	1984	1 85	8 80	11.55	8 55	0 40	6 23			6.23	1.20	4 45		25 00	10.22					10 22	6.87	7.73
AF	1984	12 35	8 10	11.10	4 00	13 40	9.79			9.79	20 65	9.70	19.45	7.95	14.44					14 44	11.86	11.86
PF	1984	0 30	4 00	0.75	6 55	0 65	2.45			2.45	0.70	0 20	1.10	1.25	0 81					0 81	1.72	1.72
ALL	1984	56.00	53 65	62.75	55.40	50.95	55.75			55.75	83.40	85.65	81.40	43.80	73.56					73.56	63 67	63 67
AG	1985	2.10	2 15	14 60	4 95	27.05	10.17			10.17	8 00	8.10	18.30	7.25	10.41					10.41	10.28	10 28
PG	1985	1 05	4 70	17 85	2.40	1.85	5 57			5.57	9.20	17.95	0 00	13.90	10.26					10 26	7 66	7.66
AF	1985	0.70	1.35	9 40	2.30	4.75	3.70			3.70	18 20	8.15	7.55	3.05	9.24					9 24	6 16	6 16
PF	1985	0 00	1.35	1.15	3 00	0.25	1.15			1.15	0 80	0 10	2.35	0.90	1.04					1.04	1.10	1.10
ALL	1985	3 85	9 55	43 00	12.65	33.90	20.59			20.59	36.20	34.30	28.20	25.10	30.95					30.95	25.19	25.19
AG	1986	17 45	1 95	7.20	11.45	13 05	10 22			10 22	9.40	4 65	13.25	7.35	8.66					8 66	9.53	9 53
PG	1986	2 20	10 75	17.25	9 85	1.30	8 27			8 27	19.85	38 65	0 00	26.00	21.13					21.13	13.98	13.98
AF	1986	25 40	16 65	38 10	10 25	16.70	21.42			21.42	27.65	34.15	25.45	8.70	23.99					23.99	22.56	22.56
PF	1986	1.15	5 35	2.30	9 15	1.25	3 84			3.84	1.80	1.95	0 05	2.55	1.59					1.59	2.84	2.84
ALL	1986	46.20	34 70	64 85	40.70	32.30	43.75			43.75	58.70	79.40	38.75	44.60	55.36					55.36	48.91	48 91
AG	1987	28 90	9 95	7 80	19 05	33.40	19 82			19.82	23 85	9.45	51.65	4.65	22.40					22.40	20 97	20 97
PG	1987	3 60	21.90	42 65	19.55	2.30	18 00			18 00	32.45	58.79	0 05	45.95	34.31					34.31	25.25	25 25
AF	1987	12 56	8.50	10 80	6.55	11 40	9.96			9 96	10.30	11.32	14 00	3.25	9.72					9.72	9 85	9 85
PF	1987	5.00	6 00	2 00	10.40	1.75	5.03			5 03	0.90	1.90	0.15	1.55	1.13					1.13	3 29	3.29
ALL	1987	50 06	46.35	63.25	55.55	48.85	52.81			52.81	67.50	81.46	65.85	55.40	67.55					67.55	59.36	59 36
AG	1988	13 80	5 05	8.10	13 80	10.15	10.18	10.40	12.24	10.51	22.95	10.10	16.75	4 80	13 65	11.95	19 20	15 85	10.40	14 00	12 32	11.72
PG	1988	1.75	8.40	11.95	9.40	3.35	6 97	16 85	17.50	9.89	17.85	21.70	0 05	30 20	17.45	9 50	12 05	10.45	14.30	14.51	12.34	11 63
AF	1988	6 08	5 25	3 60	3.10	4 00	4.41	0.00	0 35	3.20	6 30	16.15	7.55	1 80	7.95	1.20	1.45	12.35	6.12	6 61	5.16	5 98
PF	1988	11.55	15.75	2.10	4.85	3.25	7.50	0.10	0.00	5.37	0.20	2 00	0 00	4.40	1 65	15.25	8.70	2 45	4.34	4.34	4.79	4.90
ALL	1988	33.18	34.45	25.75	31.15	20.75	29.06	27.35	30 09	28.96	47.30	49.95	24.35	41.20	40.70	37.90	41.40	41.10	32.52	39.47	34 60	34.23
AG	1989	21.85	12 50	12.45	10 25	32.90	17.99	15.00	47.65	21.80	22.50	13.20	65 85	3.05	26.15	22.35	35.10	38 05	12 05	26 52	24 05	21 62
PG	1989	8.30	29 55	64 00	13.00	1.25	23 22	30 35	37.50	26.28	60.40	59 60	0 05	49.55	42.40	36.75	16 20	32 05	48 95	37.94	32.54	31.74
AF	1989	12 50	6 95	13 05	6.45	11.10	10 01	0 85	5.15	8 01	12.85	5.90	42.20	2 85	15.95	8 85	13.55	13 05	13 95	14.15	11.48	12 65
PF	1989	4.45	14.50	4.40	8 20	0.55	6.42	0.10	0 00	4.60	3 85	1.10	0.05	3.00	2.00	6 45	10.40	12.90	10 60	6 04	5 23	4 46
ALL	1989	47.10	63.50	93.90	37.90	45.80	57.64	46.30	90.30	60 69	99.60	79.80	108.15	58.45	86.50	74 40	75.25	96.05	85.55	84.66	73 31	70.47
AG	1990	36 80	16 80	17.50	32.40	53.35	31.37	12.90	5.45	25.03	18 60	7.75	61.55	13.65	25.39	23 80	35.45	36 55	19.75	27 01	26 06	28 71
PG	1990	3.30	12 85	18 35	12.70	0 05	9 45	18.40	17.55	11.89	18.70	0 00	0 00	30.00	12.18	11.90	10 70	9.30	12.10	11.59	11.73	10 66
AF	1990	7.95	2 60	8.15	4.55	8.90	6.43	0 10	0 00	4 61	7.75	2.35	15.70	3.35	7.290.3	2.75	6 90	8 95	7 00	6 84	5 80	6 81
PF	1990	0.40	9.55	1.75	3 90	0 05	3.313	0 00	0 00	2.24	0 00	0 05	0.05	1.20	3	3.95	8 55	0 05	0.20	1.76	1.98	1.88
ALL	1990	48.45	41.80	45.30	53.55	62.35	50.29	31.40	23.00	43 69	45.05	10.15	77.30	48.20	45.18	42.40	61 60	53 85	39 05	47.20	45.56	48 02
AG	1991	40.25	15 25	40 05	38.55	48 15	35.85	17.85	5.90	25.14	26.15	20 80	65.55	18 90	32 85	36 95	37 25	48 30	38 25	36 52	33 81	34.52
PG	1991	7.60	32 05	26 35	14.45	2 30	11.14	38.40	60 60	25.96	41.75	50 55	1.35	38.70	29 09	23.55	12.80	0 00	22 85	23 94	26 14	11.12
AF	1991	36.25	15 00	16.75	37.30	21.60	24.29	4 85	7.30	19 86	0 25	4.20	13.35	1.85	4.92	4 75	6 30	35 13	16 65	10 31	14.77	16 26
PF	1991	4.45	6 35	1 95	2.35	0.30	3 08	0.30	0 00	2.24	0.00	0 10	0.60	0 90	0 25	3.35	12.20	0 05	1.70	2 29	2.25	1 88
ALL	1991	88.55	63 65	85.10	89.65	72.35	74.36	61.40	73.80	76.36	61.15	75 65	80 25	60.35	66.11	68 60	68.55	83 48	79.45	72.19	76.97	63.78
AG	1992	30.30	30.20	42 60	55 95	51 60	42.13	23.90	15.20	35 67	48 70	64 25	53.15	34 24	50 09	46 00	41 80	46.15	55 15	51 18	43 95	45 67
PG	1992	3 25	15 65	11 40	5 40	2.39	7.62	31.30	33 80	14.74	25 60	20 00	0 00	32.20	19 45	18 60	10 20	5 95	8 80	15 17	14 97	12.88
AF	1992	9 85	5.55	11.95	16 40	8 95	10 54	4 65	23 05	11 48	13 15	8 15	15 05	7.15	10 87	7 65	10 20	8 80	17 25	10 93	11.19	10 693
PF	1992	9 15	10.70	2 25	4 25	1.05	5 48	0.65	6 00	4 01	0.10	0 25	0 30	0.75	0 35	1.95	12 55	1 35	3 85	2 64	3 28	20
ALL	1992	52.55	62.10	68.20	82 00	63.99	65.77	60 50	72.70	65.90	87.55	92 65	68.50	74.34	80.76	74.20	74.75	82.25	85 05	79 92	73.39	72.44

Table 3-3. Mean Herbaceous Cover for 1975 through 1995 (continued)

CLASS	YEAR	S01	S02	S03	S04	S05	X S01-5	S06	S07	XS	G01	G02	G03	G04	X G01-4	G05	G06	G07	G08	XG	XSG	G01-4, S01-5
AG	1993	27.70	34.65	53.45	58.25	48.20	44.45	23.65	57.95	43.41	46.90	68.65	43.40	29.20	47.04	38.35	28.90	68.85	59.60	47.98	45.85	45.74
PG	1993	7.15	22.14	16.25	12.85	4.00	12.48	46.10	23.15	18.81	48.25	23.35	2.00	46.10	29.93	31.40	15.40	12.25	16.35	24.39	21.78	21.2
AF	1993	12.95	8.70	12.90	14.80	13.25	12.52	2.15	9.85	10.66	13.45	5.95	22.60	10.20	13.05	10.90	16.45	13.45	9.02	12.75	11.77	12.79
PF	1993	13.70	12.70	2.690	8.65	7.40	9.01	0.05	0.05	6.45	1.45	0.00	0.75	2.15	1.09	5.85	8.85	1.55	4.50	3.14	4.68	5.05
ALL	1993	58.10	77.49	85.20	94.55	71.35	77.34	71.95	88.90	78.22	110.00	97.95	66.25	87.55	90.44	86.00	69.60	94.40	89.27	87.63	84.08	83.89
AG	1994	23.30	11.00	28.40	21.20	35.50	23.88	5.35	9.70	19.21	47.50	61.85	27.50	9.05	36.48	6.35	16.70	42.40	51.20	32.88	26.50	30.18
PG	1994	2.65	16.95	5.70	3.75	2.15	6.24	11.20	9.55	7.42	5.50	4.30	0.60	34.30	11.18	9.55	16.65	2.20	7.20	10.04	8.82	8.71
AF	1994	8.10	2.70	7.40	3.30	7.65	5.83	0.15	2.90	4.60	4.10	1.90	18.15	2.50	6.66	2.20	6.65	11.35	2.25	6.14	5.42	6.25
PF	1994	2.25	7.15	3.60	4.50	7.50	5.00	1.30	6.45	4.68	0.15	0.05	11.25	0.60	3.01	5.30	11.10	0.75	2.80	4.00	4.32	4.01
ALL	1994	36.30	37.80	45.10	32.75	52.80	40.95	18.00	28.60	35.91	57.25	68.10	57.50	46.45	57.33	23.40	51.60	56.70	63.45	53.06	45.05	49.14
AG	1995	31.80	9.25	25.8	36.15	46.75	29.95	4.0	1.1	22.12	78.65	70.60	55.50	4.80	52.39	11.10	27.65	53.65	60.20	45.21	34.47	39.92
PG	1995	17.60	98.80	30.0	8.64	2.3	31.47	55.55	12.65	32.22	10.15	18.0	4.00	64.85	24.25	47.45	4.40	16.75	22.90	26.59	27.60	28.26
AF	1995	31.45	6.65	17.75	49.62	14.75	24.04	14.30	102.1	33.81	23.75	27.5	23.35	9.65	21.06	26.25	3.75	30.85	20.65	20.72	26.96	22.72
PF	1995	2.25	7.4	2.4	3.65	8.48	4.84	4.6	6.45	5.03	0.15	0.65	0.45	0.25	0.38	7.15	5.65	0.15	2.80	2.16	3.50	2.86
ALL	1995	83.10	122.1	75.95	98.06	72.28	90.30	78.45	122.30	93.18	112.70	116.75	83.30	79.55	98.08	91.95	41.45	101.40	106.55	91.71	92.39	93.76

Figure 3-3 shows a comparison of the current data with previous data. Growing season (October 94 - April 95) precipitation (21.06 cm) increased 465% from the previous season (3.73 cm). According to Battelle Northwest Laboratories, the months of January through April were recorded as the wettest four months of the year on record. The mean temperature during the growing season was 6.43°C compared with 6.161°C for 1994. A comparison of mean cover and precipitation for 1982 through 1995 can be seen in Figure 3-4.

Fig. 3-3. Mean Herbaceous Cover for 1975-1995



3.3.2 Herbaceous Phytomass

The increase (260%) in herbaceous phytomass is in direct correlation to the increase in herbaceous cover. At grassland and shrub stations, the herbaceous phytomass production averaged 107g/m² and 123g/m² respectively. Mean herbaceous phytomass production at grassland and shrub stations is shown graphically in Figure 3-5 and summarized in Table 3-6.

Fig. 3-4. Mean Herbaceous Cover and Total Precipitation

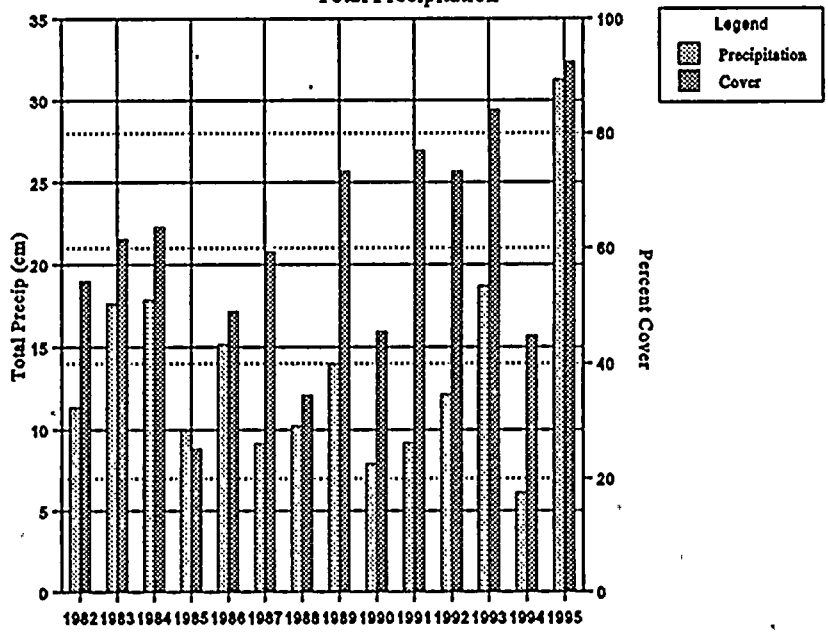


Table 3-5. Herbaceous Phytomass for 1995

DATE	SITE	PLOT	WT.(g)	WT./m²
05/25	GO1	35-3	32.0	319.8
05/25	GO1	2-6	17.5	175.2
05/25	GO1	31-7	16.7	167.1
05/25	GO1	45-7	29.1	291.4
05/25	GO1	29-4	8.9	89.1
		AVG	20.9	208.5
		STD	8.5	85.3

DATE	SITE	PLOT	WT.(g)	WT./m²
05/25	GO2	45-9	29.3	293.3
05/25	GO2	29-4	15.1	151.4
05/25	GO2	2-6	17.2	171.6
05/25	GO2	31-7	12.9	129.1
05/25	GO2	35-3	12.7	127.0
		AVG	17.4	174.5
		STD	6.2	61.6

DATE	SITE	PLOT	WT.(g)	WT./m²
05/18	GO3	31-7	0.4	3.9
05/18	GO3	2-6	1.1	11.4
05/18	GO3	29-4	2.5	24.9
05/18	GO3	45-9	4.7	46.9
05/18	GO3	35-3	8.0	80.2
		AVG	3.3	33.5
		STD	2.8	27.6

DATE	SITE	PLOT	WT(g)	WT./m²
05/15	GO4	29-4	2.6	26.0
05/15	GO4	2-6	8.7	86.6
05/15	GO4	25-3	7.9	78.8
05/15	GO4	31-7	11.1	111.2
05/15	GO4	45-9	2.5	24.9
		AVG	6.6	65.5
		STD	3.4	34.4

DATE	SITE	PLOT	WT.(g)	WT./m²
05/16	GO5	29-4	1.4	13.6
05/16	GO5	45-9	2.4	23.9
05/16	GO5	2-6	7.1	70.9
05/16	GO5	35-6	4.7	47.3
05/16	GO5	31-7	2.2	21.9
		AVG	3.6	35.5
		STD	2.1	20.9

DATE	SITE	PLOT	WT.(g)	WT./m²
05/17	GO6	31-7	7.2	71.5
05/17	GO6	29-4	13.4	134.0
05/17	GO6	35-3	8.6	86.1
05/17	GO6	45-9	3.1	30.6
05/17	GO6	2-6	14.0	139.7
		AVG	9.2	92.4
		STD	4.1	40.7

DATE	SITE	PLOT	TE.(g)	WT./m²
05/18	GO7	35-3	9.3	16.3
05/18	GO7	31-7	5.7	27.9
05/18	GO7	29-4	2.4	50.9
05/18	GO7	45-9	26.0	46.1
05/18	GO7	2-6	10.1	66.4
		AVG	10.7	41.5
		STD	.1	17.6

DATE	SITE	PLOT	WT.(g)	WT./m²
05/25	GO8	45-9	22.4	224.4
05/25	GO8	29-4	10.2	102.2
05/25	GO8	35-3	16.8	168.2
05/25	GO8	2-6	8.6	85.9
05/25	GO8	31-7	11.6	115.6
		AVG	13.9	139.3
		STD	5.1	50.7

DATE	SITE	PLOT	WT.(g)	WT./m²
05/25	SO1	2-6	12.3	123.0
05/25	SO1	35-3	5.2	51.9
05/25	SO1	45-9	2.6	26.0
05/25	SO1	31-7	5.0	49.7
05/25	SO1	29-4	13.2	131.9
		AVG	7.7	76.5
		STD	4.3	42.7

DATE	SITE	PLOT	WT.(g)	WT./m²
05/26	SO2	2-6	6.5	65.2
05/26	SO2	29-4	6.4	63.8
05/26	SO2	31-7	14.9	149.3
05/26	SO2	35-3	6.8	68.4
05/26	SO2	45-9	7.7	76.5
		AVG	8.5	84.6
		STD	3.3	32.6

DATE	SITE	PLOT	WT.(g)	WT./m²
05/12	SO3	2-6	4.8	47.5
05/12	SO3	31-3	4.7	47.0
05/12	SO3	47-4	2.4	24.4
05/12	SO3	41-5	2.0	20.3
05/12	SO3	19-7	13.0	130.0
		AVG	5.4	53.8
		STD	4.0	39.7

DATE	SITE	PLOT	WT.(g)	WT./m²
05/26	SO4	35-3	59.9	599.4
05/26	SO4	31-7	15.3	153.1
05/26	SO4	29-2	22.4	224.0
05/26	SO5	45-9	13.2	132.1
05/26	SO4	2-6	11.2	111.8
		AVG	24.4	244.1
		STD	18.2	181.6

DATE	SITE	PLOT	WT.(g)	WT./m²
05/16	SO5	2-6	8.7	87.1
05/16	SO5	29-4	6.1	61.3
05/16	SO5	35-3	2.7	27.0
05/16	SO5	31-7	31.3	312.6
05/16	SO5	45-9	8.2	81.5
		AVG	11.4	113.9
		STD	10.4	101.6

DATE	SITE	PLOT	WT.(g)	WT./m²
05/17	SO6	31-7	7.7	77.0
05/17	SO6	29-4	6.9	69.2
05/17	SO6	35-3	5.6	56.4
05/17	SO6	45-9	6.3	63.2
05/17	SO6	2-6	10.2	101.7
		AVG	7.4	73.5
		STD	1.6	15.6

DATE	SITE	PLOT	WT.(g)	WT./m²
05/08	SO7	45-9	18.0	180.1
05/08	SO7	35-3	2.5	25.2
05/08	SO7	2-6	24.5	245.1
05/08	SO7	29-4	29.4	294.3
05/08	SO7	31-7	32.8	327.9
		AVG	21.5	214.5
		STD	10.7	106.9

Phytomass Summary

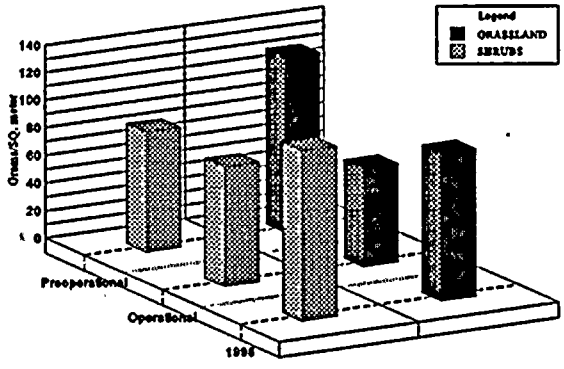
MEAN GO1-GO8	107.0 Grams/sq. meter
MEAN SO1-SO7	123.0 Grams/sq. meter

Table 3-6 presents mean phytomass values for each station in each year since 1975.

Table 3-6. Comparison of Herbaceous Phytomass (g/m²) for 1975 through 1995

YEAR	GO1	GO2	GO3	GO4	GO5	GO6	GO7	GO8	SO1	SO2	SO3	SO4	SO5	SO6	SO7
1975	359	302	--	--	--	--	--	--	126	144	88	--	--	--	--
1976	108	258	--	--	--	--	--	--	137	98	177	--	--	--	--
1977	21	11	--	--	--	--	--	--	4	7	7	--	--	--	--
1978	166	162	--	--	--	--	--	--	173	128	115	--	--	--	--
1979	64	37	--	--	--	--	--	--	21	28	16	--	--	--	--
1980	160	68	53	79	--	--	--	--	36	63	43	78	71	--	--
1981	200	255	261	159	--	--	--	--	180	115	31	52	81	--	--
1982	90	60	62	113	--	--	--	--	98	24	22	39	184	--	--
1983	77	137	64	82	--	--	--	--	171	232	54	68	136	--	--
1984	94	116	133	67	--	--	--	--	104	57	95	93	43	--	--
1985	70	27	12	37	--	--	--	--	5	1	27	11	61	--	--
1986	50	61	32	35	--	--	--	--	35	112	25	176	42	--	--
1987	83	77	134	90	--	--	--	--	62	144	48	108	145	--	--
1988	34	14	16	61	--	--	--	--	59	73	15	24	19	--	--
1989	173.3	65.7	105.1	49.5	43.2	61	113.1	112.3	53.9	72.8	67	39.8	103.7	72.7	149.5
1990	13.6	4.1	64	73.2	36.8	39.8	29.1	10	32.8	78.3	28.2	30.9	43.4	34	6.1
1991	87.7	97.2	161.6	67.6	171.8	101.4	168.4	137.3	225.1	58.2	87.6	185.2	111.3	225.1	226
1992	142.4	109.4	82.7	60	54.4	49.4	101.4	74.3	49.2	147.5	90.7	80.3	110.3	101.3	187.3
1993	146	156.6	70.3	109.8	75.3	162	150.7	100.3	80.2	84.1	91.7	261.4	173.1	93.5	330.3
1994	45.7	48.8	49.2	15.6	13.2	60.1	41.5	44.1	27.3	13.4	20.5	19.8	60.8	7	19.1
1995	208.5	174.5	33.5	65.5	35.5	92.4	106.9	139.3	76.5	84.6	53.8	244.1	113.9	73.5	214.5

Fig. 3-5. Phytomass at Grassland and Shrub Stations for 1975 through 1995



3.3.3 Soil Chemistry

In comparison to previous years data, their has been no significant change in soil chemistry for the fifteen sampling stations. The following Table (3-8) is a summation of soil chemistry for 1995.

Table 3-8 Summary of Soil Chemistry for 1995

	pH	Conductivity µS/cm	Sulfate µg/gm	Chloride µg/gm	Copper µg/gm	Zinc µg/gm	Sodium µg/gm	Bicarbonate (meq/HCO_3/gm)
GO1	6.91	29.9	1.01	0.205	8.9	46.7	0.047	0.0011
GO2	7.21	36.3	0.94	0.330	10.9	53.7	0.053	0.0010
GO3	7.13	71.8	6.43	0.606	9.0	46.4	0.046	0.0018
GO4	6.84	15.4	1.34	0.160	8.1	46.4	0.053	0.0005
GO5	6.94	19.2	0.86	0.215	7.8	38.3	0.043	0.0007
GO6	6.85	16.6	0.63	0.163	8.1	43.1	0.054	0.0005
GO7	7.08	61.1	0.83	0.205	12.7	47.6	0.056	0.0014
GO8	7.11	28.1	0.85	0.247	12.8	42.8	0.047	0.0009
SO1	7.14	33.7	1.15	0.277	9.9	33.5	0.049	0.0010
SO2	7.62	19.1	0.33	0.196	3.1	15.2	0.032	0.0010
SO3	6.22	131	2.01	0.528	10.0	53.9	0.057	0.0006
SO4	7.166	18.6	0.32	0.209	9.0	43.4	0.051	0.0008
SO5	7.03	23.9	0.37	0.143	7.8	42.6	0.051	0.0007
SO6	7.91	43.7	0.39	0.205	8.7	41.3	0.042	0.0030
SO7	8.50	212	5.85	2.51	13.1	59.2	0.056	0.0054

4.0 REFERENCES

Battelle Pacific Northwest Laboratories. 1976. Aquatic ecological studies conducted near WNP-1, 2, and 4, September 1974 through September 1975. Supply System Columbia River ecology studies Vol. 2. Richland, WA.

Battelle Pacific Northwest Laboratories. 1977. Aquatic ecological studies near WNP-1, 2, and 4, October 1975 through February 1976. Supply System Columbia River ecology studies Vol. 3. Richland, WA.

Battelle Pacific Northwest Laboratories. 1978. Aquatic ecological studies near WNP-1 ,2, and 4, March through December 1976. Supply System Columbia River ecology studies Vol. 4. Richland, WA.

Battelle Pacific Northwest Laboratories. 1979a. Aquatic ecological studies near WNP-1, 2, and 4, March through December 1977. Supply System Columbia River ecology studies Vol. 5. Richland, WA.

Battelle Pacific Northwest Laboratories. 1979b. Aquatic ecological studies near WNP-1, 2, and 4, January through August 1978. Supply System Columbia River ecology studies Vol. 6. Richland, WA.

Beak Consultants, Inc. 1980. Aquatic ecological studies near WNP-1, 2, and 4, August 1978 through March 1980. Supply System Columbia River ecology studies Vol. 7. Portland, OR.

Beak Consultants, Inc. 1981. Terrestrial monitoring studies near WNP-1, 2, and 4, May through December 1980. Portland, OR.

Beak Consultants, Inc. 1982a. Terrestrial monitoring studies near WNP-1, 2, and 4, May through December 1981. Portland, OR.

Beak Consultants, Inc. 1982b. Terrestrial monitoring studies near WNP-1, 2, and 4, May through August 1982. Portland, OR.

Black, C.A. et al., 1965. Methods of Soil Analysis. Academic Press, Inc. New York, New York.

Daubenmire, R. 1968. Plant Communities. Harper and Row, New York, New York.

Davis, W. III and T.E. Northstrom. 1987. Review of the environmental monitoring program for WNP-2 with recommendations for design of continuing studies. Washington Public Power Supply System. Richland, WA.

Droppo, J.G., C.E. Hane and R.K. Woodruff. November 1976. Atmospheric Effects of Circular Mechanical Draft Cooling Towers at Washington Public Power Supply System Nuclear Power Plant Number Two.

Environmental Protection Agency. August 1978. Quality Assurance Guidelines for Biological Testing, EPA/600/4-78/043.

Environmental Protection Agency. 1991. Methods for the Determination of Metals in Environmental Samples. EPA/600/4-91-010.

Environmental Protection Agency. September 1991. Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms. EPA/600/4-85/013.

Gilman, Lee B. 1989. Microwave Sample Preparation. CEM Corporation.

Hamilton, M.A., R.C. Russo, and R.V. Thurston. 1977. Trimmed Spearman-Karber Method for Estimating Median Lethal Concentrations in Toxicity Bioassays. Environ. Sci. Technol. 11(7) : 714-719; Correction 12(4) : 417 (1978).

Klemmedson, J.O. and J.G. Smith, 1964. Cheat Grass (*Bromus tectorum* L.) Bot. Rev. 30; 226-262.

Mudge, J.E., T.B. Stables and W. Davis III. 1982. Technical review of the aquatic monitoring program of WNP-2. Washington Public Power Supply System. Richland, WA.

Northstrom, T.E., J.L. Hickam and T.B. Stables. 1984. Terrestrial monitoring studies for 1983. Washington Public Power Supply System. Richland, WA.

Rickard, W.H. and K.A. Gano. 1976. Terrestrial ecology studies in the vicinity of Washington Public Power Supply system Nuclear Power Projects 1 and 4. Progress report for the period July 1974 to June 1975. Battelle Pacific Northwest Laboratories. Richland, WA.

Rickard, W.H. and K.A. Gano. 1977. Terrestrial ecology studies in the vicinity of Washington Public Power Supply System Nuclear Power Projects 1 and 4. Progress report for 1976. Battelle Pacific Northwest Laboratories. Richland, WA.

Rickard, W.H. and K.A. Gano. 1979a. Terrestrial ecology studies in the vicinity of Washington Public Power Supply System Nuclear Power Projects 1 and 4. Progress report for 1977. Battelle Pacific Northwest Laboratories, Richland, WA.

Rickard, W.H. and K.A. Gano. 1979b. Terrestrial ecology studies in the vicinity of Washington Public Power Supply System Nuclear Power Projects 1 and 4. Progress report for 1978. Battelle Pacific Northwest Laboratories, Richland, WA.

Schleder, L.S. 1982. Preoperational animal studies near WNP-1, 2, and 4. Annual report for 1981. Washington Public Power Supply System, Richland, WA.

Schleder, L.S. 1983. Preoperational animal studies near WNP-1, 2, and 4. Annual report for 1982. Washington Public Power Supply System, Richland, WA.

Schleder, L.S. 1984. Preoperational animal studies near WNP-1, 2, and 4. Annual report for 1983. Washington Public Power Supply System, Richland, WA.

Shipley, B.L. et al., 1980. NUREG/CR1231. Remote sensing for detection and monitoring of salt stress on vegetation: Evaluation and guidelines. Final report. September 1976-March 1979. Nuclear Regulatory Commission. Washington, DC.

Standard Methods for the Examination of Water and Wastewater. 1989. 18th Edition, APHA, AWWA, WPCF, Washington, D.C., 1989.

Standard Methods for the Examinaton of Water and Wastewater. 1995. 19th Edition, APHA, AWWA, WEF, Washington, D.C., 1995.

Washington Department of Ecology. 1992. Water Quality Standards for Surface Waters of the State of Washington (WAC 173-201A). Water Quality Planning Office of Water Programs. Olympia, WA.

Washington Public Power Supply System. Operational Ecological Monitoring Program for Nuclear Plant 2. Annual Reports for 1985-1994. Richland, WA.