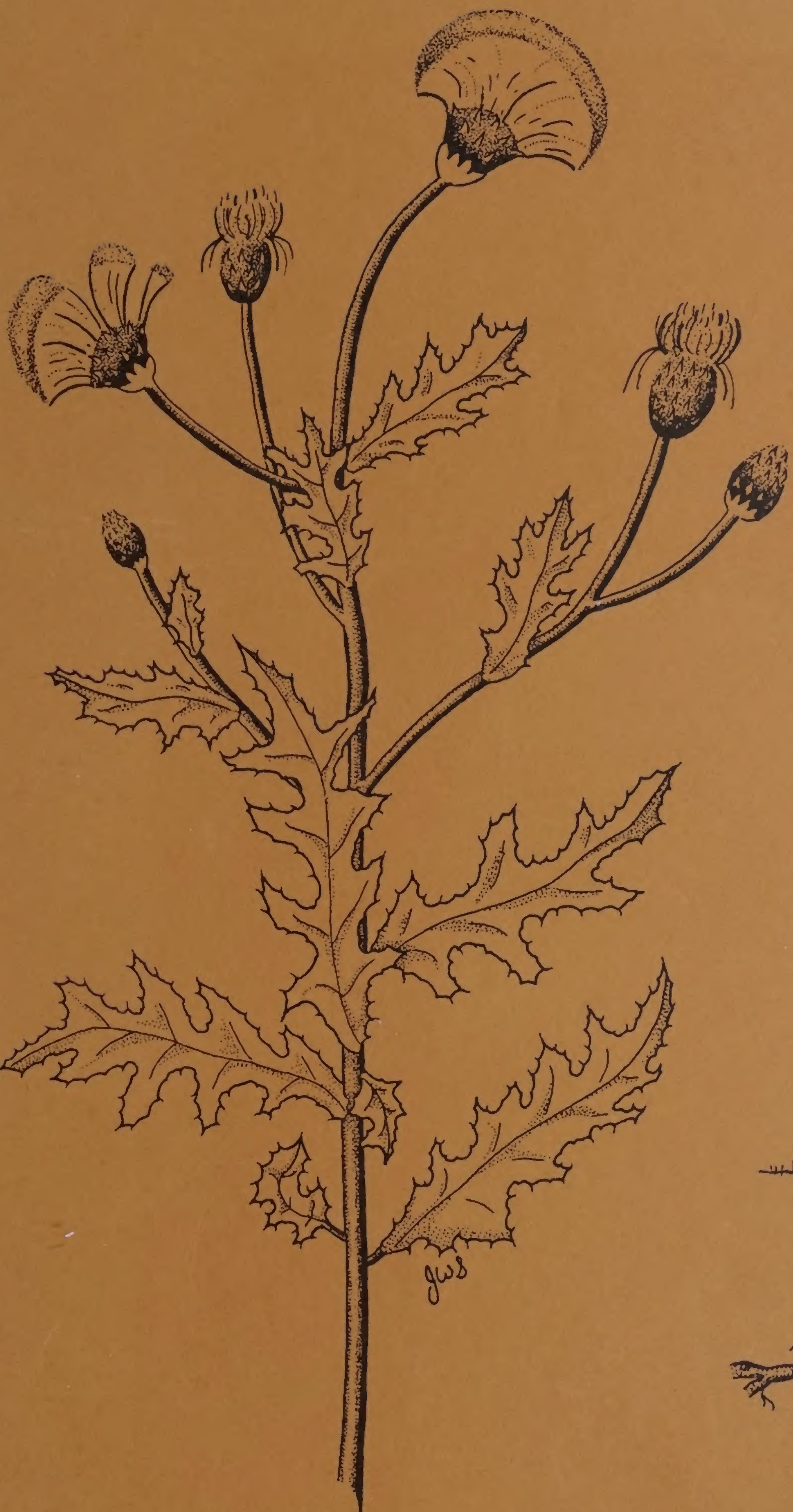
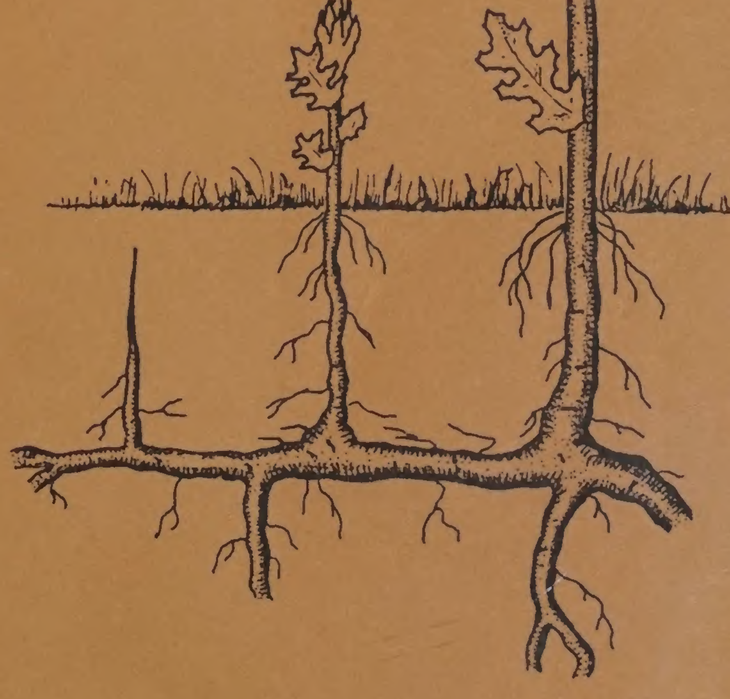
NORTH PLATTE RIVER AREA

Designated (Noxious) Weed Treatment Program
Environmental Assessment Record





THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

Wyoming Department of Agriculture

TELEPHONE: (307) 777-7321 CHEYENNE, WYOMING 82002

LARRY J. BOURRET, COMMISSIONER

NORTH PLATTE RIVER AREA

DESIGNATED (NOXIOUS) WEED TREATMENT PROGRAM

ENVIRONMENTAL ASSESSMENT RECORD

BUREAU OF LAND MANAGEMENT

RAWLINS DISTRICT, WYOMING

DECEMBER, 1978

COMPLETED UNDER CONTRACT NUMBER YA-512-CT6-196

BETWEEN

THE WYOMING DEPARTMENT OF AGRICULTURE

AND

BUREAU OF LAND MANAGEMENT

"AGRICULTURE—the backbone of Wyoming"

NORTH PLATTE RIVER AREA
DESIGNATED (NOXIOUS) WEED TREATMENT PROGRAM
ENVIRONMENTAL ASSESSMENT RECORD

Prepared By:

Wyoming Department of Agriculture   Cheyenne, Wyoming

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Dr. H.P. Alley	Professor of Weed Science, University of Wyoming, Laramie
G.A. (Lonnie) Bowman	Carbon County Weed and Pest Control District Supervisor Rawlins, Wyoming

IN REPLY REFER TO

9200 (932)

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
State Office
P. O. Box 1828
Cheyenne, Wyoming 82001

JUL [illegible] 1979

Mr. George Hittle
Weed and Pest Coordinator
Wyoming Department of Agriculture
2219 Carey Ave.
Cheyenne, Wyoming 82002

Dear Mr. Hittle:

Enclosed is the Department of the Interior approval for pesticide proposal 79-WY-003-001. We have also enclosed a copy of the weed control project transmittal memorandum to the Watershed Division in Washington, D. C. This memorandum oulines the Wyoming BLM recommended stipulations for the project. These stipulations will be a part of the approved project.

If you have any questions, please contact Phyllis Gumbmann in the BLM State Office at 778-2220, extension 2425.

Sincerely yours,

B D Leonard

for Daniel P. Baker
State Director

Enclosures (2)
1-USDI Approval Memorandum
2-Weed Control Project Transmittal Memorandum

CONSERVE AMERICA'S ENERGY

Save Energy and You Serve America!

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

JUN 29 1979

Memorandum

To: Director, Bureau of Land Management

From: Office of Environmental Project Review

Subject: Pesticide Use Proposal

Project 79-WY-003-001 has been approved.

Bruce Blanchard
Director

IN REPLY REFER TO:

United States Department of the Interior

9220 (211)

BUREAU OF LAND MANAGEMENT
WASHINGTON, D.C. 20240

JUL 16 AM 10 '79
RECEIVED
CHEYENNE, WYOMING

Memorandum

JUL 11 1979

Routing 7/12/79		Initial & Date
	SD	
	ASD	
1	PESO	CB 7/17
	OPA	
2		7/18
	Tech S.	
	Mgmt S.	
	CF	
Lead Resp. 2		

To: State Director, Wyoming

From: Leader, Water Resource Policy Staff

Subject: Pesticide Proposal

We have reviewed pesticide proposal 79-WY-003-001, and it is approved by the Departmental Pesticide Committee. Their report is enclosed.

ACTING

Enclosure

State Office
P. O. Box 1828
Cheyenne, Wyoming 82001

MAY 2 3 1979

Memorandum

To: Director (350)

From: State Director, Wyoming

Subject: North Platte River Weed Control Project (79-WY-003-001)

Attached are FWGPM Forms 1 and 2 for the proposed North Platte River weed control project for your review and approval. Also attached is the environmental assessment record and supplement.

We recommend the proposal be approved as outlined in the proposed action and mitigation sections of the EAR and supplement as indicated on FWGPM Forms 1 and 2. In addition, we recommend the following stipulations be made part of the approved project:

1. Only use one type or formulation of herbicide for treatment of a given area in any one calendar year.

2. The Carbon County Weed and Pest Control District will notify the Rawlins District BLM office of the location and date of herbicide applications prior to initiation so that a BLM Compliance Specialist can be on-site during all operations on public lands.

3. BLM will notify the Water Quality Division of the Wyoming Department of Environmental Quality of location and date of all herbicide applications on public lands.

4. Herbicides will not be applied within 10 feet horizontal distance of existing water levels.

5. Herbicides will be applied only after July 15 in those riparian areas as identified in the EAR.

6. Vehicles will be restricted to the existing roads in the Encampment River and Bennett Peak proposed wilderness study area.

7. The Weed and Pest Supervisor will notify contiguous private landowners growing crops or irrigating crops of the proposed treatment sites, herbicides to be applied, and when the sites will be treated.

8. Mixing of herbicide formulations will not be allowed in areas where spills could contaminate streams, ponds, or lakes. Mixing will occur 50 to 150 feet from all live water or whatever distance is required to prevent contamination of live water sources.

9. While obtaining water for the preparation of chemical mixtures (herbicides), care will be taken to ensure that no chemicals or herbicides are allowed to enter the water source; e.g., installation of vacuum breakers or suction cup or hose to prevent siphoning action if pump falters.

Form FWGPM-1

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
Rawlins District Office
April 23, 1979

Contact: Floyd Ewing, Medicine Bow Area Manager, FTS 328-3220

OBJECTIVE:

(1) a) Project Number:

b) Specific target pest: Canada thistle, musk thistle, yellow toadflax, leafy spurge.

c) Purpose: Control of above species that are unpalatable, compete with desirable species, and inhibit establishment of desirable species. Eradication of seed source of above species on headwaters of North Platte River drainage.

PESTICIDE:

(2) a) Common name:

1. Picloram
2. Tordon Beads
3. Banvel
4. Banvel 5G Granules
5. 2,4-D Amine

b) Formulation:

1. 4-amino-3,4,5 trichloropicolinic acid
2. 4-amino-3,4,5 trichloropicolinic acid
3. 3.6 dichloro-o-anisic acid
4. 3.6 dichloro-o-anisic acid
5. (2,4-dichlorophenoxy) acetic acid

c) AI, AE, or LB per gallon:

1. 1 lb per gallon
2. 2% AI per lb
3. 4 lbs AI per gallon
4. 5% AI per lb
5. 4 lbs AI per gallon

Form FWGPM-1 (Continued)

d) Registration no:

1. EPA #464-07087-WY
2. EPA #464-333-AA
3. EPA #876-25-AA
4. EPA #876-103-AA
5. EPA #464-1-AA, 1990-102, 677-296-A.B.; 359-331-AA

APPLICATION:

(3) a) Form applied:

1. Water solution
2. Granular
3. Water solution
4. Granular
5. Water solution

b) Use strength (%) or dilution rate:

1. 1/8 to 1 gallon Tordon 22K in 5-150 gallons water
2. 1/8 to 2/3 lbs. granules per square rod
3. 1-2 gallons Banvel in 5-150 gallons water per acre, depending on method of application and species
4. 80-160 lbs per acre
5. 4 lbs per gallon

c) Dilutent:

1. Water
2. None
3. Water
4. None
5. Water

(4) Lbs per acre or other rate:

1. ¼-2 lbs AI/Ac
2. ¼-2 lbs AI/Ac
3. 4-8 lbs AI/Ac
4. 4-8 lbs AI/Ac
5. 2-6 lbs AI/Ac

(5) a) Method: Aerial and ground.

b) Equipment: Ground units (spray booms and hand spray gun, hand spreaders, hand spreaders and shakes).

(6) a) Acres or other unit to be treated: 416 acres.

b) Number of applications: 1 initial; 4 retreatment.

c) Number of sites: Numerous.

d) Specific description of sites: Land adjoining the North Platte River and tributaries (riparian) and rangeland (non-riparian).

(7) a) Month(s) of year: June through September.

b) State(s): Wyoming

SENSITIVE AREAS:

(8) a) Areas to be avoided: None.

b) Areas to be treated with caution: Riparian areas.

REMARKS:

(9) a) Precautions to be taken:

b) Use of trained/certified personnel: All applicators are trained, experienced personnel.

c) State and local coordination: Wyoming Department of Environmental Quality is informed.

d) Other pesticides being applied to same site: None.

e) Monitoring: Stream monitoring.

f) Other:

Form FWGPM-2

NARRATIVE JUSTIFICATION
North Platte River Area
Designated (Noxious) Weed Treatment Program

1. (a) Agency: U.S. Department of the Interior, Bureau of Land Management.

   (b) Project No:

   (c) Target pest: Canada thistle, leafy spurge, yellow toadflax, and musk thistle.

2. Importance: Noxious weeds have been a problem for ranchers, farmers, and homeowners since Wyoming was settled late in the 1800's. Serious problems in rangeland are caused by broad-leafed herbaceous weeds, since many of them are unpalatable because of spines, thorns, or toxic juices. Such weeds are usually avoided by wildlife and livestock, consequently, broad-leafed herbaceous species tend to increase on improperly grazed ranges. In addition, they compete directly with desirable forage species for moisture and nutrients, decrease the amount of forage produced, and inhibit establishment of desirable forage seedlings.

   Leafy spurge has been classified by the Carbon County Weed and Pest Control Board of Directors as its highest priority. This is due to economic losses to growers in the area and because it is located mainly on the headwaters of the North Platte River which serves as an effective dispersal route for the weed. Leafy spurge has spread down the North Platte River at a rate of about 5 miles per year for the last three years. Most of the irrigation water for the Platte River Valley is drawn from the Platte River. This poses a threat of widespread infestation of leafy spurge to one of the most productive areas of Carbon County as well as to downstream areas. Intense political pressure has been directed to the Bureau of Land Management by local government officials as well as state government entities to insure the county and state control program is not rendered ineffective by lack of participation on the part of managers of public lands.

3. Area(s) to be treated: The proposed control areas on public lands consist of a total of 416.6 acres, including rangeland and riparian zones. Approximately 353 acres is riparian with the remainder non-riparian. All of the area is currently being grazed by domestic livestock and range conditions are considered to be poor to fair.

Aspects vary as the 416 acres are widely scattered. Control areas are wihin key winter ranges for deer and elk, however hand shaker application will be used in areas where browse species occur and immediately adjacent to streams.

4. Method: Application will be by ground units (hand spray gun, spray boom), hand sprayers, and hand spreaders (PCB spreaders, shakers). Rought topography make the use of hand sprayers and hand spreaders necessary in many areas. Treatment will be conducted by personnel of the Carbon County Weed and Pest Control Board who are knowledgable and skilled in the use of herbicides. In addition, operations on public lands will be supervised by an employee of the Bureau of Land Management.

5. Special Precautions: The minimum dosage necessary to control the target species will be applied. Any application adjacent to streams will be done with hand shakers to prevent herbicide from getting into the water insofar as is possible. EPA water quality standards will be adhered to. Weather criteria governing the spray project will be diligently adhered to (listed on Form FWGPM-2).

6. Alternative materials or methods: The initial application is planned for Spring-Summer-Fall of 1979. A retreatment-follow-up program will be scheduled for 1980, 1981, 1982, and 1983. This is necessary because leafy spurge, in particular, has a long period of seed germination and many seedlings will escape the initial applications.

7. Cooperators: The proposed noxious weed control project is a cooperative effort between the Wyoming State Department of Agriculture, Carbon County Weed and Pest Control District and the Bureau of Land Management, Rawlins District.

8. Monitoring: Monitoring will consist of adherence to weather criteria, necessary to insure confinement of the herbicide to target areas and species, and monitoring and analysis of water quality samples by the Wyoming Department of Agriculture, Supervisor of the Carbon County Weed and Pest Control District.

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NORTH PLATTE RIVER AREA

DESIGNATED (NOXIOUS) WEED TREATMENT PROGRAM

ENVIRONMENTAL ASSESSMENT RECORD

I. BACKGROUND AND INTRODUCTION

This Environmental Assessment Record is being prepared as a result of a proposal by the Wyoming State Department of Agriculture in cooperation with Wyoming Weed and Pest Control Districts to control designated (noxious) weeds on public lands in Wyoming.

The purpose of the environmental assessment is to assure consideration of environmental values at all levels of Bureau planning and decision making. This is in response to the National Environmental Policy Act of 1969, which directs federal agencies to use a systematic, inter-disciplinary approach to ensure the use of natural and social sciences, and the design arts, in planning and decision making for projects which may affect man's environment. Thus, analysis is needed to ensure that environmental values are considered in decisions regarding the proposed application of herbicides or the proposed alternatives for control of weeds on public lands. It is BLM policy that an environmental analysis be conducted for every Bureau program or activity that may affect the quality of the environment.

The purpose of this analysis is to:

1. Identify probable impacts from the application of herbicides on public lands.

2. Assess public controversy over the use of such herbicides.

3. Provide a basis for determining whether an environmental impact statement is required.

4. Document the analysis.

The Bureau has determined the need for the State to develop, administer, and supervise a program of designated (noxious) weed control on public lands in the Casper, Rawlins, Rock Springs, and Worland districts under the authority and intent of P.L. 90-583 (Carlson-Foley Act, Appendix 6). The program will also include an inventory of designated (noxious) weeds in each district.

Designated (noxious) weeds have been a problem for farmers, ranchers, and homeowners since Wyoming was settled. Seventeen species of designated (noxious) weeds (Wyoming Weed and Pest Control Act of 1973) exist on public lands administered by the Bureau of Land Management (BLM), (Appendix 5).

Serious problems in rangelands are caused by broad-leaved herbaceous weeds, since many of them are unpalatable because of spines, thorns or toxic juices. Such weeds are usually avoided by wildlife and livestock unless other forage is lacking; consequently, broad-leaved herbaceous species tend to increase on improperly grazed ranges. In addition, they compete directly with desirable forage species for moisture and nutrients, decrease the amount of forage produced, and inhibit establishment of forage seedlings.

The Carbon County Weed and Pest Control Board of Directors has classified leafy spurge as its highest priority due to economic losses to growers in the area, and because it is located mainly on the headwaters of the North Platte River which serves as an effective dispersal route for the weed. Leafy spurge has spread down the Platte River at a rate of about 5 miles per year for the last three years (60). Most of the irrigation water from the Platte Valley is drawn from the Platte River. This poses a threat of widespread infestation of leafy spurge to one of the most productive areas of Carbon County. In addition to leafy spurge, several other designated weeds have invaded this area and are causing economic losses.

A five-year weed treatment program (1979-1983) is proposed for the North Platte Program Area which is located in the North Platte River drainage in Carbon County (Figure 1). This area encompasses approximately 206,945 acres of private, state, and federal land. The following chart details the total number of acres, the approximate number of weed infested acres and the percentage of acres proposed for weed control efforts on the private, state, and federal lands in the program area.

Land Ownership	Total Acres	Total Infested Acres	% of Acres of Each Ownership Proposed for Treatment
Private	135,142	4695.0	3.47%
State	15,083	110.0	0.72%
BLM	56,720	416.6	0.73%
Total	206,945	5221.6	2.50%

A total of 5221.6 (2.5%) acres in all three land types would be treated. On Bureau of Land Management lands a total of 416.6 acres (0.73%) would be treated. Vegetation zones in the program area include rangeland, permanent grass pasture and riparian.

The treatment cost for the five year program is projected to be approximately $208 to $341 per acre. For the five year program the

Figure 1. General Location Map, Bureau of Land Management, Rawlins District, Carbon County, Wyoming. Area within the heavy line is the proposed program area.

total treatment cost on BLM lands would be between \$86,652 and \$142,000. Continuous maintainence programs would follow the five year initial program in order to prevent reinfestation.

II. DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

Proposed Action

The purpose of the proposed action is to control and contain designated (noxious) weeds in the North Platte River Valley of Carbon County in the BLM Rawlins District. The Carbon County Weed and Pest Control District would be in charge of the weed control program with coordinating responsibilities by the Wyoming Department of Agriculture.

The weed control program is designed to begin in early spring 1979 and continue through the fall of 1983. The site specific areas to be treated are shown on U.S.G.S. 7.5 minute quadrangle, topographic maps (Appendix 2). Tables 1 through 6a, in reference to the quadrangle maps, indicate the weed species, their location, acres of infestation, herbicide to be applied, optimum plant growth stage for herbicide application, and optimum time and method of application for each program year. For the following quadrangles this information is presented separately; first, by the initial program year and then the retreatment and follow-up years 1980-1983 in riparian and non-riparian zones:

Barcus Peak (Tables 1-1c)

Ryan Park (Tables 2-2c)

Encampment (Tables 3-3c)

Trent Creek (Tables 4-4a; Riparian Only)

Cow Creek (Tables 5-5a; Non-riparian Only)

Cow Creek Ranch (Tables 6-6a; Non-riparian Only)

The information contained in the U.S.G.S. maps (Appendix 2) and Tables 1-6a was obtained during a systematic weed survey of BLM lands in 1976.

Following the tables are discussions of the herbicides proposed for use in this program, application methodology, rate of application, time of application and recommendations for retreatment and follow-up programs. These descriptions give more detailed information than could be included in the tables. They are as specific as possible, taking into account that some decisions must be made based on observation of individual situations.

Herbicides Proposed For Use

The herbicides proposed for use on BLM land, in the Rawlins District, are Tordon, Banvel and 2,4-D. The specific formulations, application rates, EPA registration numbers and additional pertinent information for the herbicides to be used are as follows:

Tordon 22K

1. Trade name: Tordon
2. Common name: picloram
3. Chemical name: 4-amino-3,4,5 Trichloropicolinic Acid
4. Active Ingredient per gallon: 2 lbs.
5. Registration: Tordon 22K is registered for use on rangeland and permanent grass pastures in the State of Wyoming, EPA Registration No. 464-07087-WY (See label, Appendix 8).
6. Form applied: Water solution

Table 1. Barcus Peak Quadrangle (Riparian Zone)
Spring 1979 and Fall 1979

Survey No.	Weed Species	Code	Township & Range	Section	Sub-Section[1]	Acres Infestation	Herbicide Applied	Method[2] Appli.	Time of Appli.	Phenotypic Stage of Growth
196	Canada thistle	02	T15N R82W	23	SW¼	10	Tordon or Banvel	II or III II or III	July to Sept. June or Sept.	Bud to maturity Early bud or maturity
196	Leafy spurge	03	T15N R82W	23	SW¼	10	Tordon or Banvel	II or III II or III	June to Aug. June or Sept.	Bud to maturity Bud to bloom or maturity
203	Canada thistle	02	T15N R82W	26	W½, NE¼, N½SE¼. SW¼SE¼	25	Tordon or Banvel	II or III II or III	July to Sept. June or Sept.	Bud to maturity Early bud or maturity
203	Leafy spurge	03	T15N R82W	26	W½, NE¼, N½SE¼, SW¼SE¼	25	Tordon or Banvel	II or III II or III	June to Aug. June or Sept.	Bud to maturity Bud to bloom or maturity
199	Canada thistle	02	T14N R81W	20	E½W½, W½E½, SE¼ NE¼	50	Tordon or Banvel	II or III II or III	July to Sept. June or Sept.	Bud to maturity Early bud or maturity
199	Yellow toadflax	11	T14N R81W	20	NW¼NE¼	2	Tordon or Banvel	II or III II or III	June or Sept. June or Sept.	Bud or maturity Bud or maturity
					Total Acres - 122					

[1] Refer to Appendix 2 for site specific maps.

[2] I - ground units (liquid formulation) a. hand spray gun; b. spray boom.
II - hand sprayers (liquid formulation)
III - hand spreaders (granular applicator) a. PCB spreaders; b. shakers.

Table 1a. Barcus Peak Quadrangle (Riparian Zone)
Retreat and Follow-up Program: 1980, 1981, 1982, and 1983

Survey No.	Weed Species	Code	Township & Range	Section	Sub-Section[1]	Retreat[2] 25% Acres	Follow-Up[3] 75%	Herbicide Applied	Method[4] Appli.	Time of Appl.	Phenotypic Stage of Growth
196	Canada thistle	02	T15N R82W	23	SW¼	3.0		Tordon or	II or III	July to Sept.	Bud to maturity.
								Banvel	II or III	June or Sept.	Early bud or maturity.
							7.0	2,4-D Amine	II	June	Seedling stage.
196	Leafy spurge	03	T15N R82W	23	SW¼	3.0		Tordon or	II or III	June to Aug.	Bud to maturity.
								Banvel	II or III	June or Sept.	Bud to bloom or maturity.
							7.0	2,4-D Amine	II	June	Seedling stage.
203	Canada thistle	02	T15N R82W	26	W½, NE¼, N½SE¼ SW¼SE¼	6.0		Tordon or	II or III	July to Sept.	Bud to maturity.
								Banvel	II or III	June or Sept.	Early bud or maturity.
							19.0	2,4-D Amine	II	June	Seedling stage.
203	Leafy spurge	03	T15N R82W	26	W½, NE¼, N½ SE¼, SW¼SE¼	6.0		Tordon or	II or III	June to Aug.	Bud to maturity.
								Banvel	II or III	June or Sept.	Bud to bloom or maturity.
							19.0	2,4-D Amine	II	June	Seedling stage.
199	Canada thistle	02	T14N R81W	20	E½W½, W½E½, SE¼NE¼	13.0		Tordon or	II or III	July to Sept.	Bud to maturity.
								Banvel	II or III	June or Sept.	Early bud or maturity.
							37.0	2,4-D Amine	II	June	Seedling stage.
199	Yellow toadflax	11	T14N R81W	20	NW¼NE¼	0.5		Tordon or	II or III	June or Sept.	Bud to maturity.
								Banvel	II or III	June or Sept.	Bud or maturity.
							1.5	2,4-D Amine	II	June	Seedling stage.
					Total Acres -	31.5	90.5				

[1] Refer to Appendix 2 for site specific maps.

[2] The possibility exists that approximately 25% of the original area may have to be retreated with the herbicide originally recommended.

[3] The entire area needs to be rechecked for new seedlings, preferably at least once a year. The number of inspections depends on weed species and herbicide applied.

[4] I - ground units (liquid formulation) a. hand spray gun; b. spray boom.
II - hand sprayers (liquid formulation)
III - hand spreaders (granular applicator) a. PCB spreaders; b. shakers.

Table 1b. Barcus Peak Quadrangle, 1979: (Non-Riparian Zone)

Survey No.	Weed Species	Code	Township & Range	Section	Sub-Section[1]	Acres Infestation	Herbicide Applied	Method[2] Appl.	Time of Appl.	Phenotypic Stage of Growth
005	Leafy spurge	03	T14N R81W	5	NW¼NE¼	0.120	Tordon	Ia	June to Sept.	Bud to maturity
095	Yellow toadflax	11	T14N R81W	6	SE¼NE¼	0.120	Tordon or Banvel	II or III II or III	June or Sept. June or Sept.	Bud or maturity Bud or maturity
109	Canada thistle	02	T14N R82W	28	SE¼NE¼	0.280	Tordon or Banvel	II or III II or III	June to Sept. June or Sept.	Bud to maturity Early bud or maturity
131	Canada thistle	02	T14N R81W	8	NW¼NW¼	22.000	Tordon or Banvel	II or III II or III	June to Sept. June or Sept.	Bud to maturity Early bud or maturity
132	Canada thistle	02	T14N R81W	5	SW¼SW¼	2.000	Tordon or Banvel	II or III II or III	June to Sept. June or Sept.	Bud to maturity Early bud or maturity
						Total Acres - 24.540				

[1] Refer to Appendix 2 for site specific maps.

[2] I - ground units (liquid formulation) a. hand spray gun; b. spray boom.
II - hard sprayers (liquid formulation)
III - hand spreaders (granular applicator) a. PCB spreaders; b. shakers.

Table 1c. Barcus Peak Quadrangle (Non-Riparian Zone)
Retreat and Follow-Up Program: 1980, 1981, 1982, and 1983

Survey No.	Weed Species	Code	Township & Range	Section	Sub-Section[1]	Retreat[2] 25% Acres	Follow-Up[3] 75% Acres	Herbicide Applied	Method[4] Appli.	Time of Appli.	Phenotypic Stage of Growth
005	Leafy spurge	03	T14N R81W	5	NW¼NE¼		0.120	Tordon	Ia	June to Sept.	Bud to maturity.
								2,4-D Amine	Ia	June	Seedling stage.
095	Yellow toadflax	11	T14N R81W	6	SE¼NE¼			Tordon or	II or III	June or Sept.	Bud or maturity.
								Banvel	II or III	June or Sept.	Bud or maturity.
							0.120	2,4-D Amine	Ia	June	Seedling stage.
109	Canada thistle	02	T14N R82W	28	SE¼NE¼			Tordon or	II or III	June to Sept.	Bud to maturity.
								Banvel	II or III	June or Sept.	Early bud or maturity.
							0.280	2,4-D Amine	II	June	Seedling stage.
131	Canada thistle	02	T14N R81W	8	NW¼NW¼	6.0		Tordon or	II or III	June to Sept.	Bud to maturity.
								Banvel	II or III	June or Sept.	Early bud or maturity.
							16.000	2,4-D Amine	II	June	Seedling stage.
132	Canada thistle	02	T14N R81W	5	SW¼SW¼	0.5		Tordon or	II or III	June to Sept.	Bud to maturity.
								Banvel	II or III	June or Sept.	Early bud or maturity.
							1.500	2,4-D Amine	II	June	Seedling stage.
					Total Acres -	6.5	18.020				

[1] Refer to Appendix 2 for site specific maps.

[2] The possibility exists that approximately 25% of the original area may have to be retreated with the herbicide originally recommended.

[3] The entire area needs to be rechecked for new seedlings, preferably at least once a year. The number of inspections depends on weed species and herbicide applied.

[4]
I - ground units (liquid formulation) a. hand spray gun; b. spray boom.
II - hand sprayers (liquid formulation)
III - hand spreaders (granular applicator) a. PCB spreaders; b. shakers.

Table 2. Ryan Park Quadrangle (Riparian Zone)
Spring 1979 and Fall 1979

Survey No.	Weed Species	Code	Township & Range	Section	Sub-Section[1]	Acres Infestation	Herbicide Applied	Method[2] Appli.	Time of Appli.	Phenotypic Stage of Growth
193	Canada thistle	02	T15N R82W	15	NE¼NW¼	1	Tordon or Banvel	II or III II or III	July to Sept. June or Sept.	Bud to maturity Early bud or maturity
193	Canada thistle	02	T15N R82W	15	N½, E½SE¼	45	Tordon or Banvel	II or III II or III	July to Sept. June or Sept.	Bud to maturity Early bud or maturity
193	Leafy spurge	03	T15N R82W	15	N½, E½SE¼	45	Tordon or Banvel	II or III II or III	June to Aug. June or Sept.	Bud to maturity Bud to bloom or maturity
194	Canada thistle	02	T15N R82W	14	W½	30	Tordon or Banvel	II or III II or III	July to Sept. June or Sept.	Bud to maturity Early bud or maturity
194	Leafy spurge	03	T15N R82W	14	W½	30	Tordon or Banvel	II or III II or III	June to Aug. June or Sept.	Bud to maturity Bud to bloom or maturity
196	Canada thistle	02	T15N R82W	23	N½ N½, SE¼NW¼	19	Tordon or Banvel	II or III II or III	July to Sept. June or Sept.	Bud to maturity Early bud or maturity
196	Leafy spurge	03	T15N R82W	23	N½ N½, SE¼NW¼	18	Tordon or Banvel	II or III II or III	June to Aug. June or Sept.	Bud to maturity Bud to bloom or maturity
						Total Acres - 188				

[1] Refer to Appendix 2 for site specific maps.

[2] I - ground units (liquid formulation) a. hand spray gun; b. spray boom.
II - hand sprayers (liquid formulation)
III - hand spreaders (granular applicator) a. PCB spreaders; b. shakers.

Table 2a. Ryan Park Quadrangle (Riparian Zone)
Retreat and Follow-Up Program: 1980, 1981, 1982, and 1983

Survey No.	Weed Species	Code	Township & Range	Section	Sub-Section[1]	Retreat[2] 25% Acres	Follow-Up[3] 75%	Herbicide Applied	Method[4] Appl.	Time of Appl.	Phenotypic Stage of Growth
193	Canada thistle	02	T15N R82W	15	NE¼NW¼	0.25	0.75	Tordon or Banvel 2,4-D Amine	II or III II or III II	July to Sept. June or Sept. June	Bud to maturity. Early bud or maturity. Seedling stage.
193	Canada thistle	02	T15N R82W	15	N½, E½SE¼	11.00	34.00	Tordon or Banvel 2,4-D Amine	II or III II or III II	July to Sept. June or Sept. June	Bud to maturity. Early bud or maturity Seedling stage.
193	Leafy spurge	03	T15N R82W	15	N½, E½SE¼	11.00	34.00	Tordon or Banvel 2,4-D Amine	II or III II or III II	June to Aug. June or Sept. June	Bud to maturity. Bud to bloom or maturity. Seedling stage.
194	Canada thistle	02	T15N R82W	14	W½	8.00	22.00	Tordon or Banvel 2,4-D Amine	II or III II or III II	July to Sept. June or Sept. June	Bud to maturity. Early bud or maturity. Seedling stage.
194	Leafy spurge	03	T15N R82W	14	W½	8.00	22.00	Tordon or Banvel 2,4-D Amine	II or III II or III II	June to Aug. June or Sept. June	Bud to maturity. Bud to bloom or maturity. Seedling stage.
196	Canada thistle	02	T15N R82W	23	N½N½, SE¼NW¼	5.00	14.00	Tordon or Banvel 2,4-D Amine	II or III II or III II	July to Sept. June or Sept. June	Bud to maturity. Early bud or maturity. Seedling stage.
196	Leafy spurge	03	T15N R82W	23	N½N½, SE¼NW¼	5.00	13.00	Tordon or Banvel 2,4-D Amine	II or III II or III II	June to Aug. June or Sept. June	Bud to maturity. Bud to bloom or maturity.
					Total Acres -	48.25	139.75				

[1] Refer to Appendix 2 for site specific maps.

[2] The possibility exists that approximately 25% of the original area may have to be retreated with the herbicide originally recommended.

[3] The entire area needs to be rechecked for new seedlings, preferably at least once a year. The number of inspections depends on weed species and herbicide applied.

[4]
I - ground units (liquid formulation) a. hand spray gun; b. spray boom.
II - hand sprayers (liquid formulation)
III - hand spreaders (granular applicator) a. PCB spreaders; b. shakers.

Table 2b. Ryan Park Quadrangle: 1979 (Non-Riparian Zone)

Survey No.	Weed Species	Code	Township & Range	Section	Sub-Section[1]	Acres Infestation	Herbicide Applied	Method[2] Appl.	Time of Appl.	Phenotypic Stage of Growth
211	Canada thistle	02	T15N R82W	12	SE¼NW¼	2	Tordon or	II or III	June to Sept.	Bud to maturity
							Banvel	II or III	June or Sept.	Early bud or maturity
134	Canada thistle	02	T16N R82W	34	N½N½; SE¼NE¼	4	Tordon or	II or III	June to Sept.	Bud to maturity
							Banvel	II or III	June or Sept.	Early bud or maturity
						Total Acres - 6				

[1] Refer to Appendix 2 for site specific maps.

[2] I - ground units (liquid formulation) a. hand spray gun; b. spray boom.
II - hand sprayers (liquid formulation)
III - hand spreaders (granular applicator) a. PCB spreaders; b. shakers.

Table 2c. Ryan Park Quadrangle (Non-Riparian Zone)
Retreat and Follow-Up Program: 1980, 1981, 1982, and 1983

Survey No.	Weed Species	Code	Township & Range	Section	Sub-Section[1]	Retreat[2] 25% Acres	Follow-Up[3] 75%	Herbicide Applied	Method[4] Appli.	Time of Appli.	Phenotypic Stage of Growth
211	Canada thistle	02	T15N R82W	12	SE¼NW¼	0.5		Tordon or	II or III	June to Sept.	Bud to maturity.
								Banvel	II or III	June or Sept.	Early bud or maturity.
							1.5	2,4-D Amine	II	June	Seedling stage.
134	Canada thistle	02	T16N R82W	34	N½N½, SE¼NE¼	1.0		Tordon or	II or III	June to Sept.	Bud to maturity.
								Banvel	II or III	June or Sept.	Early bud or maturity.
							3.0	2,4-D Amine	II	June	Seedling stage.
					Total Acres -	1.5	4.5				

[1] Refer to Appendix 2 for site specific maps.

[2] The possibility exists that approximately 25% of the original area may have to be retreated with the herbicide originally recommended.

[3] The entire area needs to be rechecked for new seedlings, preferably at least once a year. The number of inspections depends on weed species and herbicide applied.

[4] I - ground units (liquid formulation) a. hand spray gun; b. spray boom.
II - hand sprayers (liquid formulation)
III - hand spreaders (granular applicator) a. PCB spreaders; b. shakers.

Table 3. Encampment Quadrangle (Riparian Zone)
Spring 1979 and Fall 1979

Survey No.	Weed Species	Code	Township & Range	Section	Sub-Section[1]	Acres Infestation	Herbicide Applied	Method[2] Appl.	Time of Appl.	Phenotypic Stage of Growth
231	Canada thistle	02	T14N R84W	24	NW¼NW¼	0.500	Tordon or Banvel	II or III II or III	July to Sept. June or Sept.	Bud to maturity Early bud or maturity
232	Canada thistle	02	T14N R84W	23	NE¼NE¼; NE¼SW¼ SE¼SW¼; SW¼NE¼	9.000	Tordon or Banvel	II or III II or III	July to Sept. June or Sept.	Bud to maturity Early bud or maturity
232	Musk thistle	14	T14N R84W	23	SW¼NE¼	0.062	Tordon or Banvel	II or III II or III	June or Sept. June or Sept.	Rosette stage or before flowering stalk lengthens. Spring before flowering stalk lengthens or fall in rosette stage.
233	Canada thistle	02	T14N R84W	26	NW¼	3.500	Tordon or Banvel	II or III II or III	July to Sept. June or Sept.	Bud to maturity Early bud or maturity
234	Canada thistle	02	T14N R84W	27	E½	4.500	Tordon or Banvel	II or III II or III	July to Sept. June or Sept.	Bud to maturity Early bud or maturity
235	Canada thistle	02	T14N R84W	34	E½ NW¼; NW NE	4.500	Tordon or Banvel	II or III II or III	July to Sept. June or Sept.	Bud to maturity Early bud or maturity
235	Canada thistle	02	T14N R84W	34	NW¼SW¼		Tordon or Banvel	II or III II or III	July to Sept. June or Sept.	Bud to maturity Early bud or maturity
220	Canada thistle	02	T14N R84W	34	N½ NE¼	1.500	Tordon or Banvel	II or III II or III	July to Sept. June or Sept.	Bud to maturity Early bud or maturity
					Total Acres - 33.562					

[1] Refer to Appendix 2 for site specific maps.

[2] I - ground units (liquid formulation) a. hand spray gun; b. spray boom.
II - hand sprayers (liquid formulation)
III - hand spreaders (granular applicator) a. PCB spreaders; b. shakers.

Table 3a. Encampment Quadrangle (Riparian Zone)
Retreat and Follow-Up Program: 1980, 1981, 1982, and 1983

Survey No.	Weed Species	Code	Township & Range	Section	Sub-Section[1]	Retreat[2] 25% Acres	Follow-Up[3] 75% Acres	Herbicide Applied	Method[4] Appl.	Time of Appl.	Phenotypic Stage of Growth
231	Canada thistle	02	T14N R84W	24	NW¼NW¼	0.125	 0.375	Tordon or Banvel 2,4-D Amine	II or III II or III II	July to Sept. June or Sept. June	Bud to maturity. Early bud or maturity. Seedling stage.
232	Canada thistle	02	T14N R84W	23	NE¼NE¼; NE¼SW¼ SE¼SW¼; SW¼NE¼	2.000	 7.000	Tordon or Banvel 2,4-D Amine	II or III II or III II	July to Sept. June or Sept. June	Bud to maturity Early bud or maturity. Seedling stage.
232	Musk thistle	14	T14N R84W	23	SW¼NE¼		 0.062	Tordon or Banvel 2,4-D Amine	II or III II or III II	June or Sept. June or Sept. June	Rosette stage or before flowering stalk lengthens. Spring before flowering stalk lengthens or fall in rosette stage. Seedling stage.
233	Canada thistle	02	T14N R84W	26	NW¼	0.875	 2.625	Tordon or Banvel 2,4-D Amine	II or III II or III II	July to Sept. June or Sept. June	Bud to maturity. Early bud or maturity. Seedling stage.
234	Canada thistle	02	T14N R84W	27	E½	1.125	 3.375	Tordon or Banvel 2,4-D Amine	II or III II or III II	July to Sept. June or Sept. June	Bud to maturity. Early bud or maturity. Seedling stage.
235	Canada thistle	02	T14N R84W	34	E½ NW¼; NW¼NE¼	1.125	 3.375	Tordon or Banvel 2,4-D Amine	II or III II or III II	July to Sept. June or Sept. June	Bud to maturity. Early bud or maturity. Seedling stage.
235	Canada thistle	02	T14N R84W	34	NW¼SW¼			Tordon or Banvel	II or III II or III	July to Sept. June or Sept.	Bud to maturity. Early bud or maturity.
220	Canada thistle	02	T14N R84W	34	N½ NE¼	0.375	 1.125	Tordon or Banvel 2,4-D Amine	II or III II or III II	July to Sept. June or Sept. June	Bud to maturity. Early bud or maturity. Seedling stage.
					Total Acres -	5.625	17.937				

[1] Refer to Appendix 2 for site specific maps.
[2] The possibility exists that approximately 25% of the original area may have to be retreated with the herbicide originally recommended.
[3] The entire area needs to be rechecked for new seedlings, preferably at least once a year. The number of insepctions depends on weed species and herbicide applied.
[4] I - ground units (liquid formulation) a. hand spray gun; b. spray boom.
II - hand sprayers (liquid formulation)
III - hand spreaders (granular applicator) a. PCB spreaders; b. shakers.

Table 3b. Encampment Quadrangle: 1979 (Non-Riparian Zone)

Survey No.	Weed Species	Code	Township & Range	Section	Sub-Section[1]	Acres Infestation	Herbicide Applied	Method[2] Appl.	Time of Appl.	Phenotypic Stage of Growth
222	Canada thistle	02	T15N R84W	23	S½ SW¼	2.500	Tordon or Banvel	II II	June to Sept. June or Sept.	Bud to maturity Early bud or maturity
228	Canada thistle	02	T15N R84W	34	SW¼NW¼	3.000	Tordon or Banvel	II II	June to Sept. June or Sept.	Bud to maturity Early bud or maturity
226	Canada thistle	02	T14N R84W	4	NW¼NE¼; SE¼NW¼	4.000	Tordon or Banvel	II II	June to Sept. June or Sept.	Bud to maturity Early bud or maturity
024	Canada thistle	02	T14N R84W	22	SE¼NW¼	0.012	Tordon	Ia	June to Sept.	Bud to maturity
063	Canada thistle	02	T14N R84W	14	SE¼SW¼	0.060	Tordon or Banvel	II or III II or III	June to Sept. June or Sept.	Bud to maturity Early bud or maturity
084	Canada thistle	02	T14N R84W	35	NW¼SE¼	0.156	Tordon	Ia	June to Sept.	Bud to maturity
166	Canada thistle	02	T14N R83W	20	NE¼NW¼	0.012	Tordon	Ia	June to Sept.	Bud to maturity
172	Canada thistle	02	T14N R83W	30	SE¼SW¼	0.068	Tordon	Ia	June to Sept.	Bud to maturity
173	Canada thistle	02	T14N R83W	31	NW¼NE¼	0.006	Tordon	Ia	June to Sept.	Bud to maturity
173	Musk thistle	14	T14N R83W	31	NW¼NE¼	0.006	Tordon	Ia	June or Sept.	Rosette stage in fall or before flowering stalk lengthens in spring.
					Total Acres - 9.818					

[1] Refer to Appendix 2 for site specific maps.

[2] I - ground units (liquid formulation) a. hand spray gun; b. spray boom.
II - hand sprayers (liquid formulation)
III - hand spreaders (granular applicator) a. PCB spreaders; b. shakers.

Table 3c. Encampment Quadrangel (Non-Riparian Zone)
Retreat and Follow-Up Program: 1980, 1981, 1982, and 1983

Survey No.	Weed Species	Code	Township & Range	Section	Sub-Section[1]	Retreat[2] 25% Acres	Follow-Up[3] 75%	Herbicide Applied	Method[4] Appl.	Time of Appl.	Phenotypic Stage of Growth
222	Canada thistle	02	T15N R84W	23	S½ SW¼	0.625		Tordon or	II	June to Sept.	Bud to maturity.
								Banvel	II	June or Sept.	Early bud or maturity.
							1.875	2,4-D Amine	II	June	Seedling stage.
228	Canada thistle	02	T15N R84W	34	SW¼NW¼	0.750		Tordon or	II	June to Sept.	Bud to maturity.
								Banvel	II	June or Sept.	Early bud or maturity.
							2.250	2,4-D Amine	II	June	Seedling stage.
226	Canada thistle	02	T14N R84W	4	NW¼NE¼; SE¼NW¼	1.000		Tordon or	II	June to Sept.	Bud to maturity.
								Banvel	II	June or Sept.	Early bud or maturity.
							3.000	2,4-D Amine	II	June	Seedling stage.
024	Canada thistle	02	T14N R84W	22	SE¼NW¼			Tordon	Ia	June to Sept.	Bud to maturity.
							0.012	2,4-D Amine	Ia	June	Seedling stage.
063	Canada thistle	02	T14N R84W	14	SE¼SW¼			Tordon or	II or III	June to Sept.	Bud to maturity.
								Banvel	II or III	June or Sept.	Early bud or maturity.
							0.062	2,4-D Amine	Ia	June	Seedling stage.
084	Canada thistle	02	T14N R84W	35	NW¼SE¼			Tordon	Ia	June to Sept.	Bud to maturity.
							0.156	2,4-D Amine	Ia	June	Seedling stage.
166	Canada thistle	02	T14N R83W	20	NE¼NW¼			Tordon	Ia	June to Sept.	Bud to maturity.
							0.012	2,4-D Amine	Ia	June	Seedling stage.
172	Canada thistle	02	T14N R83W	30	SE¼SW¼			Tordon	Ia	June to Sept.	Bud to maturity.
							0.068	2,4-D Amine	Ia	June	Seedling stage.
173	Canada thistle	02	T14N R83W	31	NW¼NE¼			Tordon	Ia	June to Sept.	Bud to maturity.
							0.006	2,4-D Amine	Ia	June	Seedling stage.
173	Musk thistle	14	T14N R83W	31	NW¼NE¼			Tordon	Ia	June or Sept.	Rosette stage in fall or before flowering stalk lengthens in spring.
							0.006	2,4-D Amine	Ia	June or Sept.	Seedling stage.
					Total Acres -	2.375	7.441				

[1] Refer to Appendix 2 for site specific maps.
[2] The possibility exists that approximately 25% of the original area may have to be retreated with the herbicide originally recommended.
[3] The entire area needs to be rechecked for new seedlings, preferably at least once a year. The number of inspections depends on weed species and herbicide applied.
[4] I - ground units (liquid formulation) a. hand spray gun; b. spray boom.
II - hand sprayers (liquid formulation)
III - hand sprayers (granular applicator) a. PCB spreaders; b. shakers.

Table 4. Trent Creek Quadrangle (Riparian Zone)
Spring 1979 and Fall 1979

Survey No.	Weed Species	Code	Township & Range	Section	Sub-Section[1]	Acres Infestation	Herbicide Applied	Method[2] Appl.	Time of Appl.	Phenotypic Stage of Growth
217	Canada thistle	02	T13N R81W	4	SE¼SW¼	5	Tordon or Banvel	II or III II or III	July to Sept. June or Sept.	Bud to maturity Early bud or maturity
178	Canada thistle	02	T13N R81W	9	NE¼NW¼	4	Tordon or	II or III	July to Sept.	Bud to maturity
178	Canada thistle	02	T13N R81W	9	NW¼NE¼	1	Banvel	II or III	June or Sept.	Early bud or maturity
						Total Acres - 10				

[1]Refer to Appendix 2 for site specific maps.

[2] I - ground units (liquid formulation) a. hand spray gun; b. spray boom.
II - hand sprayers (liquid formulation)
III - hand spreaders (granular applicator) a. PCB spreaders; b. shakers.

Table 4a. Trent Creek Quadrangle (Riparian Zone)
Retreat and Follow-Up Program: 1980, 1981, 1982, and 1983

Survey No.	Weed Species	Code	Township & Range	Section	Sub-Section[1]	Retreat[2] 25%	Follow-Up[3] Acres 75%	Herbicide Applied	Method[4] Appl.	Time of Appl.	Phenotypic Stage of Growth
217	Canada thistle	02	T13N R81W	4	SE¼SW¼	1		Tordon or	II or III	July to Sept.	Bud to maturity.
								Banvel	II or III	June or Sept.	Early bud or maturity.
							4	2,4-D Amine	II	June	Seedling stage.
178	Canada thistle	02	T13N R81W	9	NE¼NW¼	1		Tordon or	II or III	July to Sept.	Bud to maturity.
178	Canada thistle	02	T13N R81W	9	NW¼NE¼			Banvel	II or III	June or Sept.	Early bud or maturity.
							4	2,4-D Amine	II	June	Seedling stage.
					Total Acres - 2		8				

[1]Refer to Appendix 2 for site specific maps.

[2]The possibility exists that approximately 25% of the original area may have to be retreated with the herbicide originally recommended.

[3]The entire area needs to be rechecked for new seedlings, preferably at least once a year. The number of inspections depends on weed species and herbicide applied.

[4] I - ground units (liquid formulation) a. hand spray gun; b. spray boom.
II - hand sprayers (liquid formulation)
III - hand spreaders (granular applicator) a. PCB spreaders; b. shakers.

Table 5. Cow Creek Quadrangle, 1979 (Non-Riparian Zone)

Survey No.	Weed Species	Code	Township & Range	Section	Sub-Section[1]	Acres Infestation	Herbicide Applied	Method[2] Appl.	Time of Appl.	Phenotypic Stage of Growth
239	Canada thistle	02	T16N R83W	28	SW¼SE¼	30.000	Tordon or Banvel	I or II II	June to Sept. June or Sept.	Bud to maturity Early bud or maturity
039	Canada thistle	02	T15N R83W	8	NW¼NE¼	0.300	Tordon	Ia	June to Sept.	Bud to maturity
096	Canada thistle	02	T15N R83W	8	NE¼NE¼	0.150	Tordon	Ia	June to Sept.	Bud to maturity
042	Musk thistle	14	T15N R83W	17	SE¼NE¼	0.018	Tordon	II	June or Sept.	Rosette stage in fall or before flowering stalk lengthens in spring.

Total Acres - 30.468

[1] Refer to Appendix 2 for site specific maps.

[2] I - ground units (liquid formulation) a. hand spray gun; b. spray boom.
II - hand sprayers (liquid formulation)
III - hand spreaders (granular applicator) a. PCB spreaders; b. shakers.

Table 5a. Cow Creek Quadrangle (Non-Riparian Zone)
Retreat and Follow-Up Program: 1980, 1981, 1982, and 1983

Survey No.	Weed Species	Code	Township & Range	Section	Sub-Section[1]	Retreat[2] 25% Acres	Follow-Up[3] 75%	Herbicide Applied	Method[4] Appl.	Time of Appl.	Phenotypic Stage of Growth
239	Canada thistle	02	T16N R83W	28	SW¼SE¼	8		Tordon or Banvel	I or II II	June to Sept. June or Sept.	Bud to maturity. Early bud or maturity.
							22.000	2,4-D Amine	Ia	June	Seedling stage.
039	Canada thistle	02	T15N R83W	8	NW¼NE¼			Tordon	Ia	June to Sept.	Bud to maturity.
							0.300	2,4-D Amine	Ia	June	Seedling stage.
096	Canada thistle	02	T15N R83W	8	NE¼NE¼			Tordon	Ia	June to Sept.	Bud to maturity.
							0.150	2,4-D Amine	Ia	June	Seedling stage.
042	Musk thistle	02	T15N R83W	17	SE¼NE¼			Tordon	II	June or Sept.	Rosette stage in fall or before flowering stalk lengthens in spring.
							0.018	2,4-D Amine	II	June or Sept.	Seedling stage.
					Total Acres -	8	22.468				

[1]Refer to Appendix 2 for site specific maps.

[2]The possibility exists that approximately 25% of the original area may have to be retreated with the herbicide originally recommended.

[3]The entire area needs to be rechecked for new seedlings, preferably at least once a year. The number of inspections depends on weed species and herbicide applied.

[4]
I - ground units (liquid formulation) a. hand spray gun; b. spray boom.
II - hand sprayers (liquid formulation)
III - hand spreaders (granular applicator) a. PCB spreaders; b. shakers.

Table 6. Cow Creek Ranch Quadrangle, 1979 (Non-Riparian Zone)

Survey No.	Weed Species	Code	Township & Range	Section	Sub-Section[1]	Acres Infestation	Herbicide Applied	Method[2] Appl.	Time of Appl.	Phenotypic Stage of Growth
025	Canada thistle	02	T15N R83W	8	SW¼SW¼	0.012	Tordon or	II	June to Sept.	Bud to maturity
							Banvel	II	June or Sept.	Early bud or maturity
025	Musk thistle	14	T15N R83W	8	SW¼SW¼	0.006	Tordon or	II	June or Sept.	Rosette stage or before flowering stalk lengthens.
							Banvel or	II	June or Sept.	Rosette stage in fall or before flowering stalk lengthens in spring.
							2,4-D Amine	II	June or Sept.	Spring before flowering stalk lengthens or fall in rosette stage.
025	Canada thistle	02	T15N R83W	7	SE¼SW¼	0.006	Tordon or	Ia or II	June to Sept.	Bud to maturity
							Banvel	Ia or II	June or Sept.	Early bud or maturity
175	Canada thistle	02	T15N R83W	17	NE¼NW¼	0.180	Tordon or	Ia or II	June to Sept.	Bud to maturity
							Banvel	Ia or II	June or Sept.	Early bud or maturity
175	Musk thistle	14	T15N R83W	17	NE¼NW¼	0.006	Tordon or	Ia or II	June or Sept.	Rosette stage or before flowering stalk lengthens.
							Banvel or	Ia or II	June or Sept.	Rosette stage in fall or before flowering stalk lengthens in spring.
							2,4-D Amine	Ia or II	June or Sept.	Rosette stage in fall or b. fore flowering stalk l ngthens in spring.
					Total Acres - 0.210					

[1] Refer to Appendix 2 for site specific maps.

[2] I - ground units (liquid formulation) a. hand spray gun; b. spray boom.
II - hand sprayers (liquid formulation)
III - hand spreaders (granular applicator) a. PCB spreaders; b. shakers.

Table 6a. Cow Creek Ranch Quadrangle (Non-Riparian Zone)
Retreat and Follow-Up Program: 1980, 1981, 1982, and 1983

Survey No.	Weed Species	Code	Township & Range	Section	Sub-Section[1]	Retreat[2] 25% Acres	Follow-Up[3] 75% Acres	Herbicide Applied	Method[4] Appl.	Time of Appl.	Phenotypic Stage of Growth
025	Canada thistle	02	T15N R83W	8	SW¼SW¼			Tordon or	II	June to Sept.	Bud to maturity.
								Banvel	II	June or Sept.	Early bud or maturity.
							0.012	2,4-D Amine	II	June	Seedling stage.
025	Musk thistle	14	T15N R83W	8	SW¼SW¼			Tordon or	II	June or Sept.	Rosette stage or before flowering stalk lengthens.
								Banvel or	II	June or Sept.	Rosette stage fall or before flowering stalk lengthens in spring.
								2,4-D Amine	II	June or Sept.	Spring before flowering stalk lengthens or fall in rosette stage.
							0.006	2,4-D Amine	II	June or Sept.	Seedling stage.
025	Canada thistle	02	T15N R83W	7	SE¼SW¼			Tordon or	Ia or II	June to Sept.	Bud to maturity.
								Banvel	Ia or II	June or Sept.	Early bud or maturity.
							0.006	2,4-D Amine	Ia	June	Seedling stage.
175	Canada thistle	02	T15N R83W	17	NE¼NW¼			Tordon or	Ia or II	June to Sept.	Bud to maturity.
								Banvel	Ia or II	June or Sept.	Early bud or maturity.
							0.180	2,4-D Amine	Ia	June	Seedling stage.
175	Musk thistle	14	T15N R83W	17	NE¼NW¼			Tordon or	Ia or II	June or Sept.	Rosette stage or before flowering stalk lengthens.
								Banvel or	Ia or II	June or Sept.	Rosette stage in fall or before flowering stalk lengthens in spring.
								2,4-D Amine	Ia or II	June or Sept.	Rosette stage in fall or before flowering stalk lengthens in spring.
							0.006	2,4-D Amine	Ia	June or Sept.	Seedling stage.
						Total Acres -	0.204				

[1] Refer to Appendix 2 for site specific maps.
[2] The possibility exists that approximately 25% of the original area may have to be retreated with the herbicide originally recommended.
[3] The entire area needs to be rechecked for new seedlings, preferably at least once a year. The number of inspections depends on weed species and herbicide applied.
[4] I - ground units (liquid formulation) a. hand spray gun; b. spray boom.
II - hand sprayers (liquid formulation)
III - hand spreaders (granular applicator) a. PCB spreaders; b. shakers.

7. Application rates: 1/8 to 1 gallon Tordon 22K in 5 to 150 gallons of water per acre. The amount of water depends on method of application. Rate depends on which designated weed species is being treated. (1/8 to 1 gallon Tordon 22K per acre is equivalent to 1/4 pound to 2 pounds active ingredient per acre.)

8. Diluent: water

9. Remarks: For broadcast treatment of Canada thistle, Musk thistle, Leafy spurge and Yellow toad-flax, a permit for aerial and ground equipment must be obtained from the Wyoming Department of Agriculture.

Tordon Beads:

1. Trade name: Tordon Beads

2. Common name: picloram

3. Chemical name: 4-Amino-3,4,5 Trichloropicolinic Acid

4. Active ingredient per pound: 2%

5. Registration: EPA Registration No. 464-333-AA (See label, Appendix 8).

6. Form applied: granular; Spot treatment only in isolated non-crop areas.

7. Use strength: 1/8 to 2/3 pounds granules/sq. rd. (equivalent to 1/4 pound to 2 pounds active ingredient per acre.)

8. Diluent: none

Tordon applied at a rate of 1/4 to 2 pounds active ingredient/ acre, depending on which designated weed species is being treated, results in a concentration of 0.0713 to 0.57 ppm of active ingredient of picloram acid per acre.

Banvel

1. Trade name: Banvel

2. Common name: dicamba

3. Chemical name: 3,6-Dichloro-o-anisic Acid

4. Active Ingredient per gallon: 4 lbs.

5. Registration: EPA Registration No. 876-25-AA (See label, Appendix 8).

6. Form applied: water solution

7. Application rates: 1 to 2 gallons Banvel in 5 to 150 gallons of water per acre; amount of water depends on method of application. Rate depends on which designated weed species is being treated. (1 to 2 gallons Banvel is equivalent to 4 pounds to 8 pounds active ingredient per acre.)

8. Diluent: water

Banvel 5G Granules

1. Trade name: Banvel 5G

2. Common name: dicamba

3. Chemical name: 3,6-Dichloro-o-anisic Acid

4. Active ingredient per pound: 5%

5. Registration: EPA Registration No. 876-103-AA (See label, Appendix 8).

6. Form applied: granular

7. Application rates: 80 to 160 pounds per acre (equivalent to 4 pounds to 8 pounds active ingredient per acre).

8. Diluent: none

Banvel, applied at a rate of 4 to 8 lbs. active ingredient per acre, depending on which designated weed species is being treated, results in a concentration of 1.16 to 2.32 ppm of active ingredient per acre.

2,4-D Amine

1. Common name: 2,4-D amine salt

2. Chemical name: (2,4-Dichlorophenoxy) acetic Acid

3. Active ingredient per gallon: 4 lbs.

4. Registration: EPA Registration No. 464-1-AA; 1990-102; 677-296-A.B; 359-331-AA (See label, Appendix 8).

5. Form applied: water solution

6. Application rates: 1/2 to 1 1/2 gallons 2,4-D Amine in 5 to 150 gallons of water per acre; amount of water depends on the method of application. Rate depends on which designated weed species is being treated. (1/2 to 1 1/2 gallons 2,4-D Amine is equivalent to 2 to 6 pounds active ingredient per acre.)

7. Diluent: water

2,4-D applied at a rate of 2 to 6 pounds active ingredient per acre, depending on which designated weed species is being treated, results in a concentration of 0.57 to 1.71 ppm of active ingredient per acre.

Herbicide Application Methodology

Three different methods would be used to apply herbicide to designated (noxious) weed infestations. The application method that would be used is contingent on the existing weather conditions, type of vegetation cover, vegetation zone (i.e., riparian or non-riparian), topography, and size of the weed infestation in a given area (See tables 1-6a for the proposed application methods on each site.) A certified Weed and Pest Supervisor would determine which application methods, described below in detail, comply with label specifications, and state and federal laws.

Method 1: Ground units (motorized vehicles) will consist of truck-mounted sprayers equipped with booms and hand spray gun. Spray pattern will be at a height of 1 1/2 to 2 feet and operated when wind velocity does not exceed 5 m.p.h. Ground units will be used in non-riparian zones accessible by roads, trails, and in topography that allows access by vehicles.

a. Hand spray gun: Used for spot treatment of infested areas and also in areas less than 50 feet x 50 feet (See Figure 2).

b. Spray boom: Used for treating solid infestations larger than 50 feet x 50 feet (See Figure 3).

Method II: Hand sprayers (liquid formulation) are equipped with a single low volume nozzle (30-40 p.s.i.). This method of treatment will be conducted on foot in rough terrain, not accessible by vehicles, close to aquatic sites and in riparian zones. Treating with hand sprayers will be at a height of 1/2 to 1 1/2 feet when wind velocity does not exceed 7 m.p.h. In areas close to aquatic sites, streams and riparian zones, treatment will be conducted when wind velocities do not exceed 3 m.p.h. This method is used for spot treatment of designated (noxious) weeds and for treating individual weed plants (See Figure 4).

Method III: Hand spreaders (granular applicator) are used in application of granular herbicides. This method of treatment will be conducted on foot in rough terrain, close to aquatic sites, streams, and in riparian zones. Treating with spreaders will be at a height of 3 1/2 feet and operated when wind velocity does not exceed 7 m.p.h. In areas close to aquatic sites, streams, and riparian zones, treatment would be conducted when wind velocities do not exceed 3 m.p.h.

Two types of hand spreaders will be used:

a. PCB (granular) spreader (See Figure 5)

APPLICATION EQUIPMENT

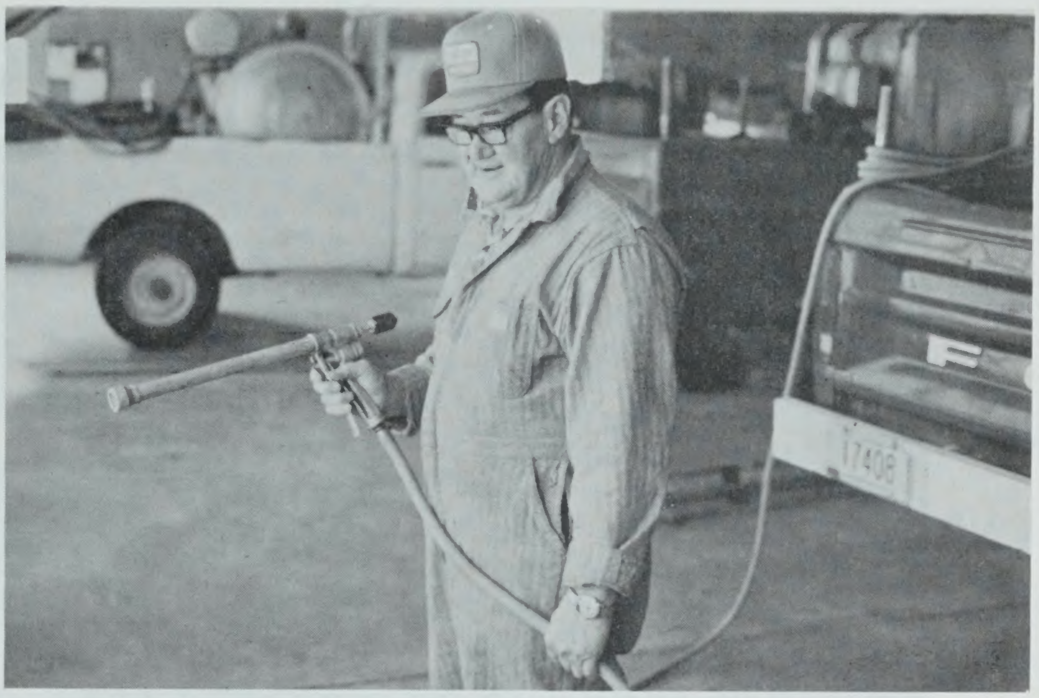


Figure 2. Truck mounted hand spray gun.

Figure 3. Spray boom.

APPLICATION EQUIPMENT

Figure 4. Backpack hand sprayers.

Figure 5. PCB granular spreader.

b. Shaker: used in areas less than 3 feet x 3 feet and for treatment of individual weed plants.

All application equipment will be equipped, calibrated, and maintained in compliance with the pesticide manual (1). (Also refer to Appendix 10.)

Herbicide application will be conducted when rain conditions are absent, and air turbulence (thermal up-drafts, etc.) are not so great as to seriously affect the normal spray pattern or bead spread. Weather will be monitored on a daily basis and all available weather information will be utilized. The Rawlins Federal Aviation Administration Station will be contacted daily for detailed meteorological data. Personnel conducting the treatment program will use a wind gauge to monitor wind velocity.

The treatment program will be conducted under contracts between the Carbon County Weed and Pest Control District and the Wyoming Department of Agriculture.

Rate of Application

Efficacious rates of herbicide application are dependent upon a variety of interacting factors. The most important of these factors are soil volume and soil moisture capacity. Soil weighs, on an average, about 3.5 million lb/acre foot; 300,000 lb/acre inch. Thus, 3.5 lbs. of chemical mixed into the top foot of soil is present at a concentration of 1 part per million (ppm). A variety of physical characteristics of the soil are also important in determining the rate herbicides are applied. The water holding capacity of soils varies greatly with the soil type. Most herbicides act through the soil solution; thus concentration of a given dosage in the soil solution depends not only on the adsorptive capacity of the soil but also on the amount of water in the soil. Soil moisture per acre foot varies from 300,000 to 1.5 million pounds. Thus a water soluble chemical would attain a concentration (in solution) five times as great in the first as in the second soil (34).

Following label and Wyoming Weed and Pest Council recommendations, Tordon will be applied at a rate up to and not to exceed 2 lbs. active ingredient per acre during any one growing season. Banvel will be applied at a rate up to and not to exceed 8 lbs. active ingredient per acre during any one growing season. The application rate of 2,4-D Amine will not exceed 6 lbs. active ingredient per acre and would be used primarily on regrowth and new seedlings in areas previously treated with Tordon and/or Banvel. 2,4-D Amine may be applied during the same season and in the same area as Tordon or Banvel. Tordon and Banvel will not be applied to the same site during any one growing season.

Time of Application

Time of application is an important factor in achieving the desired affect on the plant treated. Some weed species, in mature growth stages, become resistant to the herbicides; therefore, to accomplish control of the weeds it is necessary to apply the herbicide during the early growth stages of the weed. Optimum treatment time is in the bud stage of most perennial weeds and in the rosette stage of biennial weed species. Normal growing season (approximately 90 days) in the North Platte River area is from June through August. Optimum treatment time would correspond roughly to the growing season (See tables 1-6a).

Treatment in non-riparian zones can be accomplished anytime from June through September. Treatment near streams and rivers would be after water has reached peak flow and has receded back into the normal stream channel. Stream flow usually recedes by July 15, consequently treatment in riparian zones can be accomplished from approximately July 15 through September. The following is a discussion of the optimum time for application of each herbicide, proposed for use, on each designated weed species.

1. Canada thistle:
   a. Tordon 22K: The time of application can be anytime during the growing season from June to September. The optimum time for treatment of Canada thistle is when the plant is in the bud to maturity stages. Fall treatment with Tordon has proven to be very successful under Wyoming climatic conditions.
   b. Banvel: The best time for application is when Canada thistle is in the early bud stage. The early bud stage normally occurs in June but treatments in September have shown good results.
   c. 2,4-D Amine: Time of application for Canada thistle should be during the bud stage to prevent seed formation. Budding normally occurs in late June and early July. A second treatment is necessary in September if regrowth occurs. Treatment is required twice a year for two or three years to effectively reduce stands of Canada thistle.

2. Leafy spurge:

a. Tordon 22K: Tordon can be applied to leafy spurge anytime during the growing season, or anytime from the bud stage to maturity.

b. Banvel: The best time for application is when leafy spurge is in the bud to bloom stage which normally occurs in June. September treatment after plant maturity has shown some success.

c. 2,4-D Amine: The best time for application is when spurge is in the early bud stage, which normally occurs in late May and early June. A second treatment is required in September. Two treatments a year for three to four years are necessary to effectively reduce stands of leafy spurge.

3. Yellow toadflax:

a. Tordon 22K: Optimum time for application is June or September.

b. Banvel: Optimum time for application is June or early September. Retreatment of regrowth may be necessary.

c. 2,4-D: It has not proven effective in controlling Yellow toadflax nor is it labeled for use on this species.

4. Musk thistle:

a. Tordon 22K: The optimal time for application is from September up to the rosette stage or in June, before the flowering stalk bolts. Nearly 100% control is attainable with good residual seedling control.

b. Banvel: The optimal time of application is in June before the flowering stalk bolts or in September up to the rosette stage. Banvel has given nearly 100% control of seedling and second year growth but has no residual control.

c. 2,4-D Amine: The optimal time for application is June or September. September treatment to rosette stage and June treatment before the flowering stalk bolts are the best treatment times. Annual treatment is necessary to control new seedling growth.

The control of broad-leaved herbaceous weeds is complicated by the fact that individual species often occur in scattered stands, frequently on terrain not easily accessible for direct control measures. Many weed species become resistant to phenoxy herbicides at later growth stages; therefore, time of treatment is critical. Some perennial herbaceous weeds, such as Canada thistle and leafy spurge have extensive root systems, and the variable effectiveness of phenoxy herbicides on such plants makes repeated treatments necessary.

<u>Herbicides and Growth Stages Recommended for the Retreatment and Follow-up Program</u>

It is difficult to explicitly recommend any one retreatment program without visiting the treated sites. Those perennials missed by the first application should be treated with the herbicides originally suggested. Seedlings can be controlled by light rates of 2,4-D before they become well established.

The area will be rechecked to determine if retreatment and follow-up programs are necessary. It is difficult to achieve 100% control of designated (noxious) weeds on the initial treatment program; therefore, retreatment in several areas would probably be necessary.

Tordon and/or Banvel may be used for retreatment in the original site on areas missed in the initial treatment and on areas outside the original site. This situation may arise due to the prolific seed production and rhizomatous root system of the perennial designated (noxious) weeds.

The Amine form of 2,4-D may be used on new seedlings which can develop in areas previously treated with Tordon and/or Banvel and may be applied during the same season.

<u>Discussions of Herbicide Formulations</u>

Recommended herbicide application rates vary greatly between states and specific localities. Soil types and general climatological characteristics seem to be the dictating factors. Most herbicides or a combination of them work on most designated (noxious) weeds except for a few of the more resistant species. However, some herbicides are more advantageous to use than others.

Tordon 22K is much preferred for use on non-crop areas (rangeland) where application directly around trees and water are avoided. It is persistent in the soil and kills noxious weed seedlings in the seedling stage. It is relatively safe for use around livestock and wildlife but it does require some grazing restrictions. The residual effect lasts from 1-3 years depending on rate of application, moisture and soil types; these factors also effect the degree or percentage of kill on noxious weeds. Follow-up applications are often unnecessary. Tordon does not work well on plants belonging to either the mustard family or Kochia spp.

Banvel is used mainly for crop areas and in areas next to live-water because it is not as persistent as Tordon. It is more water soluble, and therefore, has an equal potential of water contamination. Banvel may require repeated applications on the same site, in following years, because of the low persistence of this herbicide. It may persist two growing seasons depending upon rate applied, climatic conditions, and soil characteristics.

More pounds of acid equivalent per acre of Banvel are required for effective control than pounds of Tordon. Banvel is less expensive per pound active ingredient than Tordon, but with the necessary increased rates of application and repeated treatments it may be more expensive overall.

Tordon beads have the advantage of easy handling and can be applied in the fall for seedling pre-emergence treatment. Care should be taken not to confuse Tordon beads with Tordon 5K and 10K pellets. The pellet forms are much larger and bulkier.

Experimental studies completed in 1976 near Devils Tower, Wyoming, show Tordon beads can be very effective on controlling leafy spurge in a riparian zone while causing minimum damage to non-target species. No damage was recorded on sagebrush (59).

The control of Musk thistle may be accomplished by several methods. Musk thistle is a biennial and does not resprout, therefore, plants may be easily controlled by cutting. Individual plants may be cut below the crown at any time. If cut plants have flower heads, these should be burned or otherwise destroyed so that the seeds will not mature (4). Herbicide treatment must be made before the seed stalk is 6 inches tall and preferably before it is visible because the seeds will continue to mature after the parent stalk is killed (5).

Leafy spurge is resistant to 2,4-D. Top growth can be killed and seed formation prevented with 2,4-D, but the roots are very resistant (6).

The University of Wyoming Agricultural Experiment Station recently published a report on their findings on herbicide effectiveness titled Research in Weed Science - 1978. Edited excerpts from this document that apply only to noxious weeds and herbicides mentioned in this report have been included in Appendix 4. This material points out the advantages of using persistent herbicides and demonstrates what results can be expected under Wyoming climate and soils. Alley (139) pointed out that almost all the experimental plots were on tilled soil. He recommended that herbicide application rates for untilled rangeland exceed those in the research data to obtain comparable results.

ALTERNATIVES

No-Action Alternative

The No-Action Alternative means that no control measures will be implemented to stop the growth and further spread of the designated noxious weeds.

Preventive Measures

Prevention means stopping a given species from contaminating an area. Prevention is often the most practical means of controlling weeds. This is best accomplished by making sure that new weed seeds are not carried onto the rangeland in contaminated crop seeds, feed, or on animals and machinery. Preventing weeds on the rangeland from going to seed, and preventing the spread of perennial weeds which reproduce vegetatively are also preventative control methods (7).

The ability to identify weedy plants, seedlings, seeds, etc., in crops is important. Clean, vigorous, and well adapted crop seeds should be planted at the proper time and rate. Optimum rate and placement of fertilizer, irrigation, timely tillage, and control measures directed against nematodes, disease, insects, and weeds are other practices favoring the crop. Crop rotation, often ignored because of the greater expense involved, is an excellent weed-control measure.

The most thorough and effective weed-control procedures available should be applied in seed production fields. Weed plants present in a seed field present the possibility that some of the weed seeds may find their way into the crop-seed supply even with the use of the best cleaning techniques available.

Farmers can improve seed selection by: carefully examining labels to insure satisfactory germination and the absence of potentially serious weeds and other crop seeds; selecting certified seeds of adapted varieties for planting; securing information on variety, purity, germination, and quality when purchasing uncertified seeds; providing for additional cleaning, if needed, to insure freedom from potentially serious weed seeds; and thoroughly cleaning and testing all home-grown seeds. Weed seeds are separated from crop seeds by various methods based on physical differences, including seed size, weight, shape, surface area, specific gravity, stickiness, pubescences, texture, color, and electrical properties.

Care should be taken in each step of crop-seed handling to prevent weed-seed contamination. Thorough cleaning of all equipment will reduce spread of weeds.

Many weeds are disseminated by weed-seeds adhering to the hair or feathers of animals, sticking to their feet, or passing through their digestive tracts. Managers of livestock may do much to reduce the spread of weeds through movement of animals. Special attention should be given to handling of livestock at loading and unloading points and to the proper disposal of manure and bedding. Hay and feed should be chosen not only for feeding quality, but for their freedom from weed-seeds. Preventive measures can be undertaken to reduce the possibility of weed dissemination by wildlife, such as birds. Windbreaks, fence lines, aquatic sites, and waste areas should be regularly inspected for troublesome weeds, and control programs should be started before weeds can spread to pastures and fields.

Large amounts of weed seeds or vegetative parts are likely to be transported in the movement of soil materials. Both before and after movement, such materials should be inspected, and if necessary, weed infestations should be eradicated before becoming sources of spread. Bulk soil is often sterilized by fumigation or with steam.

Another major source of infestation of farm lands is weed growth along banks of irrigation ditches and streams. Many weed seeds, corms, rhizomes, and vegetative propagules are light and readily float or remain suspended in moving water. Preventive measures may require cooperation between management and all landowners along an irrigation system in keeping weeds under control.

Many exotic plants introduced into new environments as ornamentals or experimental crops are potential weed species if they escape cultivation. Other alien plants may be introduced accidentally or unknowingly into countries in which they are not native. Undesirable alien species that spread with astounding rapidity exemplify the need for rigid seed inspection and vigilance in detecting incipient infestations. Early identification is essential if preventive measures are to succeed in eradicating or holding in check a potentially serious weed pest.

Some weeds produce seeds that are carried great distances by wind. Other plants, such as Tumble pigweed, Kochia spp. and Russian thistle, break off at ground level during heavy winds and roll across the landscape, scattering seeds along the way.

Once a farmer produces a crop infested with weeds, he must decide how best to harvest it to reduce weed dissemination. Increased mechanization of harvesting has presented special problems with respect to weeds. Harvesting machinery may scatter weed seeds and vegetative parts. Weeds may hinder the smooth operation of machinery. Harvesting procedures are often selective in preventing or reducing dissemination of weed seeds. Several management procedures have been developed that reduce weed dissemination during harvesting of different crops. One procedure is to cut weedy forage before most weed seeds have matured and use it for ensilage.

The fermentation process will destroy many of the weed seeds that have already set. Another procedure to prevent as much scattering of weed seeds as possible is for weedy grain fields to be combined as soon as the crop matures. Weed screenings should then be collected from the combine so that they are not dropped back onto the land.

Nursery men should always attempt to determine whether the plants and shrubs they are handling are potential weeds. Plants possessing weedy characteristics should not be distributed. The packing about nursery stock may be a source of weeds that passes unnoticed. Lastly, dealers should control weeds in sod prior to marketing it. In many states in recent years, there has been an emphasis on the sale of certified sod in which weeds have been controlled during production.

Various farm products such as screenings, grain, hay, and other feed-stuffs, and manure may contain large numbers of weed seeds. Care must be taken in handling these products to prevent the introduction and spread of weeds. Weed screenings are inexpensive and nutritious and therefore are often used as animal feeds. Weed screenings should always be processed to destroy seed viability. Grinding, heating, and pelleting are all measures taken to reduce seed viability.

Low moisture content, low temperatures, and a reduced oxygen supply promote seed longevity. To prevent spoilage, the moisture content of grain, hay, and straw is reduced before storage. Storage itself provides the other two factors that enhance seed longevity. Under normal farm storage conditions, most weed seeds will remain viable from 1 to 3 years.

Ensiling is another effective means of handling farm products known to contain highly undesirable weed-seeds. Few viable weed-seeds survive ensilage. Ensilage will greatly reduce weed-seed viability but will not destroy it.

Manure usually contains viable weed-seeds and should be treated in some manner that destroys seeds before it is spread on the land. Storage of manure is often employed to reduce weed-seed viability. Composting manure appears to destroy most weed seeds, although results are affected by the size of the pile, type of manure, moisture content, temperature generated within the pile, location and condition of weed seeds, climate, and length of storage in the pile.

None of the usual handling procedures for feedstuffs or manure is likely to be completely effective in destroying weed-seeds. The various methods can be ranked from most to least destructive to seeds as follows: composting of manure, ensilage, passage through an animal's digestive tract, and storage of feed, hay, or straw. A combination of treatments such as ensilage, feeding ensilage to animals, and composting of manure may destroy all weed seeds.

Physical Control Methods

Hand grubbing could be used in destroying biannual designated (noxious) weeds. Plant species that sprout from an individual stem or root and remain as a "bunch" or "clump" can be controlled by grubbing. The use of this method depends on the ease of removing the "clump" and the density of the stand.

Fire can also be used to remove designated (noxious) weed seeds at a temperature of 215°F for 15 minutes. However, fires are considered destructive to desirable plant species.

Machine tillage such as row cultivation, mowing, cutting, or smothering can also be used in controlling weeds.

Biological Control Methods

Painted-lady butterfly larvae control Canada thistle by feeding on the foliage. In Wyoming, populations large enough to significantly affect populations of Canada thistle occur about every 15 to 20 years. The root system is not affected.

Fusarium roseium (fungus) causes root rot in the Canada thistle. This method is not adaptable to Wyoming due to climatic conditions.

Larvae of the thistle weevil (Rhinocyllus conicus) feed on seed heads of Musk thistle. The adult will feed on foliage. It was introduced from Europe as an experimental biological control agent. An experimental study in Sybille Canyon, Wyoming looks promising. The larvae have been transferred into Converse County for additional studies. (Refer to Appendix 7, Biocontrol of Musk thistle in Wyoming: E.W. Spackman.)

Management

Integrated pest management uses a combination of chemical, biological, and physical control methods. Physical methods involve various management practices. In controlling noxious weeds these could include pasture rotations, competitive crops, reseeding of previously infested areas and the priority use of areas to be controlled relative to economic return.

Weed management can also involve the enacting of laws for cost-sharing at federal, state and local levels. It is also possible to develop cooperative control programs with federal agencies, state departments and municipalities. Educational programs can be offered by professionals in the extension service and research done on weed management systems. Lastly, there can be coordination of activities for effective and efficient programs.

Livestock and wildlife grazing management programs need to be explored in order to limit the amount of grazing pressure placed upon the grasses in the riparian zones. The purpose of this management would be to help curtail the spread of noxious weeds, although it would not eliminate spreading of weeds along the waterways.

III. DESCRIPTION OF THE EXISTING ENVIRONMENT

AIR

Air Movement Patterns

Wind and storm paths are predominantly from the west-southwest (occurring more than 27% of the time) and southwest (occurring about 18% of the time). The annual average wind speed associated with each of these directions is 16 mph. The annual average wind speed for all wind directions is approximately 11 mph. Figure 6 shows the wind speed, direction, and per cent of occurrence at Rawlins, Wyoming. This wind rose information is the closest available wind data to the program area. The general wind pattern in the North Platte River Area should be quite similar; however, the wind speeds are believed to be less than those demonstrated to exist in Rawlins due to the protection provided by the surrounding hills. The high winds in the area have a detrimental effect on the vegetative and water resources as the wind dries out the area. Calm conditions are not rare as they occur annually about 23% of the time. (11).

Inversion Tendencies for the Area

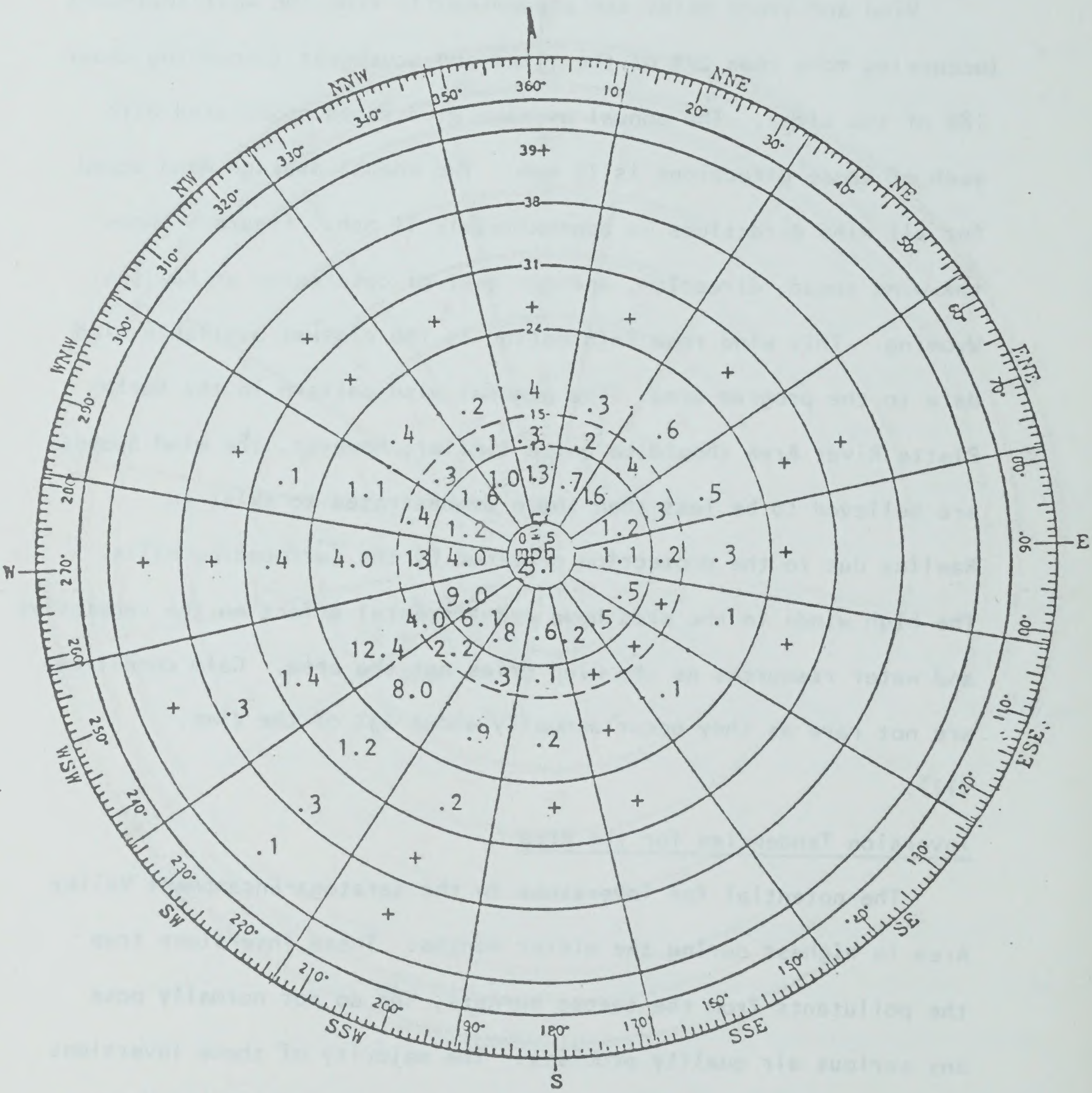
The potential for inversions in the Saratoga-Encampment Valley Area is highest during the winter months. These inversions trap the pollutants from the teepee burners, but do not normally pose any serious air quality problems. The majority of these inversions are shallow and burn off early in the day. However, it is not uncommon for inversions to last several hours (11).

Temperature

The North Platte River Program Area is subject to a wide range

Figure 6. Surface wind rose.

Job No. 51283 VFR
Station No. 24057 Rawlins, Wy.
Period. 1/60-12/64 (24 Obs/day)
VFR = $\geq$ 1000 Ft. & $\geq$ 3 miles.



The wind rose is a scaled graphical presentation of surface wind data in terms of speed and direction. The radial lines of the diagram are positioned so that areas between them are centered on the direction from which the winds are reported. The concentric circles represent limits between speed groups sectors, i.e., 5, 13, 15, 24, 31, 38, and 39+ miles per hour. Radii for these groups are accurately scaled to the respective speeds. The segments enclosed by radial lines and concentric circles on the diagram represent wind speed-direction combinations. The data from a wind summary are transferred to the appropriate area on the diagram as a percentage of the total observations examined.

+ indicates an occurrence, but less than .05%.

of temperatures ranging from an average annual low of -21°F to an average annual high of 92°F. The annual average is 42.2°F (11). The summer months are generally quite comfortable and dry with an average temperature from June to September of 59.8°F. The length of the growing season varies from 80 to 104 days (9). The winters are characterized by very cold temperatures. The short growing season and cold temperatures limit the species of vegetation that can grow in the area (11). Table 7 contains summaries of climatic data for two weather recording stations, Saratoga and Encampment, found within the project area. These give an indication of the general weather conditions present.

Air Quality

Air quality is generally considered to be quite high due to the dispersing wind and the lack of pollutants. A few localized pollution problems exist in the Saratoga, Encampment and Riverside areas. These occur from occasional burning oil and gas wells, burning dumps near towns, wind-blown dust, teepee burners (2 in Encampment, 1 in Saratoga), and natural and man-caused fires. Few studies have been done on these areas and little data exists. However, none of the polluted areas have a significant effect on the environment and all are within EPA constraints; the pollutants are dispersed by the wind within a relatively few miles. An increase in air pollution is expected to occur with the increase in energy development and the related activities (11).

On January 22, 1972, the state of Wyoming adopted air quality regulations for concentrations of total suspended particulates (TSP). The state annual standard is 60 micrograms per cubic meter

(ug/m^3) (geometric mean) (12). No air particulate measurements from within the program area are available. However, three monitoring sites (Hanna, China Butte, and Atlantic) surrounding this area show typical rural background values of 10, 39, 19 ug/m^3 (annual geometric means), respectively, which are well within the standard (13). See Table 8 for additional statewide TSP values.

Table 7. Climatic Data[1]

		Lat. $41^{o}27'$ Long. $106^{o}48'$
Saratoga Station	Elevation 6,790	Location
(1)	Average Annual Temperature	$42.2^{o}F$
(2)	Average High (occurred between June 26-July 12)	$92.0^{o}F$
(3)	Average Low (occurred between December 16 - Jan.21)	$-20.0^{o}F$
(4)	Average Annual Precipitation	9.27"
(5)	Highest Annual Precipitation (1965)	11.64"
(6)	Lowest Annual Precipitation (1971)	5.80"
(7)	Average Precipitation - January-March (snow)	1.57"
(8)	Average Precipitation - April-June (snow and rain)	3.23"
(9)	Average Precipitation - July-September (rain)	2.57"
(10)	Average Precipitation - October-December (snow)	1.90"
(11)	Frost Free Period	80 days
(12)	Approximate date last frost	June 15
(13)	Approximate date first frost	Sept. 2
		Lat. $41^{o}11'$ Long. $106^{o}37'$
Encampment Station	Elevation 7,387	Location
(1)	Average Annual Temperature	$42.2^{o}F$
(2)	Average High (occurred between June 17-Sept. 24)	$90.0^{o}F$
(3)	Average Low (occurred between Nov. 29-March 18)	$-21.0^{o}F$
(4)	Average Annual Precipitation	14.58"
(5)	Highest Annual Precipitation (1967)	20.09"
(6)	Lowest Annual Precipitation (1971)	11.64"
(7)	Average Precipitation - Jan.-March (snow)	3.16"
(8)	Average Precipitation - April-June (snow and rain)	4.83"
(9)	Average Precipitation - July-Sept. (rain)	3.60"
(10)	Average Precipitation - October-December (snow)	2.99"
(11)	Frost Free Period	104 days
(12)	Approximate date last frost	June 15
(13)	Approximate date first frost	Sept. 25

[1]Date from "Climatological Data" by the National Oceanic and Atmospheric Administration.

Table 8. Total Suspended Particulates[1]

Monitoring site	Geometric Mean 1972	1973	1974	1975
Cheyenne	44ug/m^3	57ug/m^3	32ug/m^3	34ug/m^3
Gillette	88	36	31	56
Laramie	58	74*	39*	53*
Rock Springs (Lyman Fearn Residence)	119	118*	115*	90*
Afton		55	61	
Douglas		59*	55*	33*
Granger		43	54*	27*
Green River		62	65*	46
Riverton		68	53*	33*
Rock Springs (Tom Larson Residence)		54		
Rock Springs		60		
Torrington		20	27*	24*
Grover			14	19*
Newcastle			47	26*
Lovell			25	36
Meadowlark Ski Area			16*	5
Moorcroft			56*	51*
Reno Junction			49*	22*
Rock Springs (Robert Alder Residence)			39*	44
Rock Springs (John Logan Residence)			74*	40*
Bill (Stoddard Ranch)			23*	16
Story			14	12*
Boulder				8
Cody				26
Eden				16
Kelly				11
Rawlins				16
Bill (Irene Ranch)				23
Average	77.25ug/m^3	58.83	44.45	30.68

[1]Data obtained from Wyoming's Air Quality, Ambient Air Monitoring Data 1972-1975, Wyoming Department of Environmental Quality.

*Annual geometric mean

Since there are no known measurements of gaseous pollutants in the Saratoga Valley, it was necessary to make certain assumptions based on the few measurements that have been made in the state. These measurements were obtained by the Department of Environmental Quality during the years 1972 to 1976. The annual arithmetic mean for SO_2 ranged from 1 to 4 ug/m^3 based on measurements obtained in Casper and Rock Springs. This is a minimal amount compared with the Wyoming ambient air quality standards of 60 ug/m^3 (12, 14). (Refer to Tables 9 and 11.) The annual arithmetic mean for NO_2 based on seven monitoring sites ranged from 1 to 13 ug/m^3, with the average for the two years, 1975 and 1976, being about 5 ug/m^3. The statewide indication of NO_2 pollution is well below the Wyoming air standard of 100 ug/m^3 (12, 14). (Refer to Tables 10 and 11.)

Table 9. Wyoming's Air Quality--Ambient Air Monitoring Data SO_2 - 1972-1976[1]

Monitoring site	SO_2 - arithmetic mean 1972	1973	1974	1975	1976**
Casper	2ug/m^3	2*ug/m^3	2*ug/m^3	4*ug/m^3	4ug/m^3
Cheyenne	4	5	3	2	2
Rock Springs	4	3*	1*	2*	1
Gilette				4.8	1
Lusk "A"				4	2
Newcastle				8	1
Bill					0
Kemmerer					1
Wheatland					0
Average	3.3ug/m^3	3.3ug/m^3	2ug/m^3	4.1ug/m^3	1.3ug/m^3

[1]Data obtained from Wyoming's Air Quality, Ambient Air Monitoring Data 1972-1975 and 1976, Wyoming Department of Environmental Quality.

*Annual arithmetic average.

**1976 data as yet unpublished.

The other gaseous pollutants (carbon monoxide and hydrocarbons) have not yet been monitored, but it is expected that they would have correspondingly negligible values based on the low SO_2 and NO_2 values present in the state as compared to the state air standards.

At the present time there are no ongoing programs to monitor the radiological properties of the air along the North Platte River.

The largest single source of radioactive contamination would be the Jim Bridger Power Plant, located approximately 100 miles to the west. It has been determined that significant products are contained in the coal that is burned, and much of the radioactivity will be be released up the stack. No quantitative measurements have been made to determine the total amount or dispersal patterns of the release (15).

Table 10. Wyoming's Air Quality--Ambient Air Monitoring Data NO_2 - 1975-1976[1]

Monitoring site	NO_2 - arithmetic mean 1975[2]	1976**
Gillette	5.8ug/m^3	4ug/m^3
Lusk "A"	5	4
Newcastle	6	5
Bill		1
Kemmerer		7
Wheatland		3
Casper		13
Average	5.6ug/m^3	5.3ug/m^3

[1]Data obtained from Wyoming's Air Quality, Ambient Air Monitoring Data 1972-1975 and 1976, Wyoming Department of Environmental Quality.

*Annual arithmetic average.

**1976 data as yet unpublished.

Table 11. Wyoming Ambient Air Standards [1]

		ug/m^3	ppm
Sulfur Oxides -			
annual arithmetic mean		60 ug/m^3	0.02 ppm
24-hour concentration		260* ug/m^3	0.10 ppm
3-hour concentration		1,300* ug/m^3	0.50 ppm
Particulates -			
annual geometric mean		60 ug/m^3	
24-hour concentration		150* ug/m^3	
Coh Units -			
annual geometric mean	0.4 Coh units/1,000 lineal ft.		
Total Settleable Particulates -			
1) residential areas - Includes			
1.7 grams/M^2 background	5 grams/M^2/30 days		
2) industrial areas - Includes			
1.7 grams/M^2 background	10 grams/M^2/30 days		
Carbon Monoxide -			
8-hour concentration		10,000* ug/m^3	9.0 ppm
1-hour concentration		40,000* ug/m^3	35.0 ppm
Photochemical Oxidants -			
1-hour concentration		160* ug/m^3	0.08 ppm
Nitrogen Oxides -			
annual arithmetic mean		100 ug/m^3	0.05 ppm
Hydrocarbons -			
3-hour concentration 6-9 a.m.		160* ug/m^3	0.24 ppm

*Not to be exceeded more than once a year.

[1] Data obtained from Wyoming's Air Quality, Ambient Air Monitoring Data 1972-1975, Wyoming Department of Environmental Quality.

There are also tentative plans to construct and operate at least one uranium mine/mill complex to the west, which will contribute slightly to the radioactivity concentrations in the air along the North Platte, however, these cannot be estimated until a firm location is determined and there is a commitment on the part of the operator.

Location or sources of non-ionizing radiation in the area is not available. The state does not have the capability to measure it if it does exist (15).

LAND

Soil type information was obtained from a general soil map of Carbon County, Wyoming. Soil types have been broken down by precipitation zone, parent material, depth, texture, and elevation. Soil type in the North Platte River Program, based on inventories by the Bureau of Land Management, Rawlins District (11), are as outlined below.

<u>Soils of the 10 to 14 inch Precipitation Zone</u>

Loamy Fan Terrace and Associated Steep Soils: Well drained, cobbly and gravelly loam soils on gently sloping high benchlands and cobbly loam soils on steep escarpments and deeply incised drainageways. These fan terraces are underlain with various sandstones and shales which outcrop on the sidehills. Predominant vegetation is sagebrush and native grasses. Elevation: 6,500 - 7,800.

Poorly and Somewhat Poorly Drained Irrigated Soils Along Major Streams: Predominantly nearly level to gently sloping loamy soils underlain with gravel. They occur on bottom lands and low terraces. Included are scattered areas of saline-alkali soils. Predominant vegetation consists of sedges, rushes, and domestic plants. Elevation: 6,000 - 7,500.

Soils Developing in Granite: Moderately dark to dark colored loamy soils that contain various amounts of cobble and stones. About 10 to 30 per cent of the area is granite bedrock outcrops. Soil depth varies from shallow to deep. Predominant vegetation is sagebrush and native grasses. Elevation: 6,800 - 7,800 feet.

Soils of the 15 to 30 inch plus Precipitation Zone

Forested Soils on Igneous and Sedimentary Materials: These are shallow to deep, dark colored forested loamy soils with 5 to 30 per cent bedrock outcrops. Some areas are cobbly, bouldery, or stony. Slope ranges from gently sloping to steep. Predominant vegetation is conifer and aspen. Elevation: 7,500 - 10,000 feet.

Soils of the Foothills Outwash Terraces, and Residual Uplands: Shallow to deep loamy soils underlain with gravel, cobble or Tertiary bedrock material on moderate to steeply sloping foothills. Predominant vegetation is sagebrush and native grasses. Elevation: 7,500 - 9,000 feet.

Soil inventories have been completed on small areas to provide support data for specific projects such as allotment management plans, habitat management plans, recreation site plans, coal leasing and mining-reclamation plan approval. Each of these soil inventories have their own nomenclature for soil types as more than one soil scientist inventories the various areas. No correlation is intended between soil types in the different reports, as many miles separate the inventoried areas.

Encampment River Area

Soils in the Encampment River area are fairly uniform throughout the entire area. The soils are generally classified as lithic as the soils developed from igneous and metamorphosed rocks. The other soil type predominant in the area is alluvial soil found in the drainages. Variation in the soils appears to be as a result of position on slope, land form, drainage patterns and vegetation rather than parent rock.

Depths of soils throughout the area vary from very shallow (10 inches) on the ridge tops and very steep slopes on either side of the Encampment River and Miner Creek to very deep (60 inches) in the alluvial drainages. The soil depths increase as they progress from the ridge tops towards the bottom of the drainages. This is apparent to the observer by the vegetative production. Near the ridge top production is low and is mainly a grass-black sage type. As one progresses down the slope, the production increases and the big sage-grass type picks up. This is especially evident on the northern aspects. The northern aspects generally have a higher vegetative productivity due to the increased moisture. The soils are deeper on these aspects due to the protective cover of the vegetation holding it in place. The soils formed under the forested areas (both lodgepole and aspen) are well developed and range in depth from deep (40 to 60 inches) to very deep (60 inches).

A gravelly to very gravelly loam texture is widespread throughout the area. Generally the surface horizons are loam overlaying a gravelly clay loam. This loam texture is excellent for vegetative production. Soils on some of the higher ridge tops have a very gravelly loam texture. The drainages and forested areas are the exception to this as these are a lower per cent of coarse fragment. These areas have a loamy surface horizon.

The erosion hazard for the area ranges from stable under the forested areas to moderate on the slopes having a lower productivity. Severe erosion is occurring on many of the roads constructed for exploration on the southern end of the BLM part of the transplant area. Sediment yield over the entire area averages approximately 0.23 tons of sediment/square mile/year.

<u>Bennett Peak Campground</u>

The soils in the Bennett Peak Campground area are sandy loam to sandy clay loams formed from granitic and schist parent material. The soils range from shallow (rock outcroppings) to very deep (60 inches) at the base of the hills.

The existing campground areas have a slight to moderate soil limitation as would any future campground development. This moderate rating is due to the sandy clay loam texture which is compacted fairly readily and the reduced permeability due to the compaction. (The permeability factor here is minor because of the extended dry period.) There is also a lot of dust caused by the trafficability which tends to lower the area to a moderate limitation.

<u>North Platte River Recreation Use Area</u>

Area Number 1, located near the confluence of Big Creek (T14N, R81W, Sec. 17), has a deep to very deep soil profile over granites and gravels. The surface horizon A is 19-20 inches deep having a sandy loam texture and a friable granular structure. The B horizon is 19-24 inches deep and has a sandy clay loam texture with a friable subangular blocky structure. The C horizon (24 inches to bedrock or gravel) has a sandy to a sandy loam texture with a friable granular structure. There was very little stoniness in the C profile.

Area Number 2 (T15N, R82W, Sec. 26) has a very deep soil profile with characteristics identical to area Number 1.

Camping Area Number 3 (T15N, R82W, Sec. 23) is located in a bench along the river edge. This soil is a recent alluvium comprised of a sand to a sandy loam. This is a deep to very deep deposition of material with a fairly high water table. However, the water table is below the 20 inch limit, therefore it will not affect the area rating.

Area Number 4 (T15N, R82W, Sec. 15) is located approximately 100 yards off the river in an aspen stand. Soils in this area are deep to very deep having a shallow loamy texture overlying a sandy loam to a sandy clay loam texture. The erosion in this area is quite severe with deep, active head-cuts, and steep slopes.

Erosion Condition in the Program Area

Present erosion conditions in the North Platte River Program Area show that 18 per cent of the land is stable; 23 per cent has slight erosion; 57 per cent has moderate erosion, and 2 per cent of the area is unclassified. There are no critical or severe erosion condition areas in the program area.

The current trend in erosion shows slight deterioration from the stable and slight classes into the moderate classification. This deterioration has a low significance.

Geologic Structure

The descriptions of the geologic structures of these areas are a compilation of data obtained from Blackstone's Traveler's Guide to Geology (16), Fenneman's Physiography of the Western United States (17), Thornbury's Regional Geomorphology of the United States (18), and information from the Wyoming Geological Association (19, 20).

The stratigraphic section for the North Platte River Program Area, along with a general description of the exposed rock units is as follows (youngest to oldest):

AGE	SYMBOL	NAME AND DESCRIPTION (17)
Quaternary	Qsd	Wind blown sand.
	Qal	Alluvium; chiefly silt, sand and gravel.
Tertiary Pliocene	Tnp	North Park Formation; white to buff tuff, sandstone, and bentonitic claystone.
Pre-Cambrian	pC	Pre-Cambrian rocks, undivided; chiefly granites and metasediments.

Most of the area lies within the Saratoga Basin as classified by "Fenneman's Geomorphics Classification."

During much of Tertiary time, the basins in the planning unit were depositories for debris shed from the adjacent uplifts. As a result, many thousands of feet of fluviatile, paludal, and lacustrine sediments representing all epochs of the Tertiary are to be found in the basins of the area. Pre-Cambrian rocks are abundant in the mountain ranges which bound the area on the north and south, rocks of this age are not widespread within the area proper.

The Saratoga Basin is a structural and topographic basin that lies between the Medicine Bow and Sierra Madre Mountains. The basin is relatively small, 5 to 6 miles wide at the widest point, and approximately 40 miles long. There are probably less than 3,000 feet of Tertiary sediments overlying the Pre-Cambrian crystalline rocks in the deepest part of the basin.

Mountain masses on the periphery of the area such as the Medicine Bow and Sierra Madre consist of cores of Pre-Cambrian age granites, gneisses, and schists that have been cut by numerous dikes of varying composition.

The Rawlins Uplift forms the western boundary of the area. This uplift is a large asymmetrical anticline with steep dips on the west flank and moderate dips on the east flank.

The Baggot Rocks area (T15N, R83W) displays a classic example of a superposed stream. Baggot Rocks is a Pre-Cambrian gneissic body which has been cut by numerous granitic instrusions. These crystalline bodies were subsequently covered by Tertiary deposits, including the North Park Formation. In later Tertiary times, the Encampment River established its course on these younger Tertiary deposits which had previously buried the Baggot Rocks. Later uplifting in the area and subsequent downcutting by the Encampment River produced a channel which has been cut down through the younger sediments have been completely stripped away by erosion, and the Encampment River maintains its course through the Baggot Rocks.

Current Land Uses

The lands in this program area are primarily used for domestic livestock grazing, wildlife habitat, and recreational purposes.

Current agricultural uses include both irrigated and non-irrigated classes. Although a small percentage of land is devoted to agricultural uses these lands are a vital component to year round livestock raising operations. Native irrigated and non-irrigated hay is the major product (11).

WATER

Hydrologic Cycle

Mean annual precipitation in the program area ranges from about 10 inches in the plains area in the northern part to over 30 inches in the mountains. Much of the precipitation in the mountains occurs as snow. Melting of heavy snow accumulations in the higher elevations is the source of much of the runoff of the perennial streams. Runoff also occurs from lesser accumulations of snow in the plains and from general rains and occasional heavy, localized thunderstorms. There is, in most places, a free exchange of water between streams and the groundwater reservoir in the floodplain deposits.

Streamflow from the area is used for irrigation, industrial and municipal uses and livestock and wildlife watering. A tabulation in the Wyoming Water Planning Program, Report No. 9, "Water and Related Land Resources of the Platte River Basin, Wyoming, September 1971," (22) shows a consumptive use, including evaporation loss of 166,600 acre-feet per year in the North Platte drainage above Saratoga. The North Platte River above Saratoga would encompass an area just slighyly larger than the study area. Of the total, 95,700 acre-feet was for irrigation, 980 for municipal use, and 790 for industrial use. These uses greatly increase downstream through the river system.

The average instant stream flow for the North Platte River drainage is 246.20 cubic feet per second (23). The average mean annual discharge at Saratoga, Wyoming, is 1,141 c.f.s. (25). (Refer to Tables 12 and 13 for additional information.)

Table 12. Selected Streamflow Characteristics at Gaging Stations[1]

No.	Station name	Drainage area (sq. mi.)	Records available	Mean annual discharge (cfs): Average	Mean annual discharge (cfs): Range		Mean annual discharge (cfs): Exceeded 90 percent of years	Annual minimum daily discharge (cfs): Range		Annual minimum daily discharge (cfs): Recurrence interval 2-year	Annual minimum daily discharge (cfs): Recurrence interval 20-year	Maximum discharge (cfs)	Factors affecting natural flow
6-6200	North Platte River near Northgate, Colo.	1,431	1904, 1915	430	123	873	230	19	90	43	24	6,720	Transbasin diversions, diversions for irrigation.
6-6204	Douglas Creek above Keystone, Wyo.	22.1	1955-65	33.0	24.3	42.4	25	1.4	3.1	(a)	(a)	865	Only minor diversions.
6-6210	Douglas Creek near Foxpark, Wyo.	120	[b]1946-63	76.7	33.1	112	40	2.4	6.5	4.5	2.0	1,630	Do.
6-6220	Big Creek at Big Creek Ranger Station, Wyo.	106	[c]1911 1912-24	99.2	56.6	157	57	(a)		(a)	(a)	1,300	Transbasin diversions.
6-6225	French Creek near French, Wyo.	59.6	1909-24	89.4	59.9	132	61	(a)		(a)	(a)	1,680	Diversions for irrigation.
6-6227	North Brush Creek near Saratoga, Wyo.	37.4	1960	49.2	36.4	67.9	(a)	6.4	8.3	7.2	(a)	1,120	No regulation or diversion.
6-6229	South Brush Creek near Saratoga, Wyo.	22.8	1960	31.0	18.6	45.9	(a)	0.8	4.7	2.8	(a)	559	Transbasin diversion.
6-6238	Encampment River above Hog Park Creek, near Encampment, Wyo.	72.7	1964	103	80.6	125	(a)	10	16	(a)	(a)	1,680	No regulation or diversion.
6-6239	Encampment River near Encampment, Wyo.	105	1956-64	156	112	222	(a)	(a)		(a)	(a)	2,290	Do.
6-6245	Encampment River at Encampment, Wyo.	211	1900, 1909-24 1928-32	295	125	495	180	(a)		(a)	(a)	4,680	Diversions for irrigation.
6-6250	Encampment River at mouth, near Encampment, Wyo.	265	1940	230	129	337	145	8.0	40	24	9.0	4,510	Transbasin diversions, diversions for irrigation.
6-6270	North Platte River at Saratoga, Wyo.	2,840	1903-06, 1909	1,141	330	2,210	680	38	262	138	80	18,000	Do.
6-6275	Jack Creek at Matheson Ranch, near Saratoga, Wyo.	41.2	1913-24	23.2	14.4	37.9	15	0	(a)	(a)	(a)	334	Diversions for irrigation.

[1]Data obtained from Water Resources of the Laramie, Shirley, Hanna Basins and Adjacent Areas, Southeastern Wyoming Atlas HA-471.

In most places, a free exchange of water occurs between streams and floodplain deposits to the extent that any significant change in the quantity in one will be reflected in the other. The relationship between ground water in other formations and the water in streams is not as easily identified in most places. The increase in discharge of 20 c.f.s. (cubic feet per second) in the Encampment River between Encampment and Baggot Rocks is attributed to ground-water discharge from other areas. The upper reach of the North Platte River is incised partly into rocks of this unit and contribution of ground water by this unit to the flow of the river is probably appreciable.

Ground water suitable in quantity and quality is generally available for wells at depths of 500 feet or less. Most wells for which data are available are used for stock or domestic supplies. These wells are drilled only deep enough to supply water for the intended purpose.

Sediment Load

According to a BLM inventory (11), sediment yield over the entire area averages approximately 0.23 tons of sediment per square mile per year.

The amount of vegetal cover on a drainage has an inverse relationship with sediment contribution to a stream.

The erosion condition has some effect on the water quality and sediment damage in the area, however, the effect is slight. Erosion and associated sediment damage results from several activities and land uses including agriculture, grazing practices, mineral extraction and exploration, off-road vehicles, and some from natural conditions (11). United States Geological Survey gaging stations recording water quality in mg/l sediment show the quality values resulting from runoff across agricultural and grazing lands. High water occurs during spring runoff and during periods of long duration, high intensity storms. However, this water is usually contained in the drainage channels and the floodplains. Agricultural lands along major drainage floodplains are the most susceptible to flooding. When the agricultural lands do flood, there is an increase in sediment damage and a temporary decrease in water quality. (For additional data on sediment load, refer to Table 13a.)

Dissolved Solids

Water used for irrigation in excess of that consumed by evaporation and transpiration percolates down through the soil and commonly returns to the stream. As the water moves through the soil, calcium sulfate and sodium sulfate in the soil may go into solution and, in addition, some of the calcium already in solution may be exchanged with sodium so that the water returning to the stream tends to be a sodium sulfate type. Therefore, in the lower reaches where return flows are a significant part of the stream discharge, the water in the stream is usually a calcium sulfate or calcium sodium sulfate type.

Water in the lower reaches of the stream contains the lowest dissolved solids when a discharge is large due to runoff from rainfall or snow melt. Runoff from these sources is low in dissolved solids and dilutes the water in the stream.

The Water Resources Research Institute has been taking measurements and water samples at various stations along the North Platte River and Encampment River. The chemical analysis of these samples, as well as other measurements including streamflow, etc., are presented in Tables 13-13d.

Breakdown of dissolved solids (value ranges for all stations) are as outlined:

(1) Suspended solids ranged from 0.55 to 29.48 mg/l.

(2) Suspended sediment concentration ranged from 1.7 to 9.39 mg/l.

(3) Dissolved solids at 180C ranged from 49.10 to 214.29 mg/l.

(4) Dissolved solids sum of constituents ranged from 34.33 to 250.38 mg/l.

(5) Dissolved solids ranged from 11.99 to 564.90 tons per day.

(6) Dissolved solids ranged from 0.26 to 0.61 tons per acre/ft.

(For detailed data on individual station averages for dissolved solids, refer to Table 13a.)

Total dissolved solids are well within the Drinking Water Standards, which recommend that total dissolved solids not exceed 500 mg/l (24).

Chemicals, Heavy Metals, and Toxic Substances (24)

Boron (Table 13a), fluoride, nitrate plus nitrite, phosphorus, ammonia, chloride, sulfate, iron, cyanide, arsenic, cadmium, chromium, copper, lead, manganese, zinc, and various pesticide levels (Tables 13a-13d) in the North Platte and Encampment Rivers are all within the permissable criteria limits for surface water for public water supplies as established by the Committee on Water Quality Criteria for the U.S. Department of the Interior (Table 14).

Nutrients

Carbon, nitrogen and phosphorus are three basic elemental nutrients needed to sustain aquatic life. The value function for inorganic carbon suggests an optimal range of 20-80 mg/l as carbon; above 150 mg/l as carbon, conditions may become excessively productive; and a zero total organic carbon would be nonproductive. Inorganic nitrogen primarily in the form of ammonia and nitrate, are the major forms of nitrogen nutrient available to eutrophic organisms. Trace quantities of inorganic nitrogen are essential to support aquatic ecosystems; below approximately 0.3 mg/l inorganic nitrogen (as nitrogen) is a nitrogen-deficient range. Further, 10 mg/l as nitrogen is inhibiting.

Although the concentration of inorganic phosphorus that will produce problems varies with the nature of the aquatic environment and the levels of other nutrients, some general criteria are available for developing a value function. Specifically, below 0.005 mg/l as phosphorus, one enters a nutrient-deficient region; above 0.02 mg/l as phosphorus, one gets into a region of potential algae bloom; above 0.1 mg/l as phosphorus, one is in an excessively enriched region which is assigned an environmental quality of zero (25). Allowable amounts of total phosphorus will vary, but in general a desirable guideline is 100 ug/l for rivers and 50 ug/l where streams enter lakes or reservoirs (24).

Other important elements needed by plants for growth are potassium, magnesium, calcium, manganese, iron, silicon, sulfur, and oxygen. The levels of concentration of these nutrients are shown in Tables 13-13d.

<u>Coliform Contamination</u>

The presence of coliform organisms in water is regarded as evidence of fecal contamination. The objective of using the coliform group as an indicator of the sanitary quality of water is to evaluate the disease-producing potential of the water. To estimate the probability of pathogens being contributed from feces, the coliform and fecal coliform content must be quantified. The Wyoming Water Quality Standards limit fecal coliform concentrations in bathing water to 200/100 ml (26).

The North Platte and Encampment Rivers with the project area are well within this limit with an average of less than 15 fecal coliform/100 ml (27). (See Table 13a.)

Acid Balance (pH)

The average pH value for the samples taken from various locations along the North Platte and Encampment Rivers is about 7.8 (27). The state water standards state (26) "For all Wyoming waters, wastes of other than natural origin shall not cause the pH to be less than 6.5 or greater than 8.5." Aquatic plants of greatest value as food for waterfowl thrive best in waters with a summer pH range of 7.0 to 9.2. The production and well-being of aquatic organisms require that no highly dissociated materials be added in quantities sufficient to lower the pH below 6.0 or to raise the pH above 9.0 (26).

Dissolved Oxygen

The level of concentration for dissolved oxygen in the surface water of the project area ranges from 8 to 10 mg/l (23). This is well above the critical level of 3-6 mg/l of dissolved oxygen required by nearly all fish. Low levels of dissolved oxygen adversely affect fish and other aquatic life (25).

Temperature

Water temperature is important primarily because of the sensitivity of fish and aquatic life to temperature changes. The water temperatures for the area range from 0 to 22^{o}C and average about 9^{o}C.

Radiological Contaminants

In all Wyoming waters, radioactive material of other than natural origin shall not exceed a concentration of 3pCi/l of Radium 226 (26). The desirable criteria for gross beta is less than 1,000 pc/l (24).

Table 13. Stream Classification Data Averages[1]

Ref. No.	Station Location	Dates Samples Taken	Water Temperature °C	Air Temperature °C	Instant. Streamflow CFS	Streamflow CFS	Conductivity Micromhos at 25°C	Field Conductivity Micromhos	Field pH Standard Units	Total Alkalinity mg/l	Total Hardness mg/l ($CaCO_3$)	Total CO_2 mg/l	Noncarbonate Hardness mg/l
3120	North Platte River Below Douglas Creek	8/75-6/76	8.92	11.33	557.00		190.00	72.50	8.52	73.00	57.00		
3121	North Platte River at A Bar A Ranch boundary	8/75-11/76	9.07	10.67	557.00		220.00	197.50	8.47	97.00	93.50		
3128	East Fork Encampment River at Wier	6/69-11/76	8.97	15.40	54.39		40.73	42.50	7.52	25.37	23.35		
3129	East Fork Encampment River at Stream Gauge	6/69-10/75	7.21	12.75	7.25		40.00		7.48	19.12	21.40		
3132	East Fork Encampment River below Ryan Creek	8/75-10/75	7.00	13.67	15.00		46.67		7.87	28.33	21.67		
3133	Encampment River above East Fork	6/69-5/76	10.72	16.36	200.00		53.71	38.00	7.16	25.14	23.25		
3134	Encampment River below East Fork	6/73-9/73	8.00				39.00						
3135	East Fork Encampment River above Damfino Cr.	6/69-8/71	16.00				39.17		7.31	12.76	14.93		
1056	Encampment River above Rainbow Canyon	11/67				81.00	280.00		7.70	91.00	104.00	54.58	13.00
1057	Encampment River at Mouth	7/65-12/75	7.01		390.15	280.37	258.47		7.75	84.41	96.10	49.75	14.96
1058	North Platte River at Saratoga	4/67-12/67	12.83			1253.62	375.52		7.71	107.86	125.05	64.76	17.29
5444	Encampment River at Water Valley Ranch	9/76-10/76	7.50		50.00			76.00	7.75	37.50	42.50		
2325	Encampment River above Hog Park Creek	10/64-11/75	5.82			108.39	62.53		7.18	27.04	25.62	16.34	1.01
3119	North Platte River at Six Mile Gap Campground	8/75-11/76	9.42	13.33	385.00		238.33	256.67	8.42	115.00	110.00		

[1] Data obtained from computer information of the Water Resources Research Institute, University of Wyoming.

Table 13a. Stream Classification Data Averages[1]

Ref. No.	Station Location	Coliform Immed. M-Endo Colif/100ml	Fecal Colif. M-FC Broth Colif/100ml	Suspended Solids mg/l	Susp. Sed. Concentration mg/l	Dissolved Solids ROE 180C mg/l	Diss. Solids Sum of Constituents mg/l	Dissolved Solids Tons/day	Dissolved Solids Tons per Acre/Ft.	Turbidity Hach Kit FTU	Dissolved Oxygen mg/l	Dissolved Boron Ug/l	Carbon Dioxide mg/l
3120	North Platte River Below Douglas Creek	12.80	9.00	10.00	3.43					8.00	10.00		
3121	North Platte River at A Bar A Ranch boundary	22.56	17.60	17.20	3.17					10.56	9.20		
3128	East Fork Encampment River at Wier	48.89	4.67	1.65	9.32		42.33			2.10	8.13		
3129	East Fork Encampment River at Stream Gauge	4.00	1.25		9.39		36.33			0.00	9.00		
3132	East Fork Encampment River below Ryan Creek	7.00	3.00		1.70					0.00	9.33		
3133	Encampment River above East Fork			1.00			44.33			0.77	8.13		
3134	Encampment River below East Fork				8.60								
3135	East Fork Encampemnt River above Damfino Cr.						34.33			0.00	8.00		
1056	Encampment River above Rainbow Canyon					188.00	176.00	41.10	0.26			110.00	
1057	Encampment River at Mouth		43.48			170.74	170.32	65.25	0.33		10.05	33.78	1.85
1058	North Platte River at Saratoga					214.29	250.38	564.90	0.29			51.43	
5444	Encampment River at Water Valley Ranch	1.00	.50	.55						0.00	9.00		
2125	Encampment River above Hog Park Creek	19.58	.96		5.95	49.10	45.36	11.99	0.61		9.12	15.75	7.66
3119	North Platte River at Six Mile Gap Campground	35.56	45.90	29.48	4.63					19.67	8.80		

[1] Data obtained from computer information of the Water Resources Research Institute, University of Wyoming.

Table 13b. Stream Classification Data Averages[1]

Ref. No.	Station Location	Dissolved Nitrate (N) mg/l	Dissolved Nitrite (NO_2) mg/l	Dissolved Nitrate (NO_3) mg/l	Dissolved Ammonia (NH_4) mg/l	Dissolved Calcium mg/l	Dissolved Magnesium mg/l	Dissolved Sodium mg/l	Dissolved Potassium mg/l	Dissolved Chloride mg/l	Dissolved Sulfate mg/l	Dissolved Fluoride mg/l	Dissolved Silica mg/l
3120	North Platte River Below Douglas Creek												
3121	North Platte River at A Bar A Ranch boundary												
3128	East Fork Encampment River at Wier	0.338				5.87	0.933	1.35	<0.10	0.77	17.90		
3129	East Fork Encampment River at Stream Gauge	0.273				4.67	1.15	1.57	<0.10	0.55	17.40		
3132	East Fork Encampment River below Ryan Creek												
3133	Encampment River above East Fork	0.383				6.07	2.20	1.52	<0.10	0.77	19.30		
3134	Encampment River below East Fork												
3135	East Fork Encampment River above Damfino Cr.	0.314				4.80	0.85	1.52	<0.10	0.73	17.80		
1056	Encampment River above Rainbow Canyon			0.1		34.00	4.90	13.00	2.40	7.40	36.00	0.5	23.00
1057	Encampment River at Mouth	0.144	0.60	0.27	0.20	32.13	4.21	13.64	2.16	8.08	32.97	0.34	20.76
1058	North Platte River at Saratoga			0.27		34.71	9.31	17.99	2.37	5.45	48.10	0.5	15.00
5444	Encampment River at Water Valley Ranch												
2375	Encampment River above Hog Park Creek		1.50	0.12	0.30	7.86	1.46	2.40	1.05	0.82	3.76	0.12	10.97
3119	North Platte River at Six Mile Gap Campground												

[1]Data obtained from computer information of the Water Resources Research Institute, University of Wyoming.

Table 13c. Stream Classification Data Averages[1]

Ref No.	Station Location	Phenols Ug/l	Bromide mg/l	Iron Ug/l	Total Iron Ug/l	Dissolved Iron Ug/l	Bicarbonate Ion mg/l	Carbonate Ion mg/l	Total Phosphorus mg/l (P)	Biochemical Oxygen Demd 5-day mg/l	Total Filtrable Residue mg/l	Total Non-filtrable Residue mg/l	Dissolved Nitrite Plus Nitrate mg/l
3120	North Platte River Below Douglas Creek												
3121	North Platte River at A Bar A Ranch boundary												
3128	East Fork Encampment River at Wier												
3129	East Fork Encampment River at Stream Gauge												
3132	East Fork Encampment River below Ryan Creek												
3133	Encampment River above East Fork												
3134	Encampment River below East Fork												
3135	East Fork Encampment River above Damfino Cr.												
1056	Encampment River above Rainbow Canyon						111.00	0.0					
1057	Encampment River at Mouth	7950.00	0.15	98.33	140.53	112.08	100.26	0.462	0.133				
1058	North Platte River at Saratoga			300.00	180.00		131.71	0.00					
5566	Encampment River at Water Valley Ranch												
2325	Encampment River above Hog Park Creek	5071.43	0.16	47.50	96.18	72.00	33.00	0.01	0.21	0.94	40.11	<1.89	0.28
3119	North Platte River at Six Mile Gap Campground												

[1] Data obtained from computer information of the Water Resources Research Institute, University of Wyoming.

Table 13d. Stream classification data averages for the Encampment River above Hog Park Creek sampling station; trace elements, heavy metals, radioactive elements and pesticides.

Data Parameter	Quantity A	Quantity B
Trace Elements & Heavy Metals	**Dissolved Quantity**	**Total Quantity**
Calcium (mg/l)	7.86	-
Magnesium (mg/l)	1.46	-
Sodium (mg/l)	2.40	-
Potassium (mg/l)	1.05	-
Chloride (mg/l)	0.82	-
Sulfate (mg/l)	3.76	-
Fluoride (mg/l)	0.12	-
Silica (mg/l)	10.97	-
Bromide (mg/l)	0.16	-
Iron (ug/l)	72.00	96.18
Phosphorous (mg/l)	0.24	0.21
Organic Carbon (mg/l)	-	2.00
Cyanide (ug/l)	0.00	-
Arsenic (ug/l)	1.67	-
Cadmium (ug/l)	0.14	-
Chromium (ug/l)	0.00	6.00
Cobalt (ug/l)	0.00	-
Copper (ug/l)	1.83	-
Lead (ug/l)	1.14	-
Manganese (ug/l)	0.00	3.33
Zinc (ug/l)	7.29	-
Mercury (ug/l)	-	0.23
Radioactive Elements	**Dissolved**	**Suspended**
Uranium		
Gross Alpha (Natural Pc/l)	0.93	<0.13
Gross Beta (CS-137, Pc/l)	2.59	<0.73
Natural (ug/l)	<0.40	-
Fluorometric Extract (ug/l)	0.27	-
Gross Alpha (ug/l)	<0.91	0.42
Gross Beta (SR/YT90; Pc/l)	2.09	<0.70
Radium		
226 Planchet Ct. (Pc/l)	<0.10	-
226 Radon Meth. (Pc/l)	<0.30	-
Pesticides	**Whole Water Sample (ug/l)**	**Bottom Deposit (ug/Kg)**
Aldrin	0.00	<0.10
Lindane	0.00	<0.10
Chlordane	0.00	<0.50
DDD	0.00	<0.42
DDE	0.00	<0.38
DDT	0.00	<0.88
Dieldrin	0.00	<0.15
Endrin	0.00	<0.10
Heptachlor	0.00	<0.10
Heptachlor Epoxide	0.00	<0.10
PCB's	0.00	0.00
Malathion	0.00	<0.20
Parathion	0.00	<0.13
Diazinon	0.00	<0.10
Methylparathion	0.00	<0.13
2,4-D	0.00	-
2,4,5-T	0.00	-
Silvex	0.00	-

TABLE 14. Surface Water Criteria for Public Water Supplies[1]

Constituent or characteristic	Permissable criteria	Desirable criteria	Paragraph
Physical:			
Color (color units)	75	<10	1
Odor	Narrative	Virtually absent	2
Temperature*	do.	Narrative	3
Turbidity	do.	Virtually absent	4
Microbiological:			
Coliform organisms	10,000/100 ml[1]	<100/100 ml[1]	5
Fecal coliforms	2,000/100 ml[1]	<20/100 ml[1]	5
Inorganic chemicals:	(mg/l)	(mg/l)	
Alkalinity	Narrative	Narrative	6
Ammonia	0.5 (as N)	<0.01	7
Arsenic*	0.05	Absent	8
Barium*	1.0	do.	8
Boron*	1.0	do.	9
Cadmium*	0.01	do.	8
Chloride*	250	<25	8
Chromium,* hexavalent	0.05	Absent	8
Copper*	1.0	Virtually absent	8
Dissolved oxygen	>4 (monthly mean) >3 (individual sample)	Near saturation	10
Fluoride*	Narrative	Narrative	11
Hardness*	do.	do.	12
Iron (filterable)	0.3	Virtually absent	8
Lead*	0.05	Absent	8
Manganese* (filterable)	0.05	do.	8
Nitrates plus nitrites*	10 (as N)	Virtually absent	13
pH (range)	6.0-8.5	Narrative	14
Phosphorus*	Narrative	do.	15
Selenium*	0.01	Absent	8
Silver*	0.05	do.	8
Sulfate*	250	<50	8
Total dissolved solids* (filterable residue).	500	<200	16
Uranyl ion*	5	Absent	17
Zinc*	5	Virtually absent	8
Organic chemicals:			
Carbon chloroform extract* (CCE)	0.15	<0.04	18
Cyanide*	0.20	Absent	8
Methylene blue active substances*	0.5	Virtually absent	19
Oil and grease*	Virtually absent	Absent	20
Pesticides:			
Aldrin*	0.017	do.	21
Chlordane*	0.003	do.	21
DDT*	0.042	do.	21
Dieldrin*	0.017	do.	21
Endrin*	0.001	do.	21
Heptachlor*	0.018	do.	21
Heptachlor epoxide*	0.018	do.	21
Lindane*	0.056	do.	21
Methoxychlor*	0.035	do.	21
Organic phosphates plus carbamates.	0.1[2]	do.	21
Toxaphene*	0.005	do.	8
Herbicides:			
2,4-D plus 2,4,5-T, plus 2,4,5-TP*	0.1	do.	21
Phenols*	0.001	do.	8
Radioactivity:	(pc/l)	(pc/l)	
Gross beta*	1,000	<100	8
Radium-226*	3	<1	8
Strontium-90*	10	<2	8

*The defined treatment process has little effect on this constituent.

[1]Microbiological limits are monthly arithmetic averages based upon an adequate number of samples. Total coliform limit may be relaxed if fecal coliform concentration does not exceed the specified limit.

[2]As parathion in cholinesterase inhibition. It may be necessary to resort to even lower concentrations for some compounds or mixtures. See par. 21.

The current levels of radioactive elements found in the surface water under discussion are all well below the established limits. (For further information refer to Tables 13-13d, 14.)

PLANTS (AQUATIC)

No detailed list of aquatic plants is avilable for the program area. However, the following is a list of plants which are commonly found under similar conditions. These plants may or may not exist in this locale.

Vascular plants: According to Muenscher's "Aquatic Plants of the United States" (28) the following vascular plants are found in Wyoming.

Cattails (Typha latifolia)
Arrowhead (Sagittaria cuneata, Sagittaria latifolia)
Bur Reed (Sparganium angustifolium, Sparganium eurycarpum, Sparganium minimum, Sparganium multipedunculatum)
Broad-leaved pondweed (Potamogeton amplifolius)
Sago pondweed (Potamogeton pectinatus)
Pondweed (Potamogeton alpinus, Potamogeton crispus, Potamogeton epihydrus, Potamogeton fibrillosus, Potamogeton filiformis, Potamogeton foliosus, Potamogeton gramineus, Potamogeton illinoensus, Potamogeton natans, Potamogeton nodosus, Potamogeton praelongus, Potamogeton pusillus, Potamogeton richardsonii, Potamogeton robbinsii, Potamogeton vaginatus
Widgeon grass, Ditch grass (Ruppia maritima)
Horned pondweed (Zannichellia palustris)
Arrow grass (Triglochin maritima, Triglochin palustris)
Water plantain (Alisma plantago aquatica)
Narrow-leaved water plantain (Alisma gramineum)
Waterweed (Anacharis canadensis, Anacharis occidentalis)
Foxtail (Alopecurus aequalis)
Slough grass (Beckmannia syzigachne)
Bluejoint grass (Calamagrostis canadensis)
Brook grass (Catabrosa aquatica)
Manna grass (Glyceria borealis, Glyceria grandis, Glyceria pauciflora, Glyceria striata)
Canary grass (Phalaris arundinacea)
Reed (Phragmites communis)
Cord grass (Spartina pectinata)
Sedge (Carex aquatilis, Carex lanuginosa, Carex lasiocarpa, Carex inflata, Carex vesicaria)
Spike rush (Eleocharis acicularis, Eleocharis calva, Eleocharis palustris, Eleocharis uniglumus,

Eleocharis rostellata)
Hard-stem bulrush (Scirpus acutus)
Three-square, Shore rush (Scirpus americanus)
Bulrush, Club rush (Scirpus heterochaetus, Scirpus paludosus, Scirpus olneyi)
Great bulrush, Soft-stem bulrush (Scirpus validus)
Rush (Juncus balticus)
Water smartweed (Polygonum amphibium)
Smartweed, Knotweed (Polygonum coccineum, Polygonum punctatum)
Glasswort, Samphire (Salicornia rubra)
Seaside buttercup (Ranunculus cymbalaria)
Spearwort (Ranunculus flammula)
Buttercup, Crowfoot (Ranunculus purshii)
White water-crowfoot (Ranunculus aquatilis)
Water cress (Nasturtium officinale)
Awlwort (Subularia aquatica)
Marsh cinquefoil (Potentilla palustris)
Water starwort (Callitriche palustris)
Waterwort (Elatine americana)
Water purslane (Ludvigia palustris)
Mare's-tail (Hippuris vulgaris)
Water milfoil (Myriophyllum exalbescens, Myriophyllum heterophyllum, Myriophyllum verticillatum)
Berula (Berula pusilla)
Water parsnip (Sium suave)
Sea milkwort (Glaux maritima)
Buck Bean, Bog Bean (Menyanthes trifoliata)
Hedge Hyssop (Gratiola neglecta)
Mudwort (Limosella subulata)
Monkey flower (Mimulus guttatus)
American brooklime (Veronica americana)
Bladderwort (Utricularia vulgaris)
Quillwort (Isoetes bolanderi, Isoetes occidentalis)
Horsetail (Equisetum fluviatile)
Water clover (Marsilea vestita)

Additional vascular plants found in Wyoming, according to "How to Identify and Control Water Weeds and Algae" (29) follow.

American Elodea (Elodea canadensis)
Waterstargrass (Heteranthera dubia)

Phytoplankton:

Various algae

Floating vascular plants: According to Muenscher's "Aquatic Plants of the United States" (28) the following floating plants are found in Wyoming.

Duckweed (Lemna minima, Lemna minor, Lemna trisulca)

Large duckweed (Spirodela polyrhiza)
Hornwort, Coontail (Seratophyllum demersum)
Yellow Water Lily, Spatterdock (Nuphar polysepalum)

Additionally, Water Pennywort (Hydrocotyle spp.) is also found in Wyoming and is cited in "How to Identify and Control Water Weeds and Algae" (29).

PLANTS (TERRESTRIAL)

Flora: The BLM inventory (11) states that the vegetation in the proposed treatment area can be divided into four major types: brush and shrubs, grass, broadleaf trees, and conifers. The dominate vegetation is the brush-shrub type. This type generally has an associated understory of grasses and is also classified as a shrub-grass subtype. On occasion grasses will be slightly more dominant depending upon soils and moisture. The less numerous types are the grass and the broadleaf or conifer tree types.

According to the BLM inventory (11) six different ecological types with unique vegetative subtypes exist in the proposed treatment area and are listed below.

Winter Range (juniper - sagebrush) (Figure 7)
major species: Juniper (Juniperus spp.)
Ponderosa Pine (Pinus ponderosa)
Big Sagebrush (Artemisia tridentata)
Bitterbrush (Purshia spp.)
Mountain Mahogany (Cercocarpus montanus)
Grasses

Riparian Zone (North Platte River) (Figure 8)
major species: Willow (Salix spp.)
Cottonwood (Populus spp.)
Alder (Alnus spp.)
Grasses and Shrubs (including understory)

Sagebrush Steppe (Figure 9)
major species: Big Sagebrush (Artemisia tridentata)
Black Sagebrush (Artemisia nova)
Rabbitbrush (Chrysothamnus spp.)
Winterfat (Eurotia lanata)
Shadscale Saltbush (Atriplex confertifolia)

Bud Sagewort (Artemisia spinescens)
Bottlebrush Squirreltail (Sitanion hystrix)
Indian Ricegrass (Oryzopsis hymenoides)
Bluegrass (Poa spp.)
Fourwing Saltbush (Atriplex canescens)
Antelope Bitterbrush (Purshia tridentata)
Plains Larkspur (Delphinium geyeri)
Halogeton (Halogeton glomeratus)
Purple Prairie Clover (Petalostemon purpureus)

The following is a list of vegetation, which according to the Soil Conservation Service, (138) is native to the area.

Precipitation zone 20 inches plus mountains.

Elevation: 7,000' - 10,000'

Woodland species:

Lodgepole Pine (Pinus contorta latifolia)
Douglas Fir (Pseudotsuga minziesii)
Alpine Fir (Abies lasiocarpa)
Aspen (Populus spp.)

Grassland species:

Bluebunch Wheatgrass (Agropyron spicatum)
Columbia Needlegrass (Festuca spp.)
Spike Fescue (Stipa spp.)
One-spike Danthonia (Danthonia unispicata)
Black Sagebrush (Artemisia nova)
Big Sagebrush (Artemisia tridentata)
Snowberry (Symphoricarpos racemosus)
Numerous forbs

Precipitation zone 10 to 14 inches High Plains Southeast.

Elevation: 6,500' - 7,500'

Woodland species:

Cottonwood (Populus spp.) on lowland sites

Grassland species:

Thickspike Wheatgrass (Agropyron dasystachyum)
Bluebunch Wheatgrass (Agropyron spicatum)
Low Rabbitbrush (Chrysothamnus spp.)
Big Sagebrush (Artemisia tridentata)
Needleandthread Grass (Stipa comata)
Indian Ricegrass (Oryzopsis hemenoides)
Sandberg Bluegrass (Poa secunda)

Figure 7. Winter Range (juniper-sagebrush) near Bennett Peak Campground.

Figure 8. Riparian Zone along the North Platte River, near Bennett Peak.

Figure 9. Sagebrush Steppe.

Figure 10. Encampment River Canyon at the confluence of the South Fork of the Minor Creek and the Encampment River.

Foothill Zone (mountain brush type)
major species: Subalpine Fir (*Abies lasiocarpa*)
Lodgepole Pine (*Pinus contorta latifolia*)
Quaking Aspen (*Populus tremuloides*)

understory: Fringed Sagebrush (*Artemisia frigida*)
Big Sagebrush (*Artemisia tridentata*)
Snowbush Ceanothus (*Ceanothus velutinus*)
True Mountain Mahogany (*Cercocarpus montanus*)
Rubber Rabbitbrush (*Chrysothamnus nauseosus*)
Shrubby Cinquefoil (*Potentilla fruticosa*)
Antelope Bitterbrush (*Purshia tridentata*)
Minerscandle (*Cryptantha bradburiana*)
Closed Field Gentain (*Gentiana bigelovi*)
Geranium (*Geranium* spp.)
Russet Buffaloberry (*Shepherdia canadensis*)
Dandelion (*Taraxacum officinale*)
Lupine (*Lupinus* spp.)
Bluebells (*Mertensia* spp.)
Penstemon (*Penstemon* spp.)
Clover (*Trifolium* spp.)
Grasses

Encampment River Canyon (Primarily sagebrush - short grass prairie) (Figure 10)
major species: Sagebrush (*Artemisia* spp.)
Short grasses
Aspen (*Populus* spp.)
Conifers

Agricultural Areas
major species: Various species of hay
Winter Wheat
Alfalfa
Willows (*Salix* spp.)
Native Sagebrush (*Artemisia* spp.)
Short Grasses

Precipitation zone 15 to 19 inches Foothills and Mountains Southeast.

Elevation: 7,500' - 10,000'

Woodland species:

Blue Spruce (*Piceas pungens*)
Lodgepole Pine (*Pinus contorta latifolia*)
Ponderosa Pine (*Pinus ponderosa*)

Grassland species:

Bluebunch Wheatgrass (*Agropyron spicatum*)
Western Wheatgrass (*Agropyron smithii*)

Neeleandthread grass (Stipa comata)
Idaho Fescue (Festuca idahoensis)
Antelope Bitterbrush (Purshia tridentata)
Black Sagebrush (Artemisia nova)

No plants proposed for threatened or endangered status are known to occur in the area. (See Appendix 13 for the proposed threatened or endangered plants of Wyoming.)

ANIMALS (AQUATIC)

The following is an inventory of the aquatic animals found in the program as reported by the BLM (11) and the Aquatic and Terrestrial Animal Listing for North Platte River Drainage by the State Game and Fish Department (30).

Mammals:

Beaver (Castor canadensis)
Muskrat (Ondatra zibethicus)
Raccoon (Procyon lotor)
Water Shrew (Sorex palustris)
River Otter (Lutra canadensis)

Birds:

Common Loon (Gavia immer)
Gadwall (Anas strepera)
Red Head (Aythya americana)
Lesser Scaup (Aythya affinis)
Common Goldeneye (Bucephala clangula)
American Coot (Fulica americana)
American Avocet (Recurvirostra americana)
Killdeer (Charadrius vociferus)
Spotted Sandpiper (Actitis macularia)
Greater Yellowlegs (Totanus melanoleucus)
Lesser Yellowlegs (Totanus flavipes)
Least Sandpiper (Erolia minutilla)
Wilson's Phalarope (Steganopus tricolor)
Herring Gull (Larus argentatus)
Ring-Billed Gull (Larus delawarensis)
Franklin's Gull (Larus pipixcan)
California Gull (Larus californicus)
Forster's Tern (Sterna forsteri)
Common Snipe (Capella gallinago)
Belted Kingfisher (Megaceryle alcyon
Long-billed Marsh Wren (Telmatodytes palustris)
Yellow-headed Blackbird (Xanthocephalus xanthocephalus)

Red-winged Blackbird (Agelaius phoenicius)
Dipper (Cinclus mexicanus)
Western Flycatcher (Empidonax difficilis)
Mallard (Anas platyrhynchos)
Pintail (Anas acuta)
American Green-winged Teal (Anas crecca carolinensis)
American Widgeon (Anas americana)
Northern Shoveler (Anas clypeata)
Common Merganser (Mergus merganser)
Eared Grebe (Podiceps caspicus)
Western Grebe (Aechmorphorus occidentalis)
Double-crested Cormorant (Phalacrocoras auritus)
Pied-billed Grebe (Podilymbus podiceps)
Great Blue Heron (Ardea herodias)
Canada Goose (Branta canadensis)
Bufflehead (Bucephala albeola)
Virginia Rail (Rallus limicola)
Sora Rail (Porzana carolina)
Blue-winged Teal (Anas discors)
White Pelican (Pelecanus erythrorhynchos)

Amphibians and Reptiles:

Clouded tiger salamander (Ambystoma tigrinum nebulosum)
Northwestern or boreal toad (Bufo boreas boreas)
Boreal chorus frog (Psuedacris triseriata maculata)
Leopard frog (Rana pipiens)
Western spotted frog (Rana pretiosa pretiosa)
*Northern wood frog (Rana sylvatica)
Eastern short-horned lizard (Phrynosoma douglassi brevirostre)
Eastern yellow-bellied racer (Coluber constrictor flaviventris)

*Rare species in Wyoming according to the Wyoming Game and Fish Dept. (134).

Fish:

Cutthroat trout (Salmo clarki)
Rainbow trout (Salmo gairdneri)
Brown trout (Salmo trutta)
Brook trout (Salvelinus fontinelis)
Longnose Dace (Rhinichthys cataractae)
Walleye (Stizostedion vitreum vitreum)
Carp (Cyprinus carpio)
Longnose sucker (Catostomus catostomus)
White sucker (Catostomus commersoni)
Creek Chub (Semotilus atromaculatus)
Johnny darter (Estheostoms nigrum)

According to the BLM (11), no endangered or threatened fish species and their habitats have been identified in the proposed program area. This may be due to the lack of base line information about the fishery resource in the Unit.

Invertebrates:

Stoneflies (Chloroperlidae, Perlodidae, Nemouridae, Pteronarcidae, Perlidae)
Dragonflies (Gomphidae)
Damselflies (Coenagrionidae, Argionidae)
Waterboatmen (Corixidae)
Backswimmers (Notonectidae)
Giant water bugs (Belostomatidae)
Water striders (Gerridae)
Creeping water bugs (Nancoridae)
Alderflies (Sialidae)
Caddisflies (Brachycentridae, Glossosomatidae, Hydropsychidae, Limnephilidae, Psychomyiidae, Rhyacophilidae, Phryganeidae, Leptoceridae, Hydroptilidae, Helicopsychidae, Lepidostomatidae)
Predaceous diving beetles (Dytiscidae)
Riffle beetles (Elmidae)
Leaf beetles (Chrysomelidae)
Aquatic larvae, terrestrial beetle adults (Helodidae)
Weevils (Curculionidae)
Most larvae and adults aquatic (Hydraenidae)
Water scavenger beetles (Hydrophilidae)
All larvae and adults aquatic (Dryopidae)
Crawling water beetles (Haliplidae, Heterocercidae, Histeridae)
Moth flies (Psychodidae)
Aquatic caterpillar (Moth) (Pyralidae)
Mayflies (Ephemeridae, Leptophlebiidae, Baetidae, Ephemerellidae, Caenidae, Tricorythidae, Siphlonuridae, Heptigeniidae)
Biting midges (Heleidae)
False crane flies (Liriopeidae)
Snipe flies (Rhagionidae)
Black flies (Simuliidae)
Horse flies, deer flies (Tabanidae)
Midges (non-biting) (Tendipedidae)
True crane flies (Tipulidae)
Net-winged midges (Blepharoceridae)
Flower flies (Syrphidae)
Mosquitoes (Culicidae)
Dance flies (Empididae)
Phantom midges (Dixidae)
Pouch snails (Physidae)
Limpets (Ancylidae)
Pond snails (Lymnaeidae)
Orb snails (Planorbidae, Amnicolidae)
Clams, mussells (Sphaeridae, Unionidae)
Planaria (Planariidae)
Aquatic earthworms (Lumbriculidae, Glossoscolecidae, Naididae)
Horsehair worms (Gordiidae)
Seed shrimps (Order: Podocopa)
Water fleas (Order: Cladocera)

Scuds, sideswimmers (Talidridae, Gammaridae)
Crayfish (Astacidae, Cambarinae)

ANIMALS (TERRESTRIAL)

The following species of mammals, birds and reptiles occur in habitats typical of areas to be treated, according to the BLM (11) and the State Game and Fish Department's Aquatic and Terrestrial Animal Listing for North Platte River Drainage (30).

Mammals:

Snowshoe Hare (Lepus americanus)
Pika (Ochotona princeps)
Uinta Chipmunk (Eutamias umbrinus)
Yellow-bellied Marmot (Marmota flaviventris)
Red Squirrel (Tamiasciurus hudsonicus)
Gapper's Red-backed Vole (Clethrionomys gapperi)
Porcupine (Erethizon dorsatum)
Black Bear (Ursus americana)
Elk (Cerbus canadensis)
Eastern Cottontail (Sylvilagus floridanus)
Black-tailed Jackrabbit (Lepus californicus)
Richardson's Ground Squirrel (Spermophilus richardsonii)
Thirteen-lined Ground Squirrel (Spermophilus tridecemlineatus)
White-tailed Prairie Dog (Cynomys leucurus)
Opossum (Didelphis virginiana)
Desert Cottontail (Sylvilagus audubonii)
Least Chipmunk (Eutamias minimus)
*Black-footed Ferret (Mustela nigripe)
Deer Mouse (Peromyscus maniculatus)
Montane Vole (Microtus montanus)
Long-tailed Vole (Microtus longicaudus)
Prairie Vole (Microtus ochrogaster)
Heather Vole (Phenacomys intermedius)
Bushy-tailed Wood Rat (Neotoma cinera)
American Badger (Taxidea taxus)
Long-tailed Weasel (Mustela frenata)
Coyote (Canis latrans)
Bobcat (Lynx rufus)
Ord's Kangaroo Rat (Dipodomys ordii)
Plains Harvest Mouse (Reithrodontomys megalotis)
Northern Grasshopper Mouse (Onychomys leucogaster)
Golden-mantled Ground Squirrel (Spermophilus lateralis)
Striped Skunk (Mephitis mephitis)
Townsend's Bat (Plecotus townsendii)
American Pronghorn Antelope (Antilocapra americana)

* Rare species in Wyoming according to Wyoming Game and Fish Dept. (134).

Fox Squirrel (Sciurus niger)
White tailed Deer (Odocoileus virginianus)
Mule Deer (Odocoileus hemionus)
White-tailed Jackrabbit (Lepus townsendii)
Rocky Mountain Bighorn Sheep (Ovis canadensis)
Norway Rat (Rattus norvegicus)
House Mouse (Mus musculus)
Vagrant Shrew (Sorex vagrans)
Masked Shrew (Sorex cinerus)
Merriam's Shrew (Sorex merriami)
Dwarf Shrew (Sorex nanus)
Long-eared Myotis (Myotis evotis)
Little Brown Myotis (Myotis lucifugus)
Long-legged Myotis (Myotis volans)
Small-footed Myotis (Myotis subulatus)
Silver-haired Bat (Lasionycteris noctivagans)
Big Brown Bat (Eptesicus fuscus)
Hoary Bat (Lasiurus cinereus)
Red Bat (Lasiurus borealis)
*Spotted Bat (Euderma maculatum)
Spotted Skunk (Spilogale putorius)
Red Fox (Vulpes fulva)
Plains Pocket Gopher (Geomys bursarius)

* Rare species in Wyoming according to Wyoming Game and Fish Dept. (134).

Birds:

Tree Swallow (Iridoprocne bicolor)
Bank Swallow (Riparia riparia)
Rough-winged Swallow (Stelgidopteryx ruficollis)
Water Pipit (Motacilla flava)
Bobolink (Dolichonus oruzivorus)
Red-tailed Hawk (Buteo jamaicensis)
Blue Grouse (Dendragapus obscurus)
Great Horned Owl (Bubo virginianus)
Common Flicker (Colaptes cafer)
Long-eared Owl (Asio otus)
Yellow-bellied Sapsucker (Sphyrapicus varius)
Hairy Woodpecker (Dendrocopos villosus)
Downy Woodpecker (Dendrocopos pubescens)
Northern Three-toed Woodpecker (Picides tridactylus)
Dusky Flycatcher (Empidonax oberholseri)
Steller's Jay (Cyanocitta stelleri)
Gray Jay (Perisoreus canadensis)
Clark's Nutcracker (Nucifraga columbiana)
Black-capped Chickadee (Parus atricapillus)
Mountain Chickadee (Parus gambeli)
White-breasted Nuthatch (Sitta carolinensis)
Brown Creeper (Certhia familiaris)
House Wren (Troglodytes aedon)
American Robin (Turdus migratorius)

Townsend's Solitaire (Myadestes townsendi)
Hermit Thrush (Hylocichla guttata)
Swainson's Thrush (Hylocichla ustulata)
Veery (Hylocichla fuscescens)
Mountain Bluebird (Sialia currocoides)
Ruby-crowned Kinglet (Regulus calendula)
Bohemian Waxwing (Bombycilla garrula)
Warbling Vireo (Vireo gilvus)
Orange-crowned Warbler (Vermivora celata)
Yellow Warbler (Dendroica petechia)
Mac Gillivray's Warbler (Oporornis tolmiei)
Wilson's Warbler (Wilsonia pusilla)
Western Tanager (Piranga ludoviciana)
Black-headed Grosbeak (Pheucticus melanocephalus)
Evening Grosbeak (Hesperiphona vespertina)
Cassin's Finch (Carpodacus cassinii)
Lazuli Bunting (Passerina amoina)
American Redstart (Setophaga ruticilla)
Brown-headed Cowbird (Molothrus ater)
Western Bluebird (Sialia mexicana)
White-crowned Sparrow (Zonotrichia leucophrys)
Fox Sparrow (Passerella iliaca)
Lincoln's Sparrow (Melospiza lincolnii)
Rufous Hummingbird (Selasphorus rufus)
Green-tailed Towhee (Chlorura chlorura)
Turkey Vulture (Coragyps atratus)
Swainson's Hawk (Buteo swainsoni)
Ferruginous Hawk (Buteo regalis)
Marsh Hawk (Circus cyaneus)
Merlin (Falco columbarius)
*Peregrine Falcon (Falco peregrinus)
*Burrowing Owl (Speotyto cunicularia)
Sage thrasher (Oreoscoptes montanus)
Lark Bunting (Calamospiza melanocorys)
Savannah Sparrow (Passerculus sandwichensis)
Grasshopper Sparrow (Ammodramus savannarum)
Vesper Sparrow (Pooecetes gramineus)
Lark Sparrow (Chondestes grammacus)
Sage Sparrow (Amphispiza belli)
Common Nighthawk (Chordeiles minor)
Barn Swallow (Hirundo rustica)
Short-eared Owl (Asio flammeus)
Black-billed Magpie (Pica pica)
Common Crow (Corvus brachvrhynchos)
Starling (Sturnus vulgaris)
House Sparrow (Passer domesticus)
House Finch (Carpodacus mexicanus)
Pine Siskin (Spinus pinus)
American Goldfinch (Spinus tristis)
Song Sparrow (Melospiza melodia)

*Rare species in Wyoming according to Wyoming Game and Fish Dept. (134).

Golden Eagle (Aquila chrysaetos)
Bald Eagle (Haliaeetus lencocephalus)
Horned Lark (Eremophila alpestris)
Loggerhead Shrike (Lanius ludovicianus)
Western Meadowlark (Sturnella neglecta)
Tree Sparrow (Spizella arborea)
Rough-legged Hawk (Buteo lagopus)
Lesser Goldfinch (Spinus psaltria)
Sage Grouse (Centrocercus urophasianus)
Mourning Dove (Zenaida macroura)
Brewer's Blackbird (Euphagus cyanocephalus)
Rufous-sided Towhee (Pipilo erythrophthalmus)
Gray-crowned Rosy Finch (Leucosticte tephrocotis)
Rock Dove (Columbia livia)

Reptiles:

Sagebrush Lizard (Sceloporus graciosus)
*Western Smooth Green Snake (Opheodrys vernalis)
Common Bull Snake (Pituophis melanoleucas)
Eastern Short-horned Lizard (Phrynosoma douglassi)
Prairie Rattlesnake (Crotalus viridis)
Red-sided Garter Snake (Thamnophis sirtalis)
Western Plains Garter Snake (Thamnophis radix)
Wandering Garter Snake (Thamnophis elegans)

*Rare species in Wyoming according to Wyoming Game and Fish Dept. (134).

INVERTEBRATES (INSECTS)

The insects listed below have been reported in three publications (31-33). The list might not include all of the species present in Carbon County, Wyoming, buy the data comprises the best available information.

The following list of insects found in Wyoming is from the, "Checklist of the Insects in Wyoming," Agricultural Experimental Station, University of Wyoming (31):

Order Hymenoptera (Bees, Wasps, and Ants)

Nematus ventralis
Cephus cinctus
Wesmaelia pendula
Buathra spp.
Clistopyga canadensis
Colpognathus helvus

Diadegma insulare
Diadromus helvolus
Ectopimorpha spp.
Enicospilus merdarius
Exyston excelsus
Gelis tenellus
Heterischnus spp.
Mesoleptus spp.
Phobocampe pollipes
Rhyssa alaskenis
Pentapria nigripes
Holopyga ventralis
Camponotus vicinus
Lasius alienus
Tapinoma sessili
Ancistrocerus adiabatus
Episyron oregon
Pompilus (Ammosphex) luctuosus
Pompilus (Ammosphex) occidentalis
Ancistromma distincta
Astata nubecula bechteli
Bembecinus quinquespinosus
Cerceris conifrons
Cerceris finitima finitima
Cerceris nigrescens nigrescens
Cerceris rufinoda
Lestica confluenta
Orybelus uniglumis
Steniola elegans
Stigmus americanus
Andrena (Tylandrena) hallii
Andrena heterura
Nomadopsis scitula scitula
Melissodes (Eumelissodes) confusa
Nomada articulata
Pyrobombus bifarius bifarius
Dialictus occidentalis
Dialictus pruinosiformis
Dialictus tegulariformis
Evylaeus ruficomis
Holictus (Holictus) rubicundus
Lasioglossum trizonatum
Lithurge apicolis
Megachile (Litomegachile) gentiles
Osmia (Chenosmia) nanula
Stelis (Chelynia) permaculata

The following list of insects reported from Wyoming is from Science Monograph 23, May 1971 (32):

Order Lepidoptera (Butterflies and Moths)

Erynnis icelus

Erynnis persius fredericki
Pyrgus centaureae loki
Prygus ruralis
Thorybes mexicana nevada
Hesperia harpalus
Hesperia juba
Oarisma garita
Ochlodes sylvanoides napa
Polites draco
Polites mystic dacotah
Papilio ployxenis asterius
Papilio rutulus rutulus
Papilio zelicaon gothica
Parnassius phoebus sayii
Colias alexandra alexandra
Colias meadii meadii
Colias philodice eriphyle
Colias scudderii scudderii
Phoebis sennae eubule
Anthocaris sara julia
Pieris beckerii beckerii
Pieris napi macdunnoughii
Pieris rapae
Pieris sisybmrii elivata
Callophrys sheridanii sheridanii
Euchloe ausonides coloradensis
Callophrys (Incisalia) eryphon eryphon
Callophrys (Incisalia) fotis schryveri
Callophrys (Incisalia) polios
Celastrina argiolus cinerea
Glaucopsyche lygdamus oro
Harkenclenus titus titus
Hypaurotis crysalus
Lycaeides melissa melissa
Lycaena dorcas dorcas
Lycaena heteronea klotsi
Lycaena nivalis browni
Lycaena rubidus sirius
Plebeius (Icaricia) icarioides lycea
Plebejus (Icaricia) shasta minnehaha
Plebejus saepiolus saepiolus
Satyrium acadica montonensis
Satyrium behrii crossi
Satyrium fuliginosum fuliginosum
Satyrium saepium saepium
Bolorium bellona
Bolorium selene tollandensis
Chlosyne gorgone carlota
Chlosyne polla colydon
Euphydryas anicia bernadetta
Euphydryas anicia eurythion
Euphydryas editha alebarki
Euptoieta claudia

Limenitis weidemeyerii weidemeyerii
Nymphalis antiopa
Nymphalis milberti furcillata
Phyciodes campestris camillus
Phyciodes pallida pallida
Polygonia hylas
Polygonia satyrus satyrus
Polygonia zephyrus
Speyeria atlantis electa
Speyeria atlantis hesperis
Speyeria callippe
Speyeria cybele charlottii
Speyeria egleis secreta
Speyeria hydaspe sakuntala
Speyeria mormonia eurynome
Speyeria zerene sinope
Vanessa carye
Cercyonis oetus charon
Coenonympha tullia ochracea
Erebia epipsodea epipsodea
Neominois ridingsii ridingsii
Oeneis chryxus chryxus

The following list of insects if from the University of Wyoming publication, "The Mosquitos of Wyoming" (33):

Order Diptera (Flies, Mosquitos)

Anopheles pseudopuntipennis franciscanus
Aedes campestria
Aedes cataphylla
Aedes cinereus
Aedes dorsalis
Aedes excrucians
Aedes fitchii
Aedes flavescens
Aedes hexodontus
Aedes idahoensis
Aedes impiger
Aedes implicatus
Aedes increpitus
Aedes nigromaculis
Aedes pullatus
Aedes spencerii
Aedes triseriatus
Aedes vexans
Culex tarsalis
Culiseta impatiens
Culiseta incidens
Culiseta inornata

ECOLOGICAL INTERRELATIONSHIPS

The following discussion is taken from the BLM inventory (11).

Relationships between vegetation and non-living components: In the winter range portion of the area the lack of soil in the exposed rock zones results in scattered vegetative growth. A broad grass cover has not developed. The climate is somewhat harsh with frequently gusty winds, and long cold winters; but erosion is not a problem.

The high water table and rich deep soils of the riparian zones strongly affect the types of vegetation growing there and the dominant species are typical only in these zones. Some stream bank erosion is occurring, which appears to be natural, rather than man-caused. Periodic flooding occurs in these natural floodplains.

The foothills are a transition zone between a forest community and a sagebrush-grass community. Transition zones are generally areas of great plant diversity. The interspersion of the various vegetative cover types, topography, and the presence of water, help to make these areas rich in both diversity and in numbers of plants and animals.

The soils of the area are generally low to medium in fertility and are susceptible to some leaching. Erosion has created some of the variability in the vegetative types found throughout the area. The climate of the area is generally considered severe, with cold and often severe winters and strong winds. High winds create stress to vegetation by causing excessive water loss from the plants and from the soil.

Along the bottom of the Encampment River Canyon a protected environment occurs which provides a more hospitable area for a variety of vegetative species. The moist, fertile area along the canyon bottom has resulted in a typically deciduous riparian zone. Several species exhibit more vigor here than along the higher, colder, more windswept slopes. In the sharply undulating terrain of this area the major aspen/ conifer timbered zones occur in the protected valleys and on the high, moist slopes. Although erosion is not now a problem, the thin soils covering most of the area are fragile. Flooding potential is moderate in the area's drainages. This area is a transition zone between a forest community and a sagebrush-grass community and therefore, is similar to those areas described as foothills.

The generally deeper, fertile soils (combined with good irrigation potential) have been exploited by man for agricultural purposes. The climate is often severe with long, cold winters and strong winds. High winds create stress to vegetation by causing excessive water loss from the soil. Most of the soil cover is in a stable condition which will not easily erode.

The climate of the sagebrush steppe area is generally considered severe, with cold and often severe winters and strong winds. High winds create stress to vegetation by causing excessive water loss from the plants and from the soil.

Relationship between animals and vegetation: A complex relationship exists in all biotic communities with the flow of energy and material and is often called the food chain. Primary consumers (herbivores or plant eaters) in the biotic community are the rodents, lagomorphs (rabbits and hares) and larger mammals such as deer, elk, bighorn sheep, and domestic livestock. Virtually all energy utilized by animals passes from plants to animals by consumption of the plants by herbivores. The quantity and quality of vegetation consumed by herbivores is therefore extremely important since it represents the total amount of energy available not only to the herbivores but also to the carnivores (meat eaters) that feed upon them. As a biotic community becomes more diverse, the complexity of each of the feeding (trophic) levels increases--from producer (plants) to primary consumers (herbivores) to secondary and tertiary consumers (carnivores) and finally to decomposers (bacteria and fungi). As diversity of an ecosystem increases, so does its complexity and its stability.

In the winter ranges the deer browse species are slowly deteriorating, resulting in a downward trend in winter habitat quality. The scattered juniper provide protective cover for songbirds, and cover for smaller mammals.

The Encampment River Canyon area is a critical mule deer winter range, and also provides winter habitat for some elk. Bighorn sheep live there year round. The browse species of plants growing there show signs of moderate to heavy use by these wildlife species. Livestock use is concentrated on the more level canyon bottomland where taller, more lush grass is available. Shade trees occur there also. The slopes in this area are steep enough to limit livestock use. Because of these factors, livestock use is excessively heavy along the bottom of the Encampment River Canyon.

The winter range, foothill, Encampment River Canyon and sagebrush steppe areas have a great variety of vegetation and good browse composition. Browse species utilized by deer and antelope are present. These browse plants are utilized mostly in the fall and winter. During The spring and summer, the food habits of deer change primarily to grasses and forbs. During the spring, the grasses are eagerly sought after because of their succulence and high nutritional value. They are also the first plants to become green. Since most forbs grow during summer and early fall, that becomes the time of heaviest use by big game animals.

Because deer and antelope usually establish separate winter and summer ranges, vegetation is rarely over-used on the summer ranges. Big game animals are distributed over larger areas in the summer and that gives plants a chance to rest and grow. On winter ranges problems may exist because less food is available, lower nutrition of plant species, and because animals are more concentrated and often are competing for the same plants.

Most of the forage utilized throughout the year by deer, elk, and livestock is found on the more gentle terrain, and the vegetation on the steeper slopes of the canyon walls is not utilized as much. The vegetation on the steeper slopes, therefore, is in a less disturbed condition. In the areas of heavier forage utilization, natural succession has been altered.

Important food and cover are provided in the riparian vegetation zones, benefiting both domestic livestock and wildlife. Nesting areas and hunting perches for raptors are provided by the larger trees. Most of the vegetation is not in a deteriorating state, but beavers have damaged the cottonwoods and willows in a number of locations. The agricultural production along this zone benefits ranching interests. During the winter, livestock are commonly fed on the agricultural areas.

Normal browsing and grazing generally stimulates plant growth and vigor. Therefore, a symbiotic relationship is established between some plants and the animals using them. This relationship is beneficial to both.

Relationship between animal species: Another set of complex relationships that exists between man and ecosystem is the competition for food. For example, coyotes are common hunters in this area, living primarily on rodents and some deer. Raptors both hunt and nest there, commonly feeding on small rodents. The livestock grazed there are utilized by man, as are some deer which are hunted by man.

Predator-prey relationships exist in all biotic communities. The complexity depends upon the number of interrelated species in the ecosystem. As a general rule, the numbers of predators depend upon the abundance of their prey, and predation may regulate the numbers of the prey. As predator populations increase, they will consume a progressively larger number of prey, until the prey populations begin to decline. As the prey diminishes, the predators are faced with less and less food, and they in turn decline. In time the number of predators will be so reduced by starvation that the reproduction of the prey will more than balance their loss through predation. The prey will then again increase, followed shortly by an increase of predators. This cycle may continue indefinitely, since the prey is never quite destroyed by the predator and because the predator is never completely eliminated.

Competition for forage and space between herbivores (primary consumers) exists to a varying degree. This is particularly evident during the winter season when both space and forage quality and quantity become limiting factors in most biotic communities.

Relationship between animals and non-living components: The rough rocky nature of the winter range area provides for a variety of mammal species. Nesting areas for raptors usually occur in the rougher more isolated zones. On the windblown slopes some winter feed is available for deer.

In the riparian zones, fish populations are productive due to the good water quality, favorable stream flows, adequate pool to riffle ratios and excellent populations of aquatic insect life resulting from good riffle conditions. Drinking water is also provided as a habitat requirement of livestock and wildlife. Cliffed areas provide nesting zones for swallows and some raptors.

The Encampment River Canyon area is winter range for mule deer, elk, and bighorn sheep because of the presence of windblown slopes and milder winter conditions. The fertile soils of the drainage bottoms produce lush forage for both livestock and wildlife. The sharp relief occurring in this area provides protective cover to a variety of wildlife species. Water is available in most drainages.

Food, cover, water and space, and arrangement of the components are the basic habitat requirements for all wildlife species. The vegetation of the area provides the food and most of the cover required by the animals. Space is determined by the population numbers and population dynamics of the respective animal species. Competition for space and possibly for forage may occur during severe winters when little food is available and where there are few windswept slopes.

The topography is such that it does not provide a limiting factor to the animal populations. Gullies and draws provide cover, yet do not create barriers to movement. There is usually a sufficient number of south and west exposures that remain relatively free of heavy snows and drifts, as well as a relatively large proportion of windswept ridges that remain cleared of snow through most winters. Available water is not a limiting factor because there are sufficient perennial and intermittent streams throughout the area.

The nutrient cycle is completed by the work of the decomposers. These organisms are essential for the decay of animal and plant bodies. They are responsible for the subsequent return of minerals and nutrients back to the soil, ready to cycle through the system again.

HUMAN VALUES

Landscape Character: Various landscape types exist within the program area.

Encampment River Canyon Area (See Figure 10)

This area of steep relief and incised drainages exhibits interesting land forms and vegetative patterns. Landscape color combinations are attractive, with contrasts occurring between the aspen and coniferous forested areas. A strong contrast occurs where forests meet the predominate sagebrush-grasslands of this area. Rock outcroppings also add to visible color combinations. Riparian vegetation zones also add to the landscape's quality. The autumn color display is particularly interesting in this area.

Water is a major landscape component, especially in the Encampment River Canyon where riffles and white water are a major attraction. The vegetative/geologic combinations found here are unique to this region of Wyoming.

The area is essentially free from aesthetically undesirable features, and little human influence can be noted by most visitors. Several good roads and a number of two-track roads cross the area.

Landscape Characteristics:

Form: Strongly undulating, massive, incised drainages

Line: Riparian vegetation and timbered growth along most drainages create interesting forest fringe lines. Numerous drainages also create deep slightly winding lines on the landscape.

Color: Some dull color combinations are exhibited by the areas of exposed igneous rock zones.

Texture: Major textures are the land forms, with some rugged cobbled effect by smaller exposed rock zones on the upper slopes and steeper drainages.

Vegetative Characteristics:

Form, Line, Texture: The forested fringe areas create the most noticeable contrasts in lines and textures. Sagebrush appears clumpy when within a mile of the viewer.

Color: The sagebrush grassland of the dryer slopes is typically colored with dull greens, greys, yellows and browns. The deciduous riparian zones exhibit bright greens throughout the summer, becoming grey in late fall and winter. Aspen and coniferous timbered areas add interesting shades of green to the landscape. During autumn the areas deciduous trees, primarily aspen, produce a flamboyant color display across the area.

<u>Bennett Peak and Lands Bordering the National Forest</u> (See Figure 11)

The often steep North Platte River drainage dominates the landscape in this area. The slopes along the river are commonly massive and covered with randomly exposed igneous rocks interspersed with conifers that give hillsides a polk-a-dot look. Strongly rolling sagebrush covered hills are another major component of the landscape.

EXISTING ENVIRONMENT

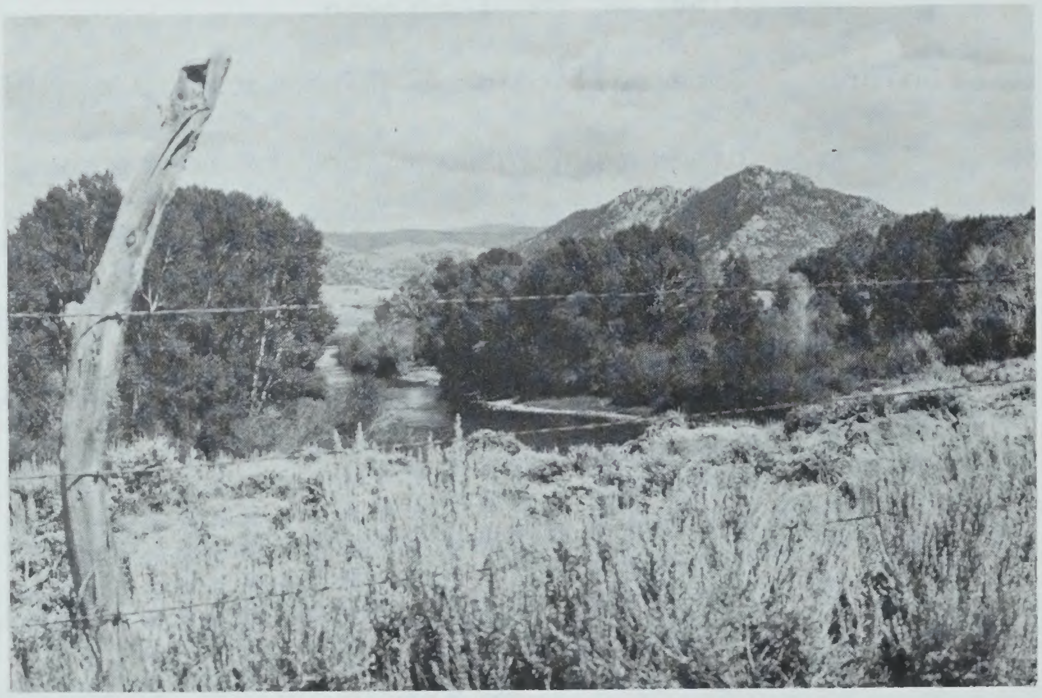


Figure 11. Bennett Peak and the surrounding land showing a variety of habitat types.

Figure 12. Ranching and agricultural lands in the North Platte River Valley.

Aspen and coniferous growth through this area create attractive line and color contrasts with the area's varied relief. Colors of the river and exposed rock often play an important role. The North Platte River is a major contributor to the area's interesting landscape. Deciduous growth, primarily aspen, produces an autumn color display that generates interest area-wide.

The local landscape combinations found in this area are unusual to this region of Wyoming.

No major scenic intrusions occur here. A few operating ranches and State Highway 130 crossing the area are the major evidences of human activity.

Landscape Characteristics:

Form, Texture: Land form is dominated by the North Platte River drainage which is steep and somewhat rugged. The river winding through the area is a major landscape component. Scattered surface rock creates a rough surface texture. Strongly rolling hills with steep side drainages are also characteristic.

Line: The North Platte River drainage and numerous steep side drainages create deep lines on the landscape.

Color: Scattered surface rock of igneous origin adds dark and dull colors to the area.

Vegetative Characteristics:

Form, Line, Texture: The scattered coniferous growths on much of the area create a strong dotted texture on the area's hillsides. Vegetation type changes lines, primarily where timbered areas meet sagebrush zones, and also where there are riparian zones occupying the major drainages.

Color: The sagebrush prairie usually exhibits dull greys, greens, yellows, and browns. Coniferous growth is dark green year-round, becoming more defined during winter months. Aspen and other shrubby deciduous growth add interesting shades of green to the landscape, and exhibit a colorful floral display during autumn.

Beaver Creek Hills (Rolling Hill Zone)

The Beaver Creek Hills are a moderately rolling zone of hills. A sagebrush prairie predominates the land, with several zones of scattered coniferous growth. Scattered surface rock creates a rough texture at several locations. The entire area exhibits predominately dull colors from rock, soil, and prairie vegetation. Water is not a landscape component. This type of area is fairly common in this region. Little human activity is evident on the landscape; some fences and a few two-track roads cross the otherwise barren land.

Landscape Characteristics:

Form, Line, Texture: Broadly rolling hills of moderate relief, minor drainage lines, and some scattered surface rock are the predominate components.

Color: Surface rock and soil colors are dull greys, browns, and yellows.

Vegetative Characteristics:

Form, Line, Texture: The scattered coniferous growth found in a few areas gives these areas a dotted appearance. The predominate sagebrush-grassland creates minor lines where vegetative changes occur along minor drainages. Sagebrush growth creates a clumpy texture when viewed within a mile.

Color: Colors are generally dull grey, greens, yellows and browns.

Beaver Creek Hills (Agricultural Zone)

This is primarily an agricultural area in a gently rolling landscape. Some of the more undulating hills are vegetated with native sagebrush and short grasses. Hay fields and wheat fields create an irregular patchwork effect on the land. Edges of irrigated fields seldom create straight lines due to rolling variations in topography that limit the lands which can be irrigated. Vegetative color contrasts are an interesting feature of the landscape. Water in the small lakes and streams of this area plays a moderate role in landscape character. Riparian zones along these drainages are quite noticeable.

This type of rural agricultural area generates interest that is further enhanced by the smaller ranches which dot the landscape. Human intrusions play only a small negative role in total landscape quality, since most human activities add to this area's picturesque rural character.

Landscape Characteristics:

Form, Line, Texture: Broad, slightly rolling landscape. Drainages create some minor lines.

Color: Geologic colors are dull in the few places where rock and soil are exposed.

Vegetative Characteristics:

Form, Line, Texture: Irrigated and cultivated agricultural areas create a weaving patchwork effect on the land. Riparian zones are an important feature.

Color: A variety of shades of green occur throughout the spring, summer, and fall. Winter wheat grown here gives some of the land a bright green color. Spring and summer months see the landscape exhibit a variety of shades of green, browns and yellows. Deciduous riparian zones show interesting fall color changes. Winter colors are generally dull.

Baggot Rocks

The Baggot Rocks are an interesting area of large rounded igneous rocks sparsely vegetated with scattered conifers and sagebrush. These rock features rise some 500 feet above the surrounding area. Colors are generally dull but varied. Much of the area is composed of pinkish color exposed rock. Water is a component of the landscape in Rainbow Canyon where the Encampment River cuts through the Baggot Rocks to reach the North Platte River.

This type of landscape is unique both locally and regionally. The Sweetwater Rocks some 100 miles to the north resemble the Baggot Rocks, but they are much larger.

This area is essentially free of undesirable aesthetic features.

Landscape Characteristics:

Form: Massive mounds of igneous rocks

Line: Rounded, some drainage lines

Color: Pinks, greys

Texture: Rugged, rounded

Vegetative Characteristics:

Form, Line, Texture: Scattered conifers, primarily junipers, dot the rocks creating a spotted texture. The riparian vegetation zone along Rainbow Canyon creates a major landscape line.

Color: Predominately duller greens, greys, browns, and yellows, but brighter greens occur in the deciduous growth along the Encampment River.

North Platte River Valley, Bennett Peak to Saratoga (See Figure 11)

The North Platte River Valley dominates the landscape here. The water flow itself is a major landscape component; however, the well developed riparian vegetation zone of cottonwoods and willows is the most striking feature. The lower Brush Creek drainage is similar to the rest of the area and is also included.

The land form is a moderately sloping valley with a nearly level alluvial bottom. Soils and rock are exposed along the river in a few locations. During summer the riparian zone and adjacent irrigated hayfields exhibit bright greens. The area is primarily vegetated with deciduous growth, resulting in a colorful autumn display as leaves change. Dull greys and browns prevail throughout the winter.

This type of area is somewhat unusual in this region of Wyoming. Ranching and agricultural activities in this area mix harmoniously with the area's visual patterns. (See Figure 12)

Landscape Characteristics:

Form, Line, Color, Texture: A moderately, sloping river valley with a predominate level alluvial bottom. The winding North Platte River creates a broadly weaving line on the landscape.

Vegetative Characteristics:

Form, Line, Texture: Riparian vegetation zones along the North Platte River and Brush Creek create major forms and broadly weaving lines along the river bottom. Agricultural lands appear as a patchwork of colors, contrasts and texture differences.

Color: Riparian zones exhibit a variety of greens throughout the summer, becoming dull greys and browns in winter. Agricultural lands which are primarily hayfields, show greens, yellows and browns.

SOCIO-CULTURAL INTERESTS

Socio-cultural values associated with the area are very high when viewed in the aggregate. Table 15 shows socio-cultural values for the program area. The groups or organizations affiliated with the values are included, as is the nature of the respective values.

The significance of the interests in Table 15 are indicated by the letters A-C in the table. The information listed in the table indicates values that are other than economic. For example, the Bald Eagle has no economic value, but it is the National Bird and represents a value which goes far beyond the dollar. Its socio-cultural value is of national significance.

South Encampment Critical Winter Range

The area is utilized by deer, elk, and bighorn sheep, and it is considered by BLM to be a region of critical winter range for the deer and sheep. Therefore, it probably is necessary for the survival of a

Table 15. Socio-Cultural Interest Areas and Their Values

Interest	Value*	Nature of Value	Affiliated Group
Encampment Mining District	B	Historical	General Population Historical Groups
Ranching Life Style	A	Traditional	Rural Population General Population
Cattle and Sheep	B	Aesthetic	General Population
Sagebrush Prairie	B	Aesthetic	General Population
Archeological Sites	A	Historical, (Cultural), Educational	General Population Archeological Groups Universities
Encampment-Rawlins Stage Road	C	Historical	General Population Historical Groups
Saratoga Stage Stop	C	Historical	Historical Groups
Antelope	A	Aesthetic, Recreational	General Population Wildlife Groups
Deer	A	Aesthetic, Recreational	General Population Wildlife Groups
Elk	A	Aesthetic, Recreational	General Population Wildlife Groups
Small Game	C	Aesthetic, Recreational	General Population Wildlife Groups
Coyote	B	Aesthetic, Traditional	Wildlife Groups Historical Groups
Golden Eagle	A	Aesthetic, Traditional	Wildlife Groups General Population
Bald Eagle (National Bird	A	Aesthetic Traditional, Historical	Wildlife Groups General Population

*A. Indicates National Significance
B. Indicates Regional Significance
C. Indicates Local Significance

significant proportion of those herds. This is the area in which black footed ferret and peregrine falcon sightings have been reported.

The South Encampment area also is very scenic, and has high quality fishing. Its aesthetic and recreational potential values are great. The historical significance of the area is primarily associated with the mining era and with related explorations.

The uniqueness of this area is enhanced by the fact that several diverse physical, biological, and cultural features occur there in a relatively small site.

Social Well-Being

Population Change

Table 16 "Population Change..." shows the population of towns in the general vicinity of the program area from 1950-1970 and estimates for 1975 and 1980. Note that the population decreased from 1950-1970, then increased. This pattern corresponds to the decline in coal production due to the change from coal to diesel fuels by the railroads in the 1950's. The populations are expected to increase in the listed towns to levels much higher than previously occurred. The increases are projected upon the basis of expected energy development projects.

Table 16. Population Change 1950 - 1980[1]

Place	1950	YEAR 1960	1970	1975	1980
Elk Mountain	196	190	127	195	235
Encampment	288	333	321	315	385
Hanna	1,326	625	460	1,150	3,000
Elmo	213	91	53	200	--
Medicine Bow	328	392	455	580	580

[1]From the Rawlins District Social-Economic Profile

Present estimates place Saratoga's current population at 1,350, reflecting growth within the past few years.

Personal Income

Real personal income has increased in an amount disproportionately greater than the population increases noted since 1970. This is due to great increases in employment in the extractive industries (mining) that have developed north of the program area. According to data supplied by the Wyoming Employment Security Commission, the average weekly wage in the mining industry in Carbon County in 1974 was $270. The average weekly wage for all other sectors of the economy was approximately $162.

The Wyoming Employment Security Commission reports that unemployment in Carbon County in 1972 was approximately 3.2 percent for the year. It is likely that unemployment in the program area is currently that or less; no data are available to make the determination. Nonetheless, the percentage unemployment value for the planning area is far below the national average.

IV. ANALYSIS OF PROPOSED ACTION AND ALTERNATIVES

ANTICIPATED IMPACTS

Air

It must be assumed that with each application of Tordon, Banvel, and 2,4-D herbicides some air contamination, with possible negative environmental effects, will occur. However, air contamination occurring from volatilization (evaporation or sublimation), or directly from spray vapor and dust, will be minimal and temporary.

Volatilization of a herbicide is a change of physical state from a solid or liquid form to a gas or vapor. "The vapor pressure of the salts of 2,4-D (as well as other phenoxy or picolinic acid compounds) is very low; bioassays in greenhouse and field studies have established a lack of off-target effects from vaporization of these salt forms" (35). Volatility of a substance increases with increasing temperature. Volatilization of the herbicides would be greatest during the mid-day hours when soil temperatures are maximum.

Air contamination from spray vapor and from dust of bead formulations will occur only during the time of application. Tordon, Banvel and 2,4-D herbicides are susceptible to decomposition by sunlight (ultra-violet light). Any of these herbicides that are released into the atmosphere will quickly be decomposed and detoxified by sunlight (36). Therefore, any adverse impacts to air quality are expected to be minimal and temporary.

Odor from the herbicide formulations may temporarily reduce air quality during the application procedure and for several days following.

In summary, air contamination of a gaseous vapor or particulate matter will be present primarily during the actual spraying process and for a short period thereafter.

Soil

There would be some adverse impacts to the soil from the use of the proposed herbicides; Tordon, Banvel and 2,4-D. The most detrimental impact that is anticipated will be increased soil erosion in certain treatment areas.

When used at recommended rates, Tordon, Banvel and 2,4-D are generally selective in action in that most grasses are not susceptible to them; whereas, most broad-leafed plants are susceptible. If significant numbers of non-target broad-leafed plants are removed from such sites as steep slopes and alluvial stream banks, increased soil erosion would result. Use of persistent herbicides such as Tordon in such areas would also prolong and increase the soil erosion potential by inhibiting recolonization by beneficial, deep rooted broad-leaf species.

In most locations erosion is expected to be negligible because spot treatment of weeds will not affect significant stands of existing vegetation. In addition, non-susceptible grasses are interspersed with the weeds and other broad-leafed plants. Most native grasses will increase in coverage in response to reduced competition from weeds and broad-leafed plants (37). In some areas, a beneficial effect from increased grass coverage will be reduced soil erosion.

There is some concern regarding the effect of herbicides on soil microorganisms and soil fertility. Several studies have been conducted to determine the effect of Tordon, Banvel and 2,4-D herbicides on the growth and numbers of bacteria and fungi in the soil. Goring et al. (38) studied the effect of Tordon on carbon dioxide evolution, urea hydrolysis and populations of bacteria and fungi. These are important factors in nutrient conversion. Tordon applied at rates as high as 1000 ppm did not appear to significantly affect soil microorganisms. In other studies, nitrification of ammonium to nitrate and nitrification of nitrite to nitrate, both important processes in soil fertility, were not significantly inhibited by 100 or 1000 ppm of Tordon herbicide (38,39). In a similar study Tu and Bollen (40) observed the effects of 1 ppm and 10 ppm of picloram on ammonification, nitrification, sulfur oxidation, and organic matter decomposition. They found no significant detrimental effects that could be considered important to soil fertility. In a study of the effects of picloram and dicamba on soil microflora in five Colorado soils May (41) reported that, "In general the presence of neither dicamba nor picloram appeared to strongly influence the microflora populations in any of the five soils examined." At the recommended application rates of one-quarter to two lbs AI/A (equivalent to a 0.74 ppm maximum) the application of Tordon will not have any detrimental effect on soil fertility. Several authors have determined that dicamba and 2,4-D applied at the recommended rates will have a negligible impact on soil microorganisms and soil fertility (42, 43, 44, 45).

The beneficial effect of this program would be reduced soil erosion in certain areas. Natural increase of native grasses coupled with increases afforded by reseeding operations will contribute to greater soil stability on presently unstable sites. Increased soil fertility may result from increases by legumes and other nitrogen fixers, in response to reduced weed competition.

Water

Herbicides applied to treatment areas could have detrimental environmental effects on water quality if allowed to contaminate stream systems in high concentrations.

Stream systems in the treatment area could be contaminated with herbicides by accidental spillage, spray vapor drift, surface water run-off, and erosion sediments, and by leached herbicides in subsurface water flow. Other possible contamination routes might include overflow from contaminated water storage basins, such as stock ponds and reservoirs, and animal and plant excretions. Water contamination via any of these routes is not expected to reach levels above 1 ppm, for any duration (>24 hours), in the North Platte River or its tributaries. Consequently Tordon, Banvel and 2,4-D contamination of the water systems in the treatment area is not expected to result in adverse or beneficial impacts on the water quality.

Accidental spillage is a possibility. The following chart may give a better understanding of possible stream contamination in the event of such an accident:

<u>Water Contamination Conversion Chart</u>

1 gallon of water	= 8.33 pounds
1 cubic foot of water	= 7.48 gallons
1 cubic foot of water	= 62.4 pounds
1 acre foot of water	= 325,851 gallons
1 acre foot of water	= 2,718,144 pounds
1 cubic foot per second	= 449 gallons per minute
1 cubic foot per second	= 1.984 acre foot per day
2.7 lbs AI/acre foot of water	= 1 ppm

In essence, to maintain a 1 ppm herbicide concentration for 24 hours in a stream flowing at one cubic foot per second, 5.35 lbs of herbicide active ingredient would have to enter the stream over the 24 hour period. The lowest flow measured on the North Platte River at a monitoring station above Douglas Creek was 60 cubic feet per second (23). Low flow rate in the North Platte River tributaries, French Creek and Big Creek, have been estimated to be approximately 10 cubic feet per second.

Contamination of the waterways from surface water run-off would occur and is anticipated to be a primary source of herbicide contamination. Such contamination is not expected to have a significant effect on water quality. Hittle et al. (46) reported data from water samples taken from the North Platte River in Carbon County, Wyoming after 34,000 lbs of 2% picloram was applied to vegetation along 340 acres of stream bank. A total of 36 water samples, taken before and after herbicide application, were analyzed for residues of picloram, dicamba, and 2,4-D. The highest levels of herbicide found were 1.73 ppb, 0.0 ppb and 1.2 ppb, respectively (see Tables 17 and 17a). All of the above values are well below the maximum permissible criteria levels established by the Federal Water Pollution Control Administration (see Table 14, Chapter II). Researchers in other areas also have found insignificant quantities of picloram and dicamba in surface run-off water. Davis et al. (48) applied 9.3 Al/A of picloram on a watershed area and measured stream concentrations after rains. The highest concentration detected in the stream was 0.37 ppm. In another study, Norris (49) found that, "In an area where 67% of a watershed was sprayed in August, residues up to a maximum of 78 ppb were detected after the initial 1 inch storm and then decreased thereafter. No residues were found where only a small portion of the watershed was treated." Evans et al.

found that concentrations of herbicide were greater in run-off water from sod areas than from fallow areas (47).

The proportion of vegetative cover in a drainage system has an inverse relation with the amount of sediment contribution to a stream. In some areas removal of vegetative cover would result in increased sediment contribution to the stream. The adverse effects of increased sediment load on water quality would be negligible particularly, if the specified precautionary measures are followed in erosion-prone sites.

The proposed herbicides can be absorbed onto soil particles in various amounts. As a result some stream sediment deposits would contain low concentrations of herbicide residues (Refer to Tables 17 and 17a).

Contamination of surface water systems from contaminated ground water will be minute. Leaching of Tordon, Banvel, and 2,4-D into ground water systems may or may not occur depending on the temperature, physical characteristics of the soil and amount of precipitation. Wicks and Fenster (50) studied the movement of picloram through sandy loam soil into ground water systems in Nebraska. Picloram was detected in 4.3% of the 1,173 ground water samples analyzed. The highest concentration of picloram measured was 28 ppb in water samples taken from irrigated and non-irrigated plots. On non-irrigated and irrigated plots picloram was detected most frequently at shallow (3.5 to 5.5 ft) water table depths. Minute amounts of picloram were detected in water samples taken from untreated plots; possibly indicating lateral movement of contaminated ground water.

Water storage basins may be contaminated by herbicides carried

Table 17. Residues of Tordon, Banvel and 2,4-D Detected in Water Samples taken from the North Platte River[1]

Sample Number	Sample Location[3]	Sampling Date	USGS Analysis[2] Banvel (dicamba)	Tordon (picloram)	2,4-D	USGS Analysis[2] Banvel (dicamba)	Tordon (picloram)	2,4-D	Stream-flow CFS
Water									
2	1	6/20	0	0.00	0.00	0	0.00	1.2	185
4	1	11/7	0	0.00	0.09	-	-	-	110
6	2	7/21	0	0.18	1.10	0	0.00	0.0	50
8	3	8/1	0	0.00	0.07	0	0.00	0.0	220
10	4	6/20	0	0.00	0.00	-	-	-	100
12	4	11/7	0	0.11	0.08	-	-	-	65
14	5	6/20	0	0.00	0.02	-	-	-	200
16	5	11/7	0	0.06	0.01	-	-	-	65
18	6	6/20	0	0.00	0.01	0	0.00	1.2	600
20	6	7/21	0	0.15	0.32	0	0.00	0.0	110[4]
22	6	7/21	0	0.01	0.10	0	0.00	0.0	550
24	6	8/1	0	0.00	0.07	0	1.73	0.0	110
26	6	9/29	-	-	0.00	0	0.30	0.0	50
28	6	11/7	0	0.02	0.18	-	-	-	160
Sediment									
1	1	6/20	0.0	0	0	0	0.0	0.00	185
3	1	11/7	0.0	0	0	-	-	-	110
5	2	7/21	0.8	0	0	0	0.0	3.90	50
7	3	8/1	0.0	0	0	0	0.0	2.51	110
9	4	6/20	0.0	0	0	-	-	-	100
11	4	11/7	0.0	0	0	-	-	-	65
13	5	6/20	0.0	0	0	-	-	-	200
15	5	11/7	0.0	0	0	-	-	-	65
17	6	6/20	0.0	0	0	0	0.0	2.30	600
19	6	7/21	0.0	0	0	0	0.0	1.93	110
21	6	7/27	0.0	0	0	0	0.0	2.87	550
23	6	8/1	0.0	0	0	0	0.0	1.95	220[4]
25	6	9/29	0.0	0	0	0	1.4	1.20	50
27	6	11/7	0.0	0	0	-	-	-	160

[1] Data obtained from Herbicide Water Study on the North Platte River, 1977. Wyoming Dept. of Agriculture.
[2] USGS Survey (46).
All values in parts per billion (ppb). ppb are the same as micrograms per liter (ug/1).
[3] For location sites see Table 17a.
[4] Samples taken at same time and location. One of these values is in error.

Table 17a. Water Sample Location Sites Along the North Platte River

Location Number	Location Site
1	North Platte River near Northgate (T11N R80W Sec11)
2	Bridge below A-A Ranch (T14N R81W Sec22)
3	Bridge above Beaver Creek (T15N R82W Sec20)
4	Encampment River at Baggot Bridge (T15N R83W Sec17)
5	Encampment River at mouth (T16N R83W Sec34)
6	Platte River at Highway 130 (T16N R83W Sec15)

by wind or surface run-off. Tordon, Banvel, and 2,4-D are susceptible to photo and microbial degradation which reduce their phytotoxic effects, especially in static bodies of water. Dilution will further reduce the detrimental effects to an infinitesimal level (47, 133).

Aquatic Plants

With certain herbicide formulations and application procedures the possibility exists that there would be some adverse impacts to aquatic plants. In general, aquatic plant control requires significantly increased application rates to compensate for the increased dilution factor in aquatic situations (29). Therefore, the proposed application rates for the control of rangeland weeds should not pose a significant adverse impact upon aquatic vegetation.

There are three forms of aquatic plants; floating, emergent, and submerged which could be affected by the three herbicides from various exposure routes. Only broad-leafed aquatic plants are susceptible and would be affected by application of the proposed herbicides. Algae, phytoplankton, most aquatic grasses, sedges and rushes are tolerant to, and therefore will not be affected by Tordon, Banvel or 2,4-D herbicides when applied at rangeland rates (51, 52, 53, 54, 55, 56). Table 18 presents a partial list of aquatic plant species found in Wyoming and their relative susceptibility to the proposed herbicides. The susceptibility ratings for 2,4-D are shown at aquatic application rates. Rangeland rates are significantly lower than aquatic rates (29).

Wind drift of Banvel or 2,4-D spray formulations when applied around the aquatic sites poses the greatest hazard to emergent broadleafed aquatic plants. Wind-carried herbicide may contact the emergent parts of these plants and could cause reduced vitality or death if exposed to phytotoxic concentrations.

All three forms of aquatic plants may be affected by water contaminated from surface water run-off. As previously discussed in the anticipated impacts section on water contamination, insignificant amounts of herbicides are expected to be carried into drainage systems by surface water run-off. In addition, dilution of herbicides to an undetectable and therefore non-toxic level will occur within a few hundred yards downstream from the point of contamination (47, 133).

Terrestrial Plants

Some broad-leafed terrestrial plants would be adversely affected by the herbicides proposed for use in this program. Tordon, Banvel, and 2,4-D are synthetic auxin herbicides. Auxins are natural plant hormones which stimulate plant cell growth. Synthetic auxin herbicides, when applied to plant shoots and roots, are absorbed by the plant and translocated throughout the plant tissue, where they supersede the action of the natural auxins. The result is that plant growth is overstimulated to such an extent that death occurs. When used at recommended

Table 18. Aquatic Plant Susceptibility to Tordon, Banvel and 2,4-D[1]

Grasses, Sedges, Rushes	Susceptibility[2] Tordon	Banvel	2,4-D[5]
Cattails (Typha latifolia)	R	R[3]	S
Horsetail (Equisetum fluviatile)	MS[4]	MS[3]	MS
Bluejoint grass (Calamagrostis canadensis)	R	R[3]	R
Spike rush (Eleocharia spp.)	R	R[3]	I
Hard Stem bulrush (Scirpus acutus)	R	R[3]	S
Three Square, Shorerush (Scirpus americanus)	R[4]	R[3]	S
Bulrush, Club rush (Scirpus spp.)	R[4]	R[3]	S
Great bulrush, Soft-stem bulrush (Scirpus validus)	R[4]	R[3]	S
Rush (Juncus balticus)	MS[4]		S
Widgeon grass, Ditch grass (Ruppia maritima)	R[3]	R[3]	
Arrow grass (Triglochin mautima, Triglochin palustris)	R[3]	R[3]	
Manna grass (Glyceria spp.)	R[3]	R[3]	
Reed (Phragmitis communis)	R[3]	R[3]	R

[1]This table is a compilation of data from the following sources: Dow Chemical Co. 1969. "Tordon Herbicide: Relative Plant Susceptibility", (Unpublished); G. C. Klingman. 1961. "Weed Control as a Science"; Applied Biochemists Inc., 1976. "How to Identify and Control Water Weeds and Algae"; C. Newbold. 1975. "Herbicides in Aquatic Systems"; R. W. Bovey. 1977. "Response of Selected Woody Plants in the United States to Herbicides", USDA Ag. Handbook No. 493; H. P. Alley, University of Wyoming. Personal Communication, (June 1978).

[2]R-Resistent, MS-Moderately Susceptible, S-Susceptible, I-Severely injured or partially controlled by 2,4-D, S-I-Control of plant falls between susceptible and intermediate classification.

[3]H. P. Alley, University of Wyoming. Personal Communication, (June 1978).

[4]Studies by Dow Chemical Co. and by G. C. Klingman (1961) indicate the susceptibility of different species within a given genus. Generally it can be expected that members within the same genus will show similar response to the herbicide.

[5]The susceptibility rating for 2,4-D is based on aquatic application rates and methods. Rangeland rates are significantly lower.

Table 18 (Cont.). Aquatic Plant Susceptibility to Tordon, Banvel and 2,4-D[1]

Broad-leafed Plants	Susceptibility[2] Tordon	Banvel	2,4-D[5]
Buttercup, Crowfoot (Ranunculus purshii)	S[4]	S[3]	S
White water-crowfoot (Ranunculus aquatilis)	S[4]		
Marsh cinquefoil (Potentilla palustris)	MS-S[4]	S[3]	S-I
Water milfoil (Myriophyllym spp.)	R[4]		S
Water Plantain (Alisma plantago)			S
Duckweed (Lemna spp.)			S
Water Pennywort (Hydrocotyle umbellata)			S
Yellow Water Lily (Nymphaea spp.)			S
Water Smartweed (Polygonum amphibium)	S[4]	S[3]	S
Smartweed, Knotweed (Polygonum spp.)	S[4]	S[3]	S
Seaside buttercup (Ranunculus cymbalaria)	S[4]	S[3]	S
Spearwort (Ranunculus flammula)	S[4]	S[3]	

[1]This table is a compilation of data from the following sources: Dow Chemical Co. 1969. "Tordon Herbicide: Relative Plant Susceptibility", (Unpublished); G. C. Klingman. 1961. "Weed Control as a Science"; Applied Biochemists Inc., 1976. "How to Identify and Control Water Weeds and Algae"; C. Newbold. 1975. "Herbicides in Aquatic Systems"; R. W. Bovey. 1977. "Response of Selected Woody Plants in the United States to Herbicides", USDA Ag. Handbook No. 493; H. P. Alley, University of Wyoming. Personal Communication, (June 1978).

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[3]H. P. Alley, University of Wyoming. Personal Communication, (June 1978).

[4]Studies by Dow Chemical Co. and by G. C. Klingman (1961) indicate the susceptibility of different species within a given genus. Generally it can be expected that members within the same genus will show similar response to the herbicide.

[5]The susceptibility rating for 2,4-D is based on aquatic application rates and methods. Rangeland rates are significantly lower.

rates the three proposed herbicides are selective herbicides. Most broad-leafed plants are susceptible and will be destroyed by exposure to the herbicides; whereas, most grasses are resistant or tolerant and will not be affected. The basis for this selectivity is not completely understood, but it depends to some degree on the different morphology and physiology of broad-leafed plants and grasses (57). Tordon can be toxic to grasses if applied at rates greater than the maximum recommended rate (2 lbs AI/A).

In light of the preceeding discussion it must be assumed that most non-target, broad-leafed plants within specific spot treatment sites will be weakened or killed by exposure to any one of the three herbicides. Some non-target plants contiguous with the treatment site may also be weakened or killed if exposed to herbicide spray drift or to herbicide in the soil. It is not anticipated that significant numbers of non-target broad-leafed plants will be exposed to the herbicide at a single treatment site. During the five year treatment program many non-target plants would be eliminated. It is unknown whether this effect on the broad-leafed plants can be construed as a significant adverse impact.

In riparian zones loss of non-target plants such as willows (Salix spp.), immature trees such as cottonwood (<u>Populus</u> spp.) and Boxelder (<u>Acer</u> <u>negundo</u>), and any other broad-leafed trees, shrubs and forbs will occur if exposed to any of the three herbicides. In non-riparian zones sagebrush (<u>Artemisia</u> spp.), rabbitbrush (<u>Chrysothamnus</u> spp.), antelope bitterbrush (<u>Purshia</u> <u>tridentata</u>), conifers and other trees may be adversely affected where present within spot treatment sites. Nitrogen fixing legumes important to soil fertility also will be weakened or destroyed by exposure to any of the three herbicides. Big sage (Artemisia tridentata), a dominant shrub species in Wyoming, is resistant to Tordon, Banvel, and 2,4-D amine when applied at recommended rates. Table 20 presents a partial list of terrestrial plants found in Wyoming and their relative susceptibility to the proposed herbicides. An extensive list of plant species that have been tested for susceptibility to Tordon is presented in Appendix 12.

Field surveys have not been conducted in Carbon County to determine the presence of plants proposed for threatened or endangered status; but, it is possible that some threatened or endangered species occur in the proposed treatment areas. A list of Wyoming plants currently proposed for federal listing as endangered plants is presented in Table 19. Since suitable habitat exists in the treatment areas, the occurrence of Arching Pussytoes (Antennaria arcuata) and Colorado Butterfly Weed (Gaura neomexicana) is possible. Habitat descriptions and Wyoming locality records for these species are presented in Appendix 13. Any of the endangered plants listed that occur within spot treatment sites will be destroyed if exposed to the herbicides.

Table 19. Plants of Wyoming Proposed for Endangered Status

Family	Species	Common Name
Asteraceae	Antennaria arcuata	Arching Pussytoes
Brassicaceae	Arabis fructicosa	Yellow Rockcress
Brassicaceae	Lesquerella fremontii	Fremont's Bladderpod
Brassicaceae	Lesquerella macrocarpa	Largefruit Bladderpod
Fabaceae	Astragalus proimanthus	Precocious Milkvetch
Onograceae	Gaura neomexicana spp. coloradensis	Colorado Butterflyweed

Table 20. Terrestrial Plant Susceptibility to Tordon, Banvel and 2,4-D[1]

	Susceptibility[2] Tordon	Banvel	2,4-D
Blue Spruce (*Piceas sungens*)	I	I-R	I-R
Juniper (*Juniperus* spp.)	MS-S	S-I	R
Ponderosa Pine (*Pinus ponderosa*)	MS	S-I	I-R
Big Sagebrush (*Artemisia tridentata*)	R	S	S-I
Willow (*Salix* spp.)	S	S-I	S
Alder (*Alnus* spp.)	S	S	S-I
Cottonwood (*Populus* spp.)	S	S	S-I
Quaking Aspen (*Populus tremuloides*)	S	S	S-I
Fringed Sagebrush (*Artemisa frigida*)	S	S[3]	S
True Mountain Mahogany (*Cercocarpus montanus*)	S	S[3]	I
Rubber Rabbitbrush (*Chrysothamnus nauseousus*)	S	S-I	S
Shrubby Cinquefoil (*Potentilla fruticosa*)	MS-S[4]	S[3]	S-I

[1]This table is a compilation of data from the following sources: Dow Chemical Co. 1969. "Tordon Herbicide: Relative Plant Susceptibility", (Unpublished); G. C. Klingman. 1961. "Weed Control as a Science"; Applied Biochemists Inc., 1976. "How to Identify and Control Water Weeds and Algae"; C. Newbold. 1975. "Herbicides in Aquatic Systems"; H. P. Alley, University of Wyoming. Personal Communication, (June 1978).

[2]R-Resistent, MS-Moderately Susceptible, S-Susceptible, I-Severely injured or partially controlled by 1 lb/acre or less of 2,4-D, S-I-Control of plant falls between susceptible and intermediate classification.

[3]H. P. Alley, University of Wyoming. Personal Communication, (June 1978).

[4]Studies by Dow Chemical Co. and by G. C. Klingman (1961) indicate the susceptibility of different species within a given genus. Generally it can be expected that members within the same genus will show similar response to the herbicide.

Table 20 (Cont.). Terrestrial Plant Susceptibility to Tordon, Banvel and 2,4-D[1]

	Susceptibility[2] Tordon	Banvel	2,4-D
Antelope Bitterbrush (Purshia tridentata)	S[3]	S[3]	S[3]
Lupine (Lupinus spp.)	S[3]	S[3]	S-I
Geranium (Geranium spp.)	S	S	S-I
Clover (Trifolium spp.)	S		S
Alfalfa (Medicago sativa)	S	S[3]	S[3]
Indian Ricegrass (Oryzopsis hymenoides)	R[3]	R[3]	R
Bluegrass (Poa spp.)	R	R[3]	R
Snowberry (Symphoricarpus occidentalis)	MS	S[3]	S-I
Thickspike Wheatgrass (Agropyron dasystachyum)	R[3]	R[3]	R[4]
Western Wheatgrass (Agropyron smithii)	R[3]	R[3]	R[4]
Idaho fescue (Festuca idahoensis)	R[3]	R[3]	R[4]
Spike fescue (Festuca kingii)	R[3]	R[3]	R[4]

[1]This table is a compilation of data from the following sources: Dow Chemical Co. 1969. "Tordon Herbicide: Relative Plant Susceptibility", (Unpublished); G. C. Klingman. 1961. "Weed Control as a Science"; Applied Biochemists Inc., 1976. "How to Identify and Control Water Weeds and Algae"; C. Newbold. 1975. "Herbicides in Aquatic Systems"; H. P. Alley, University of Wyoming. Personal Communication, (June 1978).

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[3]H. P. Alley, University of Wyoming. Personal Communication, (June 1978).

[4]Studies by Dow Chemical Co. and by G. C. Klingman (1961) indicate the susceptibility of different species within a given genus. Generally it can be expected that members within the same genus will show similar response to the herbicide.

The proposed weed control program will have a beneficial effect on some terrestrial vegetation. Competition for light, moisture and nutrients between target weed species and native plants will be reduced or eliminated on sites presently infested with weeds. Beneficial native grasses and broad-leafed forbs should re-establish and increase in coverage once the weed infestations are controlled. Increased grass coverage is anticipated to be the most significant beneficial impact within a few years after treatment. Over a longer period of time native broad-leafed species may re-establish in the treatment sites.

Aquatic Mammals

The aquatic mammals; Beaver (Castor canadensis), Muskrat (Ondatra zibethicus), Water shrew (Sorex palustris), Raccoon (Procyon lotor) and the River otter (Lutra canadensis), exist in the proposed treatment area (30). Information pertaining to the effects of Tordon, Banvel and 2,4-D on these particular mammals is not available. The toxicology of the proposed herbicides, as it pertains to domestic and laboratory animals, is discussed in a later section on terrestrial mammals. The general concensus from researchers is that mammals (laboratory and domestic) are tolerant to high concentrations of Tordon, Banvel and 2,4-D (51, 62, 93, 94, 98, 99, 100, 101, 102, 103, 104, 107, 110).

Aquatic Birds

Four studies have been located that document the effects of Tordon, Banvel and 2,4-D on Mallard ducks (90, 91, 92, 137). The results of these studies indicate that Mallard ducks are tolerant to extremely high concentrations of Tordon, Banvel and 2,4-D (>2000 mg/kg of picloram, 2009 mg/kg of Technical Banvel, and >2025 mg/kg of the sodium salt of 2,4-D). Based on the Mallard's tolerance levels to Tordon, Banvel and 2,4-D, adverse impacts to aquatic birds are not expected from direct exposure to any of the three herbicides.

Indirect impacts, both beneficial and adverse, could result from treatment of weeds in stream bank habitat. Removal of weeds and some non-target vegetation along stream banks may have variable effects on aquatic avifauna depending on the particular species in question.

Aquatic Vertebrates (Amphibians and Reptiles)

Very little information has been published regarding the effects of Tordon, Banvel, and 2,4-D herbicides on reptiles and amphibians. Sanders (89) determined the 24 hour LC_{50} for chorus frog tadpoles to be 100 ppm of 2,4-D amine. In another study Lhoste and Roth (130, cited by Pimentel 68) found that a 0.5% (5000 ppm) 2,4-D solution inhibited the development of frog (*Rana temporaria*) eggs. It appears from these two studies that 2,4-D would not be toxic to frogs at the recommended rangeland application rates. The effects of Tordon and Banvel on either reptiles or amphibians is unknown. Further research must be completed before an objective conclusion can be drawn regarding impacts of these herbicides on reptiles and amphibians.

Aquatic Vertebrates (Fish)

To reasonably evaluate the toxicity of Tordon, Banvel and 2,4-D to fish, many interrelated factors must be considered. Toxicity may vary with the stage of growth. Some species of fish, especially salmonids may be extremely susceptible during early growth stages to the herbicides proposed for use in this weed control program. Adult trout are tolerant to high concentrations. In addition to stage of growth, variations in temperature, pH and water hardness may influence the toxicity of the herbicides.

Each of the proposed herbicides has variable effects on fish. Specific information pertaining to the effects of each herbicide on fish is given in the following discussion. The effects these herbicides have on egg maturation and the possible indirect impacts that may occur from habitat changes are discussed in the concluding sections.

Tordon

Picloram is poorly absorbed by soil particles, highly persistent in the soil, and mobile in soil water; thus, it could contaminate streams from ground and surface water run-off. Woodward (72, 136) has studied the acute toxic and chronic effects of picloram on cutthroat (Salmo clarki) and lake trout (Salvelinus namaycush). Lake trout and cutthroat trout in the yolk absorptive and fry stages were the most susceptible to picloram. In a 60-day study, yolk absorption in lake trout was increased 4-5 days above normal and fry survival was significantly reduced by concentrations as low as 35 ug/l (35 ppb). Woodward (72) further reported that he was unable to determine an exact no-effect concentration for picloram because growth was affected at the lowest levels tested. Table 21 presents the data Woodward (72) obtained on lake trout growth and development in various concentrations of picloram.

In a more recent study, Woodward (136) attempted to determine the effects of picloram on cutthroat trout under natural conditions. He attempted to simulate field exposure of cutthroat trout to picloram contaminated water. Picloram in run-off water after the first simulated rainfall increased fry mortality at concentrations above 1,265 ug/l and reduced fry growth at concentrations above 613 ug/l. Concentrations below 293 ug/l had no adverse effect on fry survival or growth (136).

Table 21. Chronic Effects of Picloram (potassium salt) on Growth and Development of Lake Trout (72).

Conc. of Picloram (ug/liter)	Yolk Absorption[1] (days)	Alevin Survival (%)	Fry Survival (%)	Fry, 60 Days Posthatching Survival (%)	Weight (mg)	Length (mm)
0	34	100	100	100	373	33
35	39	75	72	52	233[2]	28[2]
75	38	63	100	58	154[2]	26[2]
240	38	29	67	17	117[2]	23[2]
500	-	0	0	0	-	-
1000	-	0	0	0	-	-

[1]Calculated from median hatch date to median yolk absorption date at 9.5°C.
[2]Significantly different from control groups ($LSD_{0.05}$).

Toxicity of picloram to lake trout and cutthroat trout varies with water temperature, pH and hardness. Woodward (72) determined the 96-hour LC_{50} in 10°C soft water at normal (7.2) pH to be 5,000 ppb and 4,250 ppb for adult cutthroat and lake trout, respectively. Lethal effects of picloram to the lake trout increased with increasing temperature and pH. Interestingly, decreasing temperature and pH increased the toxic effects of picloram to cutthroat. He recommends: "For protection of the cold-water fishery, picloram should not be applied on stream and lake slopes, flat marshy areas or areas with high water tables" (72).

The toxicity of picloram to fish varies considerably with species and chemical formulation. Generally, studies, except those by Woodward (72, 136), indicate that direct effects of picloram on aquatic organisms are not evident at levels below 1 mg/l (1 ppm). Threshold limits for Cyprinidae (carp), Centrarchidae (bass) and Salmonidae (salmon) were above 1 mg/l and LC_{50}'s were greater than 10 mg/l when the fish were exposed to the potassium salt (Tordon 22K) and amine forms of picloram (73). An extensive list of the toxicity of picloram (potassium salt formulation) to several species of adult fish is presented in Tables 22 and 23.

Banvel

Only a few reports documenting the toxicity of dicamba to fish have been published. The available evidence does, however, indicate that several species of fish are fairly tolerant to high concentrations of dicamba. Cope (74) determined the LC_{50} of Banvel D (dimethylamine salt) on rainbow and bluegill. The LC_{50} for rainbow trout at 24 and 48 hours was 35 ppm, and at 96 hours trout were susceptible to 28 ppm. For bluegills the 24, 48, and 96 hour LC_{50}'s were determined to be 130, 40, and 23 ppm respectively. In another study Bohmont (75) determined LC_{50}'s at 48 hours to be 35 ppm for rainbow trout and 130 ppm for bluegill. Bond et al. (76) reported the LC_{50}'s for juvenile coho salmon to be 151 ppm, at 24 hours and 120 ppm at 48 hours.

Based on the above research results, it is not expected that adult fish will be adversely affected. It is unlikely that concentrations of Banvel toxic to adult fish will be reached in the treatment areas. Information is unavailable pertaining to the effects of dicamba on fish growth and development.

2,4-D

Fish in the proposed treatment area will be exposed to waters contaminated with 2,4-D, but adverse impacts to adults and young are not expected. The council for Agricultural Science and Technology (77)

Table 22. Acute Toxicity of Picloram (potassium salt) to Adult Trout Species.

Species	Water temp.	Hours exposure	ppm	% mortality	Reference
Cutthroat trout	$5^{o}C$	96	6.50	50	72
"	$10^{o}C$	96	5.00	50	72
"	$15^{o}C$	96	4.10	50	72
"	$10^{o}C$	96	8.60	50	72
"	$10^{o}C$	96	4.70	50	72
"	$10^{o}C$	96	4.15	50	72
"	$10^{o}C$	96	3.70	50	72
"	$10^{o}C$	96	3.45	50	72
"	$10^{o}C$	96	3.45	50	72
Lake trout	$5^{o}C$	96	3.60	50	72
"	$10^{o}C$	96	4.25	50	72
"	$15^{o}C$	96	2.35	50	72
"	$10^{o}C$	96	4.95	50	72
"	$10^{o}C$	96	2.70	50	72
"	$10^{o}C$	96	2.05	50	72
"	$10^{o}C$	96	2.15	50	72
"	$10^{o}C$	96	1.55	50	72
"	$10^{o}C$	96	2.10	50	72
Brook trout	-	96	320.00	0	51
Brown trout	-	96	100.00	0	51
Rainbow trout	-	96	100.00	0	51
"	-	96	27.00	50	78
"	-	96	13.00	50	78
"	$55^{o}F$	24	34.00	50	79
"	$55^{o}F$	48	25.00	50	79
"	$55^{o}F$	90	24.00	50	79
Brook trout	$50^{o}F$	24	91.00	50	51, 80
"	$50^{o}F$	96	91.00	50	51, 80
"	$50^{o}F$	96	69.00	0	51, 80

Table 22 (cont.). Acute Toxicity of Picioram (potassium salt) to Adult Trout Species.

Species	Water temp.	Hours exposure	ppm	% mortality	Reference
Brown trout	50°F	24	52.00	50	51, 80
"	50°F	96	52.00	50	51, 80
"	50°F	96	22.00	0	51, 80
Rainbow trout	50°F	24	50.00	50	51, 80
"	50°F	96	58.00	50	51, 80
"	50°F	96	22.00	0	51, 80

Table 23. Acute Toxicity of Picloram (potassium salt) to Various Adult Fish Species.

Species	Water temp.	Hours exposure	ppm	% mortality	Reference
Fathead minnow	-	96	100.00	0	51
Green sunfish	-	96	180.00	0	51
Black bullhead	-	96	320.00	0	51
Goldfish	75°F	24	27-36	50	81
"	75°F	48	21-32	50	81
"	75°F	96	14-32	50	81
Bass	75°F	24	19.7	50	81
"	75°F	48	13.1	50	81
Bluegill	63°F	24	26.5	50	82
"	63°F	48	22.5	50	82
"	63°F	72	21.8	50	82
"	63°F	96	21.0	50	82
Coho salmon	63°F	24	29.0	50	82
"	63°F	48	25.0	50	82
"	63°F	72	24.0	50	82
"	63°F	96	21.0	50	82
"	63°F	24[1]	29.0	100	82
"	63°F	48[1]	29.0	100	82
"	63°F	24[1]	25.0	50	82
"	63°F	48[1]	25.0	100	82
"	63°F	24[1]	25.0	35	82
"	63°F	48[1]	24.0	90	82
"	63°F	24[1]	21.0	30	82
"	63°F	48[1]	21.0	45	82
"	66-88°F?	-	5-8	30[2]	82

[1] Fish forced to swin against a current of water.
[2] Some loss of weight in survivors.

Table 23 (Cont.) Acute Toxicity of Picloram (potassium salt) to Various Adult Fish Species.

Species	Water temp.	Hours exposure	ppm	% mortality	Reference
Fathead minnow	50°F	24	52.0	50	51, 80
"	50°F	48	32.0	50	51, 80
"	50°F	72	32.0	50	51, 80
"	50°F	96	29.0	50	51, 80
"	50°F	96	22.0	0	51, 80
Green sunfish	50°F	24	91.0	50	51, 80
"	50°F	96	91.0	50	51, 80
"	50°F	96	39.0	0	51, 80
Black bullhead	50°F	24	91.0	50	51, 80
"	50°F	96	91.0	50	51, 80
"	50°F	96	69.0	0	51, 80
Bluegill	65°F	24	8.2	50	79
"	65°F	48	7.3	50	79
"	65°F	96	5.4	50	79
Lake emerald shiner	69-78°F	4	64.6	50	83
"	69-78°F	24	34.1	50	83
"	69-78°F	48	34.1	50	83
"	69-78°F	96	30.3	50	83
Bluegill	77°F	24	43.2	50	84
"	77°F	48	43.2	50	84

[1] Fish forced to swim against current of water.
[2] Some loss of weight in survivors.

in their report on phenoxy herbicides state, "the water-soluble amine salts (of phenoxy herbicides) are to all intents nontoxic to fish."

Table 24 contains information compiled by Hughes and Davis (84) on the 24 and 48 hour 2,4-D amine LC_{50}'s for Bluegill. They did not explain the extremely variable LC_{50} values obtained for the same formulations.

Table 24. The LC_{50} for Bluegill to 2,4-D Amine Formulations Including Different Batches of the Same Formulation (Adapted from Hughes and Davis, 84).

Formulation	LC_{50} (Acid equivalent) 24 hr.	48 hr.
Dimethylamine	542	458
"	500	416
"	390	353
"	273	273
"	222	220
"	166	160

Pimentel (68) has summarized the results obtained by several researchers on the toxicity of 2,4-D to fish. Spot fish exposed to 50 ppm of 2,4-D were able to survive 48 hours without any deleterious effects (Butler 128, cited by Pimentel 68). In an east coast estuary 2,4-D was applied at a rate of 30 lbs/A; no mortality of native fish was observed (Beaven, Rawls and Beckett 129, cited by Pimentel 68). In a later study, Rawls (140, cited by Pimentel 68) found that 2,4-D applied to an estuary at a rate of 20 lbs/acre killed all the caged fish (mostly pumpkinseed) within 30 days. The maximum allowable rangeland application rate of 2,4-D is 6 lbs/acre.

King and Penfound (85) reported that bluegill and largemouth bass were not affected by 1 ppm of 2,4-D and were only slightly affected by 100 ppm. In another study Butler (55) reported that the longnose killifish (Fundulus similus) was not affected by 48 hour exposure to 15 ppm of 2,4-D. Davis and Hardcastle (86) studied the effect of 2,4-D amine on bluegill sunfish and largemouth bass. They reported that bluegill could withstand 390 ppm for 24 hours and 375 ppm for 48 hours in water with a pH of 7.0 and a total hardness of 19 ppm. They also determined the TL_m for bass to be 375 ppm for 24 hours and 250 ppm for 48 hours. Sitthichaikasem and Carlander (87) studied the effect of 2,4-D-DMA-4 on five fish species. Tables 25 and 26 show the 24 and 96 hour LC_{50}'s determined by Sitthichaikasem and Carlander (87) for five species of adult fish and various early development stages in rainbow trout. Their findings indicate that all stages of rainbow trout, from egg to adult, are tolerant to fairly high concentrations of 2,4-D dimethylamine.

Effects Upon Egg Maturation

Research information pertaining to the effects of picloram and dicamba on fertilization and subsequent egg development in trout has not been determined. Brook and brown trout are fall spawners, that is, eggs are deposited and fertilized in the tributaries of the North Platte River from late August through mid-November. Weed treatment and spawning will occur concurrently in the program area; thus, it is possible that brook and brown trout eggs would be exposed to herbicide contaminated water. The effect such exposure would have on trout eggs is unknown. Sitthichaikasem and Carlander's (87) research results indicate that the egg development stage was the most tolerant to 2,4-D concentrations (See Table 26). In any case, to avoid any uncertain effects of these herbicides on developing fish, particularly yolk sac and fry stages, the time of year these herbicides are applied should be given careful consideration (See page 169).

Table 25. Toxicities of 2,4-D-DMA-4 to Fathead Minnow, Bluegill and Channel Catfish at 20°C and to Rainbow Trout and Smallmouth Bass at 10°C in Soft Reconstituted Water (Adapted from Sitthichaikasem and Carlander, 87).

Species	Mean weight (gm)	Temp. °C	2,4-D-DMA-4 LC_{50} (95% CI)[1] (mg/l) 24 hr	96 hr
Fathead minnow	0.63	20	780(615-988)	760(595-970)
Bluegill	0.20	20	420(328-537)	335(281-399)
Channel catfish	0.15	20	560(481-652)	395(316-493)
Rainbow trout	0.07	10	560(477-657)	420(328-537)
Smallmouth bass	0.41	10	260(198-342)	236(185-301)

[1] Confidence interval.

Table 26. Comparative Toxicity of 2,4-D-DMA-4, in Soft Reconstituted Water at 10°C, on Various Trout Life Stages. (Adapted from Sitthichaikasem and Carlander, 87).

Life stage	Stock No.	Mean weight (gm)	2,4-D-DMA-4 LC_{50} (95% CI)[1] (mg/l) 24 hr	96 hr
Egg	1	0.03	6700(5431-8264)	1530(1069-2190)
	2	-	2350(1818-3037)	1450(1113-1808)
Sac fry	1	0.03	1330(1038-1704)	630(520-763)
Swim-up fry	1	0.03	590(495-703)	425(334-540)
Fingerling	2	0.20	425(358-505)	320(229-446)

[1] Confidence interval.

Indirect Impacts on Fish

Fish in the treatment areas may be adversely affected by a few indirect effects from herbicide treatment. Brook and brown trout in North Platte tributaries such as the South Fork of Minor Creek, Cottonwood Creek, French Creek and Big Creek, may be adversely affected by thermal pollution and increased sediment load caused by vegetation removal along the streambanks.

As shown on the weed survey maps in Appendix 2 a total of 5 miles of the North Platte River, 3.5 miles of the South Fork of Minor Creek, 0.2 miles of Cottonwood Creek, 0.5 miles of French Creek, and 1.5 miles of Big Creek are within the proposed program treatment areas. The total amount of streambank habitat to actually be treated, that is in the proposed treatment areas, is unknown. The total streambank lengths mentioned are not necessarily continuous miles of streambank falling within the proposed program area (See Appendix 2).

A beneficial effect may result from water contamination with 2,4-D (DMA). Mayer (88) noted that the incidence of <u>Saprolegnia</u> spp. found on fathead minnow eggs, was reduced when exposed to various concentrations of 2,4-D. <u>Saprolegnia</u> spp. is a fungus which attaches to fathead minnow eggs affecting its survival rate. In concentrations of 0.12 ppm of 2,4-D <u>Saprolegnia</u> spp. infestations were reduced approximately 20 percent.

Aquatic Invertebrates

Aquatic invertebrates will be exposed to herbicide residues in stream systems contaminated from spray drift, ground water leaching and surface water run-off. As previously stated, water contamination by the three herbicides is not expected to reach levels above 1 ppm.

Therefore, adverse impacts to aquatic invertebrates are not anticipated. The following discussion presents the findings of several researchers who have investigated the effects of Tordon, Banvel and 2,4-D on a variety of aquatic invertebrates.

Tordon

Generally, investigators have found that aquatic invertebrates are not affected by aqueous concentrations of Tordon below 1 ppm. Lynn (51) studied the effects of Tordon on Daphnia spp., aquatic snails, and oysters. He found that Daphnia spp. were not affected after 24 hours in 380 mg/l of Tordon, but 95% were killed by 24 hour exposure to 530 mg/l. (Refer to Appendix 14 for concentration conversion chart.) Snails could withstand 380 ppm at $70^{\circ}C$ for 72 hours but succumbed at 530 mg/l (51). Oyster shell growth was not affected by 96 hour exposure to 1 mg/l of Tordon (51). Sanders (61) and McCollister and Leng (62) determined the LC_{50} for the scud (Gammarus lacustris) to be 27-50 ppm depending upon the length of exposure to the herbicide. McCollister and Leng (62) also reported that a Tordon and 2,4-D mixture at concentrations below 100 ppm was not toxic to Ramshorn snails. Sanders and Cope (63) reported that 50% of the stonefly nymphs (Pteronarcys californica) exposed to picloram for 24 hours and 72 hours succumbed to an LC_{50} of 120 and 48 mg/l, respectively. Hardy (56) subjected Daphnia spp. to 1 mg/l of picloram for 10 weeks and found no discernible effects on growth and reproduction.

Available evidence indicates that Tordon does not accumulate in living systems. Lynn (51) reared algae, Daphnia spp. guppies and goldfish in a Tordon concentration of 1 ppm for ten weeks. The fish were maintained on a diet of Daphnia spp. raised in the 1 ppm Tordon solution.

No abnormalities in growth and reproduction were noted when compared to control animals reared in uncontaminated water.

Banvel

Aquatic invertebrates seem to be somewhat more sensitive to dicamba than to picloram. Oysters (Crossostrea virginica) showed a 50% reduction in shell growth after 96 hours in 5 ppm of dicamba (64). Sanders (61) and the U. S. Department of Interior FWPCA (24) reported dicamba LC_{50} values for the scud (Gammarus lacustris) to be 3.9 and 5.8 ppm, respectively. However, in a later study by Sanders (65) no adverse effects were observed when the scud (G. fasciatus), water flea (Daphnia magna), and several other aquatic invertebrates were subjected to 100 ppm dicamba for 48 hours. Mills and Lowe (64) reported that the Brown shrimp (Penaeus eztecus) is highly susceptible to dicamba and will succumb to 1 ppm after 48 hours.

Research publications concerning bioaccumulation of dicamba in aquatic invertebrates are unavailable; therefore, it is uncertain if dicamba will accumulate in these invertebrates.

2,4-D

Some research indicates that concentrations of 2,4-D below 1 ppm will have no effect on aquatic organisms. Other research reports, however, present conflicting evidence.

Pimentel (68) in his synopsis of ecological effects of pesticides on non-target species cited a report by M. Zischkale (126). Zischkale determined the minimum lethal concentrations of 2,4-D (calculated at 25% death rate) for Daphnia spp. to be 0.2 ppm; Eucypris spp. 0.6; Hyallella spp. 0.6; Paloenconetes spp. 0.8; Amphiogrion spp. 3.0; Culex spp., Aedes spp. Anopheles spp. 3.5; Chironomus spp. 1.0; Physa spp.

5.5; Heloisoma spp. 7.5 ppm. The temperature and length of exposure were not given by Pimentel (68). Crosby and Tucker (70) reported the LC_{50} for Daphnia spp. after a 48 hour exposure to be greater than 100 mg/l (100 ppm). Sanders (65) indicated the TL_{50} at 48 hours for Daphnia spp. to be 4 mg/l (4 ppm). He also determined the 48 hour TL_{50} for five additional aquatic invertebrate species. The Seed shrimp (Cypridopsis vidua) succumbed to 3 ppm, while the scud (Gammarus fasciatus), the sowbug (Asellus brevicaudus), the Glass shrimp (Palaemonetes kadiakensis), and the crayfish (Orconectes nails) were tolerant to levels above 100 ppm. In another study by Sanders (61) scuds (Gammarus fasciatus) subjected to 1000 ppm of 2,4-D amine did not show any apparent adverse effects. Butler (55) reported that oysters were not affected by 96 hour exposure to 2 ppm of 2,4-D, but 10% mortality or paralysis was exhibited by Brown shrimp exposed to 2 ppm for 48 hours.

Research publications have not been located that document bioaccumulation of 2,4-D amine formulations. However, Pimentel (68) discussed the results of several studies of bioaccumulation of ester formulations of 2,4-D. Eastern oysters exposed to 0.1 ppm of butoxy-ethanol ester of 2,4-D, accumulated 18 ppm in 17 days; however, when these oysters were placed in clean water for 7 days the 2,4-D disappeared completely. Other studies indicate that fish, mussels and clams in reservoir waters treated with 1 ppb of 2,4-D ester, accumulated amounts up to 150 ppb, 380 ppb, and 140 ppb, respectively (68). However, these researchers did not follow through with their experiments to determine residue levels after a flushing out period.

It must be recognized from the above discussion that definite conclusions are difficult to make regarding impacts of 2,4-D amine formulation on aquatic organisms. There is a good deal of interspecific variation regarding toxicity of 2,4-D to a variety of aquatic organisms. Accumulation of 2,4-D amine may or may not occur. Additional research must be implemented to determine if 2,4-D amine formulations will accumulate in aquatic organisms.

Terrestrial Mammals

Some terrestrial mammals (mule deer, elk, rabbits, hares and rodents) may be adversely affected by indirect effects of the proposed action, but direct exposure to Tordon, Banvel or 2,4-D will not have detrimental effects on either wild or domestic mammals. It is highly improbable that a wild or domestic mammal could be exposed to toxic levels of the herbicides by ingesting treated plants or by dermal and respiratory exposure to either spray or bead formulations. Ingestion of herbicide treated plants will be the most likely direct exposure route to mammals in the program areas. Exposure via the dermal and respiratory routes is a slight possibility and is not considered to be significant. In this regard, the research results presented herein are from acute and chronic oral toxicity studies.

Tordon

Research indicates that laboratory and domestic mammals are tolerant to fairly high concentrations of Tordon. Table 27 presents results of an acute oral toxicity study by Lynn (51) on rats, mice, guinea pigs, rabbits and chickens. He reports that the LD_{50} for a female rat to Tordon 22K was 10,330 mg/kg of body weight. In a similar acute oral toxicity study of the potassium salt of picloram (Tordon 22K), Olson (131, cited by National Research Council of Canada 73) reported an LD_{50} for male rats of 10,330 mg/kg of body weight.

Table 27. Acute Oral Toxicity of Tordon to Small Animals (51)

Species	LD_{50} in Milligrams of Formulations per Kilogram of Body Weight	
	4-amino-3,5,6-Trichloropicolinic Acid (Tordon)	Tordon 22K (25% potassium salt of Acid)
Rat (F)	8200	10,330
Mouse (F)	2,000 - 4,000	-
Guinea Pig (F)	Approx. 3,000	-
Rabbit	Approx. 2,000	-
Chicken (M)	Approx. 6,000	-

Beatty (93, cited by NRCC 73) studying long term (chronic) effects of exposure to herbicide, fed 20 rats (10 male, 10 female) various concentrations of picloram for 90 days. Toxicological effects at dietary picloram levels of 0, 0.01, 0.03, 0.1, 0.3, and 1.0% were noted (Equivalents = 0, 5.0, 15, 50, 150, and 500, mg/kg body weight, respectively). Adverse effects, as measured by mortality, body weight, food consumption, hematology, clinical chemistry, and terminal organ-to-body weight ratios, were not observed at the dietary levels below 0.3%. Some pathology was noted in the liver and kidney tissue from rats of both sexes fed with 0.3% and 1.0% picloram.

McCollister and Leng (62) investigated several aspects of picloram toxicity to laboratory rats and dogs. In a chronic feeding study rats were fed food treated with picloram for 90 days. No sign of adverse effects was produced in rats by dietary levels as high as 0.1% (1000 ppm). In another phase of the study albino rats and beagle dogs were fed daily doses of 15, 50, and 150 mg/kg for two years. Adverse effects as measured by body weight, food consumption, behavior, mortality, hematological and clinical blood chemistry, and urine analysis were not observed in either the rats or the dogs. No pathology was noted in microscopic examinations of various tissues. In another group of albino rats, fertility and reproduction was not affected in rats administered food containing up to 0.3% picloram. McCollister and Leng (62) noted no adverse effects as measured by indices of fertility, gestation, viability, lactation, body weight and teratological examination of fetuses.

Domestic livestock also appear to be tolerant to large doses of Tordon 22K. Jackson (94) administered single doses of 720 mg/kg and 540 mg/kg to sheep and calves, respectively, and noted no signs of toxicosis. Lynn (51) reported that no ill effect was elicited in cattle or sheep administered 3480 mg/kg and 4650 mg/kg of Tordon 22K, respectively.

Available evidence indicates that picloram ingested by or absorbed into mammals is readily passed intact in the urine and feces. Male and female dogs maintained on a diet containing 97 ppm of C^{14}-labeled picloram excreted approximately 90% of the picloram in its original form (62). In addition, some picloram was excreted in the feces and radioactivity in the urine was undetectable after 48 hours.

Kutschinski and Van Riley (95) reported that picloram did not accumulate in nine steers fed picloram, for at least two weeks, at rates of 200 to 1600 ppm in the total diet. In tissue from animals slaughtered without a withdrawal period, residues of picloram were proportional to the concentrations fed. Additionally, blood levels decreased to amounts of less than 0.05 ppm, three days after withdrawal from the 1600 ppm feeding level.

In studies of picloram residue accumulation in dairy cattle, Kutschinski (96) reported that average residues of 0.05 ppm and 0.2 ppm were found in milk from three cows fed 300 ppm and 1000 ppm, respectively, for two weeks. Within 58 hours after withdrawal from the treated diet, picloram residues were undetectable.

Research results pertaining to wild mammals, both terrestrial and aquatic, are unavailable; however, it is reasonable to assume that the effects of picloram on wild rodents and ungulates would be similar to the effects on the laboratory and domestic animals studied. The available evidence indicates that picloram does not accumulate in body tissues; therefore, wild carnivores, that prey upon rodents and ungulates, would be exposed to extremely minute amounts of picloram.

Banvel

Research of acute oral toxicity indicates that dicamba is toxic to mammals only in high concentrations. Investigations of acute and chronic toxicity with rats (97, 98, 99), guinea pigs, rabbits, mice, (97), beagle dogs (100), cattle and sheep (101, 102) indicate that these mammals are tolerant to high concentrations of dicamba. In rats fed dicamba, the LD_{50} was determined to be 2900 mg/kg USDI 1970b (141, cited by Pimentel 68). Table 28 presents the acute LD_{50} values determined by Edson and Sanderson (97) for four species of mammals.

No toxic effects were observed when cattle and sheep were drenched 10 times in, or fed a dicamba concentration of 250 mg/kg of body weight. Toxicosis was exhibited at dicamba concentrations from 500 to 1000 mg/kg of body weight (101, 102).

All available evidence indicates that dicamba will not accumulate in mamalian tissues. High doses of dicamba were administered to rats

Table 28. Acute LD_{50} Values for Dicamba in Various Species (97)

Species	Sex	Route	Test Material	LD_{50} (mg/kg) with 95% confidence limits dicamba
Rat	Male	Oral	Technical	757(449-1278)
			Formulated	1100(925-1308)
		Intraperitoneal	Technical	80(54-119)
		Subcutaneous	Technical	> 1000
		Dermal	Technical	>> 1000
Rat	Female	Oral	Pure	> 2560
			Technical	1414(1017-1065)
		Dermal	Pure	>> 1000
Mouse	Female	Oral	Technical	1189(8410-1681)
Guinea Pig	Male	Oral		566(348-923)
Rabbit	Male	Oral	Formulated	566(348-923)

(66) and cows (67, 97) and it was observed that nearly all of the compound was excreted in urine and feces within 72 hours. In general the dicamba was passed intact, but one group of researchers (97) detected the metabolite 3,6-dichlorosalicylic acid.

Again, information pertaining to the toxic effects of Banvel on wild mammals is unavailable; but, it is reasonable to assume that wild mammals would be as tolerant to dicamba as the domestic mammals studied. It is highly unlikely that wild animals or domestic livestock in the treatment areas will be exposed to high amounts of Banvel; therefore, detrimental impacts from direct exposure are not expected.

2,4-D

Acute and chronic toxicity studies have been conducted on mice (103), rats (103, 104, 105, 106), rabbits (103, 106), guinea pigs (103, 104, 106), dogs (104), cattle (105, 107, 108, 109, 110), sheep (110), and swine (105). These various researchers have determined that the mammals studies are tolerant to high concentrations of 2,4-D. Minimum lethal oral doses of 2,4-D for several of these mammals are: mice, 368 mg/kg; rats, 375 mg/kg; rabbits, 800 mg/kg; guinea pigs, 469 mg/kg and dogs, 100 mg/kg (103, 104). Table 29 presents data reported by Palmer (110) on multiple dosing of cattle, sheep and chickens with 2,4-D dimethylamine.

As with Tordon and Banvel, available research data indicates that 2,4-D is rapidly excreted from mammalian systems via the urine and feces. Clark (111) fed sheep C^{14}-labeled 2,4-D and reported that 96% of the 2,4-D was excreted in the urine within 72 hours. Similar research with rats, pigs, and cows revealed equivalent results. In addition, gross and histological examination of various tissues (i.e. liver, kidney, adipose) revealed no pathology (105, 107, 108, 109). Mitchel et al. (109) studied accumulation of 2,4-D in a lactating cow. He reported that 2,4-D was undetectable in the milk of a cow that had been on a daily diet containing 5.5 gm of 2,4-D for 106 days. No adverse effects were observed in a calf that fed on the cow's milk.

In light of the preceeding discussion, adverse impacts to mammals are not expected from direct exposure to the herbicide 2,4-D dimethylamine. Some indirect impacts, however, may occur from vegetation removal; this and other impacts will be presented in the ensuing discussion.

Table 29. Results of Multiple Oral Dosing of Cattle, Sheep and Chickens With (2,4 dichlorophenoxy) Acetic Acid (2,4-D), Dimethylamine Salt (110)

Animal and Dosage Received (mg/kg)	Doses	Means of Dosing	Results and Remarks[2]
Cattle:			
50	10	Capsule	NIE
50	10	"	"
100	10	"	"
100	10	"	7 percent weight loss
175	10	"	"
250	10	"	8 percent weight loss
Sheep:			
100	10	Capsule	NIE
100	10	"	"
175	4	"	Poisoned after 2 and died
250	7	"	Poisoned after 4 and died
250	7	"	Poisoned after 3 and died
Chickens[3]:			
25	10	Pipette	59 percent weight gain
50	10	"	"
100	10	"	38 percent weight gain
175	10	"	30 percent weight gain
250	10	"	"
375	10	"	"
500	10	"	3 died after 2 to 7 doses 26 percent weight gain in survivors
Control			57 percent weight gain

[1]DMA-4[R] 49.6 percent water soluble concentrate, Dow Chemical Co. Midland, Mich.

[2]NIE Indicates No Ill Effects Apparent.

[3]Average results of 5 treated chickens.

Indirect Impacts on Terrestrial Mammals

Loss of target and some non-target vegetation with consequent loss of forage, cover, and nesting sites may have an adverse effect on some mammalian species within the proposed weed control program area. The presence of personnel during herbicide application procedures may present a temporary disturbance to some mammalian wildlife.

Removal of target weeds and some non-target plants such as willows, bitterbrush, Mountain mahogany and sagebrush may reduce the availability of cover and nesting sites for small mammals such as deer mice (*Peromyscus maniculatus*), jumping mice (*Zapus* spp.), voles (*Microtus* spp.) and other small rodents. In a few areas where the size of the weed infestation requires that herbicide be applied to an area larger than one-quarter of an acre in size, permanent adverse impacts to some small mammals would occur. The scattered nature and small size of most of the weed infestation sites in the program area precludes the possibility of any significant adverse impacts to most small mammals.

One of the largest proposed weed control areas is along the North Platte River in the Bennett Peak Campground and surrounding area. This area is deer, elk and bighorn sheep winter range, some of which is critical winter range for deer.

Non-target browse plants such as Big Sage (*Artemisia tridentata*), Antelope Bitterbrush (*Purshia tridentata*), Mountain Mahogany (*Cercocarpus montanus*), and Oregon grape (*Mahonia* spp.) are critical components of the mule deer's winter diet. Removal of significant numbers of these important browse species would have an adverse impact on wintering mule deer populations in the Bennett Peak treatment area. The degree of this potential impact on wintering mule deer depends on the precise location of the actual critical habitat, the severity of the weed infestation in the critical habitat and the potential of removal of important browse in the critical winter range. Sufficient information is unavailable at the present time to allow for a reasonable quantitative assessment of this potential impact.

A beneficial effect of the proposed weed control program will be improved habitat for some small and large mammals in the proposed treatment areas. Grass species would increase in coverage and frequency, providing increased forage and habitat for domestic livestock and some wild mammals. Over a longer period of time broad-leafed shrubs and forbs may increase in cover and frequency in response to reduced weed competition; thereby, providing additional or improved habitat for some mammalian wildlife.

Endangered Species

According to the BLM, three endangered species exist in the proposed weed treatment area. These are: the black-footed ferret (*Mustela nigripes*), the peregrine falcon (*Falco peregrinus*), and the bald eagle (*Haliaeetus leucocephalus*). As discussed in previous sections, Tordon, Banvel and 2,4-D are of low toxicity to birds and mammals; and neither do the herbicides accumulate in living systems. In view of these facts, it is unlikely that the endangered species present in the treatment area will be adversely affected by direct exposure to the herbicides.

The black-footed ferret depends on prairie dogs for food and has reportedly been seen in white-tailed prairie dog colonies in the Encampment area. Numerous people have expressed concern regarding the potential effects of the herbicides on these prairie dog populations. Fagerstone et al. (112) treated a rangeland prairie dog colony with

2,4-D dimethylamine for 2 years. They reported a significant reduction in cover by shrubs and forbs which significantly changed the prairie dog's diet. Their diet consisted of 73% forbs and 5% grass before treatment and 9% forbs, 82% grass post treatment. Fagerstone et al. (112) concluded, "dispite the change in diet, the 2,4-D treatment appeared to have little detrimental effect on prairie dogs. They remained in good condition after treatment, as indicated by body weight, and there was no significant difference in prairie dog activity between the treated and untreated colonies." Therefore, prairie dog populations, and consequently, black-footed ferrets in the proposed treatment areas would not be affected by the weed treatment program.

The U. S. Fish and Wildlife Service was consulted regarding the effects of the proposed program on endangered species. Their response, included in the Persons, Groups, and Agencies Consulted section of this assessment record, indicates that adverse impacts on endangered species are not expected from the use of Tordon, Banvel and 2,4-D in this program.

Terrestrial Birds

Available evidence, gathered from acute and chronic oral toxicity studies, indicated that Tordon, Banvel and 2,4-D amine are of low toxicity to birds. Thus, adverse impacts to birds directly exposed to the herbicides are not anticipated.

Minimal indirect impacts to birds are anticipated from loss of target and non-target vegetation. Availability of some food, cover and nest sites may be reduced by the proposed program.

In the following discussion information pertaining to the toxic effects of Tordon, Banvel and 2,4-D is presented separately. Anticipated indirect impacts to birds are also discussed.

Tordon

Research results indicate that terrestrial avifauna are tolerant to high concentrations of Tordon. Tucker and Crabtree (92) reported the LC_{50} for pheasants fed technical picloram (90.5% pure), to be above 2000 mg/kg of body weight. Hill et al. (91) also studied the susceptibility of pheasants, and Bobwhite and Japanese quail to picloram. They reported an LC_{50} greater than 5000 ppm for the young birds that were fed picloram for five days.

Palmer and Radeleff (102) reported a 2% to 3% reduction in weight gain in chickens given daily doses of 100 mg/kg to 250 mg/kg of picloram for 10 days.

Kenaga (90) reviewed several Dow Chemical Company in-house reports on Tordon toxicity to Japanese quail, Bobwhite quail and chickens. Japanese quail that were fed Tordon at concentrations of 100 ppm to 10,000 ppm were not adversely affected at the highest levels. The LC_{50} for mature Bobwhite quail was reported to be 23,366 ppm. For five-to seven-day-old chicks the LC_{50} was determined to be 10,000 ppm.

Banvel

Oral toxicity studies on chickens (97, 102), pheasants (97), and Bobwhite quail (100) indicate that dicamba is of low toxicity to birds. The LD_{50}'s ranged from 500 mg/kg to 673 mg/kg body weight for chickens (97, 102) and 800 mg/kg for pheasants (97). The U. S. Environmental Protection Agency reported that the LC_{50} for Bobwhite quail fed dicamba for five days was above 4640 ppm (100).

2,4-D

As with Tordon and Banvel, available evidence indicates that terrestrial birds are tolerant to high concentrations of 2,4-D. Young pheasants, Japanese quail (Coturnix spp.) and pigeons exposed to an acid formulation of 2,4-D, exhibited LD_{50} values of 472 mg/kg, 668 mg/kg, and 668 mg/kg, respectively (92). Hill et al. (91) studying pheasants, Bobwhite quail and Coturnix spp., determined the LD_{50} values to be higher than 5000 ppm when the birds were fed 2,4-D for 5 days. Table 29 presents the results obtained by Palmer (110) who fed chickens 10 daily doses of 2,4-D amine in various concentrations. Weight gain in chickens fed 50 mg/kg was not affected (compared to controls) after 10 days. Chickens fed 100 mg/kg for 10 days showed a statistically significant reduction in weight gain when compared to control animals.

Terrestrial birds in the program area would be exposed to residues of 2,4-D, but in view of their high levels of tolerance it is unlikely that any would be exposed to toxic levels.

Indirect Impacts on Terrestrial Birds

The indirect effects, discussed in this section, may have greater impact on birds than direct exposure.

Removal of target and some non-target vegetation may result in reduced food supplies (plant fruits or invertebrates dependent on plants), cover and nesting sites for some passerine and gallinaceous birds. The larger the treatment site the greater this impact would be on a site specific basis.

From a beneficial standpoint, habitat for terrestrial birds may be improved over a longer period of time, perhaps 8 to 10 years, by removing the introduced weed species and allowing native vegetation (mostly grasses) to become re-established on sites presently infested by weeds.

Terrestrial Invertebrates

Impacts on terrestrial invertebrates will vary depending on the type of herbicide formulation used and the particular invertebrate species in question. Some evidence indicates that one species may be more susceptible to a herbicide than another.

Much of the research on the toxic effects of Tordon, Banvel and 2,4-D on terrestrial invertebrates, has been conducted with honey bees, and very little research has been performed with other terrestrial invertebrates. The information reported in the following discussion mostly presents evidence on the effects of Tordon, Banvel and 2,4-D herbicides on honey bees. The narrow scope of research with Tordon and Banvel and the contrary results of other investigations made with 2,4-D makes a reasonable assessment of the impacts of Tordon, Banvel and 2,4-D on terrestrial invertebrates difficult.

Tordon

Research pertaining to the effects of Tordon on terrestrial invertebrates has been performed exclusively on honey bees. Brood development and half-life were not affected in honey bees (Apis mellifera) exposed to picloram concentrations ranging from 10 to 1000 ppmw (113, 114, 115, 116). Morton et al. (113) stated, "In fact there was a significant (statistical) increase in half-life of bees fed the 100 and 1000 ppmw concentrations when compared with the check bees." In another study, Morton further states, "there was a non-significant (statistical) increase (20%) in the amount of brood produced in colonies receiving picloram when compared with the check colonies" (114).

Morton's investigations with bees (113, 114, 115, 116) indicate that Tordon, applied at recommended rates is not toxic to bees and may not be toxic to other terrestrial invertebrates. However, lack of additional evidence precludes more specific conclusions.

Banvel

The effects of Banvel on honey bees is well documented and indicates that bees are tolerant to fairly high levels of Banvel. Research results describing the toxic effects of Banvel on other terrestrial invertebrates is lacking.

Morton et al. (113, 114, 115, 116), in addition to studying the effects of picloram, investigated the effects of dicamba on honey bees. They reported that dicamba concentrations as high as 1000 ppmw fed to honey bees did not cause significant mortality. The half-life and brood development of bees were not significantly different from the control bees at any of the concentrations tested. Morton and his colleagues (113, 114, 115, 116) concluded that dicamba was relatively non-toxic to bees when compared to the toxicity of 17 other herbicides. McBride (117) also reported that Banvel was relatively non-toxic to honey bees. The lowest toxic level of dicamba to bees was reported by Edson and Sanderson (97). They reported, "the toxicity of dicamba to insects, including bees, has been shown to be very low when sprayed or applied topically, but dicamba did show some toxicity when administered orally in 20% sucrose to bees, the LD_{50} being about 3.6 ug/bee (Needham, personal communication)." A mature bee weighs about 113 mg; thus 3.6 ug/bee is equivalent to approximately 32 ppm.

The evidence indicates that honey bees are tolerant to fairly high concentrations of dicamba; thus, bees should not be affected by exposure to dicamba present in the treatment sites. The potential impacts on other terrestrial invertebrates cannot be assessed as no empirical evidence pertaining to toxicity has been located.

2,4-D

Much of the research on the toxic effects of 2,4-D on terrestrial invertebrates has been conducted with honey bees. Most researchers report that honey bees are tolerant to high concentrations of 2,4-D, while others indicate that the bees are somewhat sensitive to 2,4-D. Jones and Connell (118) and Beran and Neururer (132) reported variable LD_{50} values; 104.5 ug/bee (approx. 920 ppmw) and 11.53 ug/bee (approx. 101 ppmw) respectively. Palmer-Jones (119), investigated honey bees in New Zealand and reported 22% bee mortality from a field treated with 2,4-D dust at a rate of 3 lbs/A. In laboratory studies Palmer-Jones (119) dusted bees with 2,4-D and noted no mortality. They stated,

> Bees were not harmed by direct dusting with 2,4-D. Hence poisoning may have occurred via the nectar. It was not determined whether poisoning was due to unchanged hormone dissolved in the nectar, a toxic metabolite of 2,4-D secreted into the nectar, or a toxin arising from abnormal plant metabolism.

Other researchers (113, 114, 115, 116, 117) have reported that 2,4-D was non-toxic to adult bees, but inhibited certain development stages. Concentrations of 100 ppmw reduced brood rearing; 500 ppmw, completely stopped brood rearing and egg hatching; 1000 ppmw, completely eliminated egg laying. Brood development returned to normal when the bees were taken off the phenoxy herbicide diet.

Research with other terrestrial arthropods indicates that 2,4-D toxicity depends on the particular invertebrate species involved. In water treated with 100 ppm of 2,4-D, 3/5 fewer mosquito larvae reached the pupal stage (120, cited by Pimentel 68). The number of grasshoppers per square yard doubled in a field treated with 2,4-D at a rate of 1 lb/A (121, cited by Pimentel 68). Investigations revealed that the 2,4-D hastened the development and increased the survival of the grasshoppers. Adams (122) sprayed 2,4-D at a rate of 0.5 lb/A on coccinellid beetle larvae and reported that 70% to 75% of the larvae were killed. In a later study, Adams and Drew (123) suggested that aphid outbreaks in oat fields treated with 2,4-D (0.5 lb/A) were caused by reduced predation from coccinellid beetles. The total density of soil microarthropods such as wireworms, springtails and mites were not affected by 2,4-D applied at normal rates (124).

The only non-arthropod studies located, reported experiments on the earthworm and nematode. Martin and Wiggins (125, cited by Pimentel 68) immersed earthworms in 0.1, 1, 10, 100, and 1000 ppm 2,4-D concentrations for 2 hours. No mortality was observed at the levels below 1000 ppm; 100% mortality occurred at the 1000 ppm level. Webster and Lowe (127) soaked nematodes (Aphelencoides ritzembosi) in various concentrations of 2,4-D. Concentrations up to 5 ppm did not harm the nematodes but 50 ppm suppressed their reproduction.

It appears from the various research results that some terrestrial invertebrates, such as honey bees, are tolerant to fairly high concentrations of 2,4-D, while other species, such as coccinellid beetles, are somewhat intolerant to 2,4-D. To adequately assess the adverse effects of 2,4-D exposure to the terrestrial invertebrates in the treatment area, additional, more specific information is required.

Indirect Impacts to Terrestrial Invertebrates

Loss of target and non-target vegetation would reduce food supplies, such as; nectar, pollen, leaves and root tissue. Cover and resting sites for many terrestrial invertebrates would also be reduced.

Ecological Interrelationships

The ecosystem in the proposed weed treatment area is composed of four community types. These communities, described by the dominant vegetation present, are; sagebrush-grass, sagebrush-mountain mahogany, juniper sagebrush-juniper and riparian-deciduous woodland. In general, these are transition zone communities that comprise a region of intergradation between the major grassland and forest ecosystems. This zone of intergradation is an extremely diverse region of change, and supports numerous different species of plants and animals (See Chapter II).

As described in Chapter II, the living and non-living components of the ecosystem interact in a variety of different ways. Plants grow upon and derive nutrients and moisture from the soil and convert radiant energy to a form that animals can utilize. Herbivorous animals feed on and utilize the energy stored in plants, and carnivorous animals feed on and utilize the energy stored in herbivores. Microorganisms decompose dead plants and animals and return the stored nutrients to the soil, to begin the cycle again. These food relationships are the basis of a plethora of inter-and intraspecific interations that occur between plants and animals in the ecosystem.

It is impossible to predict precisely which or how many of these interactions will be affected by the proposed weed treatment program.

It is anticipated that the greatest affects would result from the changes in the vegetative communities that would occur from herbicide treatment. Removing the weeds and some non-target broad-leafed plants, while leaving the native grasses intact, would alter the successional stage of the vegetation on the treatment site.

It is difficult, if not impossible to state whether changing the seral stage of succession on a treatment site is an adverse or beneficial impact. Succession is a complex, natural ecological process. It is a process brought about by physical changes in the environment but the process is controlled by the biota in the community. Changes in successional stages affect all facets, both living and physical, that function in a community. What may be an adverse change for one kind of organism may be a beneficial change for another. A study by Franzres (135), of changes in bird populations after timber harvesting in Arizona, illustrates this concept. Timber harvesting significantly affected bird species density and composition. Twenty-three bird species were affected by the radical change in the vegetative community; ten were beneficially affected; thirteen were adversely affected. There are many such examples in the literature but in general it can be stated that as successional seres change so does the composition (density and diversity) of the kinds of living organisms that inhabit the community as well as the structure of the physical environment (Odum 142; 251-275).

Some specific points that may be considered regarding impacts on ecological interrelationships involve the presence of the designated weed species. Leafy spurge, Canada thistle, Musk thistle and Yellow toadflax, the weeds designed for control in this program, are foreign species, introduced from Europe and Asia. These weeds are not natural components of the ecosystem in the proposed program area, thus it is unlikely that most of the native animals utilize them for much more than protective cover. Because the native animals have not evolved through time with the introduced weed species, they may not be physiologically or behaviorally capable of utilizing the weeds for food and shelter. It stands to reason that the native animals will benefit from a reduced weed population that will allow the quality of the animal's native habitat to increase. Inter- and intraspecific competition for food, cover and nesting sites may be reduced if the quality and quantity of the animal's native habitat increases. In some areas if significant numbers of non-target plants are removed by exposure to the herbicides; food, cover and nesting site availability will be reduced for some terrestrial life forms. As a result, inter- and intraspecific competition for these habitat requirements may increase between some species.

Another point to be considered regarding ecological interrelationships, is the weed-species capacity for increase. Leafy spurge, as an example, in 1955 was estimated to infest approximately 1000 acres in six Wyoming counties. Twenty years later in 1975, the weed was growing and reproducing on 26,000 acres in 21 of 23 Wyoming counties (71). Leafy spurge, as well as the other three weed species, competes with and may eventually exclude native vegetation in some areas. In future years continued weed encroachment may constitute a significant environmental hazard to those wild animal species that are unable to efficiently utilize the weeds for food and shelter. On the other hand, removal of the weeds may impinge hardships on animal species that have adapted to the presence of the weeds and utilize them for food, cover, or nesting.

Man

Herbicide applicators and people using public lands, such as the Bennett Peak recreation area, would be exposed to the herbicides. Acute and chronic oral toxicity research has not been performed on man; however as discussed in previous sections, other mammalian forms are tolerant to high concentrations of each of the proposed herbicides and bioaccumulation does not occur.

The applicators face the greatest potential of direct exposure to the herbicides. These applicators will be supervised by licensed weed and pest control supervisors who are aware of label recommendations and proper handling procedures. Therefore, direct exposure of these personnel is not expected to cause adverse impacts to them. Public exposure to the herbicides in the treatment areas will not be significant; thus, adverse impacts are not anticipated.

Human Values

The proposed weed control program in Carbon County may have an impact on some of those human values described in Chapter II. The aesthetic values of form, line and color, of some vegetation in the treatment areas may be adversely affected by the proposed program.

The most significant impact of the proposed action on human values would be economic. As an example, in Carbon County between the years 1973-1978 the Carbon County Weed and Pest District spent $21,324.75 on weed control on one rancher's land. During the first five years the cost was shared 50% by the rancher; the final year the entire cost was remunerated by the Weed and Pest District. Thus, the cost of weed control presents a significant economic impact to the private landowner and the taxpayer.

The intent of the proposed weed treatment program is to reduce the size and number of the present weed infestations in an effort to reduce weed spread. Thus, increasing economic impacts may be reduced and over a longer period of time expenditures for weed control may be reduced to a minimum maintenance level.

Unemployment

The Carbon County Weed and Pest District has been conducting weed treatment operations on private and state lands for several years. It is not anticipated that additional Weed and Pest District crew members would be required to carry out treatment operations on federal lands.

ANTICIPATED IMPACTS OF THE ALTERNATIVES

No Action Alternative

The no action alternative will result in the continued and prolific spread of designated noxious weeds in Wyoming. Productive rangeland and wildlife habitat will be lost, due to increasing weed cover, causing economic and environmental losses. Existing weed infestations will be a continual source of reinfestation on private lands where weed control operations have been in effect for several years. Economic burdens will be placed on private individuals, and state and local agencies that must control these increasing weed problems in irrigated croplands, rangeland and other problem areas. Competing weeds will exclude native vegetation, which will reduce habitat diversity and the total productivity of the ecosystem. Increasing weed infestations will reduce the availability of wildlife forage, cover and nesting sites.

Preventive Measures Alternative

Using measures to prevent the spread of weeds will place economic burdens on the farmers and ranchers who must implement crop seed cleaning, crop rotation, livestock cleaning, and cleaning of planting and harvesting equipment as preventive weed control measures. Conversely, preventative measures should serve to reduce the spread of weeds through contaminated seed sources and unclean equipment.

Preventive weed control measures will not eliminate or reduce the existing noxious weed problem. Therefore, some adverse impacts on the terrestrial ecosystem will continue due to the spread of the present weed infestations.

Physical Control Alternative

Hand grubbing weeds, using fire, and machine tillage have been offered as possible physical weed control methods. Machine tillage is an economically unfeasible alternative due to the rough topography and limited accessibility of much of the proposed weed control area; therefore environmental impacts of this alternative will not be considered.

When it is feasible, hand grubbing weeds will have only minimal and temporary impacts on the environment. Removing weeds will loosen and bare the soil, and in certain situations cause or increase soil erosion. The presence of weed removal personnel will present a temporary disturbance to wildlife. Economic impacts from hand grubbing will be greater than other weed control methods due to the necessity of numerous hand grubbing efforts needed per season. Leafy spurge and Canada thistle are perennial weeds that reproduce by seed and vegetatively from deep, horizontal root systems. These root systems are difficult, if not impossible, to remove in one "hand grubbing" operation, therefore repeated seasonal and annual operations may be necessary to effectively control the weeds. This "high frequency" of control efforts will increase the economic impact.

Fire will destroy target and non-target vegetation, which may result in an increased soil erosion potential in some areas. In addition, Leafy spurge and Canada thistle root systems would not be affected by fire. The top growth of the weeds would be killed and seed production may be reduced but the existing infestation would not be affected without repeated treatment with fire. An "escaped" fire could burn extensive tracts of land causing significant environmental and economic losses. Smoke from the fires would reduce the air quality. Additionally, the aesthetic appearance of an area will be reduced in value by using fire as a weed control method.

Biological Control Alternative

The use of Painted Lady butterfly larvae and the thistle fungus (*Fusarium roseium*) to control Canada thistle are not feasible alternatives and impacts will not be considered. The Painted Lady butterfly reaches population peaks every 15 to 20 years, an interval that does not allow effective control of Canada thistle. The thistle fungus (*Fusarium roseium*) is not adaptable to the rigors of the Wyoming climate.

The thistle weevil (*Rhinocyllus conicus*), an introduced insect species, may prove effective in controlling Musk thistle. As demonstrated in the past, any living organism that is introduced by man into one geographic area from another, presents a significant potential environmental hazard. The Starling, the House Sparrow, and the Norway rat are prime examples of the consequences of introductions in this country. Precise ecological consequences of introducing an alien species cannot be determined until after the fact; therefore, biological control by this method must be approached with caution. Beneficial environmental effects may result from biological control of Musk thistle populations. The weed populations may be kept in check with a minimum economic output.

Management Alternative

The management alternative involves a combination of weed control methods. Chemical, biological, and mechanical weed control methods, integrated with reclamation of disturbed areas and a comprehensive livestock and wildlife grazing management plan, form an intelligent comprehensive weed management alternative. Each of the control methods available in a management plan could be implemented separately or in concert to meet the environmental and economic requirements of a particular weed control problem. This approach to integrated weed-pest management would be the most effective means of minimizing adverse environmental and economic impacts.

Assessing the possible adverse or beneficial environmental impacts of an integrated pest management program is difficult. Reference to the anticipated impacts of the proposed action and the alternatives may provide a relative estimate of the potential effects of such a program.

POSSIBLE MITIGATING AND ENHANCING MEASURES

In the following discussion of mitigative and enhancing measures, some of the measures are duplicated under several headings. These possible mitigative measures are stated in detail only once, and are referred to in following sections by the specific number in the section where originally stated.

Air Quality

Certain measures can be identified which would minimize the amount of atmospheric contamination by herbicides. These include the following:

1. Using granular formulations, where applicable, will minimize air contamination due to wind drift.

2. Use of low pressure spray equipment for applications of the herbicides will minimize wind drift.

3. The use of large droplet size in herbicide sprays will minimize wind drift. The use of spray equipment that can be calibrated to deliver droplet size with mass median diameters of 175 microns (with a small range of droplet sizes) would reduce wind drift. It also would provide adequate foliage coverage for controlling the designated weeds. (Refer to Appendix 11).

4. Restricting herbicide spray applications to cooler periods of the day would reduce thermal influences on herbicide drift and would minimize atmospheric contamination.

Soil

The following measures are means of minimizing the possibilities of soil erosion and soil sterility:

1. Reseeding by BLM with desirable grasses would reduce soil erosion where dense stands of designated weeds are removed and soil conditions are unstable.

2. Using only a single type of herbicide for the initial treatment of an area would reduce the possibility of soil sterilization.

3. Appropriate supervision and safety precautions will be implemented to reduce risks of accidental spills of concentrate that may cause soil sterility.

4. Do not apply Tordon to the same treated area more often than once a year.

5. On steep (60°), eroded stream banks, herbicides should not be applied to noxious weed infestations that are within 10' of stream bank interface vegetation. Removal of this non-target vegetation would contribute

to severe erosion. In such areas physical control methods should be implemented. (See photograph below).

6. Do not move treated soils by any means.

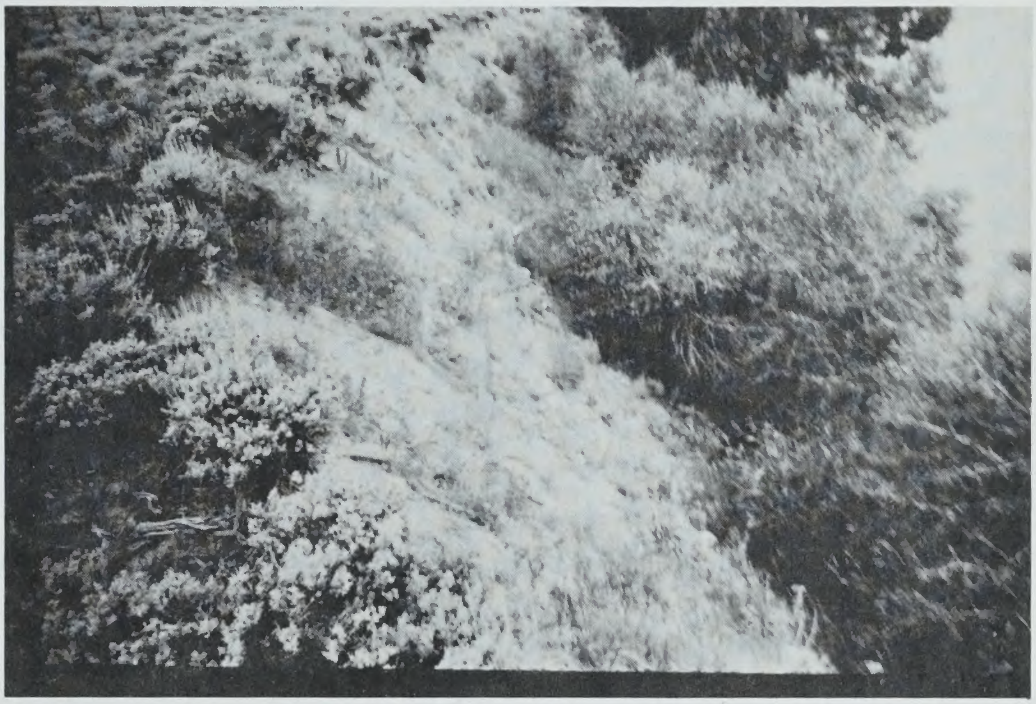


Figure 13. A weed control site along the North Platte River where soil conditions are unstable. Removal of non-target vegetation along such a stream-bank interface would contribute to severe erosion.

<u>Water</u>

Several types of measures are available for reducing potentially adverse effects of the program on water in the treatment areas. These will reduce the possibilities of herbicides entering streams and other water bodies through direct contamination:

1. Treatments in the riparian zones will be made only in areas above the year's high-water line, and will be made so as to avoid contaminating water (See Figures 14 and 15.)

2. Do not treat any weeds which overhang any water zone; These can be controlled by mechanical means.

3. Do not apply herbicide to irrigation and drainage ditches or allow spray to drift to inner stream banks.

4. Apply herbicides in all riparian zones only by hand or hand-held sprayers.

5. Monitor streams for herbicides by monthly sampling and sampling 12 to 24 hours after each moderate rainfall.

6. Analyze water within the treatment sites which collects in ponds that are to be used for irrigation of crops, gardens or stock watering.

7. The air quality mitigative measures, numbers 2 and 3 and the soil mitigative measures, numbers 3 and 5 will further reduce the possibility of water contamination.

<u>Plants</u>

The mitigative measures listed below would minimize the effects of the herbicides on non-target vegetation:

Aquatic and Terrestrial Plants

1. Bead rather than spray formulations should be used in riparian zones particularly where dense cover of willows, cottonwoods, and other riparian plant species exist.

2. Equipment and containers used for applying Tordon, liquid or beads, should not be reused for other materials. Equipment and containers used for applying Banvel and 2,4-D will be thoroughly rinsed and cleaned according to label directions before being used to apply a different herbicide or other chemicals.

3. The air quality mitigative measures, numbers 2 and 3; the soil mitigative measure, number 5; and the water mitigative measure, number 3 will further minimize impacts upon aquatic and terrestrial plants.

Figure 14. Herbicide ground application aquatic restriction chart.

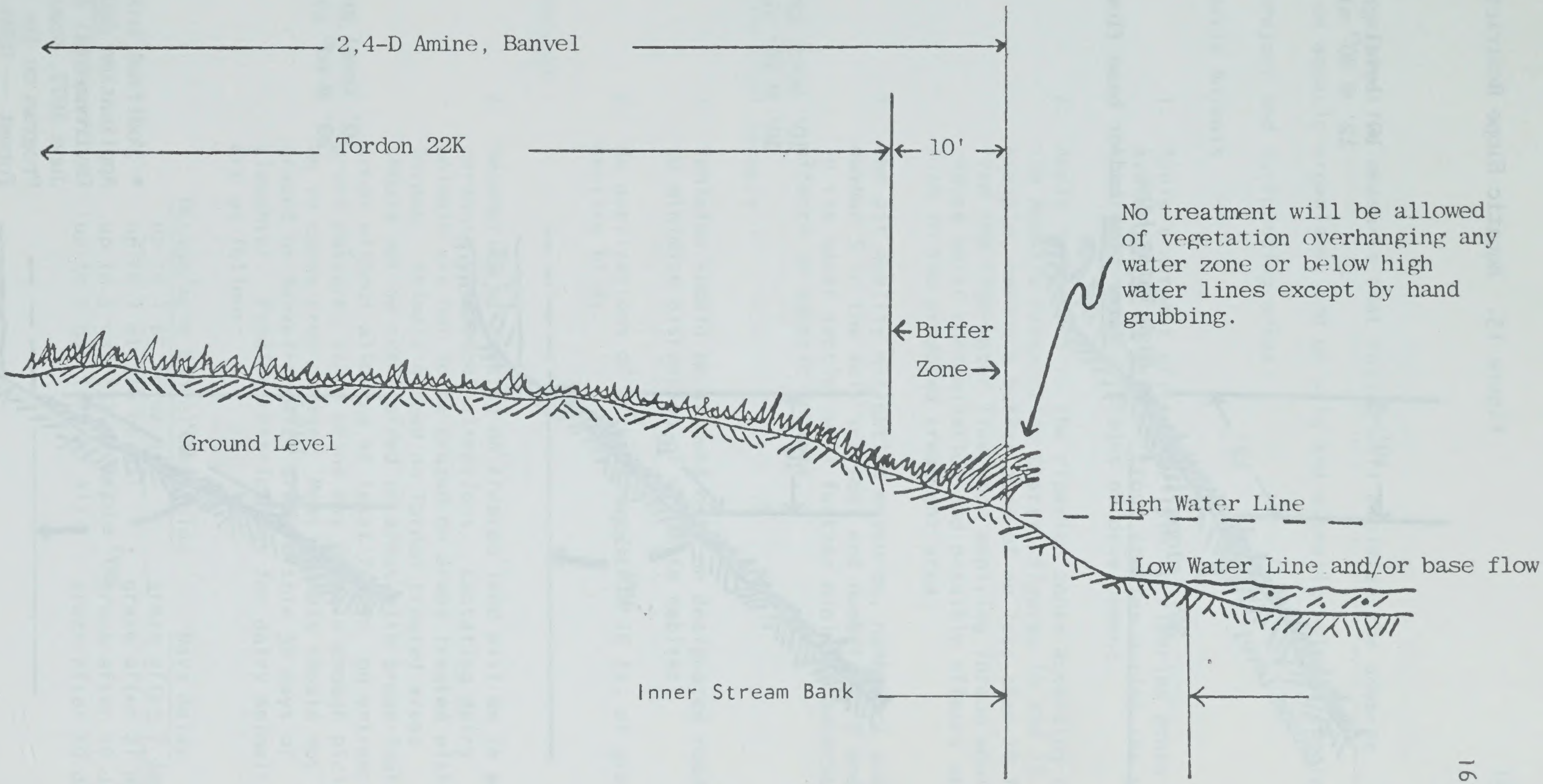
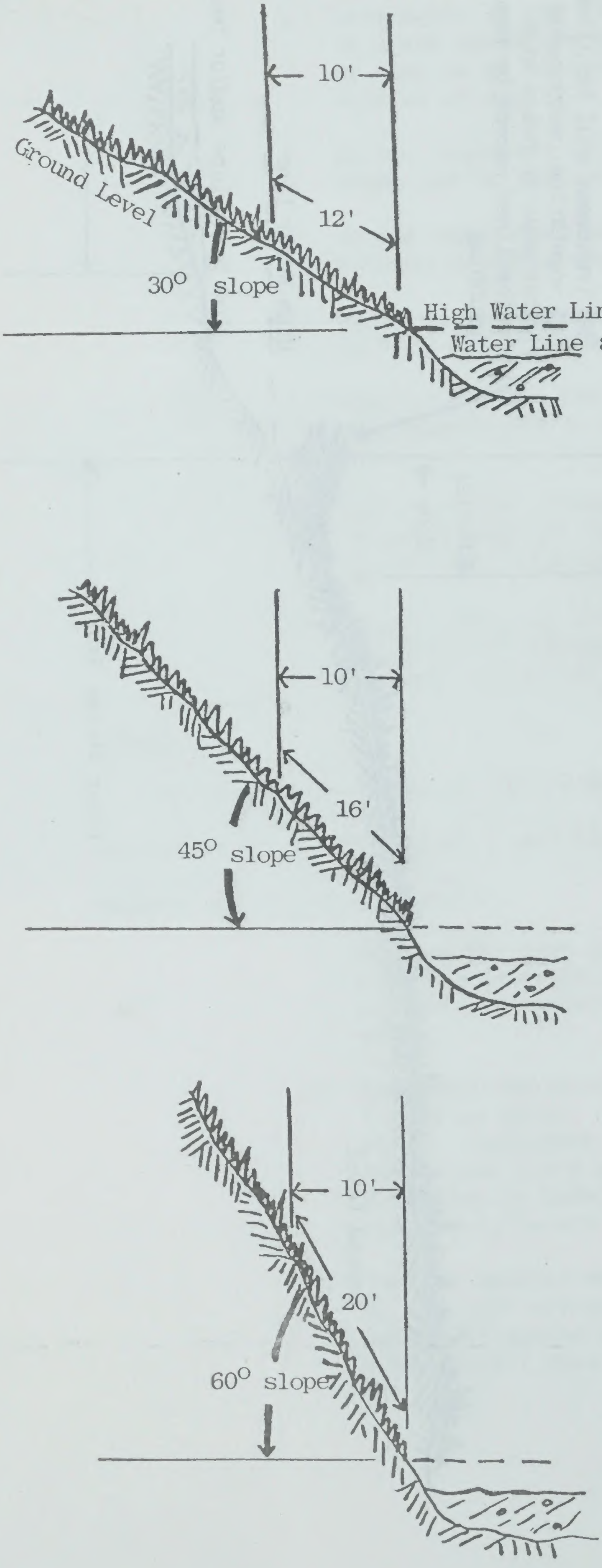


Figure 15. Aquatic Slope Restrictions *



* Modified from "Herbicide Ground Application Aquatic Restriction Chart" Environmental Analysis Report, June 1977, Noxious Weed Control Program on the Bridger-Teton National Forest -- USDA-Forest Service, Region 4.

Animals

The mitigative measures that follow will minimize the adverse effects on aquatic organisms, and on wild and domestic animals species in the project and surrounding areas:

Aquatic Animals

1. Apply treatment after July 15th in riparian zones to avoid potential kill of trout species during the yolk-absorbtion and fry stages of development.

2. Apply herbicides in the riparian zones according to the Aquatic Restriction Charts, figures 14 and 15. For example, having a buffer zone of no less than 10 ft. from the high-water line when applying Tordon would reduce water contamination and possible effects upon fish in the proposed treatment area.

3. The air quality mitigative measures, numbers 2 and 3; number 5 in the soil section; and numbers 1, 2 and 5 in the water section will further minimize adverse effects on aquatic animals.

Terrestrial Animals

1. Vehicles should be allowed only on designated roads to minimize disruption of wildlife habitat.

2. No applications of herbicides within 10 ft. of ground-nesting birds.

Livestock

1. Resumption of grazing on treated land will be in accordance with label directions. Lactating dairy animals are not to be grazed on areas treated with Tordon. Animals grazed on Tordon treated areas should not be transferred to areas with broad-leafed crops without allowing at least 7 days on untreated grass pasture, since urine may contain enough picloram to cause crop damage. Meat animals should not be grazed on Banvel-treated areas within 30 days of slaughter. Feeding restrictions for dairy animals are as follows:

Dosage/acre Banvel herbicide	Days delay
up to 1 pt (8 oz ai)	graze after 7 days
up to 1 qt (16 oz ai)	graze after 21 days
up to ½ gal (32 oz ai)	graze after 40 days
up to 2 gal (128 oz ai)	graze after 60 days

Grazing of dairy animals on areas treated with 2,4-D should not be allowed within 7 days of herbicide application. Grazing or foraging on grain fields should not be allowed within 2 weeks after treatment.

Man

The following measures could be taken for the safety of the applicator and the public:

1. Where there is possible contact with the public in campgrounds (particularly Bennett Peak Campground) the public should be prohibited from the proposed treatment site on the day(s) of herbicide application. In addition, it should be posted at each campground that herbicides have been applied in the area.

2. All safety equipment which is recommended by the manufacturer's label; such as gloves, boots and goggles should be worn by the applicator during the handling and application of all herbicides.

3. Final mix and applications of herbicides should be by a certified applicator or under direction of a certified applicator.

4. Private landowners growing sensitive crops, having land contiguous to the proposed treatment sites, should be notified prior to the application of the herbicides.

5. Irrigation farmers along the North Platte River in Carbon County should be informed of the herbicide, weed control program, by the Weed and Pest Supervisor.

Operational Procedures

Certain methods of operation can be identified that, if followed, would minimize environmental contamination. They include the following:

1. The use precautions on the labels of all three herbicides should be closely adhered to.

2. Copies or specimens of the labels of the herbicides to be used in the program should be carried by the herbicide applicators for reference. (Refer to Appendix 8).

3. The herbicide label recommendations should be followed explicitly for the cleaning and disposal of containers

and equipment. In addition, cleaning application equipment near streams or surface waters should not be allowed.

4. Care should be taken by the applicators, when off of access roads, to minimize the disturbance to non-target vegetation and animal species.

5. Mixing of herbicide formulations should be made in areas where spills will not contaminate streams, ponds, or lakes.

6. If stream waters are used for mixing the herbicide formulations care should be taken not to cause any stream contamination.

RECOMMENDATIONS FOR MITIGATION OR ENHANCEMENT

Air Quality

The mitigative measures list on page 164 should be adopted and implemented to minimize the environmental impacts of the proposed weed control program. Because of the diversity of the various treatment sites and the variety of treatment methods all of the mitigative measures cannot be followed for each application. At each treatment site discretion will have to be used in implementing the different mitigative measures.

The measures stated in this section are not only important for maintaining a high standard of air quality but also will directly minimize the impacts on water quality and on aquatic and terrestrial non-target vegetation.

Soil

All of the mitigative measure described on pages 164-165 should be implemented to lessen the impacts upon the soil and its components. The three most important measures are: 1) avoiding the use of Tordon on any given treatment site more than once every year; 2) on slopes greater than 60^{o} prohibit applying herbicide to vegetation at the stream bank interface; 3) reseeding native grass species on erosion prone sites where noxious weeds and non-target plants have been removed.

Water

The following measures are recommended for mitigation of the environmental impacts upon waters in the proposed treatment areas.

All of the measures that were listed on page 166 concerned with herbicide application in riparian zones should be closely adhered to. When applying herbicides just above the high-water line of rivers and streams extreme care must be taken. Where weeds infest steep, alluvial stream banks or grow within the high-water line, no herbicide treatment should be done. In such places, mechanical methods of weed control should be employed. Where applicable, the use of beads rather than a spray formulation in riparian zones would reduce water contamination from wind drift.

As specified on the labels of Tordon and Banvel, these herbicides cannot be applied to either the inner bank or base of irrigation ditches.

A herbicide monitoring system should be developed by the Wyoming State Department of Agriculture, which is acceptable to BLM, for monitoring the waters within the proposed treatment sites before, during and after herbicide applications. It is recommended that samples be obtained monthly and also 12 to 24 hours after moderate rainfall, to detect the presence of herbicides in the water. It is highly improbable that levels above 1 ppm will be reached in water ways in the treatment areas. However, in case unacceptable levels of the herbicides are detected in the water samples, a plan of action should be developed by the State

Department of Agriculture, which is acceptable to BLM, to avoid future contamination.

Alfalfa farmers and all other farmers who irrigate from the North Platte River should be informed of the herbicide program.

Plants

All of the mitigative measures listed on pages 166-168 to minimize adverse effects on aquatic and terrestrial plants, are recommended.

Animals

All of the mitigative measures listed on pages 169-170 are recommended to be adopted and implemented to minimize the environmental impacts upon animal life within and adjoining the proposed treatment sites.

Man

All of the measures that were listed on page 170 should be adopted and implemented to insure the public's safety and to provide the safest possible conditions for the applicators.

Operational Procedures

All of the mitigative measures which are described on page 170-171 should be strictly followed. The label instructions on each herbicide must be followed in accordance with the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as Amended 1972.

RESIDUAL IMPACTS

With the implementation of the recommended mitigating or enhancing measures there should be no impacts, either beneficial or adverse, on the aquatic plant, aquatic mammal, bird, vertebrate or invertebrate environmental components. However, if there is an accidental spill or an intense rainstorm shortly after herbicide application some direct and indirect impacts may result upon these environmental components. The air quality, soil, water, terrestrial plant and terrestrial animal environmental components, will be adversely affected after implementation of the recommended mitigative and enhancing measures. There will also be beneficial impacts on the soil, terrestrial plant and terrestrial animal environmental components. These residual impacts are presented in the following discussion.

Air

Air quality will be temporarily reduced by air contamination with herbicide spray vapor and dust from bead formulations. This effect will occur during and for a short time after the herbicide application.

Soil

Implementation of the recommended mitigating or enhancing measures will reduce, but not eliminate soil erosion. Where large, dense stands of designated noxious weeds are removed by treatment with herbicide, soil erosion will be initiated and in certain areas enhanced. This period of soil erosion is expected to last, a few months to, perhaps, one or two years, in extreme conditions, until natural increases or increases afforded by reseeding of native grasses stabilize the soil. Beneficially, soil stability may be increased on presently unstable sites by natural increases and increases afforded by reseeding of native grasses.

Water

Water contamination with Tordon, Banvel, and 2,4-D will occur, even after implementation of the recommended mitigative measures. The North Platte River, and its tributaries within the treatment areas, will unavoidably be contaminated, to some degree, from herbicide in surface run-off water, subsurface water and wind carried spray vapor.

Terrestrial Plants

Implementing the recommended mitigative measures would reduce impacts on non-target terrestrial vegetation. However, adverse impacts on some terrestrial vegetation are unavoidable. Non-target broad-leafed species and any threatened or endangered plants that are in close proximity to the designated noxious weeds may be injured by exposure to any of the three herbicides.

Beneficial impacts will result from reduced weed competition. Broad-leafed native shrubs and forbs, and native grasses should increase in response to the reduced competition.

Terrestrial Vertebrates (Mammals and Birds)

Loss of the target weeds and some non-target trees, shrubs and forbs will initially reduce the quality of habitat for the mammalian and avian wildlife that inhabit the proposed treatment area. Over a period of time habitat quality should be improved by the initial increase in grass cover, and with subsequent re-establishment of native shrubs and forbs where weed stands were removed.

Man

The proposed program will reduce the aesthetic appearance of parts of the treatment areas. This will not be a long-term adverse effect. Over a longer period, the aesthetic quality of the land will be increased by control of the designated noxious weeds. In addition, man stands to benefit economically, as livestock range and wildlife habitat are improved.

SHORT-TERM USE VS LONG-TERM PRODUCTIVITY

Implementation of the weed control program over the proposed five year period will have short-term effects on the land that will affect its future productivity. The continued use of the land by man for livestock grazing, recreation and wildlife, as an ecological niche is contingent on the future productivity of the land. The land is currently being used for these purposes, and these uses will continue during and after completion of the weed control program.

Short-term use of the land for herbicide application will cause the loss of target and some non-target vegetation that will mean the loss of food, cover and other habitat needs for livestock and wildlife. In some areas removal of the vegetation will cause soil erosion that may result in reduced soil fertility. For man, the aesthetic value of the land will be reduced for a period of perhaps one to five years. Additional, incidental, short-term uses include, land use by weed control personnel and reduced land use by recreationists the days of herbicide application procedures. Land use by livestock will be restricted for at least seven days after herbicide application procedures.

Long-term productivity of the land will be enhanced with the elimination of the designated weeds and subsequent replacement with native grasses, forbs, and shrubs. Increased diversity and coverage of native vegetation may contribute to increased soil fertility, and an improvement in rangeland and wildlife habitat. The aesthetic value of the land will be increased, enhancing its usability for recreational purposes. The productivity of farmlands downstream from the treatment areas will be increased in the long-term. Growers will be able to invest more time, energy and money in production rather than in weed control.

On a broader scale, long-term benefits will result from increased knowledge concerning the use of the herbicides Tordon, Banvel, and 2,4-D on rangelands and wildlife habitat. Monitoring water ways for herbicide residues, studying effectiveness of weed control, and studying changes in native vegetation will contribute to effective, safe, and economic weed control in the years ahead.

IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

No irreversible commitments of natural resources are anticipated from the proposed program.

The following resources will be irretrievably committed:

1. Loss of some broad-leafed plants.
2. Herbicides.
3. Vehicular gasoline and oil and maintenance costs.
4. Human labor.

PERSONS, GROUPS AND AGENCIES CONSULTED

U.S.D.I.

Bureau of Land Management   State Office, Cheyenne, Wyoming
- Wallace Evans   Environmental Coordinator
- Gerald Federer   (COAR)-Range Conservationist
- Ronald Gumtow   Fisheries Biologist
- George Hollis   Wildlife Management Specialist
- Dan Hutchinson   Archeologist
- Paul Leonard   Chief Division of Resources
- Thomas Lukow   Air Quality Specialist
- Linda MacDonald   Range Conservationist (Endangered Plants)
- Richard McQuisten   Hydrologist
- Elwin Price   Chief Branch of Environmental Coordination

Bureau of Land Management   Rawlins District Office, Rawlins, Wyoming
- Larry McMasters   Outdoor Recreation Specialist
- Bruce Waddell Jr.   Wildlife Management Specialist

Bureau of Land Management   Baker District Office, Baker, Oregon
- Matt Kniesel Jr.   Wildlife Specialist

U. S. Fish and Wildlife Service   Denver, Colorado
- James Gritman   Acting Regional Director, Region 6

U. S. Fish and Wildlife Service   Jackson, Wyoming
- Daniel Woodward   Fisheries Biologist - Pesticide Research

U. S. Environmental Protection Agency   Denver, Colorado

U. S. Geologic Survey

U.S.D.A.

U. S. Forest Service

U.S.D.A. Bee Lab
Dick Nunamaker   Doctoral Student University of Wyoming, Laramie
J. Moffett   SEA-AR Entomology Dept. Oklahoma State University

State Government and Agencies

Wyoming Board of Agriculture

Wyoming Conservation Commission

Wyoming Department of Agriculture   Cheyenne, Wyoming
Bill Gentle   Pesticide Specialist
George Hittle   Weed and Pest Supervisor
Billie Lundberg   Weed Survey Supervisor

Wyoming Department of Environmental Quality   Cheyenne, Wyoming
Carolyn Dinger
John Wagner   Water Quality

Wyoming Game and Fish Department   Department Headquarters, Cheyenne, Wyoming
Rex Corsi   Chief State Game Warden
Don Dexter   Assistant Director
Steve Facciani   Assistant Chief State Fish Warden
Harry Harju   Staff Biologist
Mike Stone   Staff Biologist
Joe White   Chief State Fish Warden

Wyoming Game and Fish Department District Offices
Fred Eisenman   Fisheries Resource Manager, Casper
Jack Kanaly   Fisheries Biologist, Laramie
Robert McDowell   Fisheries Biologist, Laramie
Robert Millis   Supervisor Water Quality Lab, Lander
Jack Neuman   Wildlife Biologist, Laramie

Wyoming Recreation Commission   Cheyenne, Wyoming
Jan Wilson   Wyoming State Historic Preservation Officer

County Agencies, Private Industry and University Personnel
Jerry Aldredge   Balcom Chemicals Inc.   Greeley, Colorado
Harold Alley   Professor of Weed Science, University of Wyoming
Robert Behnke   Professor of Fisheries Biology, Colorado State University
G. A. (Lonnie) Bowman   Carbon County Weed and Pest Supervisor, Rawlins, Wyoming
Rex Coan   Velsicol Chemical Corp.   Greeley, Colorado
Gus Foster   Velsicol Chemical Corp.   Ft. Collins, Colorado
Alvin Gale   Pesticide Specialist   University of Wyoming, Laramie

Wendy Haas Masters Wildlife-Graduate Student, Colorado State University
Phil Hoefer Professor of Forestry, Colorado State University
John Pickel Velsicol Chemical Corp. Champaign, Illinois
Panos Poulos Velsicol Chemicals Corp. Chicago, Illinois
Dick Randall Defenders of Wildlife Rock Springs, Wyoming
Paul Ritty Research and Development, Dow Chemical Co., Shawnee Mission, Kansas
Tom Schwartz Weed Science Graduate Student, University of Wyoming, Laramie
Ralph Simnacker Sweetwater County Weed and Pest Supervisor
Terry Specht Balcom Chemicals Inc., Greeley, Colorado
Hank Suzuki Velsicol Chemical Co. Chicago, Illinois

INTENSITY OF PUBLIC INTEREST

To be completed after this draft assessment record has been reviewed.

SUMMARY CONCLUSION

To be completed after this draft assessment record has been reviewed.

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DESIGNATED (NOXIOUS) WEED TREATMENT PROGRAM

ENVIRONMENTAL ASSESSMENT RECORD

SUPPLEMENT

BUREAU OF LAND MANAGEMENT

RAWLINS DISTRICT, WYOMING

APRIL 1979

INTRODUCTION

This Supplement to the North Platte River Area Designated (Noxious) Weed Treatment Program Environmental Assessment Record (EAR) was published in April 1979, in response to public comments offered during January and February of 1979. The supplement is divided into two sections. The first is the public participation section which discusses all public comments offered on the EAR by agencies, organizations and individuals. The second section is a revised text supplement to the original EAR and discusses revisions or additions that were determined to be necessary as a result of consideration of public comments.

NORTH PLATTE RIVER AREA

DESIGNATED (NOXIOUS) WEED TREATMENT PROGRAM

ENVIRONMENTAL ASSESSMENT RECORD

SUPPLEMENT

PUBLIC PARTICIPATION SECTION

PUBLIC PARTICIPATION SECTION

Organization

The North Platte River Area Designated (Noxious) Weed Treatment Program Environmental Assessment Record (EAR) was initiated in May 1978 and completed in December 1978 under a contract agreement between the Wyoming Department of Agriculture and the Bureau of Land Management. Field and Lab, Inc., agricultural and environmental consultants, Fort Collins, Colorado, performed the actual written work under the leadership of the Wyoming Department of Agriculture, Cheyenne, Wyoming. Specialists in zoology, weed and pest, pesticides, entomology, soils, agricultural product regulations, and epidemiology, had input into the EAR.

The Bureau of Land Management (BLM) and the Carbon County Weed and Pest Control District coordinated with the Wyoming Department of Agriculture and Field and Lab, Inc. during all phases of the project.

Consultation and Coordination in Preparation of the EAR

During March 1978, letters and explanatory material were sent to various interest groups and individuals, federal agencies, and state and local agencies, inviting them to take part in the EAR process by supplying comments and information.

Groups, organizations and individuals contacted by letter include: wildlife interest groups, environmental groups, recreational groups, livestock operators, federal agencies, state agencies, the Governor's office, and a major herbicide manufacturer.

Comments were received from the public through formal statements and informal contacts as the EAR was developed. Many individuals with special knowledge and expertise were consulted during the preparation of portions of the EAR (See pages 177-179 in the EAR).

Coordination in the Review of the EAR

Comments on the EAR were requested from agencies and interest groups listed in Table S-1. Those who provided comments are indicated by an asterisk.

Public Comments and Responses

The public comments period was scheduled to provide the public an opportunity to review and then offer comment on the adequacy of the analysis of impacts of the proposed action and alternatives as presented in the environmental assessment record.

A news release announcing the availability of the EAR was issued from the Rawlins District Office, Bureau of Land Management, on January 10, 1978, to news media in Colorado, Montana, and Wyoming. Distribution of the news release included the following: 22 newspapers, 4 magazines, 13 radio stations, 6 television stations, and 2 wire services in Wyoming and 3 newspapers, 3 magazines, 1 radio station, and 2 television stations in other states.

The news release also announced a 30-day public review period ending February 15, 1978.

Handling the Review Procedures for Public Comments

During the review process, 10 letters were received from state and federal agencies, environmental groups, a livestock operator, and one corporate entity.

All letters were reviewed and considered in preparation of the EAR Supplement.

Major comments are those which presented pertinent new information, questioned the EAR impact analyses or data, or raised issues bearing directly

TABLE S-1
INDIVIDUALS, AGENCIES, AND ORGANIZATIONS
FROM WHOM COMMENTS WERE REQUESTED

Federal Agencies

*Environmental Protection Agency
Fish and Wildlife Service (Department of Interior)
Forest Service (Department of Agriculture)
*Soil Conservation Service (Department of Agriculture)

State Agencies

Governor's Office
*Wyoming Department of Agriculture
*Wyoming Department of Environmental Quality
*Wyoming Game and Fish Department
Wyoming Recreation Commission

Local Government

Carbon County Weed and Pest Control District

Others

Audubon Society
Carbon County Conservation Club
*Defenders of Wildife
*Dow Chemical USA
Friends of the Earth
*Izaak Walton League
C.W. McIlvain (livestock operator)
*John Rouse (livestock operator)
Sierra Club
University of Wyoming (Weed Science Division)
Upper North Platte Water Users Association
Wyoming Outdoors Council
Wyoming Wildlife Federation

*Individuals, agencies, and organizations who provided comments.

upon the impacts of the implementation of the proposed action or its alternatives upon the environment. Major comments were responded to separately in the following pages.

Each comentator (agency, organization or individual) who submitted a letter was assigned an index number in Table S-2.

Major comments are grouped by environmental element (wildlife, vegetation, etc.). The comment was typed verbatim in most cases; the index number of the agency, organization, or individual who made the comment is shown in parentheses. Similar comments received from more than one source have several index numbers identifying the sources; the comments were paraphrased wherever possible. The response either identifies that a text revision is noted in the second half of this supplement or provides rationale for why the comment did not require a change. Other comments indicated minor changes of the text. These changes were made as appropriate in the Revised Text Section of this Supplement.

All letters received are printed at the end of this section of the EAR Supplement.

TABLE S-2
INDEX OF COMMENTATORS

Index Number	Individual, Agency, or Organization
1	Dow Chemical USA, Shawnee Mission, Kansas
2	Wyoming Game and Fish Department, Cheyenne, Wyoming
3	John Rouse (livestock operator), Saratoga, Wyoming
4	Izaak Walton League, Green River, Wyoming
5	Defenders of Wildlife, Rock Springs, Wyoming
6	Environmental Protection Agency, Denver, Colorado
7	Soil Conservation Service, Casper, Wyoming
8	Wyoming Department of Environmental Quality, Cheyenne, Wyoming
9	Wyoming Department of Agriculture, Cheyenne, Wyoming

GENERAL

1. Comment (5). "The following are BLM guidelines which speak for themselves. Would the writers please comment, 1) Were these guidelines the result of someone's desire to make rules or are they valid recommendations? 2) Will these guidelines be waived for this project? 3) If the guidelines are waived, will they still be left in the BLM books so as to confuse the lay-public into believing there are really rules and regulations?

"'Instruction memo 75-430. All areas treated by chemicals must be deferred for two full growing seasons. Grazing must be stopped when spraying begins and futher livestock use deferred until after seed-ripe time following the second growing season.'

"'Stream Management, 672. (7) Avoid use of herbicides adjacent to streams while controlling unwanted vegetation. Direct kill of fish is possible, but the loss of streamside vegetation may be more damaging.'

"'Department of the Interior Guideline for use of Pesticides, (2) No pesticides will be used when there is a basis for belief that A. Water quality will be degraded. B. Hazards exist that will unnecessarily threaten fish, wildlife, their food chain, or other components of the natural environment.' (this guideline included because page 155 indicates herbicide application may lead to a lengthy grasshopper spraying project.)

"'Brush and Weed Control, 7311. (1) A. Limit use of chemicals to those areas absolutely necessary to meet management objectives and responsibilities. They must clearly pose no threat to human health, domestic animals, or fish and wildife. (2) B. Restrict vegetative control to flat or moderate slopes. Do not remove vegetation from steep slopes, rough areas, or stream borders.'"

Response. Instruction Memo 75-430 is an outdated memo that does not actually relate to this EAR or the objectives specified therein. Stopping and deferring livestock would be appropriate if the objective of the herbicide application was to increase forage production. If this were the case, grazing would cease where herbicide was applied in order to increase vigor to plants and establish a seed source.

Herbicides would be applied in a selective manner wherever possible. The concentrations would be such that direct kills are highly improbable. Treatment areas are scattered and quite small and only some involve riparian areas. The overall impacts from the applications of herbicides on public lands would be expected to be minimal. Water quality impacts would be negligible as a result of treatment on public land.

Application of herbicides on the 416 acres of public lands is necessary in order to stop the spread of noxious weeds and to remove the seed source. In some instances it would be necessary to treat localized infestations in rough areas and along some stream borders.

2. Comment (8). "Only the BLM lands are considered in this EAR, but we are also concerned about impacts of spraying on wildlife and wildlife habitat on state and private lands. Our comments apply to the portion of the program on state and private lands, as well as on BLM lands."

Response. As indicated on page 1 of the EAR, the scope of this assessment is to address only those impacts which would result from herbicide treatment on public lands.

WATER

1. Comment (6). "On page 122 the environmental assessment states that water contamination is not expected to reach levels above 1 ppm and that this level is not expected to adversely affect water quality. Hodgson (J.M. Hodgson. 1966. The effect of herbicide contaminated irrigation water on crops. 1966 Meeting of the Weed Science Society of American. p. 88.) reported that irrigation water containing concentrations of picloram as low as 0.1 ppm reduced the yield of sugar beets. While there are no sugar beets grown in the project area and the susceptibility of other plant species can vary considerably from sugar beets, the 1 ppm could cause subtle effects on the aquatic environment. The effects of picloram contamination of water could logically cause oxygen depletion due to reduced photosynthesis or decaying plant material. This would be synomynous with a reduced carrying capacity for fish in that stream. Although these effects are conjecture not backed by research, I think that the potential is great enough that you might include this in your monitoring program."

Response. The 1 ppm level was not intended as an allowable contaminant level. It was used for ease of calculation for the purpose of the water contamination example and for comparisons with toxicity data. The assessment of no significant adverse or beneficial impact was not based upon this level, but rather on measured levels from several research studies that involved similar herbicide treatment situations.

See pages S2-11 and S2-22 in the Revised Text Section of this Supplement.

2. Comment (2). "Page 113, second paragraph. The water samples were taken in mid-stream where dilution factors were high. Still water areas (pools) close to the source should also be sampled."

Response. The water samples are not only taken in mid-stream, but at a number of points across the width and through the depth of the stream. All samples were taken according to standard USGS water quality sampling techniques.

3. Comment (2). "Page 116. All water samples noted were taken in the Platte River. Results in the tributaries where greater numbers of young-of-the-year trout are found, and where Tordon would be found in higher concentrations, would be more meaningful."

Response. The water quality samples in that report were taken only in the North Platte River because herbicide application was only made along the North Platte River. See Page S2-19 in the Revised Text Section of this Supplement.

4. Comment (2). "Page 166. Water mitigation measure number 5 is unclear. What can be done once the herbicide is in the stream?"

Response. See page S2-19 in the Revised Text Section of this Supplement.

5. Comment (8). "Page 112 states, 'Water contamination via any of these routes (spills, run-off, contaminated water storages) is not expected to reach levels above 1 ppm for any duration (<24 hours) in the North Platte River or its tributaries.' This statement and the following discussion in the report downplays the impacts on water quality. Chapter I, Section 21, of the Wyoming Water Quality Standards states that all toxic or potentially toxic materials attributable to or influenced by the activities of man shall not be present in any Wyoming surface waters in concentrations or combinations which would damage or impair the normal growth, function, or reproduction of human, animal, plant, or aquatic life. The 1 ppm concentration is above the 0.1 mg/l for 2,4-D in EPA's Quality Criteria for Water and our Standard. BLM is required to meet the Wyoming Water Quality Standards for this program and will be held responsible for any standards violations."

Response. The 1 ppm level used in the EAR (page 112 in the EAR and page S2-11 in the Revised Text Section of the Supplement) was not intended to establish an allowable limit of 1 ppm for the three herbicides. It was used for ease of calculation for the purpose of the contamination example and for comparison with later toxicity information.

EPA criteria for Tordon and Banvel have not been established and available data to date have not indicated levels of 2,4-D above the 0.1 ppm allowable level for domestic water supplies (see Table 17, page 115). As outlined in the mitigation measures section on page 172 (revised, page S2-22), a water sampling and testing program would be conducted to monitor the water quality. If unacceptable levels of the herbicides are recorded, steps will be taken to reduce water contamination.

6. Comment (8). "The towns of Saratoga, Rawlins, Sinclair, and Encampment obtain all or some of their public water supplies from surface water in the program area. The public should be notified of this proposal and, upon program implementation, of the dates of herbicide application.

"The monitoring program described in the assessment should also include the public water supplies; results should be sent to the respective towns and to DEQ.

"DEQ requests notification of all herbicide spraying dates in the pertinent program area."

Response. The public has been notified of the proposal (see the introduction to this section of the Supplement).

Text has been revised, see pages S2-19 and S2-21 in the Revised Text Section of this Supplement.

7. Comment (2). "Page 172. The last paragraph notes that it is impossible that levels above 1 ppm will be reached in waterways. Conversations with Dan Woodward (USF&WS Lab) indicate that, to be on the safe side, 0.3 ppm should be the maximum allowed. This would minimize some of the adverse effects which occur below the 1 ppm lethal point."

Response. See page S2-22 in the Revised Text Section in this Supplement.

RANGE

1. Comment (5). "Statements on pages 110 and 174 indicate erosion will increase, for a time period of a few months or a few years (quite a spread). Because this EAR does not adequatedly address the cause of infiltration by exotic or unwanted plant species, I believe erosion could continue much longer and be much worse than anticipated.

"Most experts will agree, plant species listed as 'noxious' are opportunists that thrive in areas of surface disturbance. In many areas, over-grazing most certainly opens the door to noxious weeds.

"It appears (from personal observation) that riparian areas included in this EAR have been tromped and grazed beyond any kind of responsible use of the land. And yet, this EAR proposes that grazing be continued as usual, allowing no time for re-establishment of vegetation."

Response. This EAR does not propose that grazing be continued as usual; it leaves this issue to be addressed in a forthcoming grazing environmental statement (ES). At that time, allotment management plans, allocations of forage, and the like, will be assessed in detail. The noxious weeds are a problem and infested areas on public lands are a seed source. Considering that the federal lands to be treated consist of 416 acres, not all of which adjoins waterways, it is concluded that the erosion impacts would be minimal and that any resulting increase from public lands would also be minimal.

2. Comment (4). "Weeds can become a problem on cultivated lands and weed treatment programs may be necessary in some instances on these lands. Public lands however should only be subjected to such programs in rare instances.

Especially when management changes can obtain the desired result without the destruction of a five year herbicide program. I would therefore like to propose the following recommendations.

"1. Herbicides should be used on private lands if the need is shown to exist with careful supervision.

"2. Herbicides should not be used on any known critical wildlife winter range.

"3. Livestock grazing should be decreased or eliminated on poor condition riparian zones.

"4. Revised management plans should be devised and implemented to insure that riparian areas are not overutilized in the future.

"5. Spot spraying should be done on public lands only in isolated areas of heavy weed infestations."

Response. Herbicides would be applied in a selective manner in all areas wherever possible. This would in fact, involve a small amount of winter wildlife range and the impact on public lands would be expected to be minimal, as a total of only 416 acres of public lands is involved. Treatment would only occur on infested areas.

A grazing ES will be prepared for all of the resource area in the future. This statement will consider livestock grazing, allotment management plans, overutilization, forage allocation, and the like.

3. Comment (4). "It disturbs me that a better vegetative inventory was not conducted in the proposed treatment area. Dominants such as trees and shrubs are generally well known in the area. Forbs and grasses however are not so well known and apparently were not inventoried even though they will be the two most

affected forms of vegetation. Forbs make up a very large percentage of plant species found in riparian zones, which appears to be where most of the spraying will be done. Many of the forbs which will be destroyed may be very important components of the diet of grazing animals during the growing season. Trees and willows which are extremely important to all facets of riparian ecology will also be destroyed."

<u>Response</u>. It is stated in the EAR (pages 120-121) that there will be some unavoidable loss of non-target broadleafed vegetation. A major portion of the EAR is devoted to assessing the impacts of this indirect adverse effect. Unfortunately, more precise quantification of the vegetative composition of the treatment area is not available and therefore, more specific impacts cannot be addressed. However, it is not expected that there would be significant impacts.

4. <u>Comment</u> (4, 5). Studies have shown that insect infestations (in this case, grasshoppers) are often the result of herbicide treatments. Many herbicide programs have had to be followed up with pesticide treatment programs.

<u>Response</u>. See page S2-18 in the Revised Text Section of this Supplement.

5. <u>Comment</u> (2). "Page 6. Roundup, a herbicide which poses little threat to trout fisheries, was not proposed for use."

<u>Response</u>. Roundup was not proposed for use because it is a nonselective herbicide. This means that broadleafs and grasses (essentially all green vegetative matter) would be destroyed where Roundup would be used. The use of Roundup in riparian zones could have tremendous indirect impacts upon fisheries, aquatic birds, and other wildlife that inhabit riparian zones.

6. Comment (2). "This is a five-year program, with retreatment anticipated. There are no data included that suggest the program will succeed in controlling weeds. No evaluation system is proposed to monitor effects of the program. The nature of the weeds, terrain, range conditions, extent of disturbed sites, and existing seed sources indicate that this program is likely to expand and continue for an indefinite period of time. The long-term implications of continuous herbicide application are of concern to wildlife management."

Response. There is sufficient data which indicates the proposed programs would control the specified weeds. The fact that the herbicides are registered by the EPA for use on the specific weed species indicates that the herbicides have met EPA efficacy data requirements. In addition, the herbicides and application rates proposed were taken from the 1978 Wyoming Weed Control Guide published by the Agricultural Extension Service, University of Wyoming, Laramie. See page S2-19 in the Revised Text Section of this Supplement.

7. Comment (2). "Page 36, last paragraph. Tordon 22K is not preferred for use near trees and water, but the document appears to recommend the herbicide for use on the Platte River tributaries."

Response. Tordon 22K is preferred for use on noncrop areas where trees and water would be avoided; however, this does not mean that Tordon cannot be used around water and trees if care is taken. The proposed program along with the mitigation measures stipulates that care must be taken when applying Tordon 22K in riparian zones. Herbicides will be applied on a selective target-species basis wherever possible.

8. Comment (2). "Pages 91 through 97. The Ecological Interrelationships section needs more discussion of the relationship of various animal species to plant species, and should include plants scheduled to be sprayed and non-target species that will be reduced as a result of the spraying."

Response. A more detailed discussion of the ecology of the treatment areas is beyond the scope and purpose of this EAR. Knowledge of all the specific interactions that occur within the treatment area is limited at this point in time and therefore specific details are difficult to present. The EAR does list the weed species to be treated and contains a discussion within the limits of present knowledge of the nontarget plants that may be affected by the program (see pages 5-24, 33-35, and 74-81 in the EAR).

9. Comment (5). "Your vegetative inventory appears to be incomplete. Much of the proposed treatment area includes riparian zones. Surely, numerous forbs are native to these areas and yet, the only mention they received was, 'numerous forbs' in the 7 to 10 thousand foot level.

"If the inventory was so superficial as to preclude listing forb species then I would question the statement, 'No plants proposed for threatened or endangered status are known to occur in the area.' Of course, 'not known' and 'not found' are two different things. Did anyone look?"

Response. A listing of all plant species is beyond the scope and intent of the EAR. The Weed and Pest Control District supervisors are trained in identifying the noxious weeds in the area. There is an inventory of threatened and endangered species which covers this area. It does not indicate any known occurrence of threatened and endangered species.

10. Comment (4). "Several weed treatment studies have shown that the very species that are trying to be eradicated are the very ones that reinvade the area most readily after treatment. This is due to the extraordinary ability of these weeds to establish themselves on disturbed areas. Native vegetation on the other hand usually do not reinvade the area until vegetative successional patterns are such that conditions favor their survival. Weedy species are most always the first step in the successional sequence of a disturbed area. They can then remain indefinitely if a disclimax community is created by some continual disturbance such as herbicide treatment or overgrazing.

Response. Due to the selective nature of spraying small site-specific areas which are widely scattered, it is not expected that a disclimax community would be created. Therefore, the weedy species would not remain indefinitely and surrounding areas would provide a seed source for reintroduction of existing native species.

11. Comment (5). "Why is this EAR designed to produce a mono-culture plant community of mostly grasses? Riparian wildlife communities need more than grass for food and habitat, and grass is a poor stabilizer for erosive river banks or steep, shallow-soil slopes."

Response. The EAR is not designed to produce a mono-culture; rather the EAR is assessing the impact of applying herbicides to noxious weeds. The public lands being considered consist of 416 acres scattered over a large area. Herbicides would be selectively applied to target species wherever possible. Therefore, it is not expected that a monoculture plant community would result.

12. Comment (6). "On page 121, the environmental assessment states that 'any of the endangered plants listed that occur within spot treatment sites will be destroyed if exposed to the herbicides.' There is no indication of the potential for this to occur. There is also no indication that any precautions will be taken to prevent it from happening. Because of the few endangered or threatened plant species that might occur, field personnel should be trained to recognize them. If any endangered or threatened species are found, the field crew should determine if it can be protected before continuing to spray."

Response. Inventory data does not indicate any known occurrence of endangered plant species occurring in the treatment areas on public lands. A compliance specialist will, however, be with the herbicide applicators during all treatment on public lands and insure that should any endangered plants be encountered they will be protected (see page S2-21 in the Revised Text Section of this Supplement).

13. Comment (4, 5). Noxious weeds are not a problem of good quality rangelands. Weeds invade disturbed areas that are in poor condition, usually due to overgrazing. The EAR states that livestock use is excessively heavy along certain stretches of riparian habitat. Cattle tend to congregate and overutilize stream bottom vegetation, while surrounding rangeland is underutilized. As noted in the EAR, a high percentage of the treatment area is located in riparian zones and, therefore, overgrazing may be the problem in this area. If this is the case, the program seems to treat the symptoms and not the disease. A reduction of livestock numbers or curtailment of grazing on severely affected areas were not mentioned as possible alternatives to the herbicide program. Unless the root-cause of weed infestation (land abuse) is addressed and the problem corrected, everyone's comments on this EAR and all research in preparation of this extensive document will have gone for nothing."

Response. The issue of overgrazing is not within the scope of this particular document. In the future, an ES will be prepared addressing the grazing management in the resource area. At that time, proper forage allocations will be made, and allotment management plans and livestock management facilities developed and implemented.

14. Comment (3). "The location of areas of leafy spurge to be treated, beginning on page 7 of your report does not appear to be complete. None of the land in my ranch, which includes 5,720 acres deeded, 960 BLM and 800 state land in the western half of Township 15, Range 82, is listed. There are areas in the following sections where there is leafy spurge that needes treatment:

T. 15, R. 82

Sections 16, 17, 18, private lands

Section 19, 20, 29, 30, BLM and Private

In T. 15, R. 83 W., Section 12, 13 also have leafy spurge."

Response. See Pages S2-1, S2-2, S2-25, and S2-26 in the Revised Text Section of this Supplement.

WILDLIFE

1. Comment (2). "Page 125. The impacts on all aquatic birds cannot be based upon the reported impact on the mallard. Mallards cannot be considered to be the same as gulls or rails. Because of the size difference, a teal may not be as resistant to herbicides as a mallard."

Response. See page S2-12 in the Revised Text Section of this Supplement.

2. Comment (2). "Reduction of nesting cover as a result of herbicide spraying will impact waterfowl and other birds that nest near water. Loss of vegetation, if it decreases numbers of insects, will adversely impact insectivorous birds. Can the loss of insects as a result of ingestion of sprayed vegetation and the resultant reduction in the amount of food available to birds be determined?"

Response. See page S2-12 in the Revised Text Section of this Supplement.

3. Comment (4). "The EAR states that the treatment program will increase soil erosion. Already 57% of the area experiences moderate erosion and 27% experiences slight erosion. Increased soil erosion could be very detrimental to trout egg survival as well as the survival of other aquatic organisms. It has been shown that certain aquatic organisms may be killed by herbicide concentrations of as little as 0.2 ppm. This could have a severe effect on the area's fishery since these organisms make up an intricate part of the food chain."

Response. The first paragraph of page 136 in the EAR, states that brook trout and brown trout may be adversely affected by increased sediment load in the streams. The soil section in the anticipated impacts chapter indicates that increased soil erosion is expected to occur. However, in most treatment sites it is expected to be negligible.

The referenced study stating that certain aquatic organisms may be killed by herbicide concentrations of as little as 0.2 ppm is a single case. That study was in contradiction to all the other 2,4-D toxicity studies on aquatic invertebrates (discussed on pages 138-139 in the EAR). All other toxicity studies on aquatic invertebrates that were referenced indicated toxicity levels above 1 ppm.

4. Comment (4, 5). The statement that 1 ppm of water contamination from herbicides would not affect adult trout is short sighted, since sack-fry and swim-up-fry are an integral part of the process of growing big-fish. And since studies have proven that herbicide concentrations of even 35 to 40 ppb (parts per billion) can effect major mortality on these small fish, is it not fair to assume that fisheries will be severely impacted by this treatment program?

Due to the short life span of trout, a five-year program, with follow-up spraying for several years afterwards, has the potential of having a major effect on trout populations within the treatment area. The EAR states that weed treatment will occur concurrently with spawning activities of brook and brown trout. Spraying will also occur during the time when rainbow and cutthroat eggs are hatching and developing into the fry stages.

Response. The statement that 1 ppm of any of herbicides in the streams will not affect adult trout is correct. The timeframe for herbicide application does not coincide with sac-fry and swim-up-fry development stages in the North Platte River drainage. Therefore, these development stages would not be affected.

For further clarification on another point, the study referenced, stating that 35-40 ppb of Tordon causes increased mortality of young trout, was a 60-day chronic toxicity study, a situation that could not occur under natural conditions (see page S2-13 in the Revised Text Section of this Supplement).

A more recent study by the same author, Woodward (136) attempted to simulate natural conditions and determined 293 ppb of Tordon to be the maximum safe limit (having no affect observed) on trout.

Herbicide applications would coincide with the spawning activities of brook and brown trout and it has been stated that adult trout would not be expected to be impacted. The eggs produced from these spawning activities will not hatch out until mid-February through late May the following year. Rainbow and cutthroat trout eggs hatch anywhere from late April through early June. Therefore, the time of critical development stages of all the trout species will not coincide with herbicide application, which is to occur after July 15.

5. Comment (2). "Page 93. The document notes that deer browse species are slowly deteriorating along with the quality of winter deer habitat. Unless there is an unanticipated recovery by broad-leaved species, this spraying will greatly impact big game winter range. Conversion of a shrub-grass community to a grassland will adversely affect deer, antelope, elk, and bighorn sheep where winter range is treated. Elk and bighorn sheep depend upon browse plants during severe winters, elk and bighorn sheep would be favored at the expense of deer and antelope, which seldom graze. Loss of shrubs on an already overutilized winter range will not benefit the big game dependent upon the winter range for survival. The proposed spray project will impact 343 acres of bighorn sheep critical habitat, 310 acres of mule deer critical habitat, and 300 acres of critical habitat for elk."

Response. It is stated on pages 147 and 148 in the EAR, that big game winter range will be impacted. The extent of the impact cannot quantified with the existing data; however, it is believed that any adverse impact from herbicide applications on public lands would be minimal. It is not stated or implied that the shrub-grass community will be converted to a grassland community.

The only critical winter big game habitat that coincides with the actual areas proposed for weed control is in the Bennett Peak Campground area. As indicated on the Ryan Park and Barcus Peak quadrangles in Appendix 2 in the EAR, the maximum acreage proposed for control in that area is 264 acres. The weed infestations are not contiguous over the entire 264 acres, but rather scattered; therefore, the entire 264-acre area would not be affected by herbicide treatment. The Carbon County Weed and Pest Control District Supervisor estimates that less than 20 percent (approximately 50 acres) of the area is weed infested. Within the 50 acres, herbicide treatment would be selective.

6. Comment (2). "Page 151. Removal of weed species, on which many birds depend for food and cover, and replacement by grasses, which are useful only to a very small number of seed-eating birds, will not have overall positive effects on terrestrial birds. We do not believe that habitat for terrestrial birds 'may be improved over a longer period of time, perhaps 1 to 10 years...'"

Response. To present a useful and objective report, it is necessary to assess both adverse and beneficial impacts. On page 151 in the EAR, under the heading "Indirect Impacts on Terrestrial Birds", paragraph 2 states the possible adverse effects of target and nontarget vegetation loss. Paragraph 3 suggests a possible long-term beneficial effect on the habitat from weed stand reduction.

7. Comment (2). "Pages 154 and 155. It appears that there will be losses of earthworms and other invertebrates as a result of herbicide accumulation in soil and on vegetation. What is this going to do to the food supply for birds, mammals, and soil properties which depend on these species?"

Response. The data cited in the EAR indicate that there is a great deal of interspecific variability of invertebrate tolerance to 2,4-D. It appears that earthworms and nematodes are extremely tolerant as indicated by the data cited on page 155 in the EAR. At the maximum application rate of 6 pounds active ingredient per acre, a total concentration of 1.71 ppm of 2,4-D per acre-foot of soil would be present. Therefore, it is unlikely that earthworms and nematodes would be affected by 2,4-D treatment. 2,4-D does not bioaccumulate and is rapidly broken down into nontoxic components by sunlight and soil microorganisms.

8. Comment (2). "Page 143. We do not believe it should be assumed that the effects of herbicides on wild mammals would be similar to the effects on laboratory and domestic animals tested. The table on Page 141 illustrates that it takes up to four times as much herbicide to kill a rat as it takes to kill a mouse, yet the same amount of herbicide required for a mouse will kill a rabbit. This suggests a large degree of species-specific variability."

Response. The test animals that are required by EPA for generating toxicity data are considered good representative species of natural wildlife populations. There is a degree of species-specific variability in tolerance to the herbicide; however, all the toxicity studies show that extremely high concentrations of the chemical are necessary before toxicological affects are noticed.

9. Comment (4, 5). A large part of the proposed treatment area is wildlife winter range, part of which is critical. Many vegetation species (such as sagebrush, bitterbrush, mountain mahogany, and Oregon grape), crucial to the winter diet of deer, elk, and bighorn sheep, would be adversely impacted to the enhancement of grass species which are of little value as winter forage. At a

time when Wyoming's wildlife populations are being impacted by habitat destruction from minerals development and increased people-pressures, BLM would be in error to help further these impacts.

Response. When selective herbicide application is designed as in this proposal on public lands, the impacts to species crucial to winter wildlife survival would be minimal. The total area of the 416 acres proposed for herbicide application would not be affected; rather, the herbicide would be selectively applied to target species wherever possible.

10. Comment (5). "On page 169 we find, 'Apply treatment after July 15th to avoid potential kill of trout species during yolk-absorption and fry stages of development.'

"Isn't it true that rainbow and cutthroat eggs hatch during June or July? Further, do not brown and brook trout spawn from August til (sometimes including) November? If this data is correct, please explain how treatment 'after July 15th' will alleviate destruction of eggs and fry."

Response. Rainbow and cutthroat trout do not hatch out in July, but only through early June in the North Platte River drainage in Carbon County, Wyoming. It is true that brook and brown trout spawn from August through November; however, their hatch-out does not occur until mid-February through late May of the following year. Therefore, herbicide application after July 15 could not coincide with the yolk absorption and fry stages of any trout species found in the North Platte River drainage.

11. Comment (2). "Pages 147 and 148. The discussion of impacts on critical mule deer habitat and other wildlife habitat near Bennett Peak should include a statement assessing whether the overall effect of the spray project will be

positive or negative. We believe that (because of the critical nature of the habitat) an area like this should only be subject to spot application of herbicide to prevent loss of important browse species. The document indicates that non-target browse species on critical mule deer winter range will be affected, but the magnitude of impact on mule deer is not indicated. The document cites lack of information. However, critical habitat has been delineated, weed infestations have been located, and estimates of browse loss can be predicted by range technicians. Impacts on mule deer can and should be estimated."

<u>Response</u>. The public lands addressed in this EAR consist of 416 acres, which would be treated selectively wherever possible. Considering the acreage of public lands involved and the fact that specific areas are quite small and scattered, it is expected that the impacts would be minimal. See page S2-17 in the Revised Text Section of this Supplement.

12. <u>Comment</u> (9). "Page 95 of that EAR indicates coyotes in the area live 'primarily on rodents and deer'. I believe the implication is that coyotes are 'hunters' and that coyotes are killing (hunting) deer. Are coyotes also hunting domestic livestock? This issue deserves to be fully explained and data supplied to support the contention.

"I am also puzzled by a statement in the second paragraph on page 95 which indicates that there is a general rule that applies to predator-prey relationships... I suggest that coyotes do not control rodent populations and that the 'rule' on page 95 is not supported by data. The discussion also fails to discuss the actions of predators, if one type of prey declines."

<u>Response</u>. The discussion of ecological interrelationships on page 95 in the EAR, relating to coyotes, was only intended as a brief and general review of

ecological interrelationships. A detailed discussion on coyotes is beyond the scope of this EAR and would more properly be addressed in an environmental statement (ES) relative to coyotes and depradation of domestic livestock.

RECREATION

1. Comment (8). "The proposed program area includes two DEQ designated Class I waters, the main stem of the North Platte River and the Encampment River from the U.S. Forest boundary upstream to the Colorado stateline and numerous DEQ designated Class II waters. The two Class I waters were designated because of their high quality fishery, aesthetics, and recreational values. Herbicide application would affect non-target plants (young cottonwoods, willows) in addition to noxious weeds and consequently, reduce the scenic value of the waters in the area and impair the fish habitat."

Response. Herbicide applications would occur on only 416 acres of public lands, specific treatment areas are small and scattered, and herbicides would be selectively applied wherever possible. It is concluded that impacts to nontarget vegetation, scenic values, and fish habitat as a result of operations on public lands would be minimal.

MITIGATION MEASURES

1. Comment (2). "Page 160. Since weed and pest district crew members will carry out treatment operations on federal lands, BLM should have observers present during treatment."

Response. See page S2-21 in the Revised Text Section of this Supplement.

2. Comment (2). "Spraying guidelines should be followed precisely."

Response. As indicated on page 27 and page 170 (operational procedures mitigations #1 and #2) of the EAR, label instructions will be adhered to in applying all herbicides.

3. Comment (2). "Application of herbicides should not occur before July 15 on bighorn sheep lambing areas to avoid disturbance to the sheep at this critical time."

Response. Mitigation #1 on page 169 (aquatic animals) specifies that herbicides will not be applied prior to July 15th.

4. Comment (2). "These precautions and those presented in the EAR should be required on State of Wyoming lands as well as BLM land."

Response. The BLM has no authority to impose restrictions on private or state lands.

NORTH PLATTE RIVER AREA

DESIGNATED (NOXIOUS) WEED TREATMENT PROGRAM

ENVIRONMENTAL ASSESSMENT RECORD

SUPPLEMENT

REVISED TEXT SECTION

REVISED TEXT SECTION

The following pages contain text revisions and additions supplemental to the previously printed North Platte River Area Designated (Noxious) Weed Treatment Program Environmental Assessment Record (EAR).

PAGE 24

The following should be inserted following the table on page 24.

Table 6b. Gunst Reservoir Quadrangle, 1980; (Non-Riparian Zone) Spring 1979 and Fall 1979

Weed Species	Code	Township & Range	Section	Sub-Section[1]	Acres Infestation	Herbicide Applied	Method[2] Applic.	Time of Applic.	Phenotypic Stage of Growth
Leafy Spurge	03	T15N R82W	19	E½ SE¼					
			20	W½ SW¼		Tordon or	II or III	June to Aug.	Bud to maturity
			29	W½	5	Banvel	II or III	June or Sept.	Bud to bloom or maturity
			30	E¼					
			32	NE¼ E¼ NW¼					
				Total Acres -	5				

[1] Refer to Appendix 2 for site specific maps.

[2] I - ground units (liquid formulation) a. hand spray gun; b. spray boom.
II - hand sprayers (liquid formulation)
III - hand spreaders (granular applicator) a. PCB spreaders; b. shakers.

PAGE 24 (Continued)

This table should follow Table 6b on the previous page.

Table 6c. Gunst Reservoir Quadrangle (Non-Riparian Zone)
Retreat and Follow-Up Program: 1980, 1981, 1982, and 1983

Weed Species	Code	Township & Range	Section	Sub-Section[1]	Retreat[2] 25%	Acres Follow-Up[3] 75%	Herbicide Applied	Method[4] Applic.	Time of Applic.	Phenotypic Stage of Growth
Leafy Spurge	03	T15N R82W	19	E½ SE¼						
			20	W½ SW¼	1.25	3.75	Tordon or	II or III	June to Aug.	Bud to maturity
			29	W½			Banvel	II or III	June or Sept.	Bud to bloom or maturity
			30	E¼			2,4-D Amine	II	June	Seedling stage
			32	NE¼ E¼ NW¼						
				Total Acres -	1.25	3.75				

[1]Refer to Appendix 2 for site specific maps.

[2]The possibility exists that approximately 25% of the original area may have to be retreated with the herbicide originally recommended.

[3]The entire area needs to be rechecked for new seedlings, preferably at least once a year. The number of inspections depends on weed species and herbicide applied.

[4]
I - ground units (liquid formulation) a. hand spray gun; b. spray boom.
II - hand sprayers (liquid formulation)
III - hand spreaders (granular applicator) a. PCB spreaders; b. shakers.

The following replaces the next to the last paragraph on page 28:

Method III: Hand spreaders (granular applicator) are used in application of graular herbicides. Granular herbicides may also be applied by hand. This method of treatment will be conducted on foot in rough terrain, close to aquatic sites, streams, and in riparian zones. Treating with spreaders will be at a height of 3½ feet and operated when wind velocity does not exceed 7 mph. In areas close to aquatic sites, streams, and riparian zones, treatment would be conducted when wind velocities do not exceed 3 mph.

PAGES 81-82

Replace the aquatic birds list on pages 81-82 with the following:

Birds:

Common Loon (*Gavia immer*)
Gadwall (*Anas strepera*)
Red Head (*Aythya americana*)
Lesser Scaup (*Aythya affinis*)
Common Goldeneye (*Bucephala clangula*)
American Coot (*Fulica americana*)
American Avocet (*Recurvirostra americana*)
Killdeer (*Charadrius vociferus*)
Spotted Sandpiper (*Actitis macularia*)
Greater Yellowlegs (*Totanus melanoleucus*)
Lesser Yellowlegs (*Totanus flavipes*)
Least Sandpiper (*Erolia minutilla*)
Wilson's Phalarope (*Steganopus tricolor*)
Herring Gull (*Larus argentatus*)
Ring-billed Gull (*Larus delawarensis*)
Franklin's Gull (*Larus pipixcan*)
California Gull (*Larus californicus*)
Forster's Tern (*Sterna forsteri*)
Belted Kingfisher (*Megaceryle alcyon*)
Dipper (*Cinclus mexicanus*)
Western Flycatcher (*Empidonax difficilis*)
Mallard (*Anas platyrhynchos*)
Pintail (*Anas acuta*)
American Green-winged Teal (*Anas crecca carolinesis*)
American Widgeon (*Anas americana*)
Northern Shoveler (*Anas clypeata*)
Common Merganser (*Mergus merganser*)
Eared Grebe (*Podiceps caspicus*)
Western Grebe (*Aechmorphorus occidentalis*)
Double-crested Cormorant (*Phalacrocoras auritus*)
Pied-billed Grebe (*Podilymbus podiceps*)
Great Blue Heron (*Ardea herodias*)
Canada Goose (*Branta canadensis*)
Bufflehead (*Bucephala albeola*)
Virginia Rail (*Railus limicola*)
Sora Rail (*Porzana carolina*)
Blue-winged Teal (*Anas discors*)
White Pelican (*Pelecanus erythrorhynchos*)

PAGE 82

Replace the aquatic amphibian and reptile list on page 82 with the following:

Amphibians and Reptiles:

Clouded Tiger Salamander (Ambystoma tigrinum nebulosum)
Northwestern or Boreal Toad (Bufo boreas boreas)
Boreal Chorus Frog (Psuedacris triseriata maculata)
Leopard Frog (Rana pipiens)
Western Spotted Frog (Rana pretiosa pretiosa)
*Northern Wood Frog (Rana sylvatica)

*Rare species in Wyoming according to Wyoming Game and Fish Dept. (134).

PAGE 82

Replace the aquatic fish list on page 82 with the following:

Fish:

Cutthroat Trout (*Salmo clarki*)
Rainbow Trout (*Salmo gairdneri*)
Brown Trout (*Salmo trutta*)
Brook Trout (*Salvelinus fontinalis*)
Longnose Dace (*Rhinichthys cataractae*)
Walleye (*Stizostedion vitreum vitreum*)
Carp (*Cyprinus carpio*)
Longnose Sucker (*Catostomus catostomus*)
White Sucker (*Catostomus commersoni*)
Creek Chub (*Semotilus atromaculatus*)
Johnny Darter (*Estheostoma nigrum*)

According to the BLM (11), no endangered or threatened fish species and their habitats have been identified in the proposed program area. This may be due to the lack of base line information about the fishery resource in the Unit.

PAGE 84-85

The terrestrial mammals list on pages 84-85 is replaced by the following:

Mammals:

Snowshoe Hare (Lepus americanus)
Pika (Ochotona princeps)
Uinta Chipmunk (Eutamias umbrinus)
Yellow-bellied Marmot (Marmota flaviventris)
Red Squirrel (Tamiasciurus hudsonicus)
Gapper's Red-backed Vole (Clethrionomys gapperi)
Porcupine (Erethizon dorsatum)
Black Bear (Ursus americana)
Elk (Cerbus canadensis)
Nuttall's Cottontail (Sylvilagus nuttallii)
Black-tailed Jackrabbit (Lepus californicus)
Richardson's Ground Squirrel (Spermophilus richarsonii)
Thirteen-lined Ground Squirrel (Spermophilus tridecemlineatus)
White-tailed Prairie Dog (Cynomys leucurus)
Opossum (Didelphis virginiana)
Desert Cottontail (Sylvilagus audubonii)
Least Chipmunk (Eutamias minimus)
*Black-footed Ferret (Mustela nigripe)
Deer Mouse (Peromyscus maniculatus)
Montane Vole (Microtus montanus)
Long-tailed Vole (Microtus longicaudus)
Prairie Vole (Microtus ochrogaster)
Heather Vole (Phenacomys intermedius)
Bushy-tailed Wood Rate (Neotoma cinera)
American Badger (Taxidea taxus)
Long-tailed Weasel (Mustela frenata)
Coyote (Canis latrans)
Bobcat (Lynx rufus)
Ord's Kangaroo Rat (Dipodomys ordii)
Plains Harvest Mouse (Reithrodontomys megalotis)
Northern Grasshopper Mouse (Onychomys leucogaster)
Golden-mantled Ground Squirrel (Spermophilus lateralis)
Striped Skunk (Mephitis mephitis)
Townsend's Bat (Plecotus townsendii)
American Pronghorn Antelope (Antilocapra americana)
Fox Squirrel (Sciurus niger)
White-tailed Deer (Odocoileus vriginianus)
Mule Deer (Odocoileus hemoinus)
White-tailed Jackrabbit (Lepus townsendii)
Rocky Mountain Bighorn Sheep (Ovis canadensis)
Norway Rat (Rattus norvegicus)
House Mouse (Mus musculus)
Vagrant Shrew (Sorex vagrans)
Masked Shrew (Sorex merriami)
Dwarf Shrew (Sorex nanus)
Long-eared Myotis (Myotis evotis)
Little Brown Myotis (Myotis lucifugus)
Long-legged Myotis (Myotis volans)
Small-footed Myotis (Myotis subulatus)
Silver-haired Bat (Lasionycteris noctivagans)
Big Brown Bat (Eptesicus noctivagans)
Hoary Bat (Lasiurus cinereus)
Red Bat (Lasiurus borealis)
*Spotted Bat (Euderma maculatum)
Spotted Skunk (Spilogale putorius)
Red Fox (Vulpes fulva)
Plains Pocket Gopher (Geomys bursarius)

*Rare species in Wyoming according the Wyoming Game and Fish Dept. (134).

PAGES 85-87

The following replaces the terrestrial birds list on pages 85-87:

Birds:

Tree Swallow (Iridoprocne bicolor)
Bank Swallow (Riparia riparia)
Rough-winged Swallow (Stelgidopteryx rufficollis)
Water Pipit (Motacilla flava)
Bobolink (Dolichonus oruzivorus)
Red-tailed Hawk (Buteo jamaicensis)
Blue Grouse (Dendragapus obscurus)
Great Horned Owl (Bubo virginianus)
Common Flicker (Colaptes cafer)
Long-eared Owl (Asio otus)
Yellow-bellied Sapsucker (Sphyrapicus varius)
Hairy Woodpecker (Dendrocopos villosus)
Downy Woodpecker (Dendrocopos pubescens)
Northern Tree-toed Woodpecker (Picides tridactylus)
Dusky Flycatcher (Empidonax oberholseri)
Steller's Jay (Cyanocitta stelleri)
Gray Jay (Perisoreus canadensis)
Clark's Nutcracker (Nucifraga colubiana)
Black-capped Chickadee (Parus atricapillus)
Mountain Chickadee (Parus gambeli)
White-breasted Nuthatch (Sitta carolinensis)
Brown Creeper (Certhia familiaris)
House Wren (Troglodytes aedon)
American Robin (Turdus migratorius)
Townsend's Solitaire (Myadestes townsendii)
Hermit Thrush (Hylocichla guttata)
Swainson's Thrush (Hylocichla ustulata)
Veery (Hylocichla fuscescens)
Mountain Bluebird (Sialia currocoides)
Ruby-crowned Kinglet (Regulus calendula)
Bohemian Waxwing (Bombycilla garrula)
Warbling Vireo (Vireo gilvus)
Orange-crowned Warbler (Vermivora celata)
Yellow Warbler (Dendroica petechia)
Mac Gillivray's Warbler (Oporornis tolmiei)
Wilson's Warbler (Wilsonia pusilla)
Western Tanager (Piranga ludoviciana)
Black-headed Grosbeak (Pheucticus melanocephalus)
Evening Grosbeak (Hesperiphona vespertina)
Cassin's Finch (Carpodacus cassinii)
Lazuli Bunting (Passerina amoina)
American Redstart (Setophaga ruticilla)
Brown-headed Cowbird (Molothrus ater)
Western Bluebird (Sialia mexicana)
White-crowned Sparrow (Zonotrichia leucophrys)
Fox Sparrow (Passerella iliaca)
Lincoln's Sparrow (Melospiza lincolnii)

Rufous Hummingbird (Selasphorus rufus)
Green-tailed Towhee (Chlorura chlorura)
Turkey Vulture (Coragyps atratus)
Swainson's Hawk (Buteo swainsoni)
Ferruginous Hawk (Buteo regalis)
Marsh Hawk (Circus cyaneus)
Merlin (Falco columbarius)
*Peregrine Falcon (Falco peregrinus)
*Burrowing Owl (Speotyto cunicularia)
Sage Thrasher (Oreoscoptes montanus)
Lark Bunting (Calamospiza melanocorys)
Savannah Sparrow (Passerculus sandwichensis)
Grasshopper Sparrow (Ammondramus savannarum)
Vesper Sparrow (Pooecetes gramineus)
Lark Sparrow (Chondestes grammacus)
Sage Sparrow (Amphispiza belli)
Common Nighthawk (Chordeiles minor)
Barn Swallow (Hirundo rustica)
Short-eared Owl (Asio flammeus)
Black-billed Magpie (Pica pica)
Common Crow (Corvus brachvrhynchos)
Starling (Sturnus vulgaris)
House Sparrow (Passer domesticus)
House Finch (Carpodacus mexicanus)
Pine Siskin (Spinus pinus)
American Goldfinch (Spinus tristis)
Song Sparrow (Melospiza melodia)
Golden Eagle (Aquila chrysaetos)
Bald Eagle (Haliaeetus lencocephalus)
Horned Lark (Eremophila alpestris)
Loggerhead Shrike (Lanius ludovicianus)
Western Meadowlark (Sturnella neglecta)
Tree Sparrow (Spizella arborea)
Rough-legged Hawk (Buteo lagopus)
Lesser Goldfinch (Spinus psaltria)
Sage Grouse (Centrocercus urophasianus)
Mourning Dove (Zenaida macroura)
Brewer's Blackbird (Euphagus cyanocephalus)
Rufous-sided Towhee (Pipilo erythrophthalmus)
Gray-crowned Rosy Finch (Leucosticte tephrocotis)
Rock Dove (Columbia livia)
Common Snipe (Capella gallinago)
Yellow-headed Blackbird (Xanthocephalus Xanthocephalus)
Red-winged Blackbird (Agelaius phoeniceus)
Long-billed Marsh Wren (Telmatodytes palustris)

*Rare species in Wyoming according to Wyoming Game and Fish Dept. (134).

PAGE 87

Replace the terrestrial reptiles list on page 87 with the following:

Reptiles:

Sagebrush Lizard (*Sceloporus graciosus*)
*Western Smooth Green Snake (*Opheodrys vernalis*)
Common Bull Snake (*Pituophis melanoleucas*)
Eastern Short-horned Lizard (*Phrynosoma douglassi*)
Prairie Rattlesnake (*Crotalus viridis*)
Red-sided Garter Snake (*Thamnophis sirtalis*)
Western Plains Garter Snake (*Thamnophis radix*)
Wandering Garter Snake (*Thamnophis elegans*)
Eastern Short-horned Lizard (*Phrynosoma douglassi brevirostre*)
Eastern Yellow-bellied Racer (*Coluber constrictor flaviventris*)

*Rare species in Wyoming according the Wyoming Game and Fish Dept. (134).

PAGE 112

The first paragraph on page 112 is replaced by the following:

Stream systems in the treatment area could be contaminated with herbicides by accidental spillage, spray vapor drift, surface water runoff, and erosion sediments, and by leached herbicides in subsurface water flow. Other possible contamination routes might include overflow from contaminated water storage basins, such as stock ponds and reservoirs, and animal and plant excretions. Water contamination via any of these routes is not expected to reach unacceptable levels (see the supplement for page 173) for any duration (>24 hours) in the North Platte River or its tributaries. Consequently Tordon, Banvel, and 2,4-D contamination of the water systems in the treatment area is not expected to result in adverse or beneficial impacts on the water quality.

PAGES 124-125

The "Aquatic Birds" section on pages 124-125 is replaced by the following:

Aquatic Birds

Four studies have been located that document the effects of Tordon, Banvel and 2,4-D on mallard ducks (90, 91, 92, 137). The results of these studies indicate that mallard ducks are tolerant to extremely high concentrations of Tordon, Banvel, and 2,4-D (>2,000 mg/kg of picloram, 2,009 mg/kg of Technical Banvel and >2,025 of the sodium salt of 2,4-D). Toxicity data on other wild bird species are unavailable but the mallard evidence suggests that most aquatic birds may be fairly tolerant to Tordon, Banvel, and 2,4-D. Adverse impacts to mallard ducks from direct exposure would not be expected. Lack of evidence precludes more definite conclusions about other aquatic species.

Indirect impacts, both beneficial and adverse, could result from treatment of weeds in stream bank habitat. Removal of weeds and some non-target vegetation along stream banks may have variable effects on aquatic avifauna depending on the particular species in question. Some species may be adversely affected by the loss of nesting and cover habitat and some invertebrate food sources, whereas other species may be beneficially affected by habitat improvement. However, these impacts are not quantifiable and it is anticipated that such impacts would be very minor.

The second paragraph on page 126 is replaced by the following:

Picloram is poorly absorbed by soil particles, highly persistent in the soil, and mobile in soil water; thus, it could contaminate streams from ground and surface water runoff. Woodward (72, 136) has studied the acute toxic and chronic effects of picloram on cutthroat (Salmo clarki) and lake trout (Salvelinus namaycush). Lake trout and cutthroat trout in the yolk absorptive and fry stages were the most susceptible to picloram. In a 60-day study, yolk absorption in lake trout was increased 4-5 days above normal and fry survival was significantly reduced by concentrations as low as 35 ug/l (35 ppb). Woodward (72) further reported that he was unable to determine an exact no-effect concentration for picloram because growth was affected at the lowest levels tested. Table 21 presents the data Woodward (72) obtained on lake trout growth and development in various concentrations of picloram. It should be noted that a 60-day chronic toxicity study is not representative of natural conditions.

PAGES 129-130

Table 22 on pages 129 and 130 is replaced by the following:

Table 22. Accute Toxicity of Picloram (potassium salt) AI to Adult Trout Species.

Species	Water Temp.	Hours Exposure	ppm AI	% Mortality	Reference
Cutthroat trout	5°C	96	6.50	50	72
	10°C	96	5.00	50	72
	15°C	96	4.10	50	72
	10°C	96	8.60	50	72
	10°C	96	4.70	50	72
	10°C	96	4.15	50	72
	10°C	96	3.70	50	72
	10°C	96	3.45	50	72
	10°C	96	3.45	50	72
Lake trout	5°C	96	3.60	50	72
	10°C	96	4.25	50	72
	15°C	96	2.35	50	72
	10°C	96	4.95	50	72
	10°C	96	2.70	50	72
	10°C	96	2.05	50	72
	10°C	96	2.15	50	72
	10°C	96	1.55	50	72
	10°C	96	2.10	50	72
Brook trout	---	96	320.00	0	51*
Brown trout	---	96	100.00	0	51*
Rainbow trout	---	96	100.00	0	51*
	---	96	27.00	50	78
	---	96	13.00	50	78
	55°F	24	34.00	50	79
	55°F	48	25.00	50	79
	55°F	90	24.00	50	79
Brook trout	50°F	24	91.00	50	51, 80
	50°F	96	91.00	50	51, 80
	50°F	96	69.00	0	51, 80
Brown trout	50°F	24	52.00	50	51, 80
	50°F	96	52.00	50	51, 80
	50°F	96	22.00	0	51, 80
Rainbow trout	50°F	24	50.00	50	51, 80
	50°F	96	58.00	50	51, 80
	50°F	96	22.00	0	51, 80

*Formulated picloram product (see Appendix 8).

Table 23 on pages 131 and 132 is replaced by the following:

Table 23. Accute Toxicity of Picloram (potassium salt) AI to Various Adult Fish Species.

Species	Water Temp.	Hours Exposure	ppm AI	% Mortality	Reference
Fathead minnow	---	96	100.00	0	51*
Green sunfish	---	96	180.00	0	51*
Black bullhead	---	96	320.00	0	51*
Goldfish	75°F	24	27-36	50	81
	75°F	48	21-32	50	81
	75°F	96	14-32	50	81
Bass	75°F	24	19.70	50	81
	75°F	48	13.10	50	81
Bluegill	63°F	24	26.50	50	82
	63°F	48	22.50	50	82
	63°F	72	21.80	50	82
	63°F	96	21.00	50	82
Coho salmon	63°F	24	29.00	50	82
	63°F	48	25.00	50	82
	63°F	72	24.00	50	82
	63°F	96	21.00	50	82
	63°F	24**	29.00	100	82
	63°F	48**	29.00	100	82
	63°F	24**	25.00	50	82
	63°F	48**	25.00	100	82
	63°F	24**	25.00	35	82
	63°F	48**	24.00	90	82
	63°F	24**	21.00	30	82
	63°F	48**	21.00	45	82
	66-88°F?	--	5-8	30***	82
Fathead minnow	50°F	24	52.00	50	51, 80
	50°F	48	32.00	50	51, 80
	50°F	72	32.00	50	51, 80
	50°F	96	29.00	50	51, 80
	50°F	96	22.00	0	51, 80
Green sunfish	50°F	24	91.00	50	51, 80
	50°F	96	91.00	50	51, 80
	50°F	96	39.00	0	51, 80
Black bullhead	50°F	24	91.00	50	51, 80
	50°F	96	91.00	50	51, 80
	50°F	96	69.00	0	51, 80

Table 23 (Cont). Accute Toxicity of Picloram (potassium salt) AI to Various Adult Fish Species.

Species	Water Temp.	Hours Exposure	ppm AI	% Mortality	Reference
Bluegill	65°F	24	8.20	50	79
	65°F	48	7.30	50	79
	65°F	96	5.40	50	79
Lake emerald shiner	69-78°F	4	64.60	50	83
	69-78°F	24	34.10	50	83
	69-78°F	48	34.10	50	83
	69-78°F	96	30.30	50	83
Bluegill	77°F	24	43.20	50	84
	77°F	48	43.20	50	84

*Formulated picloram product (see Appendix 8).
**Fish forced to swim against current of water.
***Some loss of weight in survivors.

PAGES 147-148

The last paragraph on page 147 (and continuing on page 148) is replaced by the following:

Non-target browse plants such as big sage (*Artemisia tridentata*), antelope bitterbrush (*Purshia tridentata*), mountain mahogany (*Cercocarpus montanus*), and Oregon grape (*Mahonia* spp.) are critical components of the mule deer's winter diet. Removal of significant numbers of these important browse species would have an adverse impact on wintering mule deer populations in the Bennett Peak treatment area. The degree of this potential impact on wintering mule deer depends on the precise location of the actual critical habitat, the severity of the weed infestation in the critical habitat and the potential of removal of important browse in the critical winter range. Sufficient information is unavailable at the present time to allow for a reasonable quantitative assessment of this potential impact. However, it is believed that any adverse impact from herbicide application on public lands would be minimal.

PAGE 155

The following paragraph is added to page 155 just prior to the first paragraph:

Treatment of weed infestations with herbicides does not often cause severe insect outbreaks. Large insect outbreaks are not expected to occur following herbicide treatment as large contiguous areas are not proposed for treatment.

PAGE 166

Water mitigation number 5 is replaced by the following:

5. Wyoming Department of Agriculture will monitor all streams adjacent to public lands treated with herbicides to determine whether herbicide concentration levels are within acceptable limits by monthly sampling and sampling 12 to 24 hours after each moderate rainfall. Public water supplies for the towns of Saratoga, Rawlins, Sinclair, and Encampment will be monitored in the same manner and the results sent to these respective towns. Results of all monitoring will be sent to the Wyoming Department of Environmental Quality--Water Quality Division. If at any time, herbicide concentration levels are above acceptable limits, additional mitigation measures will be developed and implemented.

Operational Procedures mitigation number 3 is replaced by the following:

3. The herbicide label recommendations should be followed explicitly for the cleaning and disposal of containers and equipment. Cleaning application equipment near streams or surface waters should not be allowed. Also, herbicide containers will be disposed of in accordance with the technical recommendations of the Solid Waste Management Division of Wyoming Department of Environmental Quality and the Wyoming Department of Agriculture.

PAGE 171

The following are added to the Operational Procedures mitigations on page 171:

7. The Carbon County Weed and Pest Control District will notify the Rawlins District BLM office of the location and date of herbicide applications prior to initiation so that a BLM Compliance Specialist can be on-site during all operations on public lands.

8. The BLM Compliance Specialist on-site during all herbicide applications on public lands will photograph the areas before and after treatment.

9. BLM will notify the Water Quality Division of the Wyoming Department of Environmental Quality of location and date of all herbicide applications on public lands.

PAGES 172-173

The last paragraph on page 172 (continuing on page 173) is replaced by the following:

A herbicide monitoring system will be developed by the Wyoming Department of Agriculture, which is acceptable to BLM, for monitoring the waters within the proposed treatment sites and public water supplies for the towns of Saratoga, Rawlins, Sinclair, and Encampment before, during, and after herbicide applications. The results of individual monitoring studies will be sent to the respective towns and the Wyoming Department of Environmental Quality--Water Quality Division will receive the results from all monitoring studies. Samples will be obtained monthly and also 12 to 24 hours after moderate rainfall, to detect the presence of herbicides in the water. If at any time, herbicide concentration levels are above acceptable limits, additional mitigation measures will be developed and implemented.

Unacceptable levels is a term that needs qualification. The U.S. Environmental Protection Agency has established the level 0.1 mg/l as the allowable level for 2,4-D in domestic water supplies. Allowable levels for Tordon and Banvel have not been established by the EPA. For purposes of this assessment, the following assumptions are made regarding acceptable limits for Tordon and Banvel:

Tordon--0.3 mg/l	(Woodward--136)
Banvel--1.0 mg/l	(Field & Lab, Inc. data review--see toxicity data on page 128 of the EAR)

PAGE 177

The "Irreversible or Irretrievable Commitment of Resources" section on page 177 is replaced by the following:

IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

There could be some irreversible loss of topsoil from some of the treatment areas.

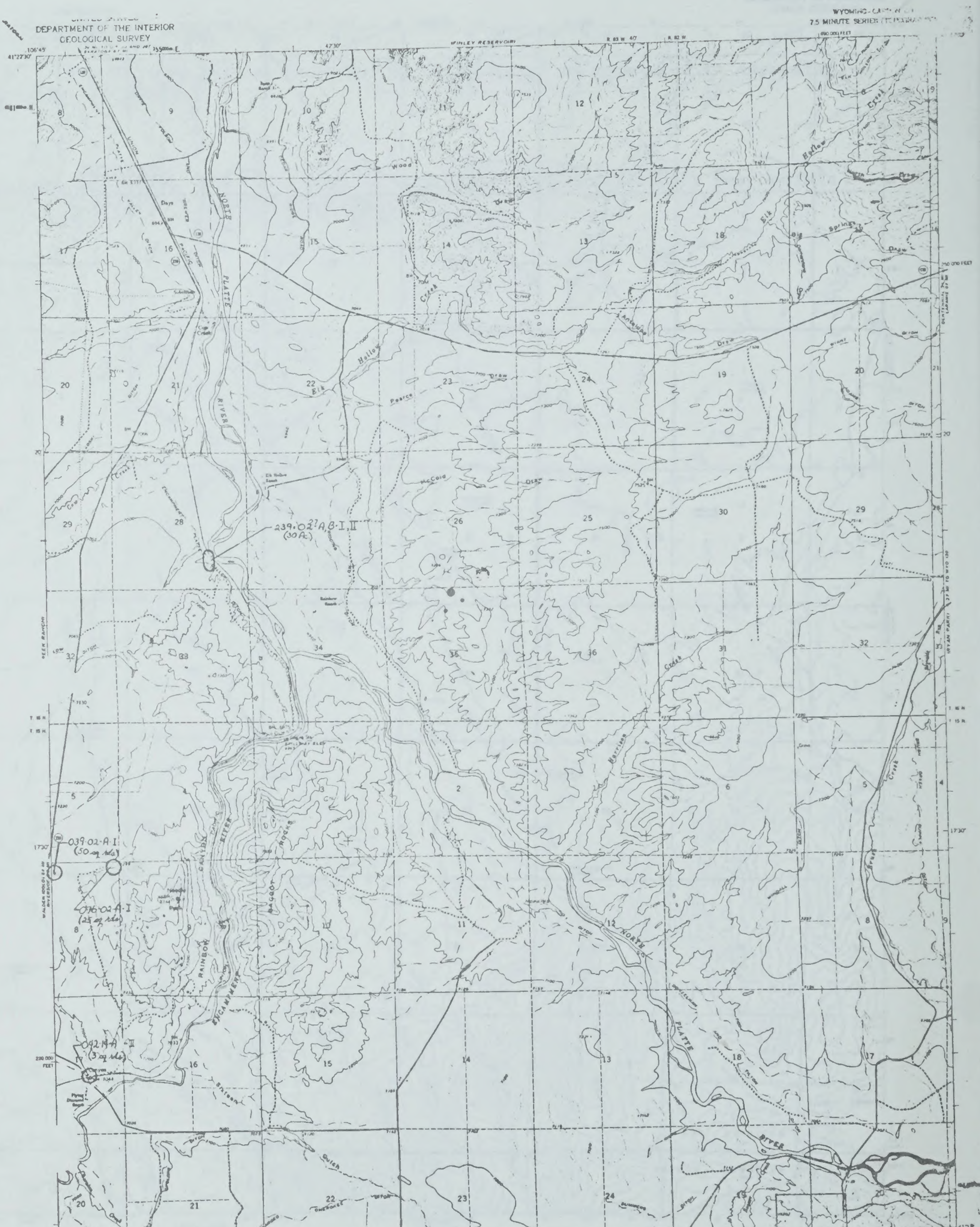
PAGE A1-1

The following replaces the term "active ingredient" on page A1-1 in Appendix 1--Glossary of Terms:

Active Ingredient (AI)--That part of a chemical compound directly responsible for the control of the specific pest.

Gunst Reservoir Quadrangle

S2-25



Cow Creek Quadrangle

S2-26

DOW CHEMICAL U.S.A.

January 19, 1979

SUITE 160
10890 BENSON
SHAWNEE MISSION, KANSAS 66210

913 · 341-2500

Bureau of Land Management
Rawlins District Office
P.O. Box 670
Rawlins, WY 82301

SUBJECT: NORTH PLATTE RIVER AREA ENVIRONMENTAL ASSESSMENT RECORD

Dear Sirs:

I have critically reviewed the North Platte River Area Environmental Assessment Record dated December, 1978, which was sent to me by Mr. George Hittle.

I find this EAR to be extremely well written and to cover the entire subject as needed for an Environmental Assessment Record. I think this is an indepth study which very fairly and impartically outlines the program, the pro's and con's of such a proposed method for the control of noxious weeds treatment in the North Platte River Area. I feel that the Weed and Pest Coordinator, Mr. George Hittle and the Project Coordinator, Mr. Ronald Broda, acting as an Agricultural and Environmental consultant are to be complimented on the caliber and fairness of the exposition of information found in the EAR.

This report should certainly alleviate many of the concerns that may have been existent in the BLM lands.

Sincerely,

Paul Ritty

P. M. Ritty
Senior Product Tech. Specialist
Dow Chemical Company USA
10890 Benson Drive, Suite 160
Shawnee Mission, Kansas 66210

wje

cc: Mr. George Hittle, Weed & Pest Coordinator
State of Wyoming, Wyoming Dept. of Agriculture
Cheyenne, Wyoming 82002

INDEX NUMBER 2

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

Game and Fish Department

CHEYENNE, WYOMING 82002

EARL M. THOMAS
DIRECTOR

February 23, 1979

EAR 209, North Platte River Area Designated (Noxious) Weed Treatment Program.

Mr. Paul D. Leonard, Chief
Division of Resources
Bureau of Land Management
2515 Warren Avenue
Cheyenne, Wyoming 82001

Dear Mr. Leonard:

We have reviewed the Environmental Assessment Record (EAR) for the proposed designated (noxious) weed treatment program for the North Platte River Area in the Rawlins (BLM) district and offer the following comments in the interest of the wildlife resource.

General Comments

The EAR addresses the noxious weed control program to be carried out on BLM lands along the Upper North Platte River in Carbon County. BLM lands comprise 416.6 acres of 5221.6 to be treated. Only the BLM lands are considered in this EAR, but we are also concerned about impacts of spraying on wildlife and wildlife habitat on state and private lands. Our comments apply to the portion of the program on state and private lands, as well as on BLM lands.

This is a five-year program, with retreatment anticipated. There are no data included that suggest the program will succeed in controlling weeds. No evaluation system is proposed to monitor effects of the program. The nature of the weeds, terrain, range conditions, extent of disturbed sites, and existing seed sources indicate that this program is likely to expand and continue for an indefinite period of time. The long-term implications of continuous herbicide application are of concern to wildlife management.

Many, if not all, of the conditions that have created this infestation will continue to exist after completion of the program in 1983. If treatment is not coupled with improved land management practices long-term benefits will be minimal.

Specific Comments

Page 6. Roundup, a herbicide which poses little threat to trout fisheries, was not proposed for use.

Page 27. Three methods of herbicide application are spelled out, however, the most common method utilized in the past was to broadcast beads by hand in a fifteen-foot circle around the target species. This method is not addressed and will, in all probability, be used again so should be included in the EAR.

Pages 33 and 34. The best time for application of Banvel to Canada thistle and leafy spurge is in the early bud stage (normally in June), however, Banvel beads were being applied on October 13, 1978, to Treasure Island for these species. Application should be keyed to dates of maximum effectiveness.

Page 36, last paragraph. Tordon 22K is not preferred for use near trees and water, but the document appears to recommend the herbicide for use on the Platte River tributaries.

Page 40. Overgrazing should be mentioned as one reason why noxious weeds invade an area. A good grazing system would eliminate some of the problem, as mentioned on Pages 44 and 45. Preventive measures that can be used to reduce the possibility of weed dissemination by wildlife should be mentioned here.

Page 43. Fire is mentioned as being destructive to desirable plant species. Chemical control is also destructive to non-target species with more prolonged effects than caused by fire.

Page 44. We encourage development of proper biological controls.

Page 63, last paragraph. Gravel mining operations and bulldozing vegetation along the river are occurring. These are not natural and contribute to streambank erosion.

Page 81. Snipe, blackbirds, and marsh wrens are not aquatic, even though they nest or feed near water.

Page 82. The eastern short-horned lizard and eastern yellow-bellied racer are not aquatic. Scientific names for brook trout and Johnny darter are spelled incorrectly.

Page 84. The Eastern cottontail would not be found in the Saratoga Valley, but the mountain cottontail (Sylvilagus nuttallii) would.

Pages 91 through 97. The Ecological Interrelationships section needs more discussion of the relationship of various animal species to plant species, and should include plants scheduled to be sprayed and non-target species that will be reduced as a result of the spraying.

Page 93. The document notes that deer browse species are slowly deteriorating along with the quality of winter deer habitat. Unless there is an unanticipated recovery by broad-leaved species, this spraying will greatly impact big game winter range. Conversion of a shrub-grass community to a grassland will adversely affect deer, antelope, elk, and bighorn sheep where winter range is treated. Elk and bighorn sheep depend upon browse plants during severe winters when grasses are snow-covered and unavailable. In less severe winters, elk and bighorn sheep would be favored at the expense of deer and antelope, which seldom graze. Loss of shrubs on an already overutilized winter range will not benefit the big game dependent upon the winter range for survival. The proposed spray project will impact 343 acres of bighorn sheep critical habitat, 310 acres of mule deer critical habitat, and 300 acres of critical habitat for elk.

Page 96. The fisheries description is inadequate.

Pages 110 and 111. On Page 110, first paragraph, soil erosion is listed as a detrimental impact. On Page 111 reduced soil erosion is listed as a beneficial effect of the program.

Page 113, second paragraph. The water samples were taken in mid-stream where dilution factors were high. Still water areas (pools) close to the source should also be sampled.

Page 116. All water samples noted were taken in the Platte River. Results in the tributaries where greater numbers of young-of-the-year trout are found, and where Tordon would be found in higher concentrations, would be more meaningful.

Page 120, second paragraph. When the applicator spreads beads in a fifteen-foot circle around the target, many non-target species are killed. In a riparian area this is an adverse impact.

Page 124. The removal of non-target species which are important food and cover for wildlife will not be beneficial to wildlife. The EAR draws no conclusions about the impact of this on the plant community. An increase in grasses followed by an increase in forbs and shrubs may not occur. There may be a loss of plant cover on treated sites, poor reproduction from residual grasses, increased soil erosion, and an eventual increase in annuals and broad-leaved perennials (i.e., noxious weeds). The net result, especially on poor range sites, may be an overall decline in range conditions rather than improvement.

Page 125. The impacts on all aquatic birds cannot be based upon the reported impact on the mallard. Mallards cannot be considered to be the same as gulls or rails. Because of the size difference, a teal may not be as resistant to herbicides as a mallard.

Reduction of nesting cover as a result of herbicide spraying will impact waterfowl and other birds that nest near water. Loss of vegetation, if it decreases numbers of insects, will adversely impact insectivorous birds. Can the loss of insects as a result of ingestion of sprayed vegetation and the resultant reduction in the amount of food available to birds be determined?

Page 129. Tables 22 and 23 are impossible to interpret since the amount of active ingredients is not listed. For instance, Table 22 shows brook trout can tolerate 320 ppm, however, this may be 80 per cent inert ingredients. Toxicity information available from the U. S. Fish and Wildlife Service Lab in Jackson, Wyoming, would be more appropriate.

Page 136. Although Saprolegnia infestations in fathead minnow eggs may have been reduced in the instance cited, we anticipate no fisheries benefits from 2,4-D contamination of streams.

Page 143. We do not believe it should be assumed that the effects of herbicides on wild mammals would be similar to the effects on laboratory and domestic animals tested. The table on Page 141 illustrates that it takes up to four times as much herbicide to kill a rat as it takes to kill a mouse, yet the same amount of herbicide required for a mouse will kill a rabbit. This suggests a large degree of species-specific variability.

Pages 147 and 148. The discussion of impacts on critical mule deer habitat and other wildlife habitat near Bennett Peak should include a statement assessing whether the overall effect of the spray project will be positive or negative. We believe that (because of the critical nature of the habitat) an area like this should only be subject to spot application of herbicide to prevent loss of important browse species. The document indicates that non-target browse species on critical mule deer winter range will be affected, but the magnitude of impact on mule deer is not indicated. The document cites lack of information. However, critical habitat has been delineated, weed infestations have been located, and estimates of browse loss can be predicted by range technicians. Impacts on mule deer can and should be estimated.

Page 151. Removal of weed species, on which many birds depend for food and cover, and replacement by grasses, which are useful only to a very small number of seed-eating birds, will not have overall positive effects on terrestrial birds. We do not believe that habitat for terrestrial birds "may be improved over a longer period of time, perhaps 8 to 10 years...."

Pages 154 and 155. It appears that there will be losses of earthworms and other invertebrates as a result of herbicide accumulation in soil and on vegetation. What is this going to do to the food supply for birds, mammals, and soil properties which depend on these species?

Pages 157 and 158. The statement; "These weeds are not natural components of the ecosystem in the proposed program area, thus it is unlikely that most of the native animals utilize them for much more than cover." is not a valid conclusion. Some exotic species are heavily used for food by wildlife (e.g. yellow and white sweet clover).

Page 160. Since weed and pest district crew members will carry out treatment operations on federal lands, BLM should have observers present during treatment.

Page 162. Starlings, sparrows, and the Norway rat are cited as examples of problems resulting from introduction in this country. Although potential hazards do exist, introduction of these three species was not for biological control. DeBach (1974) Biological Control by Natural Enemies, explains both benefits and cautions for biological control.

Page 163. We support the Management Alternative as being the most realistic approach to the problem. Many of the smaller parcels of BLM land are incorporated into pastures containing deeded or state land essentially under the management of the owner of the deeded land. Many of the sites scheduled for treatment are in rugged terrain. Reclamation or reseeding of grasses on these sites is not likely to be successful unless considerable effort is expended and grazing is deferred. Even then, considerable time may be required. Herbicide spraying is an expensive treatment for symptoms of poor range management. It has to be coupled with good management practices to be effective.

Page 166. Soil mitigation measure number 5 is unclear. What can be done once the herbicide is in the stream?

Page 168. We have observed that extra heavy treatment at the top of the slope sometimes results in herbicide percolation to the water line. Measures to prevent this should be incorporated into the aquatic slope restrictions.

Page 169. In many cases, the person applying the herbicide will not know that he has sprayed within ten feet of birds which conceal their nests. This mitigation measure will have little effect. Only two mitigation measures are offered for terrestrial wildlife, neither of which will have been effective.

Page 170. The Wyoming Game and Fish Department should be notified when herbicides are applied to Department lands.

Page 172. The herbicide monitoring system should include photographs, both before and after treatment.

Page 173. The last paragraph notes that it is impossible that levels above 1 ppm will be reached in waterways. Conversations with Dan Woodward (USF&WS Lab) indicate that, to be on the safe side, 0.3 ppm should be the maximum allowed. This would minimize some of the adverse effects which occur below the 1 ppm lethal point.

Pages A12-3 through A12-15. According to the susceptibilities to Tordon listed here, there could be losses of dogwood, juniper, pine, spruce, fir, lupine, willow, cottonwood, woods rose, elderberry, raspberry, snowberry, dandelion, clover, vetch, boxelder, alder, mountain mahogany, bitterbrush, and all sagebrush species except big sage. If care is not taken in spraying, there could be significant impacts to the ecosystem in the Saratoga Valley as a result of this program.

Potential impacts of the project have been understated. There could be heavy impacts to wildlife habitat and invertebrates used as food by many birds and mammals. There may be severe impacts to critical big game winter range. Proper range management practices should be combined with the noxious weed control program.

The following precautions should be included:

1. Extreme care should be taken to avoid non-target species, especially in riparian zones and on big game winter ranges.

2. Spraying guidelines should be followed precisely.

3. BLM should supervise treatment activities on BLM lands.

4. BLM and the Game and Fish Department should attempt to determine the impact of this spraying on target and non-target species on big game winter range.

5. Application of herbicides should not occur before July 15 on bighorn sheep lambing areas to avoid disturbance to the sheep at this critical time.

6. These precautions and those presented in the EAR should be required on State of Wyoming lands as well as BLM land.

If we can be of further help, do not hesitate to call on us.

Sincerely,

W. DONALD DEXTER, ASSISTANT DIRECTOR
WYOMING GAME AND FISH DEPARTMENT

WDD/HBM/mlr

cc: Fish Div.
cc: Game Div.
cc: R&D Div.
cc: SPC

INDEX NUMBER 3

ONE BAR ELEVEN RANCH

Box 646 • Saratoga, Wyoming 82331 • (307) 327-5571

. E. Rouse

Ref. 1791
9221

Mr. Floyd Ewing, Area Manager
Medicine Bow Resource Area
Bureau of Land Management
P. O. Box 670
Rawlins, Wyoming 82301

Dear Mr. Ewing:

This is in reply to your letter of January 10 requesting comment on the Noxious Weed Treatment Program for the North Platte Eiver area.

It is most encouraging to a landowner who has fought leafy spurge for the past 24 years to see the coordinated effort now being made to control this as well as other weeds. What is most encouraging, however, is to learn that the BLM is now going to enter into the program for the control of leafy spurge, if I correctly interpret your letter and the report. In one particular area on my ranch, where my lands practically enclose 640 acres of BLM land, my effort to control leafy spurge has been futile because no effort has been made to control this weed on the BLM land. The same condition has existed where I am reinfested in Sec. 16 T. 15 R 82 along the North Platte River because the BLM land adjoining me to the east along the river is not treated. This one is included in your proposed area for treatment.

From the experience gained in attempting to control leafy spurge since 1955, I offer the following comment.

1. Tordon must be applied at the recommended rate to infected areas annually for several years. The length of time Tordon should be applied depends on how thorough a follow-up program with 2,4-D is applied.

2. After the Tordon treatment has been started, annual applications of 2,4-D , when leafy spurge seedlings are about 6 inches high, are essential. This kills the new plants and if applied at the right time prevents seed formation on the old plants.

3. Continued application of Tordon will eventually sterilize an area so treated to the extent that there is no regrowth of leafy spurge but there is also no plant growth of any kind. The only way grass regrowth in these areas can be established is to decrease or discontinue the application of Tordon and use 2,4-D to kill seedlings and prevent seed formation.

4. The location of areas of leafy spurge to be treated, beginning on page 7 of your report, does not appear to be complete. None of the land in my ranch, which includes 5,720 acres deeded, 960 BLM and

800 state land in the western half of Township 15, Range 82, is listed. There are areas in the following sections where there is leafy spurge that needs treatment:

T. 15, R 82
Sections 16, 17, 18, private lands
Sections 19, 20, 29, 30, BLM and Private (This is the area referred to in the second paragraph of this letter)

In T.15, R.83W, Sections 12, 13 also have leafy spurge.

5. Do not let the Wyoming Game and Fish Department interfere with your weed control program. Apparently the Game & Fish people from some faulty tests have the notion that Tordon applied along stream banks is harmful to fish. I have observed some absurd tests they have conducted on my property in an endeavor to prove this that were meaningless. Migrating deer are a known source of infestation of leafy spurge on my ranch I have been told by weed scientists - a fact ignored by the Game and Fish Department.

The comments in paragraphs 1, 2, and 3 above are based on efforts to control leafy spurge on my land since 1955, all of which was done under the direction and supervision of the Weed people at Wyoming University. I have spent a total of over $100,000 in this effort, in addition to such help as I have received at times from government agencies.

Heavy concentrations of 2,4-D were used until Tordon became available. Infested areas increased until Tordon was used. Considerable experimental work was done under the supervision of Dr. Harold Alley of the University of Wyoming to determine optimum rates of application of Tordon in both granular and liquid form.

Old plant growth was eliminated in large areas by repeated annual application of Tordon, but no grass was re-established. Continued application of Tordon was thought necessary to prevent new seedlings from becoming established. Later it was found that treatment with 2,4-D in late spring when leafy spurge seedlings were 3 to 6 inches high sufficed to keep new growth from becoming established provided there was spot treatment of occasional old plants.

For the past 5 years aerial spraying of 2,4-D annually has prevented leafy spurge from becoming reestablished in several large areas. As grass growth becomes denser it appears that before long the spraying of 2,4-D can probably be discontinued. This point has not yet been established.

If I can be of any assistance in your efforts at noxious weed control, please let me know.

I would greatly appreciate it if you would confirm my assumption that BLM lands in my area will be treated with Tordon for leafy spurge control this year.

Sincerely yours,

J. E. Rouse

J. E. Rouse

INDEX NUMBER 4

311 W. Flaming Gorge Way
Green River, Wyoming 82935
February 6, 1979

Floyd Ewing, Area Manager
Medicine Bow Resource Area
Bureau of Land Management
P. O. Box 670
Rawlins, Wyoming 82301

Dear Mr. Ewing:

Thank you for the opportunity to review and comment on the North Platte River Area Designated (Noxious) Weed Treatment Program Environmental Assessment Record. I would like to applaud you and your staff for the research that has gone into this E.A.R. and for the honesty of admission of the many unknown factors relating to the study.

I am not an expert on weed treatment programs. I do however have some practical knowledge of weed ecology and various other ecological principals having been raised on a Wyoming ranch and having worked on several environmental studies since graduating from the University of Wyoming with a degree in Wildlife Management and Conservation. Several aspects of the study appear to be somewhat deficient and contradictory. I would like to discuss these issues to as stated in the E.A.R. "insure that environmental values are considered in decisions regarding the proposed application of herbicides."

It disturbs me that a better vegetative inventory was not conducted in the proposed treatment area. Dominants such as trees and shrubs are generally well known in the area. Forbs and grasses however are not so well known and apparently were not inventoried even though they will be the two most affected forms of vegitation. Forbs make up a very large percentage of plant species found in riparian zones, which appears to be, where most of the spraying will be done. Many of the forbs which will be destroyed may be very important components of the diet of grazing animals during the growing season. Trees and willows which are extremely important to all facets of riparian ecology will also be destroyed.

I am deeply concerned about possible detrimental effects to the stream ecosystem of the area. Area streams, particularly the North Platte River, are of regional and national importance as a trout fishery. In recent years several articles have appeared in outdoor recreation magazines attesting to the quality fisheries in the area. The E.A.R. states that water contamination from herbicides is not expected to reach levels over 1 ppm for long periods and that adult trout would not be affected at this level. It has been shown however that mortality in sac and swim-up fry is significantly increased by herbicide concentrations of only 35 ppb. A few years ago I assisted with a stream ecology project conducted in the Medicine Bow National Forest. Several dozen trout were aged during the study. Out of that number only one fish was found to have an age of more than four years. At present the area's fishery is maintaining itself almost entirely by natural reproduction. Due to the short life span of trout a five year treatment program, with follow up spraying for several years afterwards has the potential of having a major effect on trout populations within the treatment area. Weed treatment will as stated in the E.A.R. occure concurrently with spawning activities of brook and brown trout. Spraying will also occure during the time when rainbow and cutthrout eggs are hatching and developing into the fry stages.

The E.A.R. states that the treatment program will increase soil erosion. Already 57% of the area experiences moderate erosion and 27% experiences slight erosion. Increased soil erosion could be very detrimental to trout egg survival as well as the survival of other aquatic organisms. It has been shown that certain aquatic organisms may be killed by herbicide concentrations of as little as 0.2 ppm. This could have a severe effect on the areas fishery since these organisms make up an intricate part of the food chain.

The E.A.R. brings out that a large part of the treatment area lies on wildlife winter range, part of which is critical. Shrubs such as sagebrush, bitterbrush, mountain mahogany and Oregon grape make up a major portion of the winter diet of deer, elk and bighorn sheep. These vegetative species will all be adversely affected by the treatment program to the enhancement of grass species which are of little value as winter forage.

Studies have shown that invertebrate pests such as grasshoppers can increase dramatically after herbicide treatment, possibly because certain preditory insects are killed by the same treatment. Many herbicide programs have had to be followed up with pesticide treatment programs.

It is known that for the most part noxious weeds are not a problem on good quality rangelands. Weeds invade disturbed areas or range that is in poor condition. In many instances the disturbance is due to overgrazing. It is stated in the E.A.R. that livestock use is excessively heavy along certain stretches of riparian habitat. This has been a major problem in the mountainous west. Cattle tend to congrigate and therefore over utilize stream bottom vegetation while surrounding rangeland is under utilized. It was noted in the E.A.R. that a very high percentage of the treatment area is located in riparian zones. I therefore suspect that overgrazing may be the problem in this area. If this is the case it appears that this program is to treat the symptoms and not the disease. It was interesting to note that reduction of livestock numbers or curtailment of grazing on severely affected areas were not mentioned as possible alternatives to the herbicide program.

Several weed treatment studies have shown that the very species that are trying to be eradicated are the very ones that reinvade the area most readily after treatment. This is due to the extraordinary ability of these weeds to establish themselves on disturbed areas. Native vegetation on the other hand usually do not reinvade the area until vegetative successional patterns are such that conditions favor their survival. Weedy species are most always the first step in the successional sequence of a disturbed area. They can then remain indefinitly if a disclimax community is created by some continual disturbance such as herbicide treatment or overgrazing.

It appears as though this program is designed to turn the area into a monoculturistic grassland to be used entirely and exclusively by the livestock industry. This is not multiple use!

Weeds can become a problem on cultivated lands and weed treatment programs may be necessary in some instances on these lands. Public lands however should only be subjected to such programs in rare instances. Especially when management changes can obtain the desired result without the destruction of a five year herbicide program. I would therefore like to propose the following recommendations.

1. Herbicides should be used on private lands if the need is shown to exist with careful supervision.

2. Herbicides should not be used on any known critical wildlife winter range.

3. Livestock grazing should be decreased or eliminated on poor condition riparian zones.

4. Revised management plans should be devised and implimented to insure that riparian areas are not overutilized in the future.

5. Spot spraying should be done on public lands only in isolated areas of heavy weed infestations.

Sincerely,

Ronald K Smith

Ronald K. Smith, President
Green River Basin Chapter
Izaak Walton League of America

cc: Dick Randall
Bart Koehler
Jack Pugh
Bill Sperry

Defenders OF WILDLIFE 2/11/79

Floyd Ewing, Area Manager
Medicine Bow Resource Area
Bureau of Land Management
Box 670
Rawlins, Wyoming 82301

COMMENTS OF DICK RANDALL, FOR DEFENDERS OF WILDLIFE, ON THE ENVIRONMENTAL ASSESSMENT RECORD OF WEED TREATMENT IN THE NORTH PLATTE RIVER AREA.

Because there are so many environmental statements surfacing these days it is impossible to thoroughly study each one and submit deserving and adequate comments.

This EAR deserves high-marks for the wealth of data included and it is refreshing to read a document in which the authors do not profess to have all the answers.

I believe there are several omissions and inadequacies in this report and this missing data should be provided.

Your vegetative inventory appears to be incomplete. Much of the proposed treatment area includes riparian zones. Surely, numerous forbs are native to these areas and yet, the only mention they received was, "numerous forbs" in the 7 to 10 thousand foot level.

If the inventory was so superficial as to preclude listing forb species then I would question the statement, "No plants proposed for threatened or endangered status are know to occur in the area." Of course, "not known," and "not-found," are two different things. Did anyone look?

Further, forbs are utilized by many species of wildlife and most certainly herbicides would destroy these plants and contribute to disruption of the ecosystem.

The statement, "No irreversible commitments of natural resources are anticipated from the proposed program" is not entirely correct.

Some of the larger cottonwoods will be lost only for a few human-lifetimes, and many willows for the duration of the treatment program, plus a decade or so. However, unless someone is prepared to travel to a delta somewhere and haul back Wyoming dirt, then there is an important irreversible loss.

Statements on pages 110 and 174 indicate erosion will increase, for a time period of a few months or a few years (quite a spread). Because this EAR does not adequately address the cause of infiltration by exotic or unwanted plant species, I believe erosion could continue much longer and be much worse than anticipated.

Most experts will agree, plant species listed as "noxious" are opportunists that thrive in areas of surface disturbance. In many areas, over-grazing most certainly opens the door to noxious weeds.

It appears (from personal observation) that riparian areas included in this EAR have been tromped and grazed beyond any kind of responsible use of the land. And yet, this EAR proposes that grazing be continued as usual, allowing no time for re-establishment of vegetation.

The following are BLM guidelines which speak for themselves. Would the writers please comment, 1) Were these guidelines the result of someones desire to make rules or are they valid recommendations? 2) Will these guidelines we waived for this project? 3) If the guidelines are waived, will they still be left in the BLM books so as to confuse the lay-public into believing there are really rules and regulations?

"Instruction memo 75-430. All areas treated by chemicals must be deferred for two full growing seasons. Grazing must be stopped when spraying begins and further livestock use deferred until after seed-ripe time following the second growing season."

"Stream Management, 672. (7) Avoid use of herbicides adjacent to streams while controlling unwanted vegetation. Direct kill of fish is possible, but the loss of streamside vegetation may be more damaging."

"Department of the Interior Guideline for use of Pesticides. (2) No pesticides will be used when there is a basis for belief that A. Water quality will be degraded. B. Hazards exist that will unnecessarily threaten fish, wildlife, their food chain, or other components of the natural environment." (this guidleline included because page 155 indicates herbicide application may lead to a lengthy grasshopper spraying project).

"Brush and Weed Control, 7311. (1) A. Limit use of chemicals to those areas absolutely necessary to meet management objectives and responsibilities. They must clearly pose no threat to human health, domestic animals, or fish and wildlife.
(2) B. Restrict vegetative control to flat or moderate slopes. Do not remove vegetation from steep slopes, rough areas, or stream borders."

Why is this EAR designed to produce a mono-culture plant community of mostly grasses? Riparian wildlife communities need more than grass for food and habitat, and grass is a poor stabilizer for erosive river banks or steep, shallow-soil slopes.

On page 169 we find, "Apply treatment after July 15th to avoid potential kill of trout species during yolk-absorbtion and fry stages of development."

Isn't it true that rainbow and cutthroat eggs hatch during June, or July? Further, do not Brown and brook trout spawn from August till (sometimes including) November? If this data is correct, please explain how treatment "after July 15th" will alleviate destruction of eggs and ~~spawn~~ fry.

The statement that 1 ppm of water contamination from herbicides would not affect adult trout is rather short sighted. Since sack-fry and swim-up-fry are an integral part of the process of growing big-fish, and since studies have proven that herbicide concentrations of even 35 to 40 ppb (parts per billion) can effect major mortality on these small fish, is it not fair to assume that fisheries will be severely impacted by this treatment program?

If destruction of stabilizing plants results in more erosion (which is a certainty) then increased siltation could have a detremental effect on spawning grounds and the aquatic community as a whole. Is this not true?

Much of the proposed treatment area is critical wildlife winter-range. Many vegetative species crucial to winter-wildlife-survival (such as mountain mahogany, bitter brush, sagebrush) will be destroyed. At a time when Wyoming's wildlife populations are being impacted by habitat destruction from minerals development and increased people-pressures, I believe BLM would be in error to help further these impacts.

It is interesting to note that herbicide use often results in insect infestations (in this case, probably grasshoppers). Please discuss possibilities that pesticides will follow herbicides to further the complete disruption of this ecosystem.

Unless you address the root-cause of weed infestation (land abuse) and correct this problem, then everyone's comments on this EAR and all of your research in preparation of this extensive document will have gone for nothing - and herbicide and pesticide application can only result in further deterioration of this land.

Thank you for inviting comments from Defenders of Wildlife.

Dick Randall

Dick Randall
North central representative
Defenders of Wildlife
Box 507
Rock Springs, Wyoming 82901

INDEX NUMBER 6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VIII
1860 LINCOLN STREET
DENVER, COLORADO 80295

February 13, 1979

REF: 8AH-P

Floyd Ewing, Area Manager
Bureau of Land Management
P.O. Box 670
Rawlins, WY 82301

Dear Mr. Ewing:

I have reviewed your environmental assessment record entitled "North Platte River Area Designated (Noxious) Weed Treatment Program". There are three areas in this record that could be discussed more. These areas are hand spray gun use discussed on page 28, water contamination by tordon discussed on page 112, and protection of endangered or threatened plants discussed on page 121.

In the Wyoming Pesticide Applicator Short Course there is a presentation on calibration presented by Harold Alley and Mike McNamee. In that presentation they show that a hand spray gun applies spray at a rate several times greater than a boom sprayer. If applications are made from one tank using both the spray boom and the hand gun, there is a possibility that the application rate specified on the label will be exceeded. This would be a violation of the Federal Insecticide, Fungicide and Rodenticide Act as Amended.

On page 112 the environmental assessment states that water contamination is not expected to reach levels above 1 ppm and that this level is not expected to adversely affect water quality. Hodgson (1) reported that irrigation water containing concentrations of picloram as low as 0.1 ppm reduced the yield of sugar beets. While there are no sugar beets grown in the project area and the susceptibility of other plant species can vary considerably from sugar beets, the 1 ppm level could cause subtle effects on the aquatic environment. The effects of picloram contamination of water could logically cause oxygen depletion due to reduced photosynthesis or decaying plant material. This would be synonymous with a reduced carrying capacity for fish in that stream. Although these effects are conjecture not backed by research, I think that the potential is great enough that you might include this in your monitoring program.

On page 121 the environmental assessment states that "any of the endangered plants listed that occur within spot treatment sites will be destroyed if exposed to the herbicides." There is no indication of the potential for this to occur. There is also no indication that any precautions will be taken to prevent it from happening. Because of the few endangered or threatened plant species that might occur, field personnel should be trained to recognize them. If any endangered or threatened species are found, the field crew should determine if it can be protected before continuing to spray.

Sincerely yours,

Edward L. Stearns

Edward L. Stearns
State Program Manager
State Assistance Section
Air and Hazardous Materials Division

(1) J.M. Hodgson (1966). The effect of herbicide contaminated irrigation water on crops. 1966 Meeting of the Weed Science Society of America. p. 88.

cc: George Hittle (Wyom. Dept. of Agriculture, Cheyenne)

INDEX NUMBER 7

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
P. O. Box 2440, Casper, Wyoming 82602

February 12, 1979

Bureau of Land Management
Rawlins District Office
P. O. Box 670
Rawlins, Wyoming 82301

Dear Sir:

My staff has reviewed the North Platte River Designated Weed Treatment Program Environmental Assessment Record and we have the following comment:

Pages 54-58

The soils writeup does not meet the standards of the National Cooperative Soil Survey. There are many misuses of soil terms and inconsistencies throughout. Detailed SCS soil maps covering this study area are available for review in the SCS Saratoga Field Office.

Page 178

SCS is not listed as having been consulted for any part of this report.

We appreciate the opportunity to review this Environmental Assessment Record.

Sincerely,

Frank S. Dickson
State Conservationist acting

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

P. O. Box 2440, Casper, Wyoming [illegible]

February [illegible], 1979

Bureau of Land Management
Rawlins District Office
P. O. Box 670
Rawlins, Wyoming 82301

Dear Sir:

My staff has reviewed the [illegible] Program Environmental Assessment Record and we have the following comments:

Pages 24-58

The soils write-up [illegible] Soil Surveys [illegible] are available for review in the SCS [illegible] Field Offices.

Page 105, [illegible] SCS is not listed as having been consulted for the [illegible] of this report.

We appreciate the opportunity to review this [illegible] Environmental Assessment Record.

Sincerely,

Frank S. Dickson
State Conservationist

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

Department of Environmental Quality

SOLID WASTE MANAGEMENT

HATHAWAY BUILDING CHEYENNE, WYOMING 82002 TELEPHONE 307-777-7752

MEMORANDUM

TO: Robert E. Sundin

FROM: Charles A. Porter

DATE: January 17, 1979

SUBJECT: BLM Assessment - Weed Treatment Program
N. Platte River Drainage in Carbon County

In reviewing the above Assessment, our concern would be in the disposal of the herbicide containers. Before the program commences, the responsible parties should contact this office and the Department of Agriculture for the proper disposal techniques.

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

Department of Environmental Quality

Administration

TELEPHONE 307-777-7391 CHEYENNE, WYOMING 82002 HATHAWAY BUILDING

February 20, 1979

Floyd Ewing, Area Manager
Medicine Bow Resource Area
Bureau of Land Mgt.
P. O. Box 670
Rawlins, WY 82301

Dear Mr. Ewing:

Enclosed are comments from the DEQ Solid Waste Management Section and the Water Quality Division. We appreciate the opportunity to review this plan and submit comments.

Very truly yours,

Robert E. Sundin

Robert E. Sundin
Director
Department of Environmental Quality

RES:ak

Enclosures

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

Department of Environmental Quality

Water Quality Division

HATHAWAY BUILDING

CHEYENNE, WYOMING 82002

TELEPHONE 307 777-7781

MEMORANDUM

TO: Robert E. Sundin, Director

FROM: John Bauer JB
208 Planning Coordinator

DATE: February 2, 1979

SUBJECT: Proposed designated (Noxious) Weed Treatment Program in North Platte River area

I have completed my review of the proposed designated (Noxious) Weed Treatment Program in the North Platte River area in Carbon County and wish to submit the following comments.

The proposed program area includes two DEQ designated Class I waters the main stem of the North Platte River and the Encampment River from the U. S. Forest Boundary upstream to the Colorado State Line and numerous DEQ designated Class II waters. The two Class I waters were designated because of their high quality, fishery, aesthetics and recreational values, Herbicide application would affect non-target plants (young cottonwoods, willows) in addition to noxious weeds and consequently, reduce the scenic value of the waters in the area and impair the fish habitat.

Page 112 states,"Water contamination via any of these routes (spills, run-off, contaminated water storages) is not expected to reach levels above 1 ppm for any duration (<24 hours) in the North Platte River or its tributaries." This statement and the following discussion in the report down-plays the impacts on water quality. Chapter I, Section 21 of the Wyoming Water Quality Standards states that all toxic or potentially toxic materials attributable to or influenced by the activities of man shall not be present in any Wyoming surface waters in concentrations or combinations which would damage or impair the normal growth, function, or reproduction of human, animal, plant or aquatic life. The 1 ppm concentration is above the 0.1 mg/l for 2,4-D in EPA's Quality Criteria for Water and our Standard. BLM is required to meet the Wyoming Water Quality Standards for this program and will be held responsible for any standards violations.

The towns of Saratoga, Rawlins, Sinclair and Encampment obtain all or some of their public water supplies from surface water in the program area. The public should be notified of this proposal and, upon program implementation, of the dates of herbicide application.

The monitoring program described in the assessment should also include the public water supplies; results should be sent to the respective towns and to DEQ.

DEQ requests notification of all herbicide spraying dates in the pertinent program area.

INDEX NUMBER 9

STATE OF WYOMING

ED HERSCHLER
GOVERNOR

Wyoming Department of Agriculture

TELEPHONE: (307) 777-7321 CHEYENNE, WYOMING 82002

LARRY J. BOURRET, COMMISSIONER

February 13, 1979

Wyoming State Planning Coordinator
State Clearinghouse
2320 Capitol Avenue
Cheyenne, Wyoming 82002

Dear Sir:

I wish to comment on the North Platte River Area Designated (Noxious) Weed Treatment Program Environmental Assessment Record (EAR).

Page 95 of that EAR indicates coyotes in the area live "primarily on rodents and deer". I believe the implication is that coyotes are "hunters" and that coyotes are killing (hunting) deer. Are coyotes also hunting domestic livestock? This issue deserves to be fully explained and data supplied to support the contention.

) also puzzled by a statement in the second paragraph on page 95 which indicates that there is a general rule that applies to predator-prey relationships. It just happens that another DES on animal damage control is currently being reviewed for comment and page 78 of that DES discusses two schools of thought on this relationship--then states that few studies exist and results are inconclusive. The FWS (Fish and Wildlife Service) prepared the DES. I suggest that coyotes do not control rodent populations and that the "rule" on page 95 is not supported by data. The discussion also fails to discuss the actions of predators, if one type of prey declines.

I believe the information on page 95 is misleading to the reader. The "general rule" is a simplistic approach to a very complex situation and would lead the unwary to believe such interrelationships are very cut and dried. It seems that the simplistic approach breaks down when as if by some magic the disappearing prey suddenly overcomes the ever-more-hungry predator and a prey population explosion occurs.

I believe the EAR to contain enough flaws on page 95 that the entire page needs to be reviewed and at least the first two paragraphs need to be correctly written with data to support any conclusion drawn.

Sincerely yours,

Larry J. Bourret

y J. Bourret
issioner of Agriculture

LJBjh

cc: BLM; Rawlins District

"AGRICULTURE—the backbone of Wyoming"

LETTER NUMBER 9

STATE OF WYOMING

Wyoming Department of Agriculture

2219 CAREY AVENUE, CHEYENNE, WYOMING 82002

LARRY J. BOHRER COMMISSIONER

February 17, 1978

Wyoming State Planning Coordinator
State Clearinghouse
2320 Capitol Avenue
Cheyenne, Wyoming 82002

Dear Sir:

I wish to comment on the North Platte River Area Designated (Regional) Weed Treatment Program Environmental Assessment Record (EAR).

Page 95 of that EAR indicates coyotes in the area live "primarily on rodents and deer." I believe the implication is that coyotes are "hunters" and that coyotes are killing (hunting) deer. Are coyotes also hunting domestic livestock? This issue deserves to be fully explained and data supplied to support the contention.

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I believe the EAR to contain enough flaws on page 95 that the entire page needs to be reviewed and at least the first two paragraphs need to be correctly written with data to support any conclusion drawn.

Sincerely yours,

ry J. Bohrer
issioner of Agriculture

LJB:jn

cc: BLM: Rawlins District

6840
1792

United States Department of the Interior
FISH AND WILDLIFE SERVICE

MAILING ADDRESS:
Post Office Box 25486
Denver Federal Center
Denver, Colorado 80225

STREET LOCATION:
10597 West Sixth Avenue
Lakewood, Colorado
Across From Federal Center

Routing 7/14/78 Initial & Date

SD	
ASD	
PSEC	
CPA	
/ Res.	
Tech S.	
Mgmt S.	
CF	
Lead Resp. /	

IN REPLY REFER TO:
FA/SE/Coop.--Federal--BLM--
Weed Control Project, So.,
Carbon Co., Wyoming

JUL 11 1978

MEMORANDUM

To: State Director, Bureau of Land Management
Cheyenne, Wyoming

From: Acting Regional Director, Region 6
Denver, Colorado

Subject: Section 7 Consultation Request--Weed Control; Carbon County, Wyoming

This is our official biological opinion, prepared in response to your request of May 16, 1978, for formal consultation on the impacts of weed control in Carbon County, Wyoming on the endangered black-footed ferret, peregrine falcon, and bald eagle. We have conducted a threshold examination as prescribed in the Interagency Cooperation Regulations of January 4, 1978.

It is our biological opinion that the proposed weed control program using Tordon 22K, Banvel, and 2,4-D Amine on some 416 acres of BLM land is not likely to jeopardize the continued existence of the black-footed ferret, peregrine falcon, or bald eagle. All three chemicals are of low toxicity to birds and other warmblooded animals, and are not accumulative as are the hydrocarbons. When applied at the specified dosage rate, the chance of the concerned endangered species taking in a lethal dose is extremely small.

Some precautions in their use, however, are required. Both Tordon 22K and Banvel are water soluble and if allowed to enter bodies of water may kill aquatic plants. Banvel is toxic to fish and Tordon is persistent and will carry over in the soil. Thus, care should be taken not to contaminate streams or bodies of water, or apply these chemicals in areas where they could rapidly be flushed by heavy rain into surface waters. Tordon 22K is on the EPA restricted list, which restricts its application to a certified applicator.

Some esters of amine are toxic to fish; therefore, 2,4-D Amine should be applied with precaution around surface waters. This herbicide will tie up with the soil but is non-persistent and breaks down rapidly. In areas treated with any of the three herbicides, livestock grazing should be regulated as specified on the container's label.

This completes the formal consultation process for the Carbon County Weed Control Project. We appreciate your cooperation and interest in meeting our joint consultation responsibilities.

James V. Gutman

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

Wyoming Recreation Commission

604 EAST 25TH STREET CHEYENNE, WYOMING 82002

JAN L. WILSON
Director
777-7695

June 27, 1978

Mr. Ronald J. Broda
Environmental Biologist
Field & Lab, Inc.
P. O. Box 1297
Fort Collins, Colorado 80522

Dear Mr. Broda:

Thank you for your letter amd maps sent to us May 22, 1978 concerning the proposed noxious weed control program on Bureau of Land Management land. Because of the illness of Mr. Ned Frost, Chief of the Wyoming Recreation Commission's Historical Division we have experienced a delay in processing your letter.

The Wyoming State Historic Preservation Officer has reviewed your letter and comments that clearance for the proposed program is recommended with the following stipulations. If it becomes necessary to do road improvements in order to gain access to an area we ask you to contact us before any ground disturbance work be undertaken. We will do a cultural resources reconnaissance of the area and route of access at that time. If any objects are encountered that appear to be of prehistoric or historic value, or any monuments or markers are in the areas to be controlled we would ask to be notified so an evaluation of the resource present could be made, and any affect which might be adverse could be avoided.

Sincerely,

Jan L. Wilson

Jan L. Wilson, Director and
Wyoming State
Historic Preservation Officer

cc: Mr. George Zeimens, Associate State Archeologist

JLW/mlr

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APPENDIX 1

GLOSSARY OF TERMS

APPENDIX 1

Glossary of Terms

Acid equivalent--The theoretical yield of parent acid from an active ingredient.

Action(s)--A generic term that includes one or a group of policies, practices, projects, etc., for which an Environmental Assessment Record (EAR) is prepared.

Activator--Materials used in a pesticide formulation to increase the effectiveness of the toxic materials toward the target pest.

Active ingredient--That part of a chemical compound directly responsible for the control of the specific pest.

Acute Oral LD_{50}--The dosage required to kill 50% of the test animals when given a single oral dose in toxicity studies. The dose is expressed by the weight of the chemical per unit of body weight such as milligrams of toxicant per kilogram of body weight of the test animal.

Acutely toxic--Causing death or severe damage to an organism by poisoning during a brief exposure period, normally 96 hours or less, although there is no clear line of demarcation between acute and chronic toxicity.

Adhesive--A substance that will cause a spray material to stick to the sprayed surface, often referred to as a sticking agent.

Adjuvants--Any component of a formulation such as wetting or spreading agents, stickers, penetrants, emulsifiers, etc., which modifies the mixture benefically.

Allelopathic--The ability of a living plant to cause injury to another plant by secreting a toxic substance.

Annual--A plant that completes its life cycle in one year.

Aquatic plants--Plants that grow in water. There are three types: submergent, grow beneath the surface; emergent, root below the surface but plant extends above the water; and floating.

Biennial--A plant that completes its life cycle in two years. The first year the seed germinates and the plant produces leaves and roots and stores food which is frequently referred to as the rosette stage. The second year it flowers and produces fruit and seed.

Biological control--Controlling a pest by its natural enemies that may already occur in the area or may be introduced.

Biome--A major biotic community; natural groups of organisms characterized by the occurrence of certain plants and animals that are dominant or influential.

Botanical name--A scientific name comprised of the genus and specific name.

Brand name--The name, number, trade-mark or designation applied to an economic poison of any particular description by the manufacturer, distributor, importer or render.

Broadcast application--An application of pesticide over the entire area or field rather than only to rows, beds, middle or individual plants.

Broadleaf plants--Botanically classified as dicotyledons. Plants have two cotyledon leaves in the seedling stage; true leaves are broad and have net-like or reticulate veins.

Buffer zone--The area between the high water line and a designated point away from the stream bank.

Carrier--The liquid or solid material added to the active ingredient to facilitate its preparation, storage, shipment or field application.

Catalyst--A substance that speeds up the rate of a chemical reaction but is not itself altered throughout the reaction.

Chronically toxic--Causing death or damage to an organism by poisoning during prolonged exposure, which, depending on the organism tested and the test conditions and purposes, may range from several days to weeks, months, or years.

Community--All populations (groups of individuals of any one kind of organism) in a given area.

Compatibility--Refers to chemical compounds that can be mixed together without detrimentally affecting the performance of either.

Concentration--Refers to the amount of active ingredient or acid equivalent in a given weight or volume of a mixture. Recommendations and specifications for concentrations of pesticides are frequently given as pounds per unit volume of mixture.

Contaminate--To alter or render a material unfit for a specified use, by allowing the pesticide to come into contact with it.

Contributing factors--Man-made and natural factors, external to the element, that impact, change or modify primary characteristics.

Control--Reduction of the pest problem to a point where it does not cause significant economic damage.

Diluent--Any liquid or solid material used to dilute or carry an active ingredient.

Discrete operations--Separate identifiable operations or parts which, in the aggregate comprise the particular stage of implementation (e.g., in the case of a road, the discrete operations in the construction stage might be clearing, grading, and surfacing).

Dissolved solids--The total amount of dissolved material, organic and inorganic, contained in water or wastes. Excessive dissolved solids make water unpalatable for drinking and unsuitable for industrial uses.

Dormant--Period of time in which seeds and other plant parts do not grow due to natural causes.

Dose (Rate)--The terms are the same; however rate is preferred. They refer to the amount of active ingredient applied to a unit area regardless of percentage of chemical in the carrier.

Drift--The movement of air-borne pesticide particles by air motion or wind away from the intended target area.

EC_{50}--The concentration at which a specified effect is observed under the test conditions in a specified time in 50 percent of the organisms tested. Examples of specified effects are hemorrhaging, decreased feeding, dilation of pupils, and altered swimming patterns.

Ecology--The science concerned with the interrelationships of organisms and their environments.

Ecosystem--A unit in which the living and the nonliving environment function together.

Emulsifiable concentrate--A liquid formulation in which the chemical is dissolved in one or more water insoluble solvents such as oil or benzene and an emulsifying agent is added. The resulting mixture can be sprayed using water or oil as a diluent.

Emulsifier--A surface active material that facilitates the suspension of one liquid in another.

Emulsion--The suspension of one liquid as minute globules in another liquid such as oil dispersed in water.

Environment--All that surrounds an organism and interacts with it.

Environmental analysis--A systematic process for consideration of environmental factors in land and water management actions.

Environmental assessment record (EAR)--Procedure and format for recording environmental analysis.

Environmental components--General categories of environmental information: (1) nonliving, (2) living, (3) ecological interrelationships, and (4) human values.

Environmental elements--Subdivision of environmental subcomponent.

Environmental subcomponent--Subdivision of environmental component.

Eradication--Complete elimination of the pest problem from a designated area.

Foliar application--Applications of the pesticide to plant foliage.

Formulation--A mixture containing the active pesticide, the carrier, diluents and other additives required to made the material ready for application.

Granules-- Pesticide formulation in which the active ingredient is impregnated on small particles of a carrier such as clay or ground corncobs.

Grass-- Botanically, any plant of the Gramineae family. Grasses are characterized by narrow leaves with parallel veins; by leaves composed of blade, sheath and ligule; by jointed stems and fibrous roots; and by inconspicuous flowers usually arranged in spikelets.

Hard water--Generally defined as water containing 332 ppm of calcium carbonate. Water that contains certain minerals, usually calcium and magnesium sulfates, chlorides, or carbonates, in solution in sufficient amounts to cause the curd or precipitate instead of a lather when soap is added. Very hard water may cause precipitates in some pesticide sprays.

Hazard-- The probability that injury or detrimental effects will result if a substance is not used properly.

Herbaceous plant--A vascular plant that remains soft or succulent and does not develop woody tissue.

High volume sprays--Spray applications of more than 60 gallons per acre volume.

High-water line--Generally, the maximum level a stream will reach during the spring run-off period.

Human environment-- That which surrounds and affects man.

Impact--The results of an action on the environment; the impacts may be primary (direct) or secondary (indirect).

Infestation acre--One designated (noxious) weed plant per acre constitutes an infested acre.

Inert ingredient--That part of a compound without toxic or killing properties sometimes called the carrier.

Inner streambank--That part of the streambank that is between the year's obvious high-water line and the water level at the time of observation.

Interdisciplinary team approach--A group of specialists representing different disciplines working together to identify, discuss, and learn more about the various aspects of a common issue or problem; as distinguished from a multi-disciplinary approach where team members represent their individual disciplines, without participating in group discussion and analysis and where documentation is simply an aggregation of the individual inputs.

Invert emulsion--A mixture in which oil is the continuous phase and water is dispersed in it.

Knapsack sprayer--A light sprayer constructed to fit the back or be carried by the operator.

Label--All written, printed or graphic matter on or attached to pesticide containers as required by law.

Latent period--Dormant period.

Lateral movement--Chemical movement in a plant or in the soil to the side or horizontal movement in the roots or soil layers.

LC_{50}--The concentration of a toxicant which is lethal (fatal) to 50 percent of the organisms tested under the test conditions in a specified time. LC_{50} values are used in inhalation studies and in many toxicity experiments with fish and other wildlife.

LD_{50}--The dose of a toxicant that is lethal (fatal) to 50 percent of the organisms tested under the test conditions in a specified time. A dose is the quantity actually administered which is the amount of toxicant in a unit of test medium rather than the amount ingested by or administered to the organism.

Leaching--The downward movement of a substance in solution through the soil.

Liter (l)--The volume occupied by 1 kilogram of water at a pressure of 760 mm of mercury and a temperature of $4^{o}C$. A liter is 1.0567 quart.

Low volume spray--A spray application of 5 to 20 gallons per acre.

Low-water line--Generally, the lowest level a stream will reach during the late summer and autumn months.

Microgram per kilogram (ug/kg)--The concentration at which a millionth of a gram (1 microgram) is contained in a mass of 1 kilogram. A kilogram is 2.2046 pounds.

Milligram per kilogram (mg/kg)--The concentration at which 1 thousanth of a gram (1 milligram) is contained in a mass of 1 kilogram. A gram contains 1,000 milligrams.

Milligram per liter (mg/l)--The concentration at which 1 milligram (10^{-3}g) is contained in a volume of 1 liter.

Minimum lethal threshold concentration--That concentration barely tolerated by individuals of average resistance for indefinitely prolonged exposure.

Mist blower--Spray equipment in which hydraulic automization of the liquid at the nozzle is aided by an air blast past the source of spray.

Necrosis--Death of a tissue, such as in a designated portion of a plant.

Non-riparian zone--Land not associated with streams or any other natural body of water.

Noxious weed--A plant defined by law as being especially undesirable, troublesome, or difficult to control.

Overall treatment--Application uniformly over the entire area.

Part per million (ppm)--A concentration at which one unit is contained in a total of a million units. Any units may be used (e.g., weight, volume) but in any given application identical units should be used (e.g., grams per million grams or liters per million liters).

ppmw--Parts per million per whole body weight.

Peak flow--The maximum quality of water flowing at any one time in a river or stream. Measurement is usually made in cubic feet per second (CFS).

Penetrants--Wetting agents that enhance the ability of a liquid to enter into the pores of a substrate.

Perennial--A plant that lives for more than two years.

Pesticide tolerance--The amount of pesticide residue which may legally remain in or on a food crop.

Phenoxy herbicide--A family of herbicides with a molecular structure composed of:

(1) An aromatic (benzene) ring;

(2) An oxygen atom substituted for one hydrogen bonded to the ring;

(3) A carboxyl group bonded indirectly to an oxygen atom, separated from the oxygen atom by an aliphatic chain of one or more carbon atoms;

(4) Various constituents of a ring.

Photosynthesis--The process by which carbohydrates are manufactured by chlorophyll-bearing cell granules or chloroplasts (in green plants) from carbon dioxide and water using light as an energy source.

Phytotoxic--Poisonous or injurious to plants.

Population--A group of organisms of the same species occupying a particular area.

Primary characteristics--Aspects of an element that must be known in order to understand the impact of an action. They are often the key indicators of an impact.

psi--Pounds per square inch.

Rate--Same as dosage. It is the amount of active ingredient material applied to a unit area regardless of percentage of chemical in the carrier.

Reentry interval--The length of time between the pesticide applications and reentry into the field.

Registered--Pesticides that have been approved for use by the Environmental Protection Agency.

Residual--A compound that persists or continues to have activity against specific forms of plant and animal life.

Residue--The amount of a substance that is on or in the crop at the time an analysis is made.

Residue tolerance--The amount of pesticide residue which may legally remain in or on a food crop.

Resistance--The degree to which an organism may suppress or retard the injurious effects of a pesticide.

Rhizome--Underground root-like stem that produces roots and leafy shoots.

Riparian zone--Land that abuts on the banks of a stream or other natural body of water.

Seedling stage--Early stage of plant growth, technically prior to the development of a root system other than the seed or seminal root.

Selectivity--A characteristic of some pesticides, whereby certain undesirable species are killed while others such as crop plants or beneficial insects are harmed very little, if any.

Sensitivity--Not capable of withstanding effects of a pesticide.

Solubility--The amount of a substance which will dissolve in a given amount of liquid substance.

Species--A subdivision of a genus. A group of closely related individuals descending from the same stock.

Spot treatment--The application of a pesticide to a selected individual area.

Spreading agent--A substance to improve the setting, spreading or possibly the adhesive properties of a spray.

Stages of implementation--Different phases or stages which together comprise the total project or action (e.g., survey, construction, use, and maintenance in the case of rights-of-way as a proposed action).

Stolon--The above ground runners or slender stems that develop roots, shoots and new plants at the tip or nodes.

Surfactant--A material used to improve the emulsifying, dispersing, spreading, wetting and other surface modifying properties of pesticide formulations.

Suspension--A liquid in which very fine solid material is suspended, but not dissolved.

Synergism--Compounds working together to produce an effect greater than the sum of their individual actions.

Systemic--Any compound that, when absorbed into one part of an organism, becomes distributed throughout.

TL_{50}--Median Tolerance Limit--The concentration of a test material at which just 50 percent of the test animals are able to survive under test conditions for a specified period of exposure.

TL_m--Synonymous with TL_{50}.

Tolerant--The ability to withstand the effect.

Toxicity--The degree to which a substance is poisonous.

Translocation--The movement of a chemical from the point of absorption (plant leaves, stems, or roots) to other leaves, buds or root tips. Translocation also occurs in animals treated with certain pesticides.

ULV (Ultra low volume)--The application of a pesticide in a relatively pure form without or with very little dilution. Total volume rates are usually 1/2 gallon, or, less, per acre.

Vapor drift--The movement of pesticide vapors from the area of application to other areas.

Waiting period--The time interval (hours or days) between application and harvest which will insure conformance with residue tolerances or label directions.

Weed--A plant out of place or growing where not desired.

Weed control--The process of limiting weed infestations so that crops can be grown profitably or other operations can be conducted efficiently.

Weed eradication--The elimination of weeds from an area.

Wetting agent--A compound added to a spray to cause the liquid to spread, increasing contact area with plant surfaces.

APPENDIX 2

SITE SPECIFIC MAP KEY AND MAPS

APPENDIX 2

Site Specific Map Key

Survey No.; weed species; herbicide applied; method of application; (Acres infestation).

Weed Species	Code
Field bindweed (*Convolvulus arvensis*)	01
Canada thistle (*Circium arvense*)	02
Leafy spurge (*Euphorbia esula*)	03
Perennial sowthistle (*Sonchus arvensis*)	04
Quackgrass (*Agropyron repens*)	05
Hoary cress (whitetop) (*Cardaria draba* and *Cardaria pubescens*)	06
Perennial pepperweed (Giant whitetop) (*Lepidium latifolium*)	07
Ox-eye daisy (*Chrysanthemum leucanthemum*)	08
Skeletonleaf bursage (*Franseria discolor*)	09
Russian knapweed (*Centaurea repens*)	10
Yellow toadflax (*Linaria vulgaris*)	11
Dalmation toadflax (*Linaria dalmatica*)	12
Scotch thistle (*Onopordum acanthium*)	13
Musk thistle (*Carduus nutans*)	14
Common burdock (*Arctium minus*)	15
Plumeless thistle (*Carduus acanthoides*)	16

Herbicide Applied

A- Tordon
- a. Liquid
- b. Granules

B- Banvel
- a. Liquid
- b. Granules

C- 2,4-D Amine

Method of Application

Method No. I- Ground units (liquid formulation)
- a. Hand spray gun
- b. Spray boom

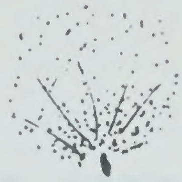
Method No. II- Hand sprayers (liquid formulation)

Method No. III- Hand spreaders (granular applicator)
- a. PCB Spreaders
- b. Shakers

APPENDIX 3

WYOMING WEED CONTROL GUIDE

APPENDIX 3



WYOMING WEED CONTROL GUIDE 1978

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AGRICULTURAL EXTENSION SERVICE
UNIVERSITY OF WYOMING, LARAMIE

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WYOMING WEED CONTROL GUIDE 1978

AUTHORS: H. P. Alley, professor of weed science and Extension weed science specialist, A. F. Gale, Assoc. professor of Agr. Extension and pesticide specialist, and N. E. Humburg, Asst. professor of weed science.

Th cultural and chemical recommendations for controlling weeds are based on results of experiments and field demonstrations in Wyoming.

At publication time, the chemicals recommended were registered for use as described in the latest edition of the EPA Summary of Registered Agricultural Pesticide Chemical Uses, a compilation of agricultural pesticide chemical uses registered with the Environmental Protection Agency. It is illegal to use herbicides other than for those uses designated on Federal or State labels.

READ THE LABEL!

Use chemicals only as recommended on the label. Follow instructions exactly as outlined. Be sure to notice all warnings and cautions.

RESIDUES

Recommendations and uses of chemicals are based on the best information currently available for each herbicide listed. If followed carefully, they should result in satisfactory control and should not leave residues that will exceed established tolerances. Use only on crops for which tolerances are specified.

To avoid excessive residues on harvested crops, carefully follow recommended dosage levels, numbers of applications, and minimum intervals between applications and harvest.

Some crops will be ruled out for forage use the same year that certain chemicals are applied. The tables show the chemicals in this class. The tables also show chemicals listed for use on non-cropped areas.

The **USER IS RESPONSIBLE** for chemical residues on his own crop as well as for problems caused by drift or soil contamination from his property to other properties or crops.

To simplify this information, it is sometimes necessary to use trade names of products or equipment. No endorsement of named products is intended, nor is criticism implied of similar products which are not mentioned.

CONTROL OF PERENNIAL AND DESIGNATED WEEDS

		CANADA THISTLE	
2,4-D amine or ester	1½	When Canada thistle is in bud stage or in fall	On cropped or non-cropped areas, treat twice a year for 2 or 3 years. The 1½ lb. rate may cause some injury to small grains but will be off-set by decreased weed competition. Do not forage or graze treated grain fields for 2 weeks after treatment. Do not use treated straw for livestock fee. (late treatment.)
2,4-D amine	40	Early spring or fall	Follow up with 2 lb. of 2,4-D on regrowth with new seedlings. Use only on non-cropland areas. To be effective the treatment must be applied early in spring or in fall after vegetative top growth is removed.
Amitrole	4 to 8	Bud stage	Non-cropland use only.
Benzoic acid boron mixture (Benzabor)	1½ lb. of granules/sq. rd.	Early spring or fall	Contains 8% trichlcrobenzoic acid. Several grass species tolerate this chemical. Use only on non-cropland areas.
Clean cultivation		Usually every 14-21 days	Intensive cultivation for one season usually eliminates more than 90% of the Canada thistle. Cultivate 3 to 4 in. deep. Root reserves are depleted by August. Spray regrowth in August with 2 lb. 2.4-D per acre.
Trichlorobenzoic acid (Trysben "200" or Benzac "1281")	20	Early spring or fall	Treatment will sterilize soil for crop production for 1 to 2 years. Use only on non-cropland areas.

[1]Refers to pounds of active ingredient or acid equivalent unless otherwise stated.

CANADA THISTLE (cont'd)

Herbicide or cultural practice	Pounds per acre[1]	Time of application	Remarks
Tordon-212	1 to 2 gal.	Spring to fall	Apply at a rate that will give a minimum of 1 lb./A picolinic acid. For use on non-cropland areas. Read label thoroughly before making treatments.
Tordon Beads	½ to ¾ lb. granules/sq. rd.	Anytime during the growing season	Use same restrictions and precautions as prescribed for Tordon-212.
Fenac	10 to 15	Early spring or fall	Several grass species tolerate Fenac. Use only on non-cropland areas.
Banvel (dicamba)	4 to 8	When Canada thistle is in early-bud stage	Has clearance for use on pasture and rangeland up to 8 lb./A. Do not graze meat animals in treated fields within 30 days before slaughter. More severe restrictions for dairy animals.
Weedmaster (Banvel + 2,4-D)	2 qt. (½ lb. dicamba 1½ lb. 2,4-D)	When Canada thistle is actively growing.	For use on pastures or rangeland grass and non-cropland areas such as fencerows, roadways, wastelands, etc.
Tordon-22K (picloram)	1 to 2	Anytime during growing season	Spot and broadcast treatment. For broadcast treatment a permit for aerial and ground equipment must be obtained from Wyo. Dept. of Agriculture.
Roundup (glyphosate)	3 qt	When plants are at least 10 in. or more in height or are approaching bud stage.	Fall treatment must be applied before frost for best results. Allow seven or more days after application before tillage. Can be used in cropping systems before emergence of barley, corn, oats, sorghum and wheat.
DYER'S WOAD			
2,4-D	1½ to 2	Bud stage	Repeated 2,4-D applications necessary for effective stand reductions.
FIELD BINDWEED			
2,4-D	1½	When bindweed is in bud to bloom stage or fall	On cropped or non-cropped areas, treat twice a year for 2 or 3 years. Same restrictions as listed under Canada thistle.
Trichlorobenzoic acid (Trysben "200" or Benzac "1281")	20	Spring or fall	Treatment will sterilize soil for crop production for 1 to 2 years. Use only on non-cropland areas.
Benzoic-boron mixture (Benzabor)	¾ to 1½ lb granules/sq. rd.	Spring or fall	¾ lb./sq. rd. has consistently controlled 100% of established stands. Treatment will sterilize soil for crop production 1 to 2 years but some grass species tolerate this mixture. Use only on non-cropland areas.

FIELD BINDWEED (cont'd.)

Banvel (dicamba)	8	When bindweed is in bud to bloom stage	Several grass species tolerate dicamba. Same restrictions as listed for Canada thistle.
Tordon-212	1 to 2 gal	Spring to fall	Apply at rate that will give a minimum of 1 lb./A picolinic acid. For use on non-cropped areas. Read label thoroughly before treatments.
Tordon Beads	½ to ¾ granules sq. rd.	Anytime during the growing season	Use same restrictions and precautions as prescribed for Tordon-212.
Clean cultivation		Every 10 to 14 days after weeds emerge—to cut off new shoots	For the most economical control, combine cultivation, cropping and spraying.
Tordon-22K (picloram)	1 to 2	Anytime during growing season	Spot and broadcast treatment. For broadcast treatment a permit for aerial and ground equipment must be obtained from Wyo. Dept. of Agriculture.
Roundup (glyphosate)	4 to 5 qt	For best results apply in late summer and fall until a bindweed killing frost to flowering plants.	Reduced control when applied to drought stressed plants. Allow 7 or more days after application before tillage. Can be used in cropping systems before emergence of barley, corn, oats, sorghum and wheat.

HOARY CRESS—See Whitetop

LEAFY SPURGE

2,4-D amine or ester	1	Early spring	Prevents seed formation only.
2,4-D amine or ester	6	When spurge is in early bud and in fall	Two treatments a year for 3 to 4 years necessary to effectively reduce stand. Use only on non-cropland areas.
2,4-D amine	40	Early spring or fall	To be effective the treatment must be applied early in spring or in fall after vegetative top growth is removed. Follow up with 2 lb. of 2,4-D on regrowth of new seedlings. Use for spot treatments. Use only on non-cropland areas.
Trichlorobenzoic acid (Trysben "200" or Benzac "1281")	20	Early spring or fall	Treatment will sterilize soil for 1 to 2 years for crop production. Use only on non-cropland areas.
Banvel (dicamba)	4 to 8	When leafy spurge is in bud to bloom stage	Several grass species tolerate to dicamba. Same restrictions as listed for Canada thistle.
Benzoic acid boron mixture (Benzabor)	¾ to 1½ lb. granules/sq. rd.	Spring or fall	Contains 8% trichlorobenzoic acid. Use only on non-cropland areas.
Amitrole	8	Bud to bloom	Use only on non-cropped areas.
Fenac	10 to 15	Early spring or fall	Several grass species are tolerant to Fenac. Use only on non-cropland areas.

[1]Refers to pounds of active ingredient or acid equivalent unless otherwise stated.

LEAFY SPURGE (cont'd.)

Herbicide or cultural practice	Pounds per acre[1]	Time of application	Remarks
Tordon-212	1½ to 2 gal.	Spring to fall	A higher rate of Tordon is usually required to obtain outstanding control of leafy spurge than Canada thistle. For use on non-cropped areas. Apply at a rate that will give a minimum of 1½ to 2 lb./A picolinic acid. Read label thoroughly before making treatments.
Tordon Beads	½ to ¾ lb. granules/sq. rd.	Anytime during the growing season	Use same restrictions and precautions as prescribed for Tordon-212.
Clean cultivation		Usually every 21 days	Leafy spurge is more persistent than Canada thistle. Best control results from combining cultivation, cropping and spraying.
Tordon-22K (picloram)	2	Anytime during growing season	Spot and broadcast treatment. For broadcast treatment a permit for aerial and ground equipment must be obtained from Wyo. Dept. of Agriculture.
MILKWEED			
Amitrole	4 to 8	Bloom stage	Use only on non-cropped areas.
Tordon-212	1½ to 2 gal.	Spring to fall	For use on non-cropped areas. Read label thoroughly before making application.
MUSK THISTLE			
2,4-D	1.5 to 2.0	Fall or spring	Fall treatment to rosettes and spring treatment before flowering stalk lengthens. Annual treatments necessary to control new seedling.
Banvel (dicamba)	½	Spring or Fall	Has given outstanding control of seedlings and 2nd year growth if applied before flowering stalk lengthens. No residual control.
Weedmaster (Banvel + 2,4-D)	2 qt (½ lb dicamba + 1½ 2,4-D)	Spring or Fall	Fall treatments to rosettes and spring treatment before flowering stalk lengthens.
Tordon-212	1 qt.	Spring or fall	Near 100% with residual seedling control. Use only as spot treatment.

PLUMELESS AND SCOTCH THISTLE

Same treatments as for Musk Thistle.

Herbicide or cultural practice	Pounds per acre[1]	Time of application	Remarks
			PERENNIAL PEPPERWEED (Giant Whitetop)
2,4-D amine	4 to 6	Bud to bloom	Retreatment of regrowth and repeated treatments necessary.
			PERENNIAL SOWTHISTLE
2,4-D amine or ester	1½	When perennial sowthistle is in bud stage or in fall	On cropped or non-cropped areas, treat twice a year for 2 or 3 years. Add wetting agent (6 to 8 oz./100 gal. of spray). Same restrictions as listed under Canada thistle.
2,4-D amine	40 to 80	Early spring or fall	Follow up with 2 lb. of 2,4-D on regrowth and new seedlings. Non-cropland use only.
			QUACKGRASS
Dalapon	15	Active growth stage (6 to 8 in. tall)	This is a foliage spray. Use suggested rate and then cultivate. Begin cultivation 2 weeks after spraying and till every 10 days if regrowth appears
AAtrex (atrazine)	3 to 4	Single application fall or spring	Apply 3 to 4 lb./A in the spring or fall. Then plow 1 to 3 weeks after application. Do not disturb land until prepared for planting. Area treated can be seeded to corn. Residue restricts growing other crops.
AAtrex (atrazine)	2 + 2	Split application	First application of 2 lb. should be either in the fall or 1 to 3 weeks prior to plowing in the spring. Second application of 2 lb. should be made 2 weeks before planting, at planting, or up to 3 weeks after planting of corn. Do not plant to crops other than corn for 2 years after initial application.
Clean cultivation		Cultivate whenever regrowth is 2 to 3 in. tall	This is the least expensive way of controlling large areas of quackgrass. Effective control results only if roots are brought to the surface and allowed to dry. Springtooth harrow is more effective than duck foot.
Roundup (glyphosate)	2-3 qt	Spray when most quackgrass is at least 8 inches in height (3 to 4 leaf stage) and actively growing.	Allow 3 or more days after application before tillage. Can be used in cropping systems before emergence of barley, corn, oats, sorghum and wheat.
Eptam (EPTC)	4 - 6	Incorporate after thoroughly chopping up rhizomes	Thoroughly chop up rhizomes before incorporating Eptam. Incorporate by disking or metering into irrigation water. Can be used for quackgrass control in corn and potatoes.
			RUSSIAN KNAPWEED
2,4-D	1½	Early spring	Prevents seed formation only. Same restrictions as listed under Canada thistle.

[1]Refers to pounds of active ingredient or acid equivalent unless otherwise stated.

Herbicide or cultural practice	Pounds per acre[1]	Time of application	Remarks
		RUSSIAN KNAPWEED (cont'd.)	
2,4-D	6	When knapweed is in bud stage or in the fall	Knapweed is quite resistant to 2,4-D. Treat twice a year for 2 or 3 years. Use only on non-cropland areas.
2,4-D amine	40	Early spring or fall	Follow up with 2 lb. of 2,4-D on regrowth and new seedlings. Use only on non-cropland areas.
Trichlorobenzoic acid (Trysben "200" or Benzac "1281")	10 to 20	When knapweed is in early bud stage	Recommended rates controlled 100% of knapweed. Bluegrass is somewhat tolerant to this herbicide. Use only on non-cropland areas.
Tordon-22K (picloram)	2	Anytime during growing season	Spot and broadcast treatment. For broadcast treatment a permit for aerial and ground equipment must be obtained from Wyo. Dept. of Agriculture.
Fenac	5 to 10	Early spring or fall	Recommended rates controlled 100% of old knapweed stands. Several grass species are tolerant to this herbicide. Use only on non-cropland areas.
Benzoic acid boron mixture (Benzabor)	¾ to 1½ lb. granules/sq. rd.	Spring or fall	Granules need moisture to activate chemical. Use only on non-cropland areas.
Tordon-212	1 to 2 gal.	Spring or fall	Apply at a rate that will give a minimum of 1 lb./A picolinic acid. For use on non-cropped areas. Read label thoroughly before treatment.
Tordon Beads	½ to ¾ lb. granules/sq. rd.	Anytime during the growing season	Use same restrictions and precautions as prescribed for Tordon-212.
Clean cultivation		Usually every 21 days	A good culture program combines intensive cultivation with use of competitive crops and selective sprays.
*Banvel (dicamba)	5 to 8	When knapweed is in early bud stage	Same restrictions as listed for Canada thistle.
Weedmaster (Banvel + 2,4-D)	2 qt. (½ lb. dicamba 1½ lb. 2,4-D)	Actively growing knapweed	For use on pasture or rangeland grass and non-cropland areas as fencerows, roadways, wastelands, etc.
		SKELETONLEAF BURSAGE	
2,4-D	1½	When Franseria is in bud to bloom stage or in fall in non-cropped areas	In cropped or non-cropped areas, treat twice a year for 2 or 3 years. Same restrictions as listed under Canada thistle.
Clean cultivation		Usually every 21 days	Intensive cultivation for one season usually eliminates more than 90% of the Franseria. Cultivate 3 to 4 in. deep. Root reserves are depleted by August. Spray regrowth in August with 2 lb. 2,4-D/A.
Tordon-212	1 to 2 gal.	Spring to fall	Apply at a rate that will give a minimum of 1 lb./A picolinic acid. For use on non-cropped areas. Read label thoroughly before treatment.

TOADFLAX (Yellow & Dalmation)			
Silvex	2	Bud to bloom	Two treatments per year for a period of 3 to 4 years necessary to reduce stand.
Banvel (dicamba)	4 to 6	Spring or early fall	Retreatment of regrowth may be necessary.
Tordon-212	1½ to 2 gal.	Spring or fall	Use on non-cropped areas only.
Tordon-22K (picloram)	¾ to 1 gal.	Spring or fall	Use on non-cropped areas only.
WHITETOP (Hoary Cress)			
2,4-D	1½	When whitetop is in bud stage	In cropped or non-cropped areas, treat twice a year for 2 or 3 years. This plant starts growing in early spring. Same restrictions as listed under Canada thistle.
2,4-D	6 to 8	Spring	Follow up with 2 lb. 2,4-D per acre on regrowth and seedlings. Non-cropland use only.
Amitrole	4 to 8	Bud to bloom	Use only on non-cropped areas.
Amitrole-T	4		More active than amitrole, less material required for same results. Use only on non-cropped areas
Clean cultivation		Usually every 21 days	Intensive cultivation for one season usually eliminates more than 90% of the whitetop. Cultivate 3 to 4 in. deep. Root reserves are depleted by August. Spray regrowth in August with 2 lb. 2,4-D/A.
TANSY			
Tordon-212	¾ to 1 gal.	Spring to fall	For use on non-cropped areas. Read label thoroughly before treatments.
Tordon Beads	½ to ¾ lb. granules/sq. rd.	Spring to fall	Use same restrictions and precautions as prescribed for Tordon-212.
Benzabor	1½ lb. granules/sq. rd.	Spring to fall	Use only on non-cropland areas.
*Banvel (dicamba)	8	Spring to bud stage	Good control year of application—no residual control one year after treatment. Same restrictions as listed under Canada thistle.
Trichlorobenzoic acid (Trysben "200" or Benzac "1281")	20	Spring to fall	Some recovery one year after treatment. Use only on non-cropland areas.
BURDOCK			
2,4-D amine or LV ester	2	Before burdock reaches the bud stage	Use the amine near susceptible plant species.

[1]Refers to pounds of active ingredient or acid equivalent unless otherwise stated.

		POISONOUS PLANTS	
		DEATH CAMAS	
2,4-D ester	2	When camas is in early bud stage	Dry growing conditions adversely affect control results. Do not graze dairy animals on treated areas within 7 days of application.
		LARKSPUR	
		Tall	
2,4,5-T ester	2 plus wetting agent	When larkspur is in early bud stage	Do not graze dairy animals on treated areas within 7 days of application.
		Plains (Geyer)	
2,4-D ester	2 plus wetting agent	Leaf Rosette (2 to 6 in. growth)	The use of 2,4-D on plains larkspur is suggested as an early spring treatment to knock down and dry up larkspur so as to reduce incidence of poisoning. Do not graze dairy animals on treated areas within 7 days of application.
Tordon-22K (picloram)	¼ to ½	Anytime during growing season	For State of Wyoming only. Applicator MUST secure permit from State Department of Agriculture before making application. Study state label carefully.
Tordon-22K (picloram) + phenoxy cmpds.			Consult University for suggestions on mixtures and specific uses.
		HALOGETON	
2,4-D ester	2	When halogeton is in early bud stage	Oil or a wetting agent will improve control. Do not graze dairy animals on treated areas within 7 days of application.
		LOCOWEED	
2;4-D ester	2	When in early bud stage	Dry growing conditions adversely affect control results. Do not graze dairy animals on treated areas within 7 days after treatment.

[1]Refers to pounds of active ingredient or acid equivalent unless otherwise stated.

Herbicide or cultural practice	Rate of application[1]	Time of application	Remarks
		SAGEBRUSH BASIN, MOUNTAIN AND LOW	
2,4-D isopropyl or butyl ester	2	Spring. (See Bul. 354R, Wyo. Agr. Exp. Sta. for complete recommendations)	Identify species before spraying. Use oil (no lower than No. 2 diesel) for aerial application. Use water for ground rig application. Six to 8 oz. of wetting agent 100 gal. of spray increases effectiveness. Do not graze dairy animals on treated areas within 7 days after treatment.
		Black	
2,4-D L. V. ester	2	Spring	Plants must be growing rapidly and soil must have good moisture at time of application. Six to 8 oz. of wetting agent/100 gal. of spray is recommended. Do not graze dairy animals on treated areas within 7 days after treatment.
		Silver	
2,4-D butyl ester	2	Spring	Plants must be growing rapidly and soil must have good moisture at time of application. Six to 8 oz. of wetting agent/100 gal. of spray is recommended. Same restrictions as listed under Big and Black Sagebrush.
		Fringed	
2,4-D LVE or 2,4,5-TP (silvex)	1½ to 2	Early bud to bloom stage	The 1½ to 2 lb./A rate of either 2,4-D LVE or silvex has given outstanding control. Moisture at time of treatment is critical. If dry conditions are prevalent poor control is obtained. Same restrictions as listed above for other sagebrush.
Tordon-212	1 qt.	Bud to bloom	Tordon-212 has given virtually 100% control. The stage of treatment is not as critical as with 2,4-D. For use in rangelands and permanent pastures in State of WYOMING only.

		SNAKEWEED (GUTIERREZIA)	
2,4-D amine or LV esters	2 lb./A	Pre-bud	The 2 lb./A rate of 2,4-D amine or low volatile ester has given 92 to 98% control. Timing of application is critical. Do not graze dairy animals on treated areas within 7 days of application.
Tordon-212	1 to 2 qt.	Bud to Bloom	For use in rangelands and permanent pastures in WYOMING only. Applicator must secure permit from State Department of Agriculture. Read State Label Carefully.
		SOAPWEED (YUCCA)	
2,4,5-T ester	¼ lb. emulsified in 1 gal. diesel oil and 9 gal. water/A	Spring	Use as spot treatment. Wet thoroughly. Do not graze dairy animals on treated areas within 7 days of application.
2,4,5-TP (silvex)	2	Bud stage	Aerial application in 2 to 3 gal./A oil.
		RABBITBRUSH	
Tordon-22K (picloram)	1/8 to ¼	Anytime during growing season	For use in rangelands and permanent pastures in State of Wyoming only. Applicator MUST secure permit from State Department of Agriculture. Read state label carefully.
		WILD IRIS	
2,4-D butyl ester	3	When iris is in late bloom stage	Six to 8 oz. of wetting agent/100 gal. of spray is recommended. Do not graze dairy animals on treated areas within 7 days after treatment.
		DOWNY BROME (CHEAT)	
AAtrex 80W or 4L (atrazine)	1 to 1¼ lb. 80W 1.6 to 2.0 pt. 4L	Fall treatment. Do not apply to crested or intermediate wheatgrass.	Do not cut or feed range grass hay. Do not graze treated area within 7 months following fall application. Make only one treatment per year. Use minimum of 5 gals. water/acre with aerial application.
		UNDESIRABLE WOODY SPECIES	
		WILLOWS	
2,4-D ester	2-3	Full leaf development	By airplane—apply 2 to 3 lb./A in 2-3 gal. of diesel oil. Increase the volume of oil carrier for dense stands or when water is used as a carrier. May require annual treatment for 2 to 3 years. By ground equipment—thoroughly wet the foliage. Use 150 to 200 gal./A.

[1]Refers to pounds of active ingrediant or acid equivalent unless otherwise stated.

		WILLOWS (cont'd.)	
2,4-D ester	2 qt. in 10 gal. diesel oil	Basal treatment any time	Wet lower tree trunk to point of runoff.
Ammate	60 lb./100 gal. water	Full-leaf stage	Add 4 to 8 oz. spreader-sticker to mixture. Consult label for further instructions.
Hyvar X (bromacil)	2½ lb. in 5 gal. water	Active growth	Apply at rate of 1 to 2 fl. oz./stem 2 to 4 in. in basal diameter; wet base to run-off.
Hyvar XL (bromacil)	1 gal. in 5 gal. water		Apply 1-2 fl. oz./stem 2 to 4 in. in basal diameter; wet base to run-off.
		STUMP TREATMENT	
2,4-D or 2,4,5-T or a mix of the two (brushkiller)	1 to 2 qt. in 25 gal. diesel oil	Freshly cut stump (See Bul. 451, Wyo. Agr. Ext. Serv. for additional information	Wet stump surface, top, sides and exposed roots thoroughly.
Ammate	1 tsp. ammate crystals for every 2 in. diameter of tree stump		Use dry by placing crystals in holes drilled in stump or mix with water and thoroughly wet stump. Resprouting seldom occurs after using ammate.
		COTTONWOODS	
2,4-D ester	2 qt. 2,4-D in 10 gal. diesel oil	When tree is dormant (see Bulletin 451 Wyo. Agr. Ext. Serv. for additional information.)	Spray basal bark, cut surface, or frill cuts. Basal bark or frill treatments should encircle tree. Spray to point of runoff.
		FENCELINE, ROADSIDE, AND WASTE AREAS	
Soil sterilants—temporary or permanent	Use as recommended under sterilants	Spring or fall	Gives complete vegetative control on isolated patches.
Selective herbicides	Use as recommended for specific weeds	Spring or fall	Apply lightly to keep infestation from seeding or heavily to eliminate infestation.
Roundup (glyphosate)	2-4 qt. Perennial grasses and broadleaf weeds 1 to 1½ qt. Annual grasses and broadleaf weeds	Early bud stage to early seed head to maturity	Industrial site only—Nonselective herbicide which has no soil residual. Do not allow material to drift or contact desirable vegetation.

HERBICIDE GLOSSARY

The information presented in this section is intended only as a ready reference for general information on the herbicides most commonly used in Wyoming and included in this guide. The label for specific herbicides should be consulted for additional and more detailed information.

Trade Name	Chemical Designation	Leading Producer	Usual Form	Discussion
AAtrex	atrazine	Ciba-Geigy Shell	80% WP 4 lb/gal liq.	AAtrex is the Ciba-Geigy trade name for atrazine. Atrazine is available under several private labels; however, some labeled uses are only for AAtrex. Is a preplant, preemergence and postemergence s-triazine for control of broadleaf and certain grass weeds in corn, sorghum, rangelands and for weed control in noncrop areas and industrial sites.
Ammate x	AMS	DuPont	Gran (85% and 95% active)	Primary use has been to kill woody plants and poison ivy. It can be used to prevent tree stumps from sprouting when applied to the freshly cut stump or at the base of certain kinds of trees. Can be used also as a temporary soil sterilant.
Amitrol weedazol amino-triazole	amitrole	Amchem. Amer. Cyanamid	90% soluable powder	For non-crop areas only. Effective as a foliage treatment for control of Canada thistle, hoary cress, quackgrass and cattails. Is an anti-chlorophyll agent which causes chlorosis in plants.
Amitrole-T Cytrol	amitrole-T	Amchem American-Cyanamid	2 lb/gal soluable Conc. + 1% acrosol	Liquid formulation containing amino-Triazole and ammonium thiocyanate (15%). Can be used for control of the same weeds as Amitrol but at approximately half rates.
Aquathal	See Endothall			

Avadex	diallate	Monsanto	4 lb/gal EC 10% Gran	For control of wild oats in spring planted crops such as sugar beets, barley, corn, forage legumes and potatoes.
Avadex BW Far-Go	triallate	Monsanto	4 lb/gal EC	Avadex BW or Far-Go is specifically cleared for wild oat control in barley and wheat only. Far-Go shows better crop tolerance than Avadex on these two crops. Must be incorporated immediately after application to insure success.
Avenge	difenzoquat	American Cyanamid	2 lb/gal EC	Used for control of wild oat in fall and spring seeded wheat and barley. Apply when wild oats are in the 3 to 5-leaf stage. It can be applied in tank-mix with MCPA amine or bromoxynil for broadleaf weed control. When applying in more than 10 gpa spray, follow instructions relating to addition of surfactant.
Balan	benefin	Elanco	1.5 lb/ gal EC	Balan is recommended for weed control in alfalfa, alsike clover, birdsfoot trefoil, ladino, and red clover. Must be applied before seeding. Also used in established turf for control of undesirable annual grasses.
Banvel	dicamba	Velsicol	4 lb/gal EC 5% Gran	Broad spectrum selective herbicide. Used for selective broadleaf weed control in corn, small grains and grasses. Used to control weeds in lawns and turf. Control of perennial broadleaf weeds. Has clearance for use on pasture and rangeland up to 8 lb/A.
Betanal	phenmedipham	Nor-Am	1.3 lb/ gal EC	Selective postemergence herbicide for annual weed control in sugar beets. Pigweed resistant. Temperature sensitive. High temperatures beet damage — low temperature poor activity.
Betanex	desmedipham	Nor-Am	1.3 lb/ gal EC	Selective postemergence herbicide for annual weed control in sugar beets. More effective on pigweed than Betanal. Can be tank-mixed with Betanal for broader spectrum weed control.

Betasan Prefar	bensulide	Stauffer	4 lb/ gal	Selective herbicide for control of Crabgrass and other annual grasses and specific broadleaf weeds in lawn and turf.
Bexton	See Ramrod			
Bladex	cyanazine	Shell	80% WP 4 lb/ gal Fl.	A short soil residual triazine for grass and broadleaf weed control in corn and sorghum. It has a short residual life and is not expected to carryover to affect crops the following cropping season.
Brominal Buctril	bromoxynil	Amchem Rhodia Chipman	2 lb/ gal EC	A contact herbicide for selective control of broadleaf weeds in small grains. Wheat and barley are tolerant to bromoxynil from the one or two leaf stage up to flowering. Has advantage over 2,4-D in that it can be used as a fall or early spring treatment. More effective for control of blue mustard, tansy mustard and wild wild buckwheat than 2,4-D.
Brominal Plus Bronate		Amchem Rhodia Chipman	4 lb/ gal EC 2 lb/ Bromoxynil 2 lb/gal MCPA	A mixture of bromoxynil and MCPA. The combination makes possible a longer spraying season than possible with phenoxy herbicides. Crop can be sprayed as soon as it has reached the 3 to 4-leaf stage.
Carbyne	barban	Gulf	1 lb/gal EC	Selective wild oat herbicide for postemergence application in wheat, barley, sugar beets and peas. Timing of application critical for effective wild oat control.
Casoron	dichlobenil	Thompson Hayward	50% WP 4 & 10% Gran	Suggested for control of certain grasses and broadleaf weeds in fruit nurseries and established woody ornamentals and for around home-flower gardens, hedgerows, etc. Must be applied to a weed free surface.
Chem Hoe	propham	Pittsburg Plate Glass	4 lb/gal Fl. 15% Gran	Chem Hoe was formerly IPC which belongs to the carbamate group of chemicals. Used for downy brome control in alfalfa.

Chloro IPC Furloe	chloropropham	Pittsburg Plate Glass	4 lb/gal EC 10% Gran	Suggested primarily for dodder control in alfalfa for Wyoming.
Cobex	dinitramine	U. S. Borax	2 lb/gal EC	New preplant incorporated drybean herbicide similar to Treflan for grass control. Shorter residual life and narrower margin of crop safety than Treflan. A tank-mix with Eptam is commonly suggested.
Cytrol	See Amitrole-T			
Dacthal	DCPA	Thompson Hayward	50% WP 4 & 10% Gran	Used for preemergence control of annual grass and certain broadleaf weeds in turf, ornamental and horticultural crops. Must apply to weed free surface.
Dowpon	dalapon	Dow	74% WP	Used for grass control in many broadleaf crops such as sugar beets, corn, potatoes, legume seedlings and fruits.
Dinitro Weed Killer	dinoseb	Dow Niagara (FMC Corp.)	5 to 5.7 lb/gal EC 1 to 3 lb/gal salt	Several dinitro formulations are used as contact weed killers and for selective preemergence weed control. Dow General and Sinox General are soluable in most oils. These formulations are used mainly for non-selective general contact weed control. Examples: alfalfa in dormant season, orchard floor spray, pre-harvest desication of alfalfa and killing potato vines. Premerge and Sinox PE contain the alkanolamine salt. Used as a selective preemergence or early post-emergence herbicide. Dow Selective and Sinox W (ammonium salt) are used for postemergence selective weed control in certain crops including barley, oats, wheat, onions, seedling alfalfa and established alfalfa.
Dual	metolachlor	Ciba-Giegy	6 lb/gal EC	A new alachlor-like herbicide for weed control in corn grown for grain. Does not carry over in the soil to affect subsequent crops. Is cleared in combination with AAtrex.
Endothall	endothall	Pennwalt	0.52 to 2 lb/gal. Sol. Conc. & 5 & 10% Gran	Endothall is used for weed control in alfalfa and sugar beets; has been used for pre-harvest drying of seed crops, as a general contact herbicide and as an aquatic herbicide.

Eptam	EPTC	Stauffer	7 lb/gal EC	A preplant soil incorporated herbicide for grass and certain broadleaf weeds in corn, legumes, sugar beets and many horticultural crops.
Eradicane	EPTC + R-25788 antidote	Stauffer	7 lb/gal EC	Used similar to Eptam but has antidote included which provides greater crop safety for corn.
Fenac	fenac	Amchem	1.5 lb/gal EC	Perennial broadleaf control in non-cropped land.
Furloe	See Chloro IPC			
Hyvar Hyvar X Hyvar XL	bromacil	DuPont	80% WP 2 lb/gal liquid	Used as a soil sterilant and for woody plant control. Hyvar X is a wettable powder. Hyvar XL is a water soluable liquid.
Ingran	terbutryn	Ciba-Giegy	80% WP	A short residual S-triazine used for preemergence weed control in sorghum. Combine with AAtrex or Milogard for broader spectrum weed control.
IPC	See Chem Hoe			
Karmex	diuron	DuPont	80% WP	A substituted urea for selective annual weed control at light rates and as a soil sterilant at high rates.
Kerb	pronamide	Rohm + Haas	50% WP	A new herbicide preemergence and early postemergence weed control, especially annual and perennial grasses in alfalfa.
Knoxweed	Eptam + 2,4-D	Stauffer	10-4% Gran	A combination of Eptam + 2,4-D for preemergence annual weed control in corn. Do not use on sandy soils.
Krovar I	bromacil + diuron	DuPont	80% WP	Combination of 40% bromacil and 40% diuron. Intended for use in non-cropland areas. Do not use near desirable trees, along walks, driveways or similar areas.
Kuron 2,4,5TP	silvex	Dow Amchem	4 lb/gal EC	Similar to 2,4,5-T. Used to control chickweed in lawns and prickly pear cactus on rangelands.

Lasso	alachlor	Monsanto	4 lb/gal EC	Registered for preemergence use on corn, drybeans and potatoes.
Lexone	metribuzin	DuPont	See Sencor	
Lorox	linuron	DuPont	50% WP	Selective herbicide for preemergence broadleaf weed control in field corn, potatoes, and short-term vegetation control along irrigation ditches.
MCPA methoxone Chiptox Weedone	MCPA	Dow Rhodia Chipman Amchem	2 + 4 lb/gal EC and amine salts	Closely related to 2,4-D but safer on oats, peas and flax.
Milogard	propazine	Ciba-Giegy	4 lb/gal liq. 80% WP	Used for preemergence weed control in sorghum. Often combined with AAtrex or Igran for improved weed control.
Monobar chlorate		U. S. Borax	Gran	Contains 68% sodium metaborate and 30% sodium chlorate. Has equivalent of 23.3% boron trioxide. Nonselective grass and broadleaf killer for use in parking lots, fence lines, highway and railroad sites, under asphalt ect.
Modown	bifenox	Mobil	80% WP 2 lb/gal EC	A preemergence herbicide for the control of broadleaf and certain grass weeds in corn and sorghum. Early injury observed on corn.
MSMA Ansar Daconate Weed-Hoe Trans-Vert	MSMA	Ansar Amchem Dia-Shamrock	6 lb/gal sol. conc.	Used for selective crabgrass control in turf and for the control of broadleaf and grass weeds in non-cropped areas.
Paraquat CL	paraquat	Chevron	2 lb/gal water soluable cation	General non-selective contact herbicide for several no-till uses and for non-cropland, and as a pre-harvest application for desiccation of plants.
Polybor Chlorate		U. S. Borax	Gran	Is a non-selective herbicide for use where complete elimination of plant growth is desired. Is completely soluable in water andcan be applied as a spray. Contains 73% disodium octoborate and 25% sodium chlorate. Has equivalant of 49% boron trioxide.

Pre Beta I	pebulate + diallate	Great Western Sugar Co.		A preplant incorporated herbicide for control of annual grasses and certain broadleaf weeds in sugar beets.
Pre Beta II	cycloate + diallate	Great Western Sugar Co.		A preplant incorporated herbicide for control of annual grasses and certain broadleaf weeds in sugar beets.
Prefar	See Betansan			
Pramitol	prometone	Ciba-Geigy	80% WP 5% pellet 1.97 lb/ gal. Liq.	A long lasting non-selective soil sterilant. The 25E formulation contains 1.97 lb prometone per gal. Parmitol 5PS is a pelleted form containing 5% prometone 0.75% simazine, 40% sodium chlorate, and 50% sodium metaborate.
Preemerge	See Dinitro Weed Killer			
Princep	simazine	Ciba-Giegy	80% WP 4 lb/gal Fl. 4% gran	Simazine is used primarily as a soil sterilant but is also used for weed control in shelterbelts, deciduous fruits, established alfalfa, ornamentals and nursery plantings.
Prowl	pendimethalin	Amer. Cyanamid	3 lb/gal EC	Used preemergence on corn. Has been evaluated for weed control in drybeans, seedling alfalfa and potatoes.
Pyramin	pyrazon	BASF	75.5% WP	Used for preemergence broadleaf weed control in sugar beets. Often combined with other herbicides to increase spectrum of weed control.
Ramrod	propachlor	Monsanto Dow	65% WP 4 lb/gal Fl. and 20% gram	Preemergence herbicide for control of annual grasses in corn and sorghum.
Ro-Neet	cycloate	Stauffer	6 lb/gal EC 10% gran	A preplant incorporated herbicide for control of annual grasses and certain broadleaf weeds in sugar beets.
Roundup	glyphosate	Monsanto	3 lb/gal EC	A postemergence non-selective translocated herbicide effective on many annual and perennial weeds, both grasses and broadleaf species. No soil residual. Late (fall) applications on several perennials appear to be most effective time application. Also used for renovation of lawns.

Sencor	metribuzin	Chemagro	80% WP 4 lb/gal Fl.	Preemergence or early postemergence weed control in potatoes. Recently received clearance for weed control in established alfalfa.
Silvex	See Kuron			
Sinbar	terbacil	DuPont	80% WP	Used for Dormont season control of annual grass and broadleaf weeds in established alfalfa.
Spike	tebuthiuron	Elanco	80% WP	Total vegetation control product. Is resistant to leaching and lateral movement. New clearances include road shoulders where no vegetation is desired and under asphalt and concrete pavements.
Sutan+	butylate + R-25788	Stauffer	6.7 lb/ gal EC 10% Gran.	A preplant incorporated herbicide for the control of annual grass in corn. Sutan+ mixed with other herbicides such as AAtrex and Bladex control a broader spectrum of weeds.
Tandex	karbutilate	FMC	80% WP 4 and 10% gran.	For use on non-crop areas for non-selective broad spectrum weed control. Lateral movement is minimal. Railroad, highway, utility-rights-of-way, industrial sites.
TCA	TCA	Dow	90% SP 90% pellets	Grass killer for use on non-crop areas such as right-of-ways, fence rows, drainage ditch banks, airfields, etc.
Tillam	pebulate	Stauffer	6 lb/gal EC 10% gran	Preplant incorporated herbicide for annaul grass control in sugar beets.
Tolban	profluralin	Ciba-Giegy	4 lb/gal EC	Preplant incorporated herbicide for weed control in alfalfa (seedling), drybeans, and sunflowers.
Tordon 22K	picloram	Dow	2 lb/gal EC	Tordon is suggested for control of deep-rooted perennial broadleaf weeds. Many grass species are tolerant to Tordon. Federal label only for non-cropland use only. However, Wyoming has a state lavel for use on rangelands for control of poisonous plants, woody plant species and herbaceous perennials. Persistant compound in the soil.

Tordon-212	(mixture of 1 lb/gal picolinic acid + 2 lb/gal 2,4-D)			Same use and restrictions as for Tordon 22K.
Tordon Beads	(2% granule material)			Same use and restrictions as for Tordon 22K.
Treflan	trifluralin	Elanco	4 lb/gal EC 5% Gran	Preplant incorporated herbicide for use in drybeans, alfalfa and a number of other crops including several horticultural crops. Is weak on weeds in the night-shade family.
Trysben 200 Benzac 1281	2,3,6TBA	DuPont Amchem	2 lb/gal EC	For control of certain deep-rooted perennial weeds on non-crop areas.
Tupersan	siduron	DuPont	50% WP	Selective preemergence berbicide for control of certain annual weed grasses in turf areas such as lawns, golf course fairways, etc.
Ureabor		DuPont	Conc. Gran	There are three formulations of Ureabor which include Ureabor 31 and Ureabor 62. They contain different percentages of disodium tetraborate pentahydrate, disodium tetraborate decahydrate, monuron and 2,3,6TBA. They are all non-selective soil sterilants.
Vapam VPM	metham	Stauffer DuPont	4 lb/gal liq.	A soil fumigant used to kill germinating seeds, rhizomes, tubers, roots, and stems of weeds in the soil. Often used as a preplanting treatment in areas that are to planted or replanted with lawngrasses, seed beds, flowers, ornamentals, etc.
Velpar		DuPont	90% SP	Has both contact and soil residual activity. Suggested for general vegetation control on industrial sites, railroad rights-of-way, ditchbanks and similar areas.
Weedazol	See Amitrol			
Weedmaster	dicamba + 2,4-D	Velsicol	1 lb/gal dicamba + 2 lb/gal 2,4-D	For control of annual and perennial broadleaf weed on pasture and rangeland grasses, and non-cropland areas such as fence-rows, roadways, wastelands and around farm buildings.

2,4-D (many trade names)	2,4-D	Dow Chipman Hercules Diam-Sham.	Acid, salts, amines, exters	2,4-D is widely used, foliar applied, translocated herbicide for broadleaf weed control in cereal crops, turf, pastures, rangeland and non-cropland.
2,4,5-T (many trade names)	2,4,5-T	Dow	4 lb/gal and amine salts	2,4,5-T is similar to 2,4-D but is usually more effective on certain woody plants than 2,4-D. Is mixed with 2,4-D and marketed as "Brush Killer".
2,4,5-TD	See Kuron			
4(2,4-DB) Butoxone Butyrac	2,4-DB	Rhodia-Chipman Amchem	2 lb/gal EC and amine salts	Selective postemergence, translocated herbicide for broadleaf weed control in legumes. Susceptible plants are able to oxidize 2,4-DB into 2,4-D. Legume plants do not possess the enzymes or ability to oxidize 2,4-DB therefore selectivity results.

CALIBRATING A SPRAYER

Too often, sprayers are not calibrated properly. This results in poor weed control or even over application which injures crop plants. Correct application is one factor which the operator can control. It is essential that the liquid applied per acre be known so that the proper amount of chemical can be included in that specified volume of liquid and so proper application can be made.

BOOM SPRAYERS

Step 1. Determine the effective boom width. This is the width of the spray pattern on the ground.

Step 2. Calculate the distance the sprayer must travel to cover one acre by dividing effective boom width into square feet per acre. The distance necessary to spray an acre usually takes too much time to measure. The common practice is to reduce the area sprayed to a fraction of an acre: 1/6, ¼, etc.

Step 3. Fill the supply tank to an easily determined point. Adjust the pressure (35 to 40 psi for most uses). Adjust the tractor speed to 3 to 4 mph (or whatever speed you plan to use in the field). It is best to make trial runs to adjust speed and pressure. Spray the measured distance.

Step 4. Carefully measure water required to refill the supply tank to the determined point. Make two or three calibration runs to be sure the sprayer is applying the same volume each time.

Step 5. Multiply the number of gallons required to fill the supply tank by the reciprocal of the fraction of an acre sprayed (the reciprocal of 1/6 is 6, 1/4 is 4, etc.) to obtain the sprayer rate in gallons per acre at the speed and pressure used.

Example (Sprayer with 20-foot boom)

Step A. $\frac{43{,}560 \text{ (sq. ft./A)}}{20 \text{ (effective boom width)}}$ = 2178 feet necessary to travel to cover one acre

¼ of 2178 = 544 feet to cover ¼ acre.

Step B. 10 gallons of water required to refill supply tank.

Step C. 10 x 4 = 40 gallons per acre sprayed.

Step D. To each 40 gallons of water in supply tank, add the number of pints, quarts, gallons, or pounds of chemical needed to obtain the recommended application rate.

HAND OR KNAPSACK SPRAYER

Step 1. Mark out one square rod (16½ ft. x 16½ ft.).

Step 2. Put two quarts of water in spray can.

Step 3. Pump sprayer to 35 to 40 pounds pressure if it has a pressure gauge. If not, count number of strokes used to pump up the spray can.

Step 4. Spray the square rod, walking the same speed you plan to use in the field or yard.

Step 5. Measure the water remaining in the spray can and subtract this from the original two quarts.

Step 6. Compute the rate of spray per acre by the following formula: Gallons per acre = amount sprayed out (in pints) x 20.

Example

You find you sprayed two pints on the square rod.

2 x 20 = 40 gal./A

You now know what rate of water you are applying per acre. But how much chemical do you add to each gallon of water?

If the application rate calls for one pound of 2,4-D per acre and you have a four pound per gallon active material, here is how you mix.

If we have four pounds active per gallon, there is one pound per quart. There are 946 cc per quart and 160 square rods per acre.

160 ÷ 946 = 5.9 cc required to equal one pound per acre. This amount of chemical would be added to each quart of water.

HIGH PRESSURE, SINGLE NOZZLE SPRAYER

Step 1. Measure an area 16½ x 16½ feet (one square rod).

Step 2. Set sprayer at desired pressure and spray pattern.

Step 3. Determine the time (in seconds) it takes to thoroughly spray the measured area.

Step 4. Spray into a container for the same amount of time required to spray the square rod.

Step 5. Determine the amount of spray in quarts and multiply by 160 (160 sq.rd./A) and divide by 4 (4 qt. gal.)

Example

4 quarts recovered; 4 x 160 = 640 qt /A
640 ÷ 4 = (160 gal./A).

CONVERSION TABLES

The following tables can be used to determine the amount of pesticide, liquid or dry formulation, needed per unit area to give the rate recommended for effective control.

LIQUID CONVERSION FACTORS

1 gallon equals 4 quarts or 8 pints or 3785 c.c.* or 128 fluid ounces

1 quart equals 2 pints or 4 cups or 946 c.c. or 32 fluid ounces

1 pint equals 2 cups or 473 c.c. or 16 fluid ounces

1 cup equal 16 tablespoons or 236.5 c.c. or 8 fluid ounces

1 tablespoon equals 3 teaspoons or 15 c.c. or ½ fluid ounces

WEIGHT CONVERSION FACTORS

1 pound equals 16 ounces, or 454 grams

1 ounce equals 28.4 grams

*c.c. = cubic centimeter

PLOT SIZE FACTORS

1 rod equals 16.5 feet

1 square rod equals 16.5 x 16.5 feet or 272 square feet

1 acre equals 160 square rods

1 acre equals 43,560 square feet

APPLICATION FACTORS

1 cup per square rod = 10 gallons per acre

1 pint per square rod = 20 gallons per acre

1 quart per square rod = 40 gallons per acre

1 gallon per square rod = 160 gallons per acre

Conversion Table for Pesticides on an Acre Basis

Formulation	Amount of Chemical Recommended in Pounds Active Material Per Acre								
	1/8	¼	½	¾	1	1½	2	2½	3
	Amount of Formulation Needed to Obtain the Above Rates of Application								
10%-12% (Contains 1 lb. active/gal.)	1 pt.	1 qt.	2 qt.	3 qt.	1 gal.	1½ gal.	2 gal.	2½ gal.	3 gal.
15%-20% (Contains 2 lb. active/gal.)	1/3 qt.	2/3 qt.	1-1/3qt.	2 qt.	2-2/3 qt.	1 gal.	1-1/3 gal.	1-2/3 gal.	2 gal.
25% (Contains 2 lb. active/gal.)	½ pt.	1 pt.	1 qt.	3 pt.	2 qt.	3 qt.	1 gal.	5 qt.	1½ gal.
45%-50% (Contains 4 lb. active/gal.)	¼ pt.	½ pt.	1 pt.	1½ pt.	1 qt.	3 pt.	2 qt.	5 pt.	3 qt.
60%-65% (Contains 6 lb. active/gal.)	1/6 pt.	1/3 pt.	2/3 pt.	1 pt.	1-1/3 pt.	1 qt.	2-2/3 pt.	3-1/3 pt.	2 qt.
5% Wettable Powder	2½ lb.	5 lb.	10 lb.	15 lb.	20 lb.	30 lb.	40 lb.	50 lb.	60 lb.
25% Wettable Powder	½ lb.	1 lb.	2 lb.	3 lb.	4 lb.	6 lb.	8 lb.	10 lb.	12 lb.
40% Wettable Powder	5 oz.	10 oz.	1¼ lb.	1-7/8 lb.	2½ lb.	3¾ lb.	5 lb.	6¼ lb.	7½ lb.
75% Wettable Powder	1/6 lb.	1/3 lb.	2/3 lb.	1 lb.	1-1/3 lb.	2 lb.	2-2/3 lb.	3-1/3 lb.	4 lb.
80% Wettable Powder	2½ oz.	5 oz.	5/8 lb.	15/16 lb.	1¼ lb.	1-7/8 lb.	2½ lb.	3-1/8 lb.	3¾ lb.

Example: To apply 1 lb./A of the 4 lb./gal. material it would require 1 qt. of this formulation for each acre sprayed.

Conversion Table for Dry Formulations

Per 1000 square feet

Rate desired lb./A	100%	90%	80%	75%	70%	60%	50%	40%	30%	25%	20%	10%	5%
	Concentration of Active Ingredients in Formulation												
	(Grams of formulation per 1000 square feet)												
1	10	12	13	14	15	17	21	26	35	42	52	104	208
2	21	23	26	28	30	35	42	52	69	83	104	208	417
3	31	35	39	42	45	52	63	78	104	125	156	312	625
4	42	46	52	56	60	69	83*	104	139	167	208	417	833
5	52	58	65	69	74	87	104	130	174	208	260	521	1040
6	63	69	78	83	89	104	125	156	208	250	312	625	1250
7	73	81	91	97	104	121	146	182	243	292	364	729	1460
8	83	93	104	111	119	139	167	208	278	333	417	833	1670
9	94	104	117	125	134	156	187	234	312	375	469	937	1870
10	104	116	130	139	149	174	208	260	347	417	521	1040	2080

*Example: To treat a 1000 sq. ft. area at the rate of 4 lb./A active ingredient using a formulation containing 50% active ingredient, use 83 grams of the 50% formulation in the amount of carrier your application equipment is applying per unit area (1000 sq. ft.).

Conversion Table for Liquid Formulations

Per 1000 square feet

Rate desired lb./A	Concentration of Active Ingredients in Formulation: 1		2		2.5		3		4		5		6	
	(c.c. or tablespoon (tbsp.) of formulation per 1000 square feet)													
	c.c.	tbsp.	c.c.	tbsp.	c.c.	tbsp.	c.c.	tbsp.	c.c.	tbsp.	c.c.	tbsp.	c.c.	tbsp.
1	87	(5¾)	43	(3)	35	(2-1/3)	29	(2)	22	(1½)	17	(1¼)	14	(1)
2	173	(11½)	87	(5¾)	69	(4-2/3)	58	(3¾)	43	(3)	35	(2-1/3)	29	(2)
3	260	(18-1/3)	130	(8-2/3)	104	(7)	87)	(5¾)	65	(4-1/3)	52	(3½)	43	(3)
4	348	(23¼)	174	(11-2/3)	139	(9¼)	116	(7¾)	87	(5¾)	70	(4-2/3)	58	(3¾)
5	434	(29)	217	(14½)	174	(11-2/3)	145	(9-2/3)	109*	(7¼)	87	(5¾)	72	(4¾)
6	521	(34¾)	260	(17-1/3)	208	(13¾)	174	(11-2/3)	130	(8-2/3)	104	(7)	87	(5¾)
7	608	(40½)	304	(20¼)	254	(16¼)	203	(13½)	152	(10)	122	(8)	101	(6¾)
8	694	(46¼)	347	(23)	278	(18½)	231	(15½)	174	(11-2/3)	139	(9¼)	116	(7¾)
9	781	(52)	390	26)	312	(20¾)	260	(17-1/3)	195	(13)	156	(10½)	130	(8-2/3)
10	867	(57¾)	433	(28¾)	347	(23)	289	(19¼)	217	(14½)	173	(11½)	144	(9-2/3)

*Example: To spray a 1000 sq. ft. area at the rate of 5 lb./A active ingredient using a formulation containing 4 lb./gal. active ingredient, use 109 c.c. or 7¼ tablespoons of the 4 lb./gal. formulation in the amount of carrier your application equipment is applying per unit area (1000 sq. ft.).

W.D.A. 33
4-78

No. ____________

____________ COUNTY WEED AND PEST CONTROL DISTRICT

DAILY WORK ORDER

Date ____________

____________ (Name of Cooperator)* , ____________ (Address, Zip Code)*

Name of Pest(s) ____________ Commodity* ____________

*Location T. ________ R. ________ Sec. ________ Other (spec.) ________

Land Status: Private [ ] State [ ] Fed. [ ] Other [ ] ________

CUSTOMER(S) NOTIFICATION (*Information required for restricted use pesticides)

1. Pesticide(s) to be applied* ____________
2. Residue hazards* ____________
3. Re-entry period* ____________
4. Waiting periods* ____________

Customer notified prior to application: [ ] verbally or [ ] in written form

Customers signature ____________ Date ____________

SERVICE PERFORMED

Approx. Temp. - Air* ________ Soil ________ Wind velocity* ________ Wind dir.* ________

Relative humidity ________ Barometer ________ Weather ________

Soil type ________ Soil moisture* ________ Moisture depth ________

Rate of application/Ac* ________ Carrier ________ Total mixture/Ac ________

Total No. acres treated ________ Total amt. pesticide used* ________

Brand name of pesticide used* ____________

Time: Start ________ Stop ________

Mileage: To ________ From ________

Remarks ____________

Applicator ____________ (Signature) Date* ________

Rechecked by ____________

Estimate kill% ____________

Remarks ____________

(White copy retained by District) (Yellow copy to W.D.A.) (Pink copy to customer)

APPENDIX 4

RESEARCH IN WEED SCIENCE

APPENDIX 4

RESEARCH IN WEED SCIENCE [1]

1977

Harold P. Alley & Neil E. Humburg [2]

The information and data reported herein are a compilation of field research and demonstrational plots established throughtout Wyoming to evaluate herbicides and crop and weed tolerances under varied Wyoming climate, soil and farming operations.

The data have been accumulated, analyzed, and published for record and informational purposes and used by commercial concerns, weed science personnel, cooperators, University extension agents and others interested in the performance of various herbicides, combinations or both under Wyoming soil and climatic conditions.

This report does not imply weed control suggestions or herbicide registration for the uses where evaluated. Information regarding use clearances and restrictions for specific herbicides can be obtained from the Wyoming Weed Control Guide, published annually by the Agricultural Extension Service, University of Wyoming.

1/ The data and summaries contained herein were complied by Dr. H. P. Alley and Dr. N. E. Humburg with assistance in establishing and securing field data from Dr. A. F. Gale, Pesticide Specialist, Jerry Costel, Supt., Sheridan Agricultural Substation, and Graduate Students, Tom Schwartz, Rod Lym and Technician Walt York.

2/ Professor of Weed Science and Extension Weed Specialist, and Asst. Professor of Weed Science, respectively. The ranking of the author's names does not imply senior or junior author; the publication is a joint effort.

PERENNIAL AND RANGELAND WEED CONTROL

SECTION I - PERENNIAL WEEDS

Herbicide effectiveness upon four perennial designated weeds is reported and discussed in this section. All herbicides were applied with a 3-nozzle knapsack unit in a total volume of 40 gpa water, unless specified otherwise in the corresponding tables. Plots were one sq rd, randomized with three replications. Percentage weed control and other evaluations were determined by visual estimates approximately 1, 2 or 3 years following treatments. Data accumulated are included in the following tables.

CANADA THISTLE - RAILROAD RIGHTS-OF-WAY. Sheridan County. (Table 28).

Plots were established on the CB & Q railroad rights-of-way to a heavy infestation of Canada thistle on June 15, 1976, to compare the effectiveness of several granular formulations of picolinic acid with other herbicides. The Canada thistle was in the pre-bud stage, 24 to 30 inches tall at time of treatment. The plot area received 1.1 inches of precipitation one day following treatment.

Granular Formulations of Picolinic Acid

M-3864 - is a 5% machine protruded material which was not uniform in size, therefore resulted in uneven distribution of the material. Early evaluations 1 and 2 months following application indicated very little immediate activity to the Canada thistle, flowering was not arrested and new thistle growth was evident within 2 months. At rates of application of 1 and 2 lb/A ai only a 50% reduction in Canada thistle stand was evident 1 year after treatment.

M-4190 - is a 2% ammonium sulfate impregnated granule which is not uniform in size, powdery and easy flowing. This material stopped the Canada thistle flowering within 1 month of treatment with new growth being evident within 2 months. There was no apparent stand reduction of Canada thistle 1 year following treatment.

M-4188 - is a 2% Borax KMB/Dow granule which is approximately the consistency and size of sugar. This formulation gave similar results as the ammonium sulfate granule; it stopped flowering within a month of treatment with new growth within 2 months and no apparent reduction in stand 1 year following application.

M-4189 - is a 2% Borax USB/Dow granule which at the 2 lb/A rate gave a 45% reduction in Canada thistle stand and showed good activity 1 and 2 months following application.

M-2834 - is a 2% granule very similar to Tordon Beads only lighter in color and easier to see on the ground. This formulation exhibited good early activity and gave a 95% reduction in Canada thistle stand at the one year evaluation date.

Tordon 22K and Tordon 212 were the most effective treatments included in the trial. Although new growth was evident at the early evaluation dates, both Tordon 22K at 2 lb/A ai and Tordon 212 at 1 gal/A gave 100% reduction in Canada thistle stand after 1 year.

Dowco 233 (formulations M-3724 and M-4021) - both at 2 and 4 lb/A ai did not exhibit the effectiveness of either the Tordon 22K or Tordon 212 formulations. At 4 lb/A ai M-3724 resulted in a 95% reduction in stand.

Weedmaster - a mixture of 1 lb of Banvel + 3 lb of 2,4-D/gal at 2 gal/A resulted in an 80% reduction in Canada thistle stand; however, new growth was common on treated plots 1 year following treatment.

Vel 4027 - at the 8 lb/A ai treatment gave 85% control of the thistle but also killed all the grass growing on the treated area.

Roundup at the 2 and 4 lb/A ai rate per acre was not effective in reducing the Canada thistle stand; a maximum of a 55% reduction with the 4 lb/A ai rate.

CANADA THISTLE - Platte County. (Table 29).

Plots were established September 2 and 30, 1976, to mature plants. The soil was a sandy loam - 68% sand, 25.6% silt, 6.4% clay, 8.4% O.M. with a 7.5 pH. Percentage control evaluations were made on May 23 and June 26, 1977, approximately 8 and 10 months following application.

Banvel at 4 and 6 lb/A, Dowco 290 (M-3927) at 1.5 and 3 lb/A; Tordon 212 at 0.5, 1 and 2 gal/A, and Tordon 10K at 1 and 2 lb/A ai were the most effective treatments resulting in 93% to 100% control 10 months following treatment. There were indications that the Tordon 10K formulation was more effective at the later date of evaluation than at the earlier date. Recovery, reinfestation or both was apparent on the Weedmaster, M-4021, 2,4-D amine, and

Roundup treatments. Vel 4207 was very damaging to the associated grass common to the area, especially at the higher rate of application. Krenite exhibited some early activity but showed no promise as a Canada thistle herbicide as indicated in these tests.

FIELD BINDWEED. Platte County. (Table 30).

Several herbicides will result in immediate activity and initial reduction in vegetative growth of field bindweed. The problem is obtaining and maintaining control for extended periods without reinfestation, recovery or both of the bindweed on treated areas. With plots established in 1975 and evaluated in 1976 and 1977 the initial control and the lack of longevity of control is evident. Of the 32 treatments, Banvel at 8 lb/A and Vel 4207 at 8 lb/A were the only treatments resulting in 90% reduction in bindweed stand 1 year after treatment. These two treatments were considerably less effective after 2 years.

LEAFY SPURGE. Sheridan County. (Table 31).

Leafy spurge is probably the most difficult of the perennial, designated weeds to control and could be the most serious threat to croplands and rangelands in Wyoming. The acreage infested is increasing yearly with new and larger areas being reported.

Evaluation of plots established in 1975 and evaluated in 1976 and 1977 indicated that only Tordon 22K and Tordon 212, at the rates applied, gave 90% or greater reduction of the leafy spurge stand 1 year following application and the only treatments that showed residual activity resulting in any leafy spurge reduction 2 years following treatment.

Even though good early control can be obtained with Banvel, heavy rates of 2,4-D, and Roundup, follow-up treatments will be essential to reduce the infestation or maintain control.

RUSSIAN KNAPWEED - Albany County. (Table 32).

Plots were established July 9, 1974, and percentage control evaluations made in 1975, 1976 and 1977 to determine longevity of control.

Tordon 212 at 2 qt and 1 gpa, Dowco 290 (M-3724) at 0.75, 1.5 and 3 lb/A, and the combination of Dowco 290 + 2,4-D (M-3785) at 0.25 + 0.5, 0.25 + 1, and 0.5 + 2 lb/A showed 100% control of Russian knapweed 3 years following treatments. The percentage control obtained with Banvel at 2 and 4 lb/A decreased the second year after treatment but remained about the same after 3 years. Weedmaster, at the rates applied, did not show any control after 1 year. The initial control obtained with Roundup was complete as evidenced by limited reinfestation 2 and 3 years following application.

RUSSIAN KNAPWEED - Converse County. Richard Cross Ranch. (Table 33).

The experimental site was on undisturbed rangeland which was heavily infested with Russian knapweed in the pre-bud, 12 to 18-inch growth stage at time of treatment, June 12, 1975. Control evaluations were made June 22, 1976, and June 16, 1977, 1 and 2 years following treatment.

Tordon 22K and Tordon 212 resulted in complete elimination of Russian knapweed 1 and 2 years following treatment. The perennial grass on the plots treated with the 2 lb/A rate of Tordon 22K exhibited prostrate growth even after 2 years.

Dowco 290 (M-3972) at the 1 and 2 lb/A application rate was as effective as Tordon 22K and Tordon 212 with an apparent advantage of not causing any prostrate growth or phytotoxicity to the associated grass species.

Weedmaster, Dowco 233 (M-3724) and 2,4-D were not effective in reducing the Russian knapweed stand.

RUSSIAN KNAPWEED - Fremont County - Ron Cunningham plots. (Table 34).

The plots were established by Ron Cunningham to compare the effectiveness of Dowco 290 (M-3972) with Banvel, Tordon 22K and heavy rate of 2,4-D for Russian knapweed control. At time of evaluation August 9, 1977, 1 year following application, all treatments except the heavy rate of 2,4-D amine gave 98% or greater kill. Again, as in other trails, Dowco 290 (M-3972) did not cause the prostrate growth of grass evidenced where Tordon 22K was applied.

In summary, from the plots established and evaluated over the past 3 years, one would conclude that either of the formulations of picolinic acid (Tordon 22K or Tordon 212) could be utilized at the low rate of 1 lb/A ai to eliminate Russian knapweed. Banvel and Weedmaster will give early control; however, reinfestation, recovery or both is common within 2 to 3 years, indicating less soil persistence than picolinic acid. The Dowco 290 (M-3972) is outstanding on Russian knapweed and has the advantage over Tordon 22K and Tordon 212 of not causing the prostrate growth of the grass.

SECTION II - RANGELAND.

SNAKEWEED CONTROL DEMONSTRATION. Pat Price Ranch. Weston County. (Table 35).

One-acre demonstration plots were on heavily infested range near New-castle, Wyoming June 19, 1975, and evaluated for control in 1976 and 1977. The treatments were applied with a truck-mounted spray unit in a total volume of 20 gpa water.

Tordon 212 at 1 qt/A (0.25 picolinic acid + 0.5 lb 2,4-D/A) resulted in 100% control which has been maintained for 2 years. The 2,4-D LVE treatment at 2 lb/A gave 80% control; however, there were snakeweed escapes 1 year following treatment and recovery, reinfestation or both after 2 years. Silvex was not an effective treatment.

SNAKEWEED CONTROL - NEW HERBICIDES. Albany County. (Table 36).

A replicated series of plots were established June 19, 1974, utilizing new compounds El-103, Weedmaster and Dowco 233 (M-3724) in comparison with Tordon 212, Silvex and 2,4-D amine.

El-103 (Spike) did not show activity on snakeweed until 2 years after application at which time the 2, 3 and 4 lb/A rates gave near complete control. At the rates applied, which was necessary for adequate control, El-103 was very damaging to the associated grass species, reducing the stand 50 to 85%. Tordon 212 at 0.5 gal/A was the outstanding treatment resulting in 100% control with no apparent reduction in grass stand. Silvex, 2,4-D amine or Dowco 233 were not effective treatments. Weedmaster at 1 gal/A approached the effectiveness of Tordon 212.

DOWNY BROME CONTROL ON RANGELAND. Johnson County. (Table 37).

Atrazine at 1 lb/A and Chem Hoe 135 were applied by fixed wing aircraft to rangeland infested with a moderate stand of downy brome on October 25, 1976. Herbicides were applied in a total volume of 2 gpa water.

Downy brome control was near 100% where coverage was obtained. The

75 ft spray swath so designated by the applicator was too wide and only 50 ft was adequately covered.

Enclosures established early in the growing season were clipped August 15, 1977 and oven-dry grass production computed on treated versus untreated rangeland. No downy brome was harvested with the native forage on the atrazine treated range and the 6.6 lb/A harvested from the Chem Hoe treated area came from one of the 3 enclosures. The untreated rangeland yielded 180.6 lb/A of oven-dry native forage and 48.6 lb/A downy brome; whereas, the Chem Hoe treated range yielded 419.6 lb/A, an increase of 232% desirable forage.

Table 28: Herbicide, Canada thistle control, and visual observations. Sheridan County.

Herbicide 1/	Rate lb/A ai	Percent Control & Observations		
		July 15, 1976	August 18, 1976	May 13, 1977
Roundup	2			25-New growth - annuals.
Roundup	4			55-New growth - annuals.
Weedmaster	2 gal			80-New growth - annuals.
Sencor	2			0 -New growth - annuals.
Sencor	4			10-New growth - annuals.
Vel 4207	4			60-New growth - annuals.
Vel 4207	8			85-Took out grass.
*M-3724 (Dowco 233)	2	No thistle growth.	No thistle growth.	75-Annuals present.
*M-3724 (Dowco 233)	4	No thistle growth.	New thistle growth.	95-Annuals present.
*Tordon 212	1 gal	Few thistle growth.	New thistle growth.	100-Annuals present.
*Tordon 22K	2	Few thistle growth.	New thistle growth.	100-Annuals present.
*M-4021 (Dowco 233)	2	Many new thistle.	Many new thistle.	55-Annuals present.
*M-4021 (Dowco 233)	4	Many new thistle.	Many new thistle.	55-Annuals present.
*M-3864 (5% Gran)	1	Thistle flowering.	New thistle growth.	50-Annuals present.
*M-3864 (5% Gran)	2	Thistle flowering.	New thistle growth.	50-Annuals present.
*M-4190 (2% Gran)	1	Flowering stopped.	New thistle growth.	0 -Annuals present.
*M-4190 (2% Gran)	2	Flowering stopped.	New thistle growth.	0 -Annuals present.
*M-4188 (2% Gran)	1	Flowering stopped.	New thistle growth.	0 -Annuals present.
*M-4188 (2% Gran)	2	Flowering stopped.	New thistle growth.	0 -Annuals present.
*M-4189 (2% Gran)	1	New thistle growth.	New thistle growth.	0 -Annuals present.
*M-4189 (2% Gran)	2	No thistle growth.	No thistle growth.	45-Annuals present.
*M-2834 (2% Beads)	1	No flowering - no growth.	No thistle growth.	15-Annuals present.
*M-2834 (2% Beads)	2	No flowering - no growth.	No thistle growth.	95-Annuals present.
Banvel + Chloroflurenol	1 + 0.66			85-Annuals present.

1/ Treated June 15, 1976; evaluated July 15, 1976, August 18, 1976 and May 13, 1977.

* Trademark of the Dow Chemical Company.
M-3864 (5% Tordon Gran)
M-4190 (2% Tordon Gran - ammonium sulfate)
M-4188 (2% Tordon Gran - Borax KMG/Dow)
M-4189 (2% Tordon Gran - Borax USB/Dow)
M-2834 (2% Tordon Gran).

Table 29: Herbicides, Canada thistle control, and visual observations. Platte County.

Herbicide 1/	Rate lb/A ai	Percent Control May 23, 1977	Percent Control July 26, 1977	Ave Height Thistle (inches)	Observations
Banvel	4	100	93	10	Sparse population of annuals.
Banvel	6	87	99	6.5	Sparse population of annuals.
Vel 4207	4	70	45	16	25:75% ratio old vs. new thistle
Vel 4207	6	72	80	9	Severe - bare ground.
Weedmaster 2/	2 + 6	97	63	11	75:25% ratio old vs. new thistle
Weedmaster	4 + 12	90	73	10	50:50% ratio old vs. new thistle
Dowco 290 (M-3972)	1.5	100	100	--	Light stand of kochia.
Dowco 290 (M-3972)	3	100	100	--	Light stand of kochia.
M-4021	1.5	92	35	14.5	Excellent grass - few annuals.
M-4021	3	56	47	14	Very few annuals.
Krenite	2	40	0	19.3	Some annuals in plot.
Krenite	4	58	0	17	Some annuals in plot.
Krenite	6	82	30	20	Some annuals in plot.
Krenite	8	83	56	13.6	Some annuals in plot.
2,4-D amine	3	72	78	12	Few kochia plants.
2,4-D amine	6	63	25	17	Very few annuals.
2,4-D amine	12	61	42	16	Very few annuals.
2,4-D amine	20	66	40	14.6	Very few annuals.
2,4-D amine	40	94	83	10	Sparse vegetation.
Tordon 212 3/	0.5 + 1	100	100	--	Sparse kochia - no annual growth
Tordon 212	1 + 2	90	100	--	Excellent.
Tordon 212	2 + 4	100	100	--	Few kochia plants.
Tordon 10K	1	89	97	30	Few kochia, thistle twisted.
Tordon 10K	2	97	100	--	Sparse kochia.
Roundup	1.5	96	77	9	Killed perennial grasses.
Roundup	2.25	95	77	10	Killed perennial grasses.
Roundup	3	84	58	13.3	Annual braodleaf present.
M-3785 (Dowco 290 + 2,4-D)	0.25 + 1	100	75	9.3	Good grass - few annuals.
M-3785 (Dowco 290 + 2,4-D)	0.5 + 2	96	87	8	Good grass - few annuals.
Check				22	

1/ Treated Sept. 2 & Sept. 10, 1976; evaluated May 23, 1977 & July 26, 1977.
2/ Dicamba + 2,4-D (Velsicol's Weedmaster = 1 lb dicamba + 3 lb 2,4-D/gal).
3/ Picloram + 2,4-D (Dow's Tordon 212 = 1 lb picolinic acid + 2 lb 2,4-D/gal).

Table 30: Herbicide, field bindweed control, and visual observations 1 & 2 years following application. Platte County.

Herbicide 1/	Rate lb/A ai	Percent Control 1976	Percent Control 1977	Observations
Banvel	1	30	0	
Banvel	2	45	30	
Banvel	4	75	25	Reinfested.
Banvel	8	90	75	Reinfested.
Vel 4207	1	40	15	
Vel 4207	2	50	35	
Vel 4207	4	70	10	
Vel 4207	8	90	35	Reinfested.
Maintain CF 125	0.66	0	20	
Sencor	2	10	15	
Sencor	4	10	25	
Dowco 233 (M-3724)	0.375	30	40	
Dowco 233 (M-3724)	0.75	55	45	
Dowco 233 (M-3724)	1.5	40	40	
Dowco 233 (M-3724)	2.25	75	50	
Dowco 233 (M-3724)	3	60	45	
Dowco 233 + 2,4-D amine	0.375 + 1	30	55	
Dowco 233 + 2,4-D amine	0.75 + 1	30	40	
Dowco 233 + 2,4-D amine	1.5 + 1	50	65	
Dowco 233 + 2,4-D amine	2.25 + 1	55	50	
Dowco 233 + 2,4-D amine	3 + 1	80	50	
Dowco 290 (M-3972)	0.375	15	15	
Dowco 290 (M-3972)	0.75	15	15	
Dowco 290 (M-3972)	1.87	30	30	
Dowco 290 + 2,4-D amine	0.375 + 1	25	55	
Dowco 290 + 2,4-D amine	0.75 + 1	30	55	
Dowco 290 + 2,4-D amine	1.87 + 1	60	55	
Basagran	3	20	25	
Basagran	4	20	25	
Roundup	2	30	45	
Roundup	3	30	45	
Roundup	4	30	40	

1/ Treated July 9, 1975; evaluated June 2, 1976 & July 6, 1977.

Table [illegible]: Herbicide, leafy spurge control, and visual observations 1 & 2 years following treatment. Sheridan County.

Herbicide [1]	Rate lb/A ai	Percent Control 1976	Percent Control 1977	Observations
Dowco 233 (M-3724)	1.5	0	-	
Dowco 233 (M-3724)	3	0	-	Complete reinfestation.
Dowco 233 + 2,4-D amine	1.5 + 1	0	-	No apparent
Dowco 233 + 2,4-D amine	3 + 1	0	-	reduction of
Dowco 290 (M-3972)	1	0	-	infestation.
Dowco 290 (M-3972)	2	0	-	
Dowco 290 + 2,4-D amine	1 + 1	0	-	
Dowco 290 + 2,4-D amine	2 + 1	0	-	
Tordon 22K	1	98	80	
Tordon 22K	2	98	90	
Tordon 212 [2]	1 + 2	96	80	
Tordon 212	2 + 4	98	90	
Tordon 22K + Banvel	0.25 + 2	80	-	Complete reinfestation.
Tordon 22K + Banvel	0.5 + 2	88	-	No apparent
Banvel	2	20	-	reduction of
Banvel	4	50	-	infestation.
Banvel	8	80	-	
Vel 4207 (E.C.)	4	50	-	
Vel 4207 (E.C.)	8	60	-	
Weedmaster [3]	1 + 3	70	-	
2,4-D amine	6	40	-	
2,4-D amine	20	80	-	
Roundup	2	80	-	
Roundup	3	85	-	
Roundup + 2,4-D amine	1 + 2	50	-	

1/ Treated June 25, 1975; evaluated Aug. 18, 1975, June 15, 1976 & June 26, 1977.
2/ Picloram + 2,4-D (Dow's Tordon 212 = 1 lb picolinic acid + 2 lb 2,4-D/gal).
3/ Dicamba + 2,4-D (Velsicol's Weedmaster = 1 lb dicamba + 3 lb 2,4-D/gal).

Table 32: Herbicides, Russian knapweed control, and visual observations 1, 2, and 3 years following application. Albany County.

Herbicide 1/	Rate lb/A ai	Percent Control 1975	1976	1977	Observations
Weedmaster 2/	1 + 3	70	0	0	Reinfested.
Weedmaster	1.5 + 4.5	100	0	0	Reinfested.
Banvel	2	100	50	50	Reinfested.
Banvel	4	95	60	60	Good Grass Cover.
Vel 4207	2	100	80	70	Reinfested.
Vel 4207	4	100	80	70	Reinfested.
Vel 4359	2	98	20	20	Reinfested.
Vel 4359	4	100	40	20	Reinfested.
Tordon 212 3/	0.5 + 1	100	100	100	Good grass cover.
Tordon 212	1 + 2	100	100	100	Good grass cover.
Dowco 233 (M-3724)	0.75	95	50	0	Reinfested.
Dowco 233 (M-3724)	1.5	95	50	0	Reinfested.
Dowco 233 (M-3724)	3	95	50	0	Reinfested.
Dowco 290 (M-3972)	0.75	100	100	100	Good grass -
Dowco 290 (M-3972)	1.5	100	100	100	better than
Dowco 290 (M-3972)	3	100	100	100	Tordon 212 plots.
Dowco 290 + 2,4-D (M-3785)	0.125 + 0.5	100	100	100	Kochia abundant.
Dowco 290 + 2,4-D (M-3785)	0.25 + 1	100	100	100	Kochia abundant.
Dowco 290 + 2,4-D (M-3785)	0.5 + 2	100	100	100	Kochia abundant.
GK-40	2 gal	95	10	10	Reinfested.
Roundup	3	100	95	70	Reinfested.
Roundup	4	100	95	70	Reinfested.

1/ Treated July 9, 1974; evaluated July 1, 1975, June 25, 1976 and July 5, 1977.
2/ Dicamba + 2,4-D (Velsicol's Weedmaster = 1 lb dicamba + 3 lb 2,4-D/gal).
3/ Picloram + 2,4-D (Dow's Tordon 212 = 1 lb picolinic acid + 2 lb 2,4-D/gal).

Table 33: Herbicides, Russian knapweed control, and visual observations 1 & 2 years following treatment. Converse County.

Herbicide 1/	Rate lb/A ai	Percent Control 1976	Percent Control 1977	Observations
Tordon 22K	1	100	100	No damage to grass.
Tordon 22K	2	100	100	Grass prostrate.
Tordon 212 2/	1 + 2	100	100	Killed silver
Tordon 212	2 + 4	100	100	sagebrush.
Dowco 233 (M-3724)	1.5	0	0	
Dowco 233 (M-3724)	2.25	0	0	
2,4-D amine	20	30	30	
Weedmaster 3/	2 + 6	50	50	
Dowco 290 (M-3972)	1	100	100	No damage to grass.
Dowco 290 (M-3972)	2	100	100	Killed silver sagebrush.
Dowco 233 (M-3724) + 2,4-D amine	1.5 + 1	0	0	
Dowco 233 (M-3724) + 2,4-D amine	3 + 1	0	0	

1/ Treated June 12, 1975; evaluated June 22, 1976 and June 16, 1977.
2/ Picloram + 2,4-D (Dow's Tordon 212 = 1 lb picolinic acid + 2 lb 2,4-D/gal).
3/ Dicamba + 2,4-D (Velsicol's Weedmaster = 1 lb dicamba + 3 lb 2,4-D/gal).

Table 34: Herbicides, Russian knapweed control, and visual evaluations. Fremont County. (R. Cunningham).

Herbicide	Rate lb/A ai	Percent Control	Observations
Dowco 290 (M-3729)	1	100	Epinasty of new knapweed seedlings - regrowth of old and new bindweed seedlings. No hoarycress control.
Dowco 290 (M-3972)	1.5	100	No effect on hoarycress. No damage to grass.
Dowco 290 (M-3972)	2	100	No damage to grass.
Dowco 290 (M-3972)	2.5	100	Very little activity on bindweed - annual weeds present. No activity on hoarycress.
Banvel	4	100	New knapweed seedlings.
Banvel	6	98	Hoarycress plants seeding - No damage to grass.
Banvel	8	100	Some damage to grass, some hoary-cress recovery.
Tordon 22K	0.5	98	Good grass.
Tordon 22K	1	100	Grass prostrate.
2,4-D amine	40	60	Reinfestation & recovery.

1/ Treated Aug. 6, except Dowco 290 treated Sept. 15, 1976; evaluated Aug. 9, 1977.

Table 35: Snakeweed Control. Weston County.

Herbicide 1/	Rate lb/A ai	Percent Control June 17, 1976	June 13, 1977	Observations
Tordon 212 2/	0.25 + 0.5	100	100	Clean.
2,4-D LVE (PGBE)	2	85	80	Some reinfestation.
Silvex	2	60	50	Some reinfestation.

1/ One acre plots applied June 19, 1975 in 20 gpa water with truck-mounted spray unit. Evaluated June 17, 1976 and June 13, 1977.

Table 36: Snakeweed control and vegetative response. Albany County.

Herbicide 1/	Rate lb/A ai	Percent Control 1975	1977	Observations
EL-103 (Spike)	1	10	25	Took out 50% of grass.
EL-103 (Spike)	2	15	100	Took out 60% of grass.
EL-103 (Spike)	3	15	99	Took out 60% of grass.
EL-103 (Spike)	4	20	100	Took out 85% of grass.
Weedmaster 2/	0.5 gal	30	30	Good grass.
Weedmaster	1 gal	97	94	Good grass.
Tordon 212 3/	0.25 gal	90	60	Good grass.
Tordon 212	0.5 gal	100	100	Good grass.
Silvex	2	30	10	Good grass coverage.
2,4-D amine	2	40	10	
Dowco 233 (M-3724)	1.5	10	0	
Dowco 233 (M-3724)	3	65	40	
2,4-D LVE	2	50	40	

1/ Treated June 19, 1974; evaluated July 1, 1975 and July 5, 1977.
2/ Dicamba + 2,4-D (Dow's Tordon 212 - 1 lb picolinic acid + 2 lb 2,4-D/gal).
3/ Picolinic acid + 2,4-D (Dow's Tordon 212 = 1 lb picolinic acid + 2 lb 2,4-D/gal).

Table 37: Chemical control of downy brome and resulting grass production. Johnson County.

Herbicide 1/	Rate lb/A ai	Desirable Grass lb/A oven dry 2/	Downy brome
Atrazine	1	243.4	0
Chem Hoe 135	2	419.6	6.6
Untreated Range	-	180.6	48.6

1/ Aerial applied Oct. 25, 1976; clipped Aug. 15, 1977.
2/ Desirable grasses included blue grama, needleandthread, western wheatgrass, and threadleaf sedge.

APPENDIX 5

WYOMING WEED AND PEST CONTROL ACT OF 1973

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W.S. 11-5-102 (a)

(x) "Designated list" means the list of weeds and pests from time to time designated by joint resolution of the board and the Wyoming Weed and Pest Council;

(xi) Designated Noxious Weeds:

(1) Field bindweed (convolvulus arvensis)
(2) Canada thistle (circium arvense)
(3) Leafy spurge (euphorbia esula)
(4) Perennial sowthistle (sonchus arvensis)
(5) Quackgrass (agropyron repens)
(6) Hoary cress (whitetop) (cardaria draba and cardaria pubescens)
(7) Perennial pepperweed (giant whitetop) (lepidium latifolium)
(8) Ox-eye daisy (chrysanthemum leucanthemum)
(9) Skeletonleaf bursage (franseria discolor)
(10) Russian knapweed (centaurea repens)
(11) Yellow toadflax (linaria vulgaris)
(12) Dalmation toadflax (linaria dalmatica)
(13) Scotch thistle (onopordum acanthium)
(14) Musk thistle (carduus nutans)
(15) Common burdock (arctium minus)
(16) Plumeless thistle (carduus acanthoides)
(17) Dyers Woad (isatis tinctoria L)

(xii) Designated Pests

(1) Grasshoppers
(2) Mormon crickets
(3) Prairie dogs
(4) Ground squirrels
(5) Mountain pine beetle
(6) Beet Leafhopper

CHAPTER 5
Weed and Pest Control
ARTICLE 1
IN GENERAL

11-5-101. Citation and purpose. (a) This act may be cited as the "Wyoming Weed and Pest Control Act of 1973".

(b) The purpose of this act is controlling designated weeds and pests.

11-5-102. Definitions. (a) As used in this act:

(i) "Agricultural pesticide" means any material used to control or eradicate weeds or pests;

(ii) "Authorized dealer" means a resident of Wyoming who sells, retails, wholesales, distributes, offers or exposes for sale, exchanges, barters or gives away any agricultural pesticide within this state;

(iii) "Board" means the Wyoming board of agriculture established by authority of W.S. 11-2-101 through 11-2-104;

(iv) "Commissioner" means commissioner of agriculture for the state of Wyoming or his designated agent;

(v) "Control" means the process of containing and limiting weed and pest infestations;

(vi) "County commissioners" means the board of county commissioners of a county within which a district is located;

(vii) "Declared pest" means any animal or insect which the board and the Wyoming weed and pest council have found, either by virtue of its direct effect, or as a carrier of disease or parasites, to be detrimental to the general welfare of persons residing within a district;

(viii) "Declared weed" means any plant which the board and the Wyoming weed and pest council have found, either by virtue of its direct effect, or as a carrier of disease or parasites, to be detrimental to the general welfare of persons residing within a district;

(ix) "Department" means the state department of agriculture;

(x) "Designated list" means the list of weeds and pests from time to time designated by joint resolution of the board and the Wyoming weed and pest council;

(xi) "Designated noxious weeds" means the weeds, seeds or other plant parts that are considered detrimental, destructive, injurious or poisonous, either by virtue of their direct effect or as carriers of diseases or parasites that exist within this state, and are on the designated list;

(xii) "Designated pests" means animals or insects which are on the designated list considered detrimental to the general welfare of the state;

(xiii) "Director" means the director, division of plant industry, state department of agriculture, or his designated agent;

(xiv) "District" means any county weed and pest control district;

(xv) "District board" means the board of directors of a district having jurisdiction within the boundaries of the district it represents;

(xvi) "District board member area" means a geographical area within a district from which a member of the board of the district is appointed;

(xvii) "Division" means division of plant industry, state department of agriculture;

(xviii) "Farm products" means all crops, crop products, plants or portions thereof, but shall not mean livestock;

(xix) "Infested farm products" means farm products which contain injurious insects, pests, weed seed, poisonous or injurious plants or any injurious portion thereof, or plant diseases;

(xx) "Landowner" means any owner or lessee of state, municipal or private land, and includes an owner of any easement, right-of-way or estate in the land. Federal landowner means the federal agency having jurisdiction over any lands affected by this act;

(xxi) "Supervisor" means the person appointed or employed by the district board for the purpose of carrying out this act within a district;

(xxii) "Wyoming weed and pest council" means the state council composed of one (1) representative of each district as authorized in writing by that board of directors. The commissioner of agriculture or his designated representative shall serve ex officio;

(xxiii) "This act" means W.S. 11-5-101 through 11-5-119.

11-5-103. Composition of districts. All land within the boundaries of Wyoming including all federal, state, private and municipally owned lands, is hereby included in weed and pest control districts within the county in which the land is located, with the boundaries of the district being the same as the boundaries of the county. Each district shall be known as the ". . . . County Weed and Pest Control District, State of Wyoming."

11-5-104. District board of directors; appointment; terms; vacancies; compensation and expenses. (a) The county commissioners of each district shall hold a public meeting for appointing a district board of directors for the district. Prior to the meeting the county commissioners shall establish the number of members of the district board and shall establish district board member areas. The county commissioners may seek the advice and counsel of the members of the former district board for the establishment of district board member areas. Each district board member area shall be contiguous. Notice of the meeting shall be advertised in the official newspaper of the county at least two (2) times before the date of the meeting, with the last publication being at least ten (10) days prior to the date of the meeting. The notice shall solicit nominations for directors by petition signed by at least ten (10) landowners to be submitted at least five (5) days before the date of the meeting.

(b) From the nominations submitted the county commissioners shall appoint the district board which shall consist of five (5) or seven (7) directors. Directors shall serve for a term of four (4) years or until their successors are appointed and qualified.

(c) Any qualified elector in the district board member area he is appointed to represent is eligible to hold the office of director.

(d) All district board members shall be appointed by the county commissioners at their first regular meeting in January of each year from among nominations submitted by petition in the manner set forth in subsection (a) of this section. In districts encompassing cities or towns with a population of five thousand (5,000) or more, one (1) district board member shall be appointed from within the limits of a city or town. A district board member shall assume office at the first regular meeting of the district board following appointment.

(e) The county commissioners shall remove a director for repeated unexcused failure to attend meetings or for refusal or incapacity to act as a district board member.

(f) When a vacancy occurs on a district board the county commissioners shall, at the next regular meeting, appoint an individual who possesses the necessary qualifications as a district board member to fill the unexpired term.

(g) At the first regular meeting in February the district board shall elect from its members a chairman and a vice-chairman, and appoint a secretary and a treasurer. The positions of secretary and treasurer need not be members of the district board. The treasurer shall furnish a surety bond to the district before entering upon the duties of office in an amount to be set by the district board but not less than three thousand dollars ($3,000.00).

(h) The members of the district board shall serve without pay, but are entitled to reimbursement for actual and necessary expenses and a mileage allowance at the rate as established for state employees.

<u>11-5-105. Duties; powers; supervisor compensation.</u> (a) The district board shall:

(i) Implement and pursue an effective program for the control of designated weeds and pests;

(ii) Fix the time and place of regular meetings, which shall occur at least once each month and shall be open to the public;

(iii) Keep minutes of all meetings and a complete record of all official acts, including all warrants issued against monies belonging to the district, which are open for public inspection during regular office hours;

(iv) Employ certified supervisors and if certified personnel are not available, employ an acting supervisor who shall become certified within twenty-four (24) months from the initial date of employment;

(v) Make at least one (1) annual inspection to determine the progress of weed and pest activities within a district;

(vi) Obtain competitive bids for any purchase costing more than one thousand five hundred dollars ($1,500.00);

(vii) Control and disburse all monies received from any source;

(viii) Render technical assistance to any city or town with a population of five thousand (5,000) or more which establishes a program as provided in W.S. 11-5-115.

(b) The district board of each district may:

(i) Sue and be sued;

(ii) Employ personnel and determine duties and conditions of employment;

(iii) Coordinate activities with the department and enter into cooperative agreements with other agencies;

(iv) Secure and maintain bond or liability insurance, when deemed feasible by the district board;

(v) Submit to the department reports required by the board;

(vi) Participate in programs for the control of declared weeds and declared pests not included on the designated list. Such programs do not qualify for cost-sharing from the department.

(c) The supervisor shall receive a salary and expenses as approved by the district board.

11-5-106. Board of certification; duties. A board of certification is established consisting of the director, a University of Wyoming weed or pest specialist appointed by the dean of the college of agriculture, two (2) certified supervisors and a district board member appointed by the Wyoming weed and pest council. The board of certification shall promulgate rules and requirements for certification of supervisors and shall certify all personnel meeting the established requirements. All inspectors certified as of February 10, 1973 are deemed certified supervisors without any further actions of the board of certification.

11-5-107. Purchase and sale of pesticides and equipment. (a) The district board may purchase from authorized dealers such quantities of agricultural pesticides and equipment as are necessary, and hire labor to carry out the provisions of this act. Warrants in payment shall be drawn on the weed and pest control fund.

(b) The district board may sell agricultural pesticides which have been registered with the department for weed and pest control.

(c) In the case of delinquent indebtedness under this section the district board may seek a judgment from the district court for the indebtedness, reasonable attorneys' fees and costs. The judgment shall be enforced as provided by law.

11-5-108. Rates and application of pesticides; payment by landowner. The district board may establish rates and engage in the application of agricultural pesticides for weed and pest control. The district board may cost share in the agricultural pesticides, and the landowner shall pay the full cost of the application. If services provided are not paid for by the landowner for whom rendered, such indebtedness may be collected as provided by W.S. 11-5-107(c).

11-5-109. Inspection of land; remedial requirements; cost to landowner. (a) Whenever the district board has probable cause to believe that there exists land infested by weeds or pests which are liable to spread and contribute to the injury or detriment of others, it shall make or have made an investigation of the suspected premises through the use of lawful entry procedures. The designated representative of the district board, after giving the landowner written notice, may go upon premises within the district, through the use of lawful entry procedures, without interference or obstruction for purposes of making a reasonable investigation of the infested area. Notice is deemed to have been given if it is deposited in a United States post office by certified mail with sufficient postage, addressed to the last known address of the landowner at least five (5) days before entry.

(b) If the suspected area is found to be infested, the district board, by resolution adopted by two-thirds (2/3) of its members, shall confirm such fact. The district board may set forth minimum remedial requirements for control of the infested area.

(c) The district board shall deliver, by certified mail, to the address of the landowner appearing on the most recent tax roles of the district:

(i) A copy of the resolution;

(ii) A statement of the cost of fulfilling the requirements; and

(iii) A request that the requirements contained in the resolution be carried out at the owner's expense within a designated period of time or on a cooperative basis.

(d) At the request of the landowner, the district board shall hold a hearing in accordance with the Wyoming Administrative Procedure Act.

(e) A landowner who is responsible for an infestation and fails or refuses to perform the remedial requirements for the control of the weed or pest on the infested area within the time designated may be fined not more than fifty dollars ($50.00) per day for each day of violation and not more than a total of two thousand five hundred dollars ($2,500.00) per year as determined by the court. Any person accused under this act is entitled to a trial by jury. The accumulated fines under this section are a lien against the property of the landowner from the day notice is delivered to the landowner by the district board. All fines shall be deposited with the county treasurer and credited to the county school fund.

11-5-110. Appraisal of damage to landowner; hearing. When the district board determines by resolution that the landowner's property has been damaged as a result of carrying out its requirements, the district board shall by resolution appoint three (3) disinterested freeholders within the district to appraise the amount of damage, upon which the district shall forthwith compensate the landowner. The landowner may file a claim for damages and is entitled to a hearing relative to the amount of damages pursuant to the Wyoming Administrative Procedure Act.

11-5-111. Tax levied on property in district; maximum amount; weed and pest control fund. The county commissioners shall annually levy a tax to carry out this act. The tax shall be levied upon all property in the district and shall not exceed one (1) mill on each one dollar ($1.00) of assessed valuation. The tax is not part of the general county or city mill levies. All taxes levied and collected shall be remitted to the district for a separate fund to be known as the weed and pest control fund, which shall be used only to carry out this act.

11-5-112. Repealed by Laws 1979, ch. 135.

11-5-113. Allocation of funds; formula; special funding. (a) An allocation committee composed of the commissioner, three (3) members appointed by the Wyoming weed and pest council and one (1) member of the board shall allocate the funds of any legislative appropriation to the district boards pursuant to a formula adopted by the committee. No district board shall receive an amount in excess of one-third (1/3) of its actual expenditures from any appropriation, unless the appropriation provides assistance in control to a district board under subsection (b).

(b) If the district board determines a weed or pest is seriously endangering areas of a district or the state, assistance in control may be provided by legislative appropriation for this purpose, and the allocation committee shall allocate the appropriation accordingly, and the allocation committee and each affected district board shall be responsible for insuring that the funds are properly expended.

11-5-114. Allocated funds; procedure to disburse. A request for allocated funds pursuant to W.S. 11-5-113 shall be initiated by the district board by submitting a voucher and documentation. Upon the approval of the voucher by the allocation committee, payment shall be made by the state auditor out of funds provided for control of weeds and pests.

11-5-115. Program in cities and towns authorized; funding; use of monies. (a) The governing body of any city or town with a population of five thousand (5,000) or more may establish and administer a program for the control of weeds and pests within the jurisdictional limits of the city or town. If such a program is not established, the district board shall administer a program for the city or town.

(b) A district having a city or town with a population of five thousand (5,000) or more which establishes a program shall, within thirty (30) days after receipt of any funds collected pursuant to W.S. 11-5-111, transfer eighty-five percent (85%) of the funds attributed to the property within the corporate limits of the city or town to the governing body of the city or town, retaining fifteen percent (15%) of the funds for administration of the district and for technical assistance rendered to the city or town by the district board.

(c) Monies received by the cities from the district may be used in any phase of weed and pest control as determined by the governing body of the city or town. The control program shall include work on designated weeds and pests as determined by the district board.

(d) The governing body of a city or town which establishes a control program may petition the district board for special assistance and funding authorized by W.S. 11-5-113 and 11-5-114.

11-5-116. Quarantine by commissioner; request by district. (a) Whenever the commissioner, the district board or their agents find any section of the state to be infested with insects, pests, poisonous or injurious plants or plant diseases, and it is established that farm products from that section are liable to spread the insects, pests, poisonous or injurious plants or plant diseases into other sections to the injury of others, the commissioner shall without unnecessary delay, declare a quarantine against such section to prevent the transfer of farm products from the quarantined area. When it is ascertained that insects, pests, weed seed, poisonous or injurious plants or plant diseases are likely to be introduced into Wyoming by the importation of farm products, domestic animals or other objects, the commissioner shall declare a quarantine against the importation of such farm products.

(b) A district may initiate a district-wide quarantine by one (1) of the following procedures:

(i) A district may request in writing that the commissioner declare a district-wide quarantine. Upon receipt of the request, the commissioner shall instruct the district to circulate a petition for ninety (90) days within the district to obtain signatures of at least two-thirds (2/3) of all resident landowners owning at least fifty-one percent (51%) of all resident-owned land. Upon receipt of the properly executed petition, the commissioner shall declare a district-wide quarantine;

(ii) A district board may hold a hearing in compliance with the Wyoming Administrative Procedure Act. The commissioner shall declare a district-wide quarantine when the district has provided the commissioner with proper documentation that a hearing has been held and the district has found a need for a district-wide quarantine;

(iii) The district board may hold a district-wide referendum. The commissioner shall declare a district-wide quarantine upon receipt of a certified document indicating that the referendum was accepted by a majority of the electors who voted in the election.

(c) The commissioner shall declare an individual quarantine when requested by resolution adopted by a two-thirds (2/3) majority of the board.

(d) The district board in compliance with W.S. 11-5-101 through 11-5-119 may request a quarantine against the entry of infested farm products that may be injurious and detrimental to the state and enter into agreements with the law enforcing agencies to carry out the quarantine provision:

(i) Farm products and equipment shall be certified free of designated noxious weed seeds or infested farm products prior to entry into the state, with the exception of any processed feed or grain to be reprocessed and fed to livestock;

(ii) Farm products and equipment are to be certified in the state of origin by the proper officials;

(iii) Interstate shipment of farm products through the state need not be certified if covered in a prescribed manner as not to allow the dissemination of infested farm products.

11-5-117. Criminal provision; penalty. Any person violating any provision of this act is guilty of a misdemeanor, and shall be fined not more than one hundred dollars ($100.00) in addition to fines provided for in W.S. 11-5-109(e).

11-5-118. Inspection for contamination. Farm products and agricultural, commercial or industrial equipment entering or moving within the district are subject to inspection for contamination of designated weeds and pests by the district board through its designated agents. The board and the Wyoming weed and pest council may promulgate rules and regulations which establish inspection standards and remedial requirements under this section.

11-5-119. Rules and regulations. The board, with the approval of a majority of the districts, may promulgate, adopt and publish rules and regulations in accordance with the Wyoming Administrative Procedure Act for the purpose of carrying out the intent of this act.

If any provision of this act or its application to any person or circumstance is held invalid, the invalidity does not affect other provisions or applications of the act which can be given effect without the invalid provision or application, and to this end the provisions of this act are severable.

This act is effective May 25, 1979.

ARTICLE 2
LEAFY SPURGE CONTROL

11-5-201. Leafy spurge control program. (a) A leafy spurge control program is authorized and shall be carried out as provided by this section and legislative appropriation acts. As used in this act [this section] leafy spurge refers to EUPHORBIA ESULA. All state and local governmental entities shall comply with the program.

(b) The program shall be funded by landowner, weed and pest district and state contributions as follows:

(i) Landowners shall contribute twenty percent (20%) of the cost of the treatment program on their land but not to exceed a total cost of sixty dollars ($60.00) per acre;

(ii) Except as provided by paragraphs (i) and (iii) of this subsection, weed and pest districts shall contribute the total cost of the treatment program with the district with funds available under subsection (c) of this section;

(iii) The state shall contribute the total cost of the treatment program on state land plus the amount under paragraph (ii) of this subsection which cannot be funded by a weed and pest district under subsection (c) of this section.

(c) A weed and pest district may levy not to exceed an additional one (1) mill on the assessed value of the taxable property within the district to fund its contributions under this section. Upon request by a weed and pest district the board of county commissioners may levy the amount of tax requested not to exceed the mill levy authorized by W.S. 11-5-111 and this subsection. When no longer needed for the purpose of this section, the county commissioners shall remove the additional levy authorized by this paragraph. Funds necessary to carry out provisions of this act [this section] in excess of the revenue derived from the one (1) mill levy authorized by this subsection shall be funded by the state under paragraph (b)(iii) of this section.

(d) In addition to the penalty provided by W.S. 11-5-109, any landowner who refuses to perform remedial requirements to control leafy spurge after due notice as required by W.S. 11-5-109 is subject to a civil penalty not to exceed one hundred dollars ($100.00) per day for each day the landowner is in violation but not to exceed a total penalty of five thousand dollars ($5,000.00) per year. The accumulated penalties under this section constitute a lien on the land from the day notice from the weed and pest board is delivered to the landowner. Civil penalties received under this subsection shall be paid to the weed and pest district in which the land is located.

Eight hundred eighty-five thousand dollars ($885,000.00) is appropriated from the general fund to the department of agriculture for the purpose of treating leafy spurge on private lands under this act. Five hundred and fourteen thousand dollars ($514,000.00) is appropriated from the farm loan account within the trust agency fund authorized by W.S. 11-34-202, for the purpose of treating leafy spurge on state lands under this act. The state board of agriculture shall adopt rules and regulations as provided by W.S. 11-5-119 to implement an effective program to control leafy spurge in Wyoming.

This act is repealed July 1, 1984.

This act is effective July 1, 1978.

REGULATIONS

WYOMING WEED AND PEST CONTROL ACT OF 1973

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CHAPTER XXXXII

REGULATIONS

WYOMING WEED & PEST CONTROL ACT OF 1973

Section 1. Authority. These regulations are promulgated pursuant to Section 11-69.21 of the Wyoming Weed and Pest Control Act of 1973, hereinafter called the Act, and the Wyoming Administrative Procedure Act for the purpose of carrying out the intent of the Act, and are applicable to all sections of the Act except Section 11-69.9.

Section 2. Definitions. For the purpose of carrying out the intent of the Act the following definitions shall be considered as well as those contained in the Act and the Wyoming Administrative Procedure Act.

a. The term "district-wide" means the area contained within the boundaries of a weed and pest control district, including all federal, state, private and municipally owned lands.

b. The term "emergency" means those situations which are related to outbreaks of insects, pests, poisonous or injurious plants or any injurious portion thereof or plant diseases of an unforeseen nature.

c. The term "farm products" means all crops, crop products, plants or portion thereof, livestock and livestock products.

d. The term "individual quarantine" shall mean the area owned or controlled by one person or company or legal entity or agency in one weed and pest control district.

e. The term "infested farm products" means farm products which contain insects, pests, weed seed, poisonous or injurious plants or any injurious portion thereof, or plant diseases.

f. The term "designated weed seed" shall mean weed seed from weeds as provided in Section 11-69.3(j).

g. The term "prevent" means to stop the transfer of insects, pests, weed seed, poisonous or injurious plants or any injurious part thereof or plant diseases.

h. The term "section of the state" means any portion of one or more weed and pest control district(s) larger than an area owned or controlled by one person in one weed and pest control district.

j. The term "state-wide" shall mean the area contained within the boundaries of the State of Wyoming.

k. The term "landowner" shall mean agricultural tenants or agricultural lessees and owners of easements or rights-of-way on all lands, including federal, state and private.

m. The term "person" means any individual, partnership, association or organized group of persons whether incorporated or not.

n. The term "visible weed seed" shall mean weed seed capable of being seen; apparent; manifest; obvious.

o. The term "agency" shall mean any authority, bureau, board, commission, department, division, officer or employee of the state, county, municipality or other political subdivision of the state, except the state legislature and the judiciary.

p. The term "control"(in addition to its definition under Section 11-69.3(f) of the Act) shall mean the process or containing and limiting of weed and pest infestations.

q. The term "prevention" shall mean forestalling the contamination of an area by insects, pests, poisonous or injurious plants or any injurious portion thereof or plant diseases.

r. The term "eradication" shall mean the complete elimination of all insects, pests, poisonous or injurious plants or any injurious portion thereof or plant diseases.

Section 3. Amendments to designated list (Section 11-69.3(j)). The procedures for amending the designated list are as follows:

a. A person may propose an amendment to the designated list which shall be presented in writing to the district board.

b. The district board shall approve or disapprove the proposed amendment by motion at its next regular scheduled meeting.

c. If the district board approves the proposed amendment, the complete file, including the board's motion, shall be presented to the Wyoming Weed and Pest Council.

d. The Wyoming Weed and Pest Council shall approve or disapprove the board's motion at its next regular scheduled meeting and, if approved, shall prepare a joint resolution to be signed by the president and presented to the Wyoming Board of Agriculture. The Wyoming Board of Agriculture shall also be provided the original file and the district board motion.

e. The Wyoming Board of Agriculture shall approve or disapprove the proposed amendment by motion at its next regular scheduled meeting. If the proposed amendment is approved, the president of the Wyoming Board of Agriculture shall co-sign the joint resolution and shall advise the Wyoming Weed and Pest Council and the Secretary of State that the designated list has been amended.

Section 4. Discretionary program participation under Section 11-69.8(p). If the District desires to participate in discretionary programs for the control of weeds and pests not included in the designated list as provided in Section 11-69.8(p), the procedure set forth in Section 3 shall be applicable except that the weed or pest species shall not be added to the designated list and the Board of Agriculture need not notify the Secretary of State of Wyoming.

Section 5. Notices. Under Section 11-69.12, agricultural lessees or tenants shall be furnished copies of all notices and/or resolutions in the same manner as such notices and/or resolutions must be furnished to landowners.

Section 6. Damages, claims, etc.

a. The provisions of Section 11-69.13 shall be applicable in all respects to agricultural lessees or tenants.

b. Each Weed and Pest District shall be liable for any statutory damages arising out of a quarantine issued by the Commissioner of Agriculture as a result of carrying out its request for a quarantine, and agrees to save the State of Wyoming, and the Wyoming Board of Agriculture and the Commissioner of Agriculture harmless from any and all liability in connection with any claims for damages arising out of a quarantine.

c. The Weed and Pest Control District Board shall conduct all hearings referred to in Section 11-69.13 of the Act.

Section 7. Request for quarantine, general requirements.

a. Each request for a quarantine shall be accompanied by a sworn affidavit which contains the following information:

(1) The area, object or item to be quarantined.

(2) A statement that the person requesting the quarantine has found the lands, object or item to be infested by designated weed(s) and/or pest(s) and that the requesting person has a reasonable belief that infested farm products from those lands, objects or items are liable to spread the weed or pest into other sections to the injury of others.

(3) Infested farm products, object or item to be quarantined.

(4) Inspection and release procedures for the farm products, object or item.

(5) Termination date of the quarantine, if such date is anticipated.

b. The district should have specific requirements in mind when requesting a quarantine and when the requirement is reached in a portion of the quarantined area, that portion of the quarantined area should be released from the quarantine.

Section 8. District-wide quarantines. District-wide quarantines shall be declared when the requesting district has provided the Commissioner of Agriculture with the affidavit referred to in Section 7 with their initial request; and when the district has complied with the provisions of the first paragraph of Section 11-69.19(b) of the Act.

Section 9. State-wide quarantines. The procedure for declaring a state-wide quarantine shall be as follows:

a. If a person residing within a district ascertains that insects, pests, weed seed, poisonous or injurious plants or plant diseases are likely to be introduced into Wyoming by the importation of farm products, domestic animals or other objects, the person ascertaining such may file a request for quarantine with the district board if the person provides such information as may be required by the district board.

b. The district board shall approve or disapprove the request by two-thirds majority within forty-eight hours after the request has been properly filed.

c. If the district board approves the request, the Board of Agriculture must be provided with a copy of the request and of the board minutes indicating that a two-thirds majority had approved the request.

d. The request forwarded to the Board of Agriculture shall contain information set forth in Section 7 a (1) and (3) of these rules.

e. Upon initial review of the person's request and the district board's approval, the Wyoming Board of Agriculture may immediately instruct the Commissioner of Agriculture to declare a quarantine for ten (10) days.

f. The Wyoming Board of Agriculture shall hold a hearing within ten (10) days of the receipt of such request and approval or declaration of temporary quarantine to determine if the Commissioner of Agriculture shall declare a quarantine.

g. If the Board of Agriculture determines that the Commissioner of Agriculture shall declare a quarantine, he will be provided with the original quarantine request, a copy of the Board's approval, a copy of the Board of Agriculture motion to declare a quarantine and a hearing transcript.

Section 10. Individual quarantines.

a. The district board shall notify the landowner in writing of its intent to quarantine the land or portion thereof. The notice shall describe the lands to be quarantined and shall contain a notice of time and place for hearing before the district board. Such hearing, unless relinquished in writing, shall be held not less than ten (10) days nor more than twenty (20) days from date of such notice. At such hearing the district board shall determine by resolution if a quarantine should be declared on such lands by the Commissioner of Agriculture.

b. If a district board determines that a quarantine should be declared by the Commissioner of Agriculture, the board shall forward a request containing the information set forth in Section 7 of these rules a certified copy of the board's resolution adopted by a two-thirds majority of the board requesting such quarantine, and a copy of the hearing transcript, if the same was transcribed, to the Commissioner of Agriculture who shall declare the quarantine.

Section 11. Quarantine of movement of infested farm products.

a. If the district or its agent has a reasonable belief that infested farm products that are being transported are liable to spread the visible weed or pest into other sections to the injury of others, it may cause the vehicle containing such products to be detained, and its cargo inspected, providing the vehicle has not already been inspected by another Wyoming Weed and Pest District and found free of infested farm products.

b. Upon completion of inspection of the cargo, if the agent and/or supervisor does not find infested farm products he shall give the person in possession of the vehicle a certificate showing he has not found infested farm products and that the vehicle and cargo are released. The certificate should also contain the date, time, place, vehicle's cargo description, and origin and destination of the load; or, if the agent and/or supervisor finds infested farm products, he will inform the owner of the farm products and the person in possession of the vehicle of his findings.

c. Inspection of infested farm products.

(1) If the cargo contains infested farm products, the agent and/or supervisor shall instruct the person in charge of the vehicle that the following options are available to him.

(a) Return the cargo to its point of origin;

(b) Take the cargo to a processing plant to have the infestation rendered harmless; and/or reclean to the point that no infested farm products are present;

(c) Change the destination of the cargo to a place where the infested farm products will not be detrimental;

(d) Destroy the infested farm products in a manner that destroys the infesting agent.

(2) The district or its agent shall give notice to the person in possession of said vehicle of his right to a hearing within twenty-four (24) hours before the district board.

In the event the person does not comply with options as specified in Section 11. c. (a), (b), (c) or (d), the agent and/or supervisor shall instruct the person and/or owner to either appear at a hearing before the district board or sign a statement relinquishing the rights to a hearing before the board. At such hearing, the person and/or owner so cited and detained may appear in person or by counsel.

(3) In the event the hearing is relinquished, the district board or its agent shall forward such waiver or a duplicate thereof with the information provided for in Section 7 a (1) and (3) to the Commissioner of Agriculture, who upon receipt thereof shall declare the quarantine forthwith.

d. The procedures outlined in Section 11 may be followed in the district-wide quarantine, section-of-the-state quarantine, state-wide quarantine.

e. In the event a hearing is held if the district board determines a quarantine should be declared, it shall adopt a resolution by two-thirds majority to that effect and forward the same, together with the information provided for in Section 7 a (1) and (3) to the Commissioner of Agriculture who shall declare the quarantine.

Section 12. <u>Section of the state quarantine.</u>

a. In the event several districts desire a section of the state to be quarantined, they shall provide the Board of Agriculture with the documents referred to in Section 7 of these regulations. Those documents and written request from the district boards involved shall be provided to the Board of Agriculture with one letter of transmittal signed by the chairman of each district board and the combined district boards may request the Commissioner of Agriculture to declare a temporary quarantine for ten (10) days and he shall thereupon declare a temporary quarantine.

b. The district boards shall hold a hearing, said hearing to be held within the said ten (10) days, notice thereof to be published in a newspaper of general circulation in the area of the state to be quarantined. At such hearing the district boards shall determine if the Commissioner of Agriculture should declare a quarantine. If the district boards determine the Commissioner of Agriculture should declare a quarantine, they shall provide the Commissioner with the original quarantine request, the individual board requests, the consolidated request, copies of the findings, conclusions and the final requests of the board and copies of the hearing transcripts, and upon receipt of the same the Commissioner shall declare such quarantine.

c. In the event the district boardsdo not concur, those districts which do concur will transmit all documents to the Board of Agriculture, by letter signed by all concurring district board chairmen. Upon receipt of such letter and documents, the Board of Agriculture shall convene a hearing within ten (10) days to determine if the Commissioner shall be instructed to declare a quarantine. Copies of all documents will be provided to the Commissioner of Agriculture.

Section 13. Administrative Procedure Act. All hearings shall be held in compliance with the Wyoming Administrative Procedure Act.

Section 14. Termination date. All quarantines which do not contain a termination date shall remain in effect until terminated by the same procedure under which the quarantine was initiated.

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CHAPTER XLIX

RULES AND REGULATIONS OF THE
LEAFY SPURGE CONTROL ACT OF 1978

Section 1. Authority. These regulations are promulgated pursuant to W.S. 11-5-201, also known as the Leafy Spurge Control Act of 1978, hereinafter the Act; and the Wyoming Administrative Procedure Act, for the purpose of carrying out the intent of W.S. 11-5-201.

a. The program for the treatment of Leafy spurge (euphorbia esula) shall be carried out under the provisions of the Wyoming Weed and Pest Control Act of 1973, as modified by W. S. 11-5-201 and the rules and regulations of the Board of Agriculture as provided for and in compliance with the Act;

b. The treatment program shall be under the direction of the Board of Directors of each Weed and Pest Control District;

c. Compliance with the program shall be the responsibility of the landowner;

d. The overall program shall be coordinated by the Department of Agriculture in consultation with other pertinent agencies and organizations.

Section 2. Definitions. For the purpose of carrying out the intent of W.S. 11-5-201, the following definitions shall be considered as well as those contained in Title 11, Chapter 5, and the Wyoming Administrative Procedure Act.

a. The term "state lands" means the lands under the jurisdiction of the State Board of Land Commissioners and Farm Loan Board;

b. The term "District Evaluation Committee" means the committee consisting of one representative from each district, within the respective area, with the Executive Director for each area serving as chairman. The District Evaluation Committee shall review each district program annually, and determine if the districts in their respective areas are implementing and pursuing an effective program for the treatment of Leafy spurge, and will submit a report, by July 15 of each year, to the County Commissioners and State Evaluation Committee;

(1) The Board of Directors for each district shall select their own representative who may be a member of the Board of Directors, and/or a Supervisor;

(2) The district shall have the right to comment upon any report prior to distribution. Comments shall be distributed with the report;

(3) Areas are: Area 1 - Big Horn, Hot Springs, Park, and Washakie; Area 2 - Campbell, Crook, Johnson, and Sheridan; Area 3 - Converse, Natrona, Niobrara, and Weston; Area 4 - Lincoln, Sublette, Teton, and Uinta; Area 5 - Carbon, Fremont, and Sweetwater; Area 6 - Albany, Goshen, Laramie, and Platte.

c. The term "State Evaluation Committee" means the committee consisting of one representative from the following organizations: The University of Wyoming, Plant Science Division, appointed by the Dean, College of Agriculture; Executive Board of Directors, appointed by the President, Wyoming Weed and Pest Council; Wyoming Department of Agriculture, appointed by the Commissioner of Agriculture; Public Land Office, appointed by the Commissioner of Public Lands; Wyoming Board of Agriculture, appointed by the Chairman of the Board of Agriculture; and the Governor's Office, appointed by the Governor. The committee shall annually review the district evaluation reports and have the authority to conduct on-site inspections and make adjustments as they deem feasible. The committee shall submit an annual report by August 15 of each year to the Board of Agriculture, County Commissioners, Public Land Office, Governor's Office, District Evaluation Committee, and each district;

d. The term "treatment program" means the program implemented by the Board of Directors of each district;

e. The term "treatment" means the treatment recommended in the current Wyoming Weed Control Guide, and/or as approved by the State Evaluation Committee, using a Weed Management Program which is an interdisciplinary approach to control unwanted plants;

f. The term "cropland" means lands that are being cultivated;

g. The term "Executive Board of Directors" means the governing body of the Wyoming Weed and Pest Council.

Section 3. Standards and Procedures. The Wyoming Board of Agriculture, in cooperation with the Executive Board of Directors, may suggest standards and procedures for carrying out an effective treatment program.

Section 4. Landowner Agreements. The district shall obtain a landowner agreement which assures that an approved treatment progarm will be carried out on the landowner's property.

a. The approved treatment progarm must be a continuous three (3) year program, subject to continued funding. If State funds are used, they may be used only during these three (3) years on any given acre;

(1) Exceptions can be made to the continuous three (3) year program upon approval of exception request approved by the District Board, Executive Board of Directors, and the Board of Agriculture.

b. The District shall put into effect agreements, as recommended by the District Board, with the landowners to assure the continuation of the maintenance program after the expiration of the three (3) year progarm. The maintenance program will be continuous as recommended by the District Board under Title 11, Chapter 5.

c. The landowner agreements on property described in the agreement are binding upon all heirs and assignees until termination of the agreement.

Section 5. Cooperative Agreements. The Wyoming Department of Agriculture may enter into cooperative agreements with the districts to carry out the intent of the program.

Section 6. Application of Treatment Program. The district may engage in the application of herbicides and/or may have application equipment available to supplement commercial and private applicators. The treatment under the program is the responsibility of the landowner.

a. A landowner carrying out the treatment program will be credited at the same rate for herbicides and/or application of the same as established for (or by) the district, or by bid. He shall be allowed to purchase herbicides from the district at bid price plus five percent (5%). If the district lets bids, the district may reject any and all bids;

b. If the project is bid, the landowner may conduct the program by meeting the low, acceptable bid;

c. A landowner may be reimbursed in cash for eighty percent (80%) of application and herbicide cost until he has reached his sixty dollar ($60.00) contribution, and thereafter, he may be reimbursed at one hundred percent (100%).

d. If any other entity of Government cost-shares on any acre of Leafy spurge, the landowner shall advise the District Board of such cost-sharing and such shall not be considered to be a landowner contribution;

e. When bids are not let, the cost of application shall be negotiated by the Weed and Pest Control District, and shall specify the herbicide cost and application cost.

Section 7. Treatment Program. The district shall submit plans for each fiscal year to the Department for carrying out the treatment progarm.

a. Districts submitting a program under Section 12(d) for State appropriated funds shall carry out that program or return any unused state appropriated funds immediately to the State;

b. Any district which does not submit a letter of intent prior to July 31, 1979, indicating the estimated State appropriated funds that will be requested during the 1981 and 1982 biennium shall not be eligible to receive State appropriated funds during that biennium;

c. Any district which does not submit a letter of intent prior to July 31, 1981, indicating the estimated state appropriated funds that will be requested during the 1983 and 1984 biennium shall not be eligible to receive State appropriated funds during that biennium.

Section 8. Progress Reports. The district shall submit annually progress reports to the District Evaluation Committee, and the District Evaluation Committee shall forward each district report as well as the District Evaluation Committee report to the State Evaluation Committee.

Section 9. Enforcement. The district shall be responsible for the enforcement of the program.

a. In the event that a landowner will not cooperate in a treatment program, the district will enforce the legal remedies as provided by law, W.S. 11-5-101 through 11-5-119 inclusive, and W.S. 11-5-201.

Section 10. Implementation by the Weed and Pest Control District.

a. The District shall initiate a treatment program to treat at least one-third (1/3) of the reported acres of Leafy spurge each fiscal year for the first three (3) years, plus initiate a maintenance program, providing funds are made available through W.S. 11-5-111 or W.S. 11-5-201;

b. If State appropriated funds are required, the district shall be limited to initiating treatment on one-third (1/3) of the reported acres of Leafy spurge on private lands each fiscal year;

c. Exceptions to the one-third (1/3) may be approved by the Department after receiving recommendations from the Board of Agriculture in cooperation with the Executive Board of Directors.

Section 11. Implementation by the Public Land Office.

a. Trust and agency funds may be expended as soon as a district program is approved, and shall be used in all counties where Leafy spurge exists;

b. Public Land Office administration cost shall not exceed one percent (1%) of the total appropriation for the biennium;

(1) Administration costs are limited to contractual services, supplies and equipment.

c. Appropriation of Five Hundred Fourteen Thousand Dollars ($514,000.00) is for the biennium ending June 30, 1980;

d. A request for trust and agency funds pursuant to W.S. 11-5-201 shall be initiated by the district by submitting a State voucher to the Public Land Commission, accompanied by an invoice;

e. District programs on lands under the jurisdiction of the State Board of Land Commissioners and Farm Loan Board shall be subject to approval by the Public Land Office.

Section 12. Implementation by the Wyoming Department of Agriculture.

a. Wyoming Department of Agriculture administration cost shall not exceed one percent (1%) of the total appropriation for the biennium;

(1) Administration costs are limited to contractual services, supplies and equipment.

b. Appropriation of Eight Hundred Eighty-Five Thousand Dollars ($885,000.00) is for the biennium ending June 30, 1980;

c. Department funds may be expended when a district program is approved and districts have complied with the minimum requirements under W.S. 11-5-201 and pertinent regulations as follows:

d. Minimum requirements:

(1) The Leafy spurge budget must be prepared and submitted to the

County Commissioners, and an additional one (1) mill must be approved by the County Commissioners;

(2) The budget as approved by the County Commissioners must be submitted to the Department;

(3) A request for appropriated funds pursuant to W.S. 11-5-201 shall be initiated by the district by submitting a State voucher to the Department;

(4) District programs shall be subject to approval by the Department after receiving recommendations from the Board of Agriculture in cooperation with the Executive Board of Directors;

(5) The Board of Directors or their authorized representative must file a statement that the district has fully obligated the additional one (1) mill, and that the landowner has obligated twenty percent (20%) of the amount of funds for the fiscal year for the treatment of Leafy spurge;

(a) The Board of Directors or their authorized representative must submit a statement to the Department to show that district Leafy spurge funds will be totally obligated for that fiscal year.

(6) Once the minimum requirements have been met, the district is eligible to receive up to seventy percent (70%) of the appropriated funds requested by that district for any given fiscal year.

(a) Upon completion of the treatment program for the fiscal year, the district is eligible to receive the remaining thirty percent (30%) after final accounting and report have been received by the Department.

Section 13. Budget. The District Board of each district shall budget the necessary money in their district to carry out the intent of the Act.

Section 14. Monitoring. When deemed necessary, a herbicide monitoring program may be initiated.

a. The cost for a monitoring program shall be shared by the Department, Public Land Commission, District, and Federal Agencies, and shall not be considered an administrative cost;

b. The cost will be as follows, based on the percentage (%) of land status in a program area:

(1) Federal land - paid by Federal agencies;

(2) State land - paid by the Public Land Commission;

(3) Private land - paid by District and Department.

c. The Department, District, and Public Land cost for a monitoring program shall be paid for by funds appropriated under W.S. 11-5-201.

Section 15. Compliance. All districts where Leafy spurge is identified shall comply with the following sections regardless of whether or not State funds are used on private lands:

a. Section 1. Authority;

b. Section 2. Definitions;

c. Section 4. Landowner Agreements;

d. Section 6. Application of Treatment Program;

e. Section 8. Progress Reports;

f. Section 9. Enforcement;

g. Section 10. Implementation by the Weed & Pest Control District;

h. Section 11. Implementation by the Public Land Office (Only if State land is involved);

i. Section 13. Budget.

CHAPTER XXXXIV

CERTIFICATION RULES & REGULATIONS

FOR

WEED & PEST SUPERVISORS

Section 1. Authority. Pursuant to the authority vested in the Board of Certification by virtue of Wyoming Statutes 11-69.1 through 11-69.21 and Wyoming Statutes 9-276.19 through 9-276.33, the following rules and regulations are hereby promulgated.

Section 2. Qualifications. Agricultural background with:

a. College degree, preferably with a major in agriculture and/or related field, who shall have satisfactorily completed courses in Entomology and Weed Science or their equivalent, from an accredited college or university, or;

b. High school graduate or its equivalent and in addition has two (2) years practical experience working in job-related fields of weed and pest operations, who shall have satisfactorily completed courses in Entomology and Weed Science or their equivalent, from an accredited college or university.

c. If the qualifications as specified in Section 2 a or b have been achieved, the person shall be deemed a certified supervisor under the Wyoming Weed and Pest Control Act of 1973. The certified supervisor will not be subject to additional testing and examinations under the act.

Section 3. Supervisors employed. Prior to promulgation shall be deemed certified supervisors if the following requirements have been met.

a. Have satisfactorily completed Entomology and Weed Science courses or their equivalent, from an accredited college or university.

b. If the qualificatons as specified in Section 3 a have been achieved, the person shall be deemed a certified supervisor under the Wyoming Weed and Pest Control Act of 1973. The certified supervisor will not be subject to additional testing and examinations under the act.

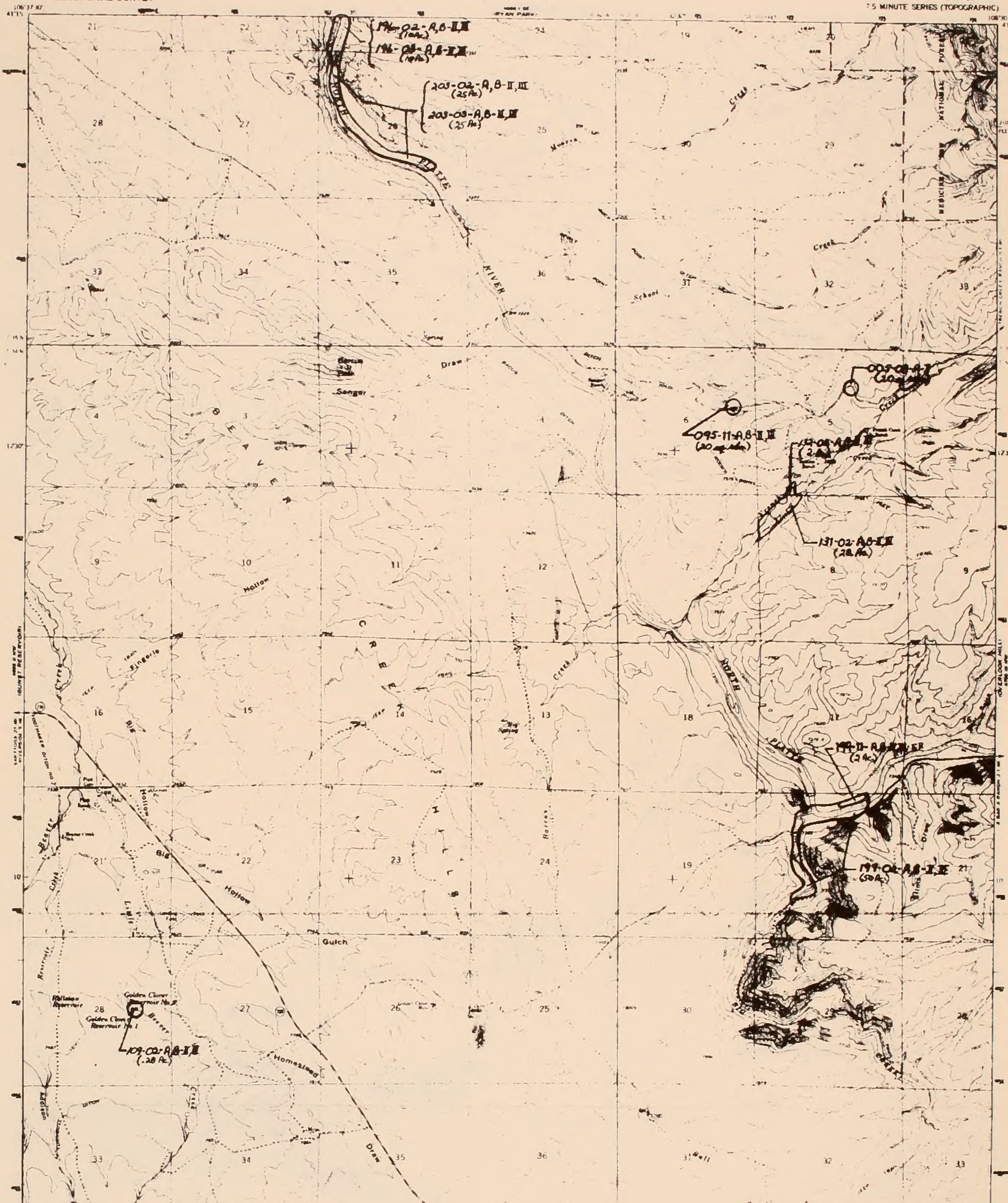
c. If the requirements as specified in Section 3 a have not been achieved, the supervisor will be subject to testing and additional requirements as specified by the Weed & Pest Board of Certification under the act.

d. A passing grade of seventy percent (70%) shall be required. Answers to tests would be predetermined.

Section 4. Supervisors. Supervisors are required to attend at least one workshop and/or training course every two years to maintain their status.

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

BARCUS PEAK QUADRANGLE
WYOMING-CARBON CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



Mapped, edited, and published by the Geological Survey as part of the Department of the Interior program for the development of the Missouri River Basin

Control by USGS and USC&GS

Topography by photogrammetric methods from aerial photographs taken 1958. Field checked 1961

Polyconic projection. 1927 North American datum
10,000 foot grid based on Wyoming coordinate system, east central zone
1000-meter Universal Transverse Mercator grid ticks, zone 13, shown in blue

Fine red dashed lines indicate selected fence lines

UTM GRID AND 1961 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
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A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

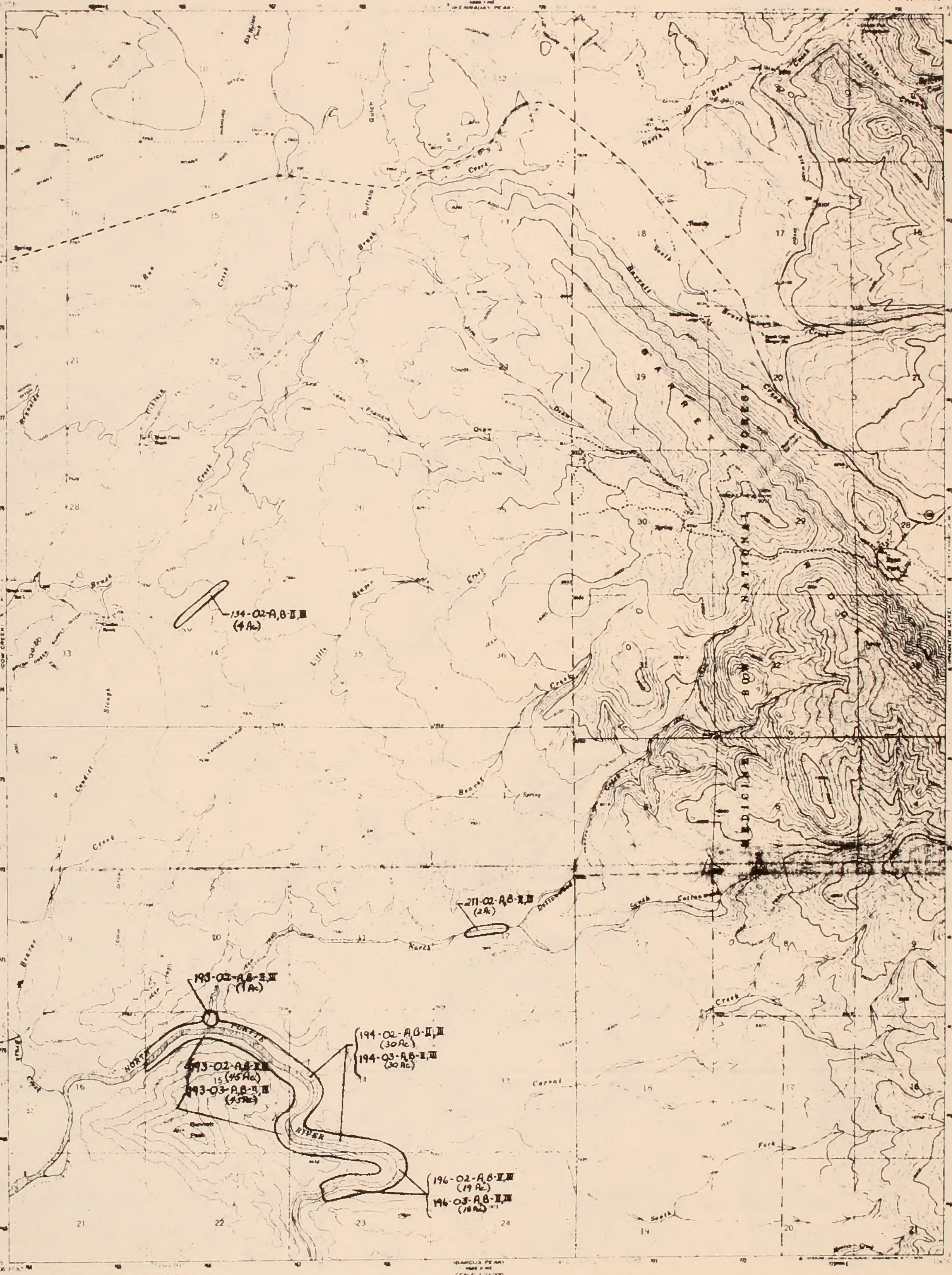
ROAD CLASSIFICATION
Medium duty — — — Light duty
Unimproved dirt
State Route

QUADRANGLE LOCATION

BARCUS PEAK, WYO.
1961
AMS 4666 II NE SERIES V874

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

RYAN PARK QUADRANGLE
WYOMING–CARBON CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



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for the development of the Missouri River Basin

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET

ROAD CLASSIFICATION

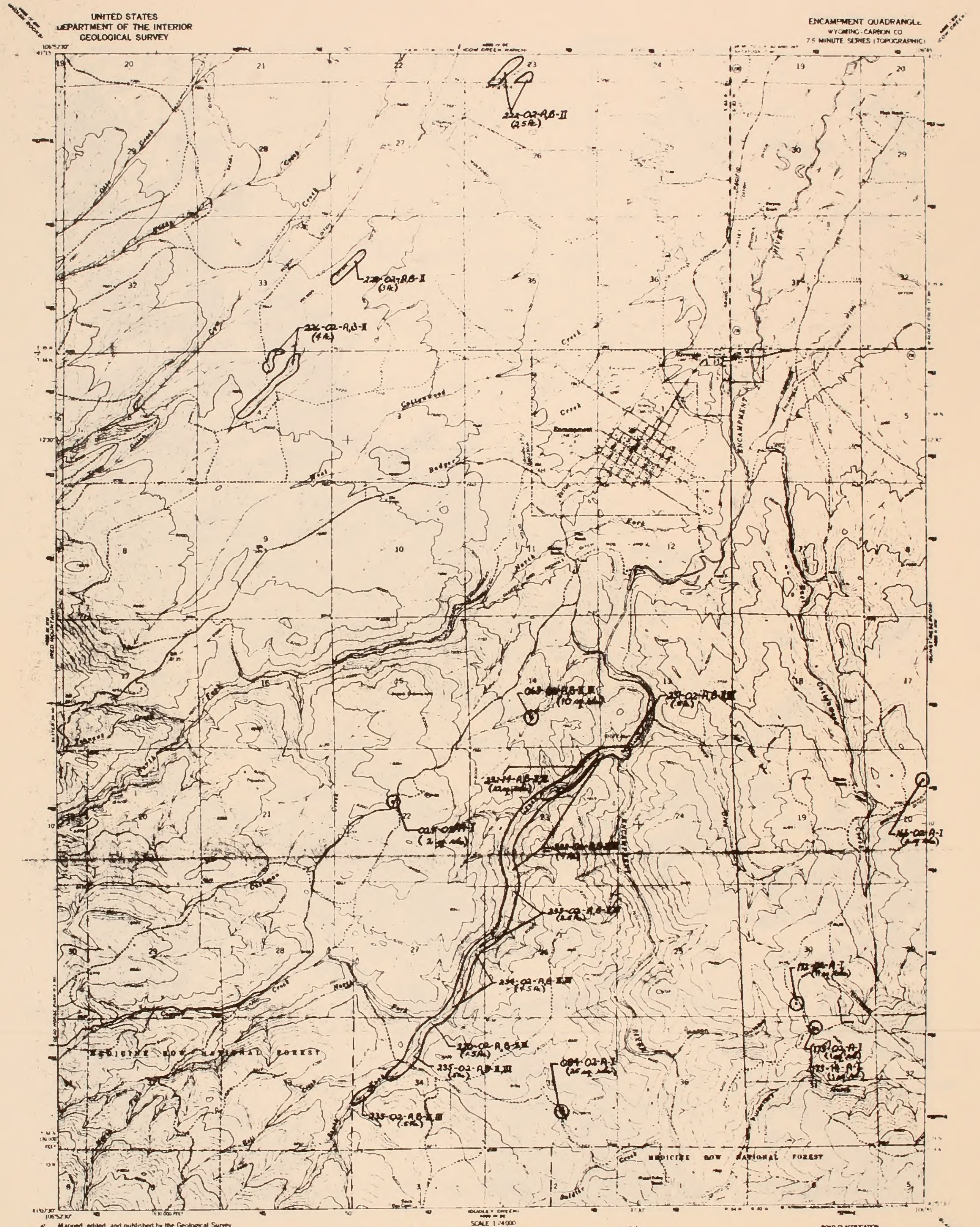
Medium duty — Light duty

Unimproved dirt

State Route

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR WASHINGTON, D. C. 20242

RYAN PARK, WYO.


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
ENCAMPMENT QUADRANGLE
WYOMING-CARBON CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
222-02-A,B-II
(2.5 Ac.)
224-02-A,B-II
(3 Ac.)
226-02-A,B-II
(4 Ac.)
MEDICINE BOW NATIONAL FOREST
Mapped, edited, and published by the Geological Survey
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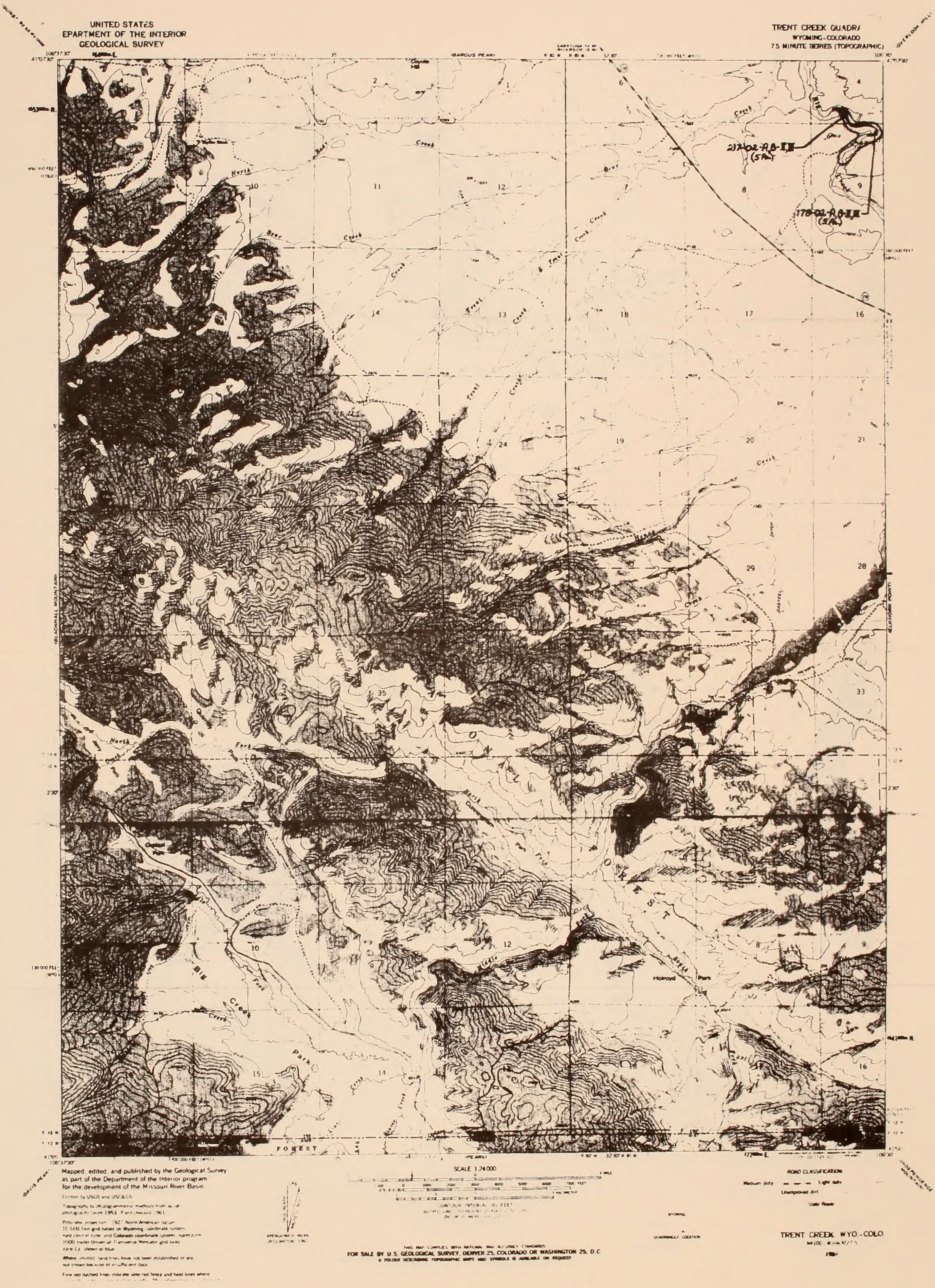
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST
ROAD CLASSIFICATION
ENCAMPMENT, WYO.
1961


UNITED STATES
EPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
TRENT CREEK QUADR/
WYOMING-COLORADO
7.5 MINUTE SERIES (TOPOGRAPHIC)
BAROUS PEAK
Coyote Hill
North
Bear
Creek
Trout
Trail
217-02-R.B-II
(5 Ac)
178-02-R.B-II
(5 Ac)
BLACKHALL MOUNTAIN
ELKHORN POINT
Fork
FOREST
Big
Creek
Park
Holroyd Park
PEARL
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TRENT CREEK, WYO.-COLO.


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
COW CREEK QUADRANGLE
WYOMING-CARBON CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
NORTH PLATTE RIVER
ENCAMPMENT RIVER
RAINBOW
UNION PACIFIC
Elk Hollow Creek
Bailey Creek
McCord Draw
Cow Creek
Pearce
239-02-AB-I, II
(30 ft.)
039-02-A-I
(50 sq. ads)
090-02-I
(25 sq. ads)
092-14-A -I
(5 sq. ads)
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CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL
TRUE NORTH
MAGNETIC NORTH
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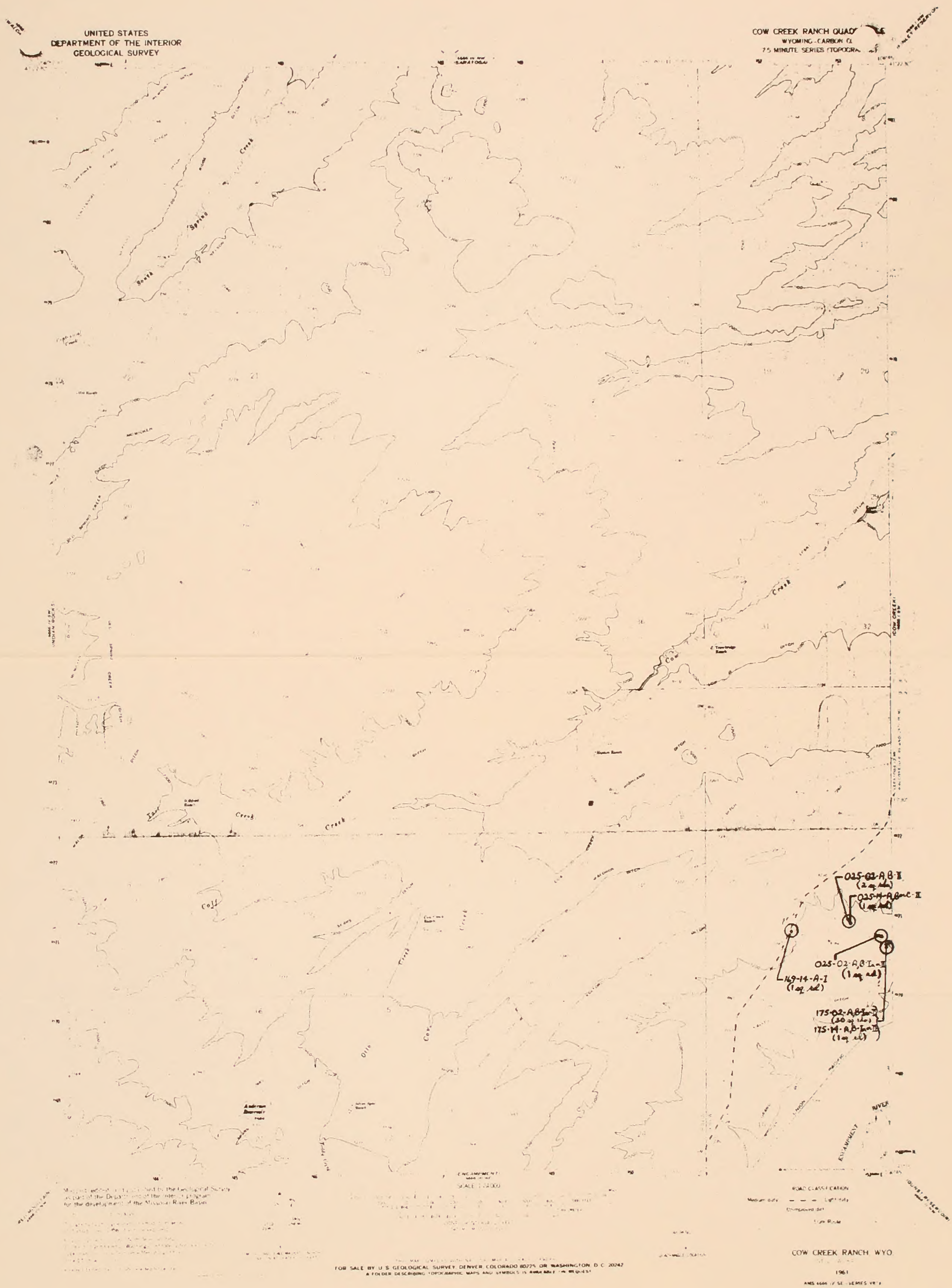
COW CREEK, WYO.
1961


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
COW CREEK RANCH QUAD
WYOMING-CARBON Co.
7.5 MINUTE SERIES (TOPOGRAPHIC)
SARATOGA
South Spring Creek
Cow Creek
COW CREEK
INDIAN ROCKS
Coal Creek
Otto
Cow
Anderson Reservoir
ENCAMPMENT RIVER
025-02-A,B-I
(2 sq. mi.)
025-14-A,B,C-II
(1 sq. mi.)
025-02-A,B-I, II
(1 sq. mi.)
149-14-A-I
(1 sq. mi.)
175-02-A,B-I, II
(20 sq. mi.)
175-14-A,B-I, II
(1 sq. mi.)
ENCAMPMENT
SCALE 1:24 000
ROAD CLASSIFICATION
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225 OR WASHINGTON, D.C. 20242
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST
COW CREEK RANCH, WYO.
1961

APPENDIX 6

PUBLIC LAW 90-583

APPENDIX 6

PUBLIC LAW 90-583
90th Congress, S. 2671
October 17, 1968

AN ACT

82 Stat. 1146

To provide for the control of noxious plants on land under the control or jurisdiction of the Federal Government.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the heads of Federal departments or agencies are authorized and directed to permit the commissioner of agriculture or other proper agency head of any State in which there is in effect a program for the control of noxious plants to enter upon any lands under their control or jurisdiction and destroy noxious plants growing on such land if--- Noxious Plant control.

(1) such entry is in accordance with a program submitted to and approved by such department or agency: Provided, That no entry shall occur when the head of such Federal department or agency, or his designee, shall have certified that entry is inconsistent with national security;

(2) the means by which noxious plants are destroyed are acceptable to the head of such department or agency; and

(3) the same procedure required by the State program with respect to privately owned land has been followed.

Sec. 2. Any State incurring expenses pursuant to section 1 of this Act upon presentation of an itemized account of such expenses shall be reimbursed by the head of the department or agency having control or jurisdiction of the land with respect to which such expenses were incurred: Provided, That such reimbursement shall be only to the extent that funds appropriated specifically to carry out the purposes of this Act are available therefor during the fiscal year in which the expenses are incurred.

Sec. 3. There are hereby authorized to be appropriated to departments or agencies of the Federal Government such sums as the Congress may determine to be necessary to carry out the purposes of this Act. Appropriation authorization.

Approved October 17, 1968

CONSIDERATIONS FOR IMPLEMENTING PL 90-583 (CARLSON BILL)

(Prepared by Interagency Ad Hoc Committee selected by The Weed Committee of the Department of Agriculture and Interior, and reviewed by representatives from USDA, Interior and Defense Agencies having jurisdiction over Federal lands)

Interpretation of PL 90-583

1. "Heads of Federal departments or agencies" suggest delegation to appropriate field unit administrators directly responsible for resource management and action programs.

2. "Commissioner of Agriculture or other proper agency head of any State" is construed to mean such instrumentality, including weed districts, in those States with effective weed laws and an active noxious plant control program with the coordination responsibility centered in the State Department of Agriculture

3. Authorizes suitable appropriation of funds by Congress to Federal departments or agencies to conduct adequate and effective noxious plant control on federally administered lands in cooperation with those States in which there is in effect a noxious plant control program. This appears to be the key provision of the Act. State control of noxious plants occurring on Federal lands is very unlikely without assurance of reimbursement. Further, improved financing levels would enable Federal agencies to undertake appropriate plant control programs as a normal phase of resource management with or without State cooperation.

Implementation of PL 90-583

1. Documentation of Federal land-managing agencies'-bureaus' known noxious plant control needs in those States with active control programs as a basis for requesting suitable funding for this purpose from Congress.

2. Where cooperative Federal-State control programs are contemplated, determination of annual needs will require close coordination of concerned parties to establish realistic goals within funding ability of each party. Such determination should be accomplished well in advance of Federal agencies' annual budget submission to insure inclusion of this item.

3. Suitable appropriation of funds by Congress for Federal departments', agencies' or bureaus' noxious plant control programs is not to be construed as an obligation to utilize the State, or proper agency head thereof, in the control effort. Purposes of the Act can be fulfilled

by the Federal department or agency performing the needed control work providing it is of a quality comparable to that accomplished by the State program on private lands.

Recommendations

1. Cooperative aspects of action programs involving Federal agency-bureau and State field units to be coordinated and implemented through maximum use of local agreements under existing authorities. Present agreements between federal and states appear to be adequate for purposes of this Act.

2. Concerned Federal departments should request respective agencies or bureaus to contact their State Commissioners of Agriculture (or other proper State agency head) advising them of the agency's or bureau's desire to implement provisions of PL 90-583 and to solicit bureau involvement for FY 1971 with a projection of annual needs for a subsequent 5-year period (through FY 1975).

3. Each Federal agency or bureau to seek appropriations beginning in FY 1971 or as soon thereafter as possible to implement the cooperative control programs developed with those States in which there is in effect a program for control of noxious plants.

4. Consider resolution by appropriate memoranda of understanding between concerned heads of Federal agency or bureau and State in the event that coordination cannot be effectively realized in localized situations.

APPENDIX 7

SUCCESSFUL BIO-CONTROL OF MUSK THISTLE, E.W. SPACKMAN

APPENDIX 7

Biocontrol of Musk Thistle in Wyoming

by

Everett W. Spackman *

The thistle weevil, Rhinocyllus conicus, was released in Wyoming in 1975 at a site on the Wyoming Game & Fish Department Reserve in the Sybille Canyon within an infestation of musk thistle. The release was made in cooperation with Gary Lee, Weed Science Researcher.

Perhaps before giving the present status of the thistle in Wyoming there should be some background on the biology of the weevil. In 1968, R. conicus was introduced into the United States from France and Italy for biocontrol of musk thistles, by L. A. Andres, Biological Weed Control Laboratory, ARS, USDA. The weevil is a native of central and eastern Europe, western Asia, and the Mediterranean region and lives in many climates, including extremely cold winters. The insect seeks out four genera of thistle among which are the musk thistle and Canada thistle. The insect hibernates overwinter as an adult. When spring arrives the adults mate and lay eggs on the bud of the plant on the flower bracts and they hatch in about 6 to 8 days. The young larvae then burrow into the head where they form cells in which they mature while feeding on the developing seeds. After 25 to 30 days in the larval stage, they pupate and adults occur in 8 to 14 days. The adults remain within the leaf for a few weeks before leaving the plant. The adults overwinter in the soil, under trash, etc. There is one generation per year in Wyoming.

Back in 1973 a contact was made with Paul Dunn, Entomologist, Western Region, Biological Control of Weeds Laboratory at Albany, California to see about obtaining a number of the thistle weevil. As you may recall, Mr. Dunn presented some information to you at last years conference on Biological Control of Weeds. After waiting two years, we finally received 500 weevil which were released on June 16, 1975. These were released on the Wyoming Game & Fish Department Game Reserve in Sybille Canyon approximately 40 miles Northeast of Laramie.

On July 18, 1975 we checked for weevil and were elated at the amount of activity. Eggs had been layed, adults were feeding and some larvae were observed in two open heads. Only two heads were opened in which to confirm the presence of larvae; one of these had two and the other had eleven larvae. We examined the outside of a number of other heads in the area and found the brown scales which is a good indication of eggs being present. The female lay eggs then cover them with brown scale-like material.

In 1976 I showed the release site to Dr. Harold Alley. At the time of this visit he was interested in collecting some seeds from musk thistle. We were unable to collect very many good seeds.

On August 17, 1976 Dr. Harold Alley and Dr. Neil Humberg measured the density of the thistle in the release area. In two plots, 18 ft. x 18 ft., there were 184 and 97 thistle plants.

Visual observations indicated only a few first year plants. We traveled one mile east of the release site and found plants infested with weevil larvae. The weevil had moved at least one mile within the first year.

During the summer of 1976 it was decided to transfer some of the adults to a location in Converse County. This was accomplished on July 20 and August 26.

In June 1977 when the research plot was surveyed, it was quite a surprise to find but a very few surviving plants in the area, all of which had thistle weevil larvae within the heads.

The year 1977 did not appear to be a good year for musk thistle. The decrease in thistle infestation in the Sybille area cannot all be attributed to the weevil. It was observed that the thistle were not nearly as robust at the Converse County release site in 1977 as they were in 1976.

Paper presented at the Wyoming Weed & Pest Conference, Casper, Wyoming, November 1, 2, & 3, 1977.

* Extension Entomologist, Plant Science Division, Colloge of Agriculture, University of Wyoming.

APPENDIX 8

SPECIMEN LABELS OF TORDON 22K, TORDON BEADS,

BANVEL, BANVEL 5G AND 2,4-D DIMETHYLAMINE

TORDON® 22K
WEED KILLER

For control of certain weed and brush species in rangelands and permanent grass pastures

in the state of WYOMING *only*

CAUTION: KEEP OUT OF REACH OF CHILDREN
Read Complete Precautions on Rear Panel

THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN 48640

CAUTION

KEEP OUT OF THE REACH OF CHILDREN
MAY CAUSE IRRITATION • COMBUSTIBLE LIQUID
AVOID CONTACT WITH SKIN AND EYES
AVOID BREATHING SPRAY MIST • KEEP CONTAINER CLOSED
KEEP AWAY FROM HEAT AND OPEN FLAME

ACTIVE INGREDIENT:
Picloram (4-amino-3,5,6-trichloropicolinic acid)
as the potassium salt 24.9%
INERT INGREDIENTS: 75.1%
Acid Equivalent:
4-amino-3,5,6-trichloropicolinic acid 21.5% — 2 lb/gal.

NOTICE: Seller warrants that the product conforms to its chemical description and is reasonably fit for the purposes stated on the label when used in accordance with directions under normal conditions of use, but neither this warranty nor any other warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE, express or implied, extends to the use of this product contrary to label instruction, or under abnormal conditions, or under conditions not reasonably foreseeable to seller, and buyer assumes the risk of any such use.

U.S. Patent No. 3,285,925

First Class
Permit No. 294
Midland,
Michigan

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN U.S.

(Return Postage Guaranteed)

THE DOW CHEMICAL COMPANY
Agricultural Center
P.O. Box 1706
Midland, Michigan 48640

USE DIRECTIONS

Use TORDON 22K weed killer to control broadleaved perennial weeds such as Canada thistle, field bindweed (wild morningglory), leafy spurge, Russian knapweed and other rangeland weed and brush species such as fringed sagebrush, snakeweed, Geyer (plains) larkspur, rabbitbrush and pricklypear cactus. Treat anytime during the growing season using low pressure (10 to 30 psi) sprays.

Spot Treatment: Use TORDON 22K at rates of 2 to 4 quarts per acre. Use this amount in 20 to 100 gallons of water per acre and apply as a spray to wet foliage. Use the higher rates to control leafy spurge and Russian knapweed. Use the lower rates for field bindweed and Canada thistle. For a 1,000 square foot treatment use 2¼ fluid ounces of TORDON 22K per 1 gallon of water (equivalent to 3 quarts per acre of TORDON 22K). NOTE: During a single season do not use more than 10 gallons of TORDON 22K for any 100 acre area and do not treat more than 20 acres of any 100 acre area.

Broadcast Treatment: For broadcast treatment a permit for aerial and ground application must be obtained from the Wyoming Department of Agriculture. To control fringed sagebrush, snakeweed, Geyer (plains) larkspur, rabbitbrush, and pricklypear cactus use 1 to 2 pints of TORDON 22K weed killer in 20 to 100 gallons of water per acre with ground equipment or 3 to 5 gallons of water per acre aerially. Apply only as a single broadcast spray during any one growing season.

To control perennial broadleaved weeds such as Canada thistle, leafy spurge and Russian knapweed use 2 to 4 quarts of TORDON 22K weed killer in 20 to 100 gallons of water per acre with ground equipment or 3 to 5 gallons of water per acre aerially and apply only as a single broadcast spray during any one growing season. For mixture with phenoxy herbicides consult University of Wyoming suggestions on mixtures for specific species.

USE PRECAUTIONS

Do not allow spray drift. TORDON herbicide is highly active. Small amounts may cause damage to plants if applied during either growing or dormant periods. Do not apply or otherwise permit TORDON 22K or sprays containing it to contact desirable plants such as vegetables, flowers, grapes, fruit trees, ornamentals, tomatoes, potatoes, beans of all types, and other valuable broadleaved plants, nor the soil containing roots of nearby valuable plants. Apply TORDON 22K only when there is little or no wind or no hazard from spray drift.

Do not contaminate water. To avoid crop or other plant injury, do not treat or allow spray drift to fall onto inner banks or bottom of irrigation and drainage ditches. Dike around and do not irrigate through treated areas.

Do not move treated soil. Do not go over treated areas with land levelers, cultivation or harvesting equipment, or move the soil by any other means.

Do not transfer livestock directly from areas treated in any one growing season onto broadleaved crop areas without allowing 7 days on untreated grass pastures as urine may contain enough picloram to cause crop injury.

Do not graze treated areas with dairy animals.

Do not treat pastures containing valuable legumes or those intended for harvesting as hay or to be rotated to broadleaved crops.

Do not mix with other pesticides, except phenoxy herbicides in accordance with University of Wyoming suggestions.

Other precautions: Do not store near food, feedstuff, fertilizer, seeds, insecticides, fungicides or other pesticides. To avoid injury to desirable plants, containers and sprayers used for TORDON 22K should not be reused to contain or apply other materials. Be sure that all use of TORDON 22K conforms to local regulations.

Rinse equipment and containers thoroughly with water and dispose of wastes by burying in non-crop land away from water supplies. Containers should be disposed of by punching holes in them and burying with waste.

1276

TORDON® 22K Weed Killer Use Questionnaire

NOTICE TO PURCHASER

So that we may better serve you please complete and return this card.

The above label:

Directions are:

Understandable . . . ☐ Confusing . . . ☐

Precautions are:

Clear . . . ☐ Unclear . . . ☐

Comments ______________________________

____

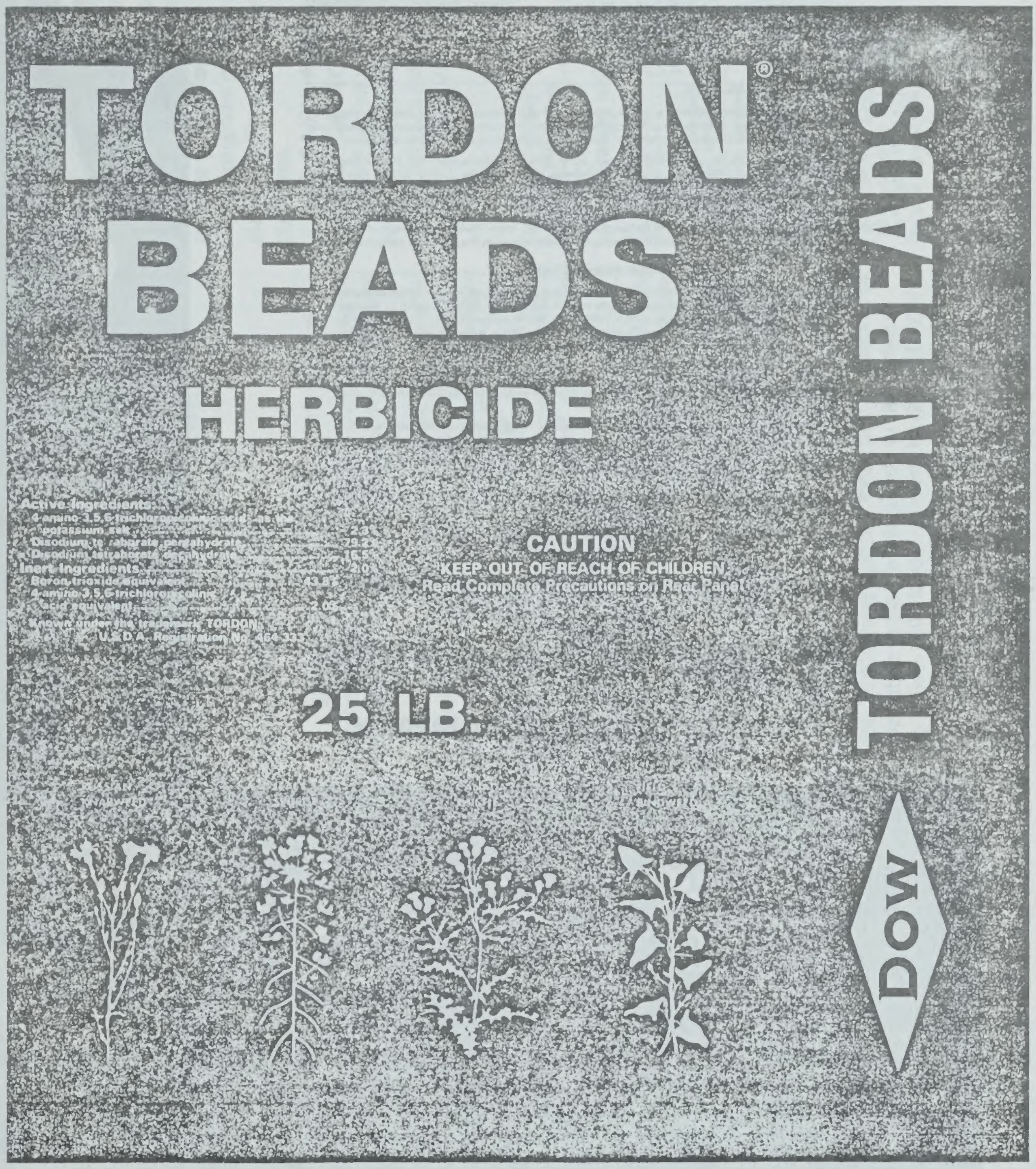
Name ______________________ Address ______________________

Thanks for your cooperation. A token of our appreciation will be returned to you.

THE DOW CHEMICAL COMPANY

1276

SPECIMEN LABEL



TORDON Beads herbicide applied to the soil over plant roots is highly effective for the control of broad-leaved perennial and annual weeds and undesirable woody plants on utility, highway and other right-of-ways, fencerows, headlands around farm and industrial buildings and storage sites.

For Control of Broadleaved Perennial and Annual Weeds: Apply TORDON Beads uniformly anytime during the normal growing season where sufficient moisture is available to carry the herbicide into the soil. In areas where little or no summer rainfall occurs, application should be made in late summer or early fall. Maximum effects of the treatment do not become apparent until the chemical has been carried by moisture into the soil.

APPLICATION RATES

Weeds Controlled*	TORDON Beads – Amount to apply	Remarks
Docks Larkspur Pigweed Povertyweed Sowthistle (perennial) Sunflower Tansy Thistle (plumeless) Toadflax (dalmation)	50 to 100 lb. per acre 19 to 37 oz. per 1000 sq. ft. 5 to 10 oz. per square rod	Use lower rates in low rainfall areas in the northern states such as Idaho, Montana, North Dakota, Oregon, South Dakota, Wyoming, and Washington. Higher rates should be used where rainfall is greater or in southern states such as Arizona, Arkansas, Kansas, Missouri, New Mexico, Oklahoma and Texas.
Bindweed (field) Bursage (bur ragweed woolyleaf povertyweed) Knapweed (Russian) Milkweed Spurge (leafy) Thistle (Canada)	100 to 150 lb. per acre 37 to 56 oz. per 1000 sq. ft. 10 to 16 oz. per square rod	

* These are typical examples of weeds controlled

TORDON **Beads** herbicide is effective against a wide range of weeds. Local conditions may affect the use of herbicides. Consult your State Agricultural Experiment Station or Extension Service weed specialists for local recommendations. Be sure that the use of this product conforms to all applicable regulations.

For Control of Woody Plants such as maple, locust, aspen, conifers, other woody trees, shrubs, wild rose, brambles, wild grapes and other vines, apply TORDON Beads uniformly to the soil over the root zone. Apply anytime during the normal growing season where sufficient moisture is available to carry the herbicide into the soil. In areas where little or no summer rainfall occurs application should be made at "bud break" in late winter or early spring. Use at the rate of 300 to 400 pounds per acre (equivalent to approximately 7½ to 10 lb per 1000 square feet, 2 to 2½ lb per square rod, or ¾ to 1 lb per 100 sq ft). Maximum effects of the treatment do not become apparent until the chemical has been carried by moisture into the soil in the root zone of the plants.

USE PRECAUTIONS

Avoid Improper Application: TORDON herbicide is highly active against most broadleaved plants. Small quantities may cause damage to plants whether applied during the growing or dormant season. Do not apply or otherwise permit TORDON Beads to contact desirable plants such as vegetables, flowers, grapes, fruit trees, ornamentals, cotton, beans, soybeans and other valuable broadleaved plants, nor the soil containing roots of such plants growing thereon or nearby or where such plants are to be grown.

Avoid Water Contamination: To avoid crop or other plant injury, do not treat inner banks or bottom of irrigation and drainage ditches. Do not contaminate water to be used for drinking or other domestic purposes.

Avoid Movement of Treated Soil: Avoid the movement of treated soil into untreated areas.

Other Precautions: Do not store near food, feedstuffs, fertilizer, seeds, insecticides, fungicides or other pesticides. To avoid injury to desirable plants, containers and equipment used for TORDON Beads should not be re-used to contain or apply other materials.

Dispose of empty containers: Burn or Bury in non-croplands away from desirable plants and water supplies.

CAUTION

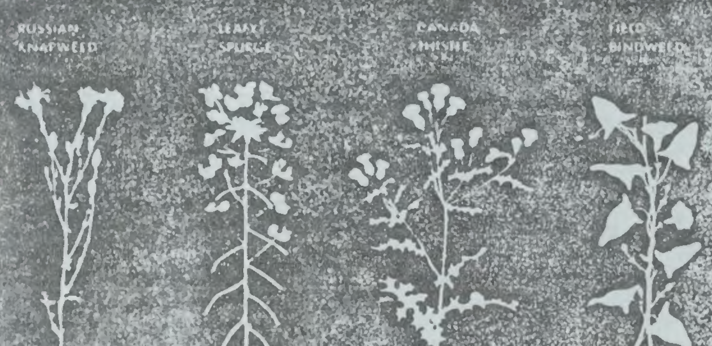
DUST CAUSES IRRITATION • MAY BE HARMFUL IF SWALLOWED
KEEP OUT OF REACH OF CHILDREN
Avoid Skin and Eye Contact
Wash After Handling

NOTICE: Seller warrants that the product conforms to its chemical description and is reasonably fit for the purposes stated on the label when used in accordance with directions under normal conditions of use, but neither this warranty nor any other warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE, express or implied, extends to the use of this product contrary to label instructions, or under abnormal conditions, or under conditions not reasonably foreseeable to seller, and buyer assumes the risk of any such use.

13100-003-S U.S. Patent No. 3,285,925 E268

THE DOW CHEMICAL COMPANY

MIDLAND, MICHIGAN 48640



DOW

TORDON BEADS

86-1174 PRINTED IN U.S.A. IN MARCH 1969

REPLACES SPECIMEN LABEL 86-1174 PRINTED IN JANUARY 1969

REVISIONS INCLUDE: (1) DIRECTIONS FOR USE HAVE BEEN COMPLETELY REWRITTEN TO INCLUDE A TABLE OF REVISED APPLICATION RATES. (2) DELETION OF DIKING RECOMMENDATION IN USE PRECAUTIONS SECTION.

VELSICOL®
BANVEL® HERBICIDE

ACTIVE INGREDIENTS:

Dimethylamine Salt of dicamba (3, 6-dichloro-o-anisic acid)	49.0%
Dimethylamine Salts of related acids	7.9%
Inert Ingredients	43.1%
Total	100.0%

Contains 40.6% 3, 6-dichloro-o-anisic acid (dicamba) or 4 pounds per gallon

CAUTION: Keep Out of Reach of Children
See Below for Additional Cautions

E.P.A Registration No. 876-25-A-A

Hazard to Humans and Domestic Animals

Caution. Harmful if swallowed. Avoid breathing spray mist. Avoid contact with skin, eyes, or clothing. Wash thoroughly after handling. In case of contact, wash skin with soap and water; for eyes flush with water for 15 minutes and get medical attention.

Environmental Hazard

This product is toxic to fish. Keep out of lakes, streams or ponds. Do not contaminate water by the cleaning of equipment or disposal of wastes. Apply this product only as directed on label.

DO NOT USE IN ANY MANNER NOT SPECIFIED ON THIS LABEL.

LIMIT OF WARRANTY AND LIABILITY

The exclusive remedy of the user or buyer and the limit of the liability of this company or any other seller for any and all losses, injuries or damages resulting from the use or handling of this product shall be the purchase price paid by the user or buyer for the quantity of this product involved. There is no warranty and this company and any other seller disclaim all liability for all losses, personal injuries or damages arising from combining substances and from any use of this product not recommended in label directions or arising from misuse, improper handling or improper storage.

IMPORTANT

Do not apply (except as recommended) on or near desirable trees or plants or in locations where chemicals may be washed or moved in contact with their roots.

Prevent drift of product, when applying by ground or air, to desirable plants, particularly beans, flowers, fruit trees, grapes, ornamentals, peas, potatoes, soybeans, sunflowers, tobacco, tomatoes and other broadleaf crops. Coarse sprays are less likely to drift.

Do not apply by airplane when sensitive crops are nearby. Consult your State or local authorities for possible aerial application or other application restrictions. When using ground equipment, use sufficient water to give good coverage.

Do not contaminate irrigation ditches or water used for domestic purposes. To avoid injury to desirable plants, equipment used for BANVEL Herbicide should be thoroughly cleaned before reuse to handle or apply any other agricultural chemicals.

All uses of BANVEL Herbicide are intended for a normal growing interval between planting and harvest. If this interval is shortened, such as in cover crops which will be plowed under, do not follow up with the planting of sensitive crops.

Observe all precautions on labeling of all products used in tank mixtures.

Consult your State Agricultural Experiment Station or Extension Service weed specialists for advice concerning special local use situations or tolerance of specific crop varieties to Banvel Herbicide or tank mixes.

All tank mixes including those with fluid fertilizers must be properly agitated and mixed according to recommended rates and gallonages to insure compatibility.

SPECIMEN LABEL

CONTAINER DISPOSAL

Do not reuse empty container. Wash thoroughly with water and detergent. Discard in a safe place.

IMPORTANT

For aerial application use 3 or more gallons of water per acre. For ground application use sufficient water to give good coverage.

Pasture and rangeland grasses and grasses grown for seed may be grazed for dairy feed.

Do not graze meat animals in treated fields within 30 days of slaughter. Do not use seed from treated grasses for feed or food purposes.

FOR DAIRY ANIMALS OBSERVE DOSAGE RATES AND DAYS OF DELAY BETWEEN TREATMENT AND GRAZING.

THERE IS NO WAITING PERIOD BETWEEN TREATMENT AND GRAZING FOR ANIMALS OTHER THAN DAIRY ANIMALS WHEN USING BANVEL ALONE. WHEN USING BANVEL PLUS 2,4-D OR BANVEL PLUS 2,4,5-T SEE RESTRICTIONS BELOW.

FEEDING RESTRICTIONS:

When using BANVEL alone.
Interval Between BANVEL Treatment and Grazing of Dairy Animals.

Dosage/Acre BANVEL Herbicide	Days Delay*
Up to 1 pt. (8 oz. a.i.)**	graze after 7 days
Up to 1 qt. (16 oz. a.i.)	graze after 21 days
Up to ½ gal. (32 oz. a.i.)	graze after 40 days
Up to 2 gal. (128 oz. a.i.)	graze after 60 days

* There is no waiting period between treatment and grazing for animals other than dairy animals when applying BANVEL alone.
**Dicamba acid equivalent.

Treated grasses may be harvested for (dry) hay. OBSERVE DOSAGE RATES AND DAYS OF DELAY BETWEEN TREATMENT AND HARVESTING FOR HAY.

BANVEL Herbicide Dosage/Acre	Days Delay
Up to 1 pt. (8 oz. a.i.)*	Harvest after 37 days
Up to 1 qt. (16 oz. a.i.)	Harvest after 51 days
Up to ½ gal. (32 oz. a.i.)	Harvest after 70 days
Up to 2 gal. (128 oz. a.i.)	Harvest after 90 days

*Dicamba acid equivalent

When using BANVEL plus 2,4-D or 2,4,5-T

Do not graze meat animals on treated areas within 30 days of slaughter.
Interval Between Treatment and Grazing of Diary Animals.

BANVEL Herbicide Dosage/Acre	2,4-D or 2,4,5-T Dosage/Acre	Days Delay
Up to ½ gallon (32 oz. a.i.)*	2 lbs.**	42 days
Up to 2 gallons (128 oz. a.i.)	2 lbs.**	60 days

* Dicamba acid equivalent
**Active Ingredient

OBSERVE DOSAGE RATES AND DAYS OF DELAY BETWEEN TREATMENT AND HARVESTING FOR HAY.

BANVEL Herbicide Dosage/Acre	Days Delay
Up to 1 pt. (8 oz. a.i.)*	Harvest after 37 days
Up to 1 qt. (16 oz. a.i.)	Harvest after 51 days
Up to ½ gal. (32 oz. a.i.)	Harvest after 70 days
Up to 2 gal. (128 oz. a.i.)	Harvest after 90 days

*Dicamba acid equivalent

VELSICOL CHEMICAL CORPORATION
341 East Ohio Street • Chicago, Illinois 60611

DIRECTIONS FOR USE

PASTURE AND RANGELAND GRASSES AND NONCROPLAND

Use	Weed	Dosage/Acre	Application Directions
Pasture and Rangeland Grasses and Noncropland areas such as fencerows, roadways, wasteland and similar areas	bloodweed, wild buckwheat, annual clover, hubam clover, cow cockle, corn cockle, cocklebur, dog fennel (mayweed), corn chamomile, knawel (German knotgrass), knotweed, lambsquarters, mustard, field pennycrass, redroot pigweed, tumble pigweed, poorjoe, common ragweed, rabbitbrush, rad sorrel (sheep sorrel), annual smartweed, Spanish nettle, spikeweed, prostrate spurge, sunflower, waterhemp	½ Pint BANVEL Herbicide (4 oz. dicamba acid equivalent) For spot treatment mix 0.3 teaspoon BANVEL Herbicide with 1 gallon water to treat 1 square rod (272 square feet)	For control or suppression of listed weeds, apply BANVEL when weeds are actively growing. For ground equipment use 10 to 20 gallons of water per acre when treating annual broadleaf weeds and for top growth control of perennial broadleaf weeds. For maximum control of perennial broadleaf weeds use 100 gallons or more of water per acre.
	bladder campion, buffalobur, burclover, chickweeds, chicory, croton, curly dock, kochia, annual morning-glory, puncturevine, tansy ragwort (rosette stage), giant ragweed, rattlebush, sesbania, shepherdspurse, teasel, velvetleaf, wormwood TOP GROWTH CONTROL: Canada thistle Russian thistle field bindweed black knapweed Russian knapweed leafy spurge perennial sowthistle and other perennial broadleaf weeds.	1 Pint BANVEL Herbicide (8 oz. dicamba acid equivalent) For spot treatment mix 0.6 teaspoon BANVEL Herbicide with 1 gallon water to treat 1 square rod (272 square feet)	Rates of BANVEL Herbicide in excess of 4 pounds per acre (dicamba acid equivalent) may cause temporary injury to sensitive grass species. For waiting period between treatment and grazing or harvest of treated grass see IMPORTANT section.
	spiny aster, slender aster, balloonvine, clover, dwarf mallow, wild garlic, goldenrod, diffuse knapweed, spotted knapweed, wild onion, povertyweed, perennial ragweed, smallleaf sida, rough sumpweed, tarbush, sowthistle, yellow thistle, starthistle, tievina, water primrose	1 quart BANVEL Herbicide (1 lb. dicamba acid equivalent) For spot treatment mix 1⅛ teaspoons BANVEL Herbicide with 1 gallon water to treat 1 square rod (272 square feet)	
	blueweed, buckrush, wild carrot, cottonwood (seedlings), creosotebush, evening primrose, gransol, spotted knapweed, lote, western whorled milkweed, climbing milkweed, stinging nettle, silverleaf nightshade, pepperweed (tall whitetop), pingua, poison ivy, bur ragweed, tansy ragwort (mature stage), redvine, sagebrush, perennial smartweed, snakeweed, woodsorrel, musk thistle, trumpet creeper, yarrow, yaupon	2 quarts BANVEL Herbicide (2 lbs. dicamba acid equivalent) For spot treatment mix ¾ teaspoon BANVEL Herbicide with 1 gallon water to treat 1 square rod (272 square feet)	

PASTURE AND RANGELAND GRASSES AND NONCROPLAND (Continued)

Use	Weed	Dosage/Acre	Application Directions
Pasture and Rangeland Grasses and Noncropland areas such as fencerows, roadways, wasteland and similar areas	bedstraw, field bindweed, blackberry, bluebell, bracken fern, hop clover, dewberry, grape, Carolina geranium, wild honeysuckle, horsemint, horseweed, Russian knapweed, kudzu, bullnettle, running live plantain (turbinella), bracted plantain, poison oak, pokeweed, leafy spurge, sumac, Canada thistle, sowthistle, Dalmation toadflax, vetch, white lupine, wild plum, waterhemlock, willow, yucca	1 to 2 gallons BANVEL Herbicide (4 to 8 lbs. dicamba acid equivalent) For spot treatment mix 1½ to 3 tablespoons BANVEL Herbicide with 1 gallon water to treat 1 square rod (272 square feet)	For control or suppression of listed weeds, apply BANVEL when weeds are actively growing. For ground equipment use 10 to 20 gallons of water per acre when treating annual broadleaf weeds and for top growth control of perennial broadleaf weeds. For maximum control of perennial broadleaf weeds use 100 gallons or more of water per acre.
		Rates of BANVEL Herbicide in excess of 4 pounds per acre (dicamba acid equivalent) may cause temporary injury to sensitive grass species. For waiting period between treatment and grazing or harvest of treated grass see IMPORTANT section.	
	bracken fern	1 to 2 gallons BANVEL Herbicide (4 to 8 lbs. dicamba acid equivalent)	Apply as a preemergence application before emergence of the fronds.
	Eastern persimmon	Prepare a spray mix using 1 to 2 gallons BANVEL Herbicide (4 to 8 lbs. dicamba acid equivalent) in 100 gallons of water	Apply to ground under tree as basal treatment using ⅛ to ¼ pint of spray solution per inch diameter of the plant. May also be used as a stem foliage treatment with sufficient water to give good coverage.
Grass Seed Production For establishment of perennial grasses including bluegrass, lawn-type fescues grown for seed or Established perennial grasses grown for seed	red sorrel (sheep sorrel)	½ to 1 pint BANVEL Herbicide (4 to 8 ounces dicamba acid equivalent)	For established perennial grasses, make application to emerged weeds prior to boot stage of crop. Make application using 5-40 gallons of water per acre.
		For new seeding make application to foliage in spring after the seed crop has 3 to 5 leaves.	
	nightflowering catchfly white cockle alfalfa	½ to 1 pint BANVEL Herbicide (4 to 8 ounces dicamba acid equivalent)	For established perennial grasses make application to foliage in spring and when seed crop is 2 to 4 inches high. For new seedings see sheep sorrel control directions above.
	campion bladder chickweeds (common, mouseear, perennial or stitchwort) clover, curly dock dog fennels (mayweed and corn chamomile) knotweed, and TOP GROWTH CONTROL OF: field bindweed Russian knapweed Canada thistle	**Established Grass** 1 to 2 pint BANVEL Herbicide (½ to 1 lb. dicamba acid equivalent) **New Seedlings** ½ to 1 pint BANVEL Herbicide (4 to 8 ounces dicamba acid equivalent)	For established perennial grasses make application to foliage in spring. For new seedings see sheep sorrel control directions above.
	downy bromegrass (cheatgrass) rattail fescue ripgut brome	2 to 4 quarts BANVEL Herbicide (2 to 4 lbs. dicamba acid equivalent)	Make application after harvest and burning and within 3 to 14 days after first irrigation and weed has more than 2 leaves.

CAUTION

Avoid contact with skin, eyes and clothing. In case of contact, wash with plenty of water. Do not store near feed or foodstuffs.

CONTAINER DISPOSAL

Do not reuse empty container. Wash thoroughly with water and detergent. Discard in a safe place.

IMPORTANT

Do not apply BANVEL granules under desirable trees or other plants, or areas where the roots might extend or where BANVEL might be washed into the root area. Do not contaminate domestic or irrigation waters. Pasture and rangeland grasses may be grazed or harvested for dairy feed (green or dry) 60 days after treatment. There is no waiting period between treatment and grazing for animals other than dairy animals. Do not graze meat animals in treated fields within 30 days of slaughter. Rates in excess of 8.0 lbs. dicamba acid equivalent per acre for spot treatment in noncropland may temporarily stunt or eliminate the growth of desirable grasses in the treated areas.

SP-15R

VELSICOL®

Banvel®

5G
GRANULES

NEW BRUSH AND WEED
HERBICIDE

ACTIVE INGREDIENTS:
dicamba (3,6-dichloro-o-anisic acid) 5.0%
Related acids 0.9%
INERT INGREDIENTS 94.1%
100.0%

CAUTION
KEEP OUT OF THE REACH OF CHILDREN
SEE LEFT PANEL. FOR ADDITIONAL CAUTIONS.
E.P.A. Reg. No. 876-103-AA
NET CONTENTS:
25 POUNDS

NOTICE

Because Velsicol Chemical Corporation has no control over storage, handling and conditions of use, which are of critical importance, Velsicol Chemical Corporation makes no representation or warranty, either express or implied, for results or residues greater than any tolerance which may be established by appropriate governmental agencies due to misuse, improper handling or storage of this material. Nor does Velsicol Chemical Corporation assume any responsibility for injury to persons, crops, animals, soil or property arising out of misuse, improper handling or storage of this material.

VELSICOL CHEMICAL CORPORATION
341 East Ohio Street, Chicago, Illinois 60611

Printed in U.S.A.

DIRECTIONS FOR USE

USE: PASTURE, RANGELAND, AND NONCROPLAND AREAS SUCH AS FENCEROWS, ROADWAYS, WASTELANDS AND SIMILAR AREAS.

WEED/BRUSH	DOSAGE	APPLICATION
Eastern Persimmon	Use 2 level teaspoonsful of BANVEL 5% Granules per inch diameter of the trunk of the plant. (Example: Use 6 teaspoonsful for a tree with a trunk 3 inches in diameter.)	Scatter the granules evenly on the ground within 6 inches of the trunk. Apply BANVEL granules any time after buds start to open and before the leaves and branches stop growing in the summer.
Creosotebush Tarbush	Use 2 heaping tablespoonsful of BANVEL 5% Granules per 4 feet diameter of canopy.	Make application just prior to or in the early part of the rainy season. Scatter the granules uniformly under the canopy of the shrub.
Salt Cedar	Use 100 to 200 pounds of BANVEL 5% Granules per acre (5 to 10 lbs. dicamba acid equivalent).	Make application just prior to or in the early part of the rainy season. Apply BANVEL granules uniformly over the area to be treated.
Canada Thistle Field Bindweed (Morningglory) Russian knapweed Leafy spurge Bur ragweed Skeletonweed	Apply at the rate of 80 to 160 lbs. BANVEL 5% Granules (4 to 8 lbs. dicamba acid equivalent) per acre. For spot treatment apply 0.5 to 1.0 lbs. BANVEL 5% Granules per sq. rod (272 sq. ft.)	For best results, apply BANVEL granules uniformly when plants are actively growing. This would normally be in the spring or fall when plants are putting out new growth.
Bracken fern	Apply at the rate of 120 to 160 lbs. BANVEL 5% Granules (6 to 8 lbs. dicamba acid equivalent) per acre. For spot treatment apply .75 to 1.0 lb. BANVEL 5% Granules per sq. rod (272 sq. ft.).	Apply granules uniformly as a pre-emergence application before emergence of the fronds.
Artichoke thistle	Apply at the rate of 20 to 40 lbs. BANVEL 5% Granules (1 to 2 lbs. dicamba acid equivalent) per acre. For spot treatment apply 2 to 4 oz. BANVEL 5% Granules per sq. rod (272 sq. ft.).	Make uniform application of BANVEL granules when plants are actively growing.

VCC376

DOW*

SPECIMEN LABEL
REDUCED TO 80%

FORMULA 40*

HERBICIDE

CONTAINS ALKANOLAMINE SALTS† OF 2,4-D

Acid Equivalent: 4 Pounds per Gallon

For the Selective Control of Many Broadleaf Weeds in Non-Crop Areas, Grass Pastures, Rangelands and in Certain Crops. Also for Control of Trees by Injection

ACTIVE INGREDIENTS:	
Alkanolamine Salts† (of the Ethanol and Isopropanol series) of 2,4-Dichlorophenoxyacetic acid	59.7%
INERT INGREDIENTS:	40.3%
2,4-Dichlorophenoxyacetic Acid Equivalent	38.6%

E.P.A. Registration No. 464-1-AA E.P.A. Est. No. 464-MI-1

†Salts are the least volatile forms of 2,4-D and do not release enough vapors from treated areas to reduce yield of adjacent susceptible crops.

AGRICULTURAL CHEMICAL

Do Not Ship or Store with Food, Feeds, or Clothing

PRECAUCION AL USUARIO: Si usted no lee inglés, no use este producto hasta que la etiqueta le haya sido explicada ampliamente.
TRANSLATION: (TO THE USER: If you cannot read English, do not use this product until the label has been fully explained to you.)

CAUTION

KEEP OUT OF REACH OF CHILDREN
HARMFUL IF SWALLOWED
CAUSES IRRITATION OF SKIN AND EYES
Do Not Get in Eyes, on Skin
or on Clothing

In case of contact, flush eyes with plenty of water for at least 15 minutes and get medical attention; wash skin with soap and plenty of water. Remove and wash contaminated clothing before re-use. Do not wear contaminated shoes.

18.9 L / 5 GAL

86-1142 PRINTED IN U.S.A. IN SEPTEMBER, 1976.
REPLACES SPECIMEN LABEL 86-1142 PRINTED IN AUGUST, 1976.
DISCARD PREVIOUS SPECIMEN LABELS.
REVISIONS INCLUDE: RESTRICTION ON FEEDING TREATED STRAW TO LIVESTOCK DELETED FROM SECTION ON SMALL GRAINS.

SPECIMEN LABEL
(BACK)
REDUCED TO 80%

WEED LIST

FORMULA 40 herbicide is recommended for control of numerous broadleaf weeds and certain 2,4-D susceptible woody perennials without injuring most grasses. Species controlled include the following plus many others:

bitterweed	flixweed	morningglory, annual	ragweed, common	sweetclover
broomweed	galinsoga	mustards	rape, wild	tansymustard
burdock	hemp, wild	pennycress	rocket, yellow	thistle, bull
carpetweed	jewelweed	pennywort	shepherdspurse	thistle, musk
carrot, wild	jimsonweed	pepperweed	sicklepod	thistle, Russian
chicory	lambsquarters	pigweed	smartweed	tumbleweed
cocklebur	loco, bigbend	plantains	sneezeweed, bitter	velvetleaf
coffeeweed	lupines	poorjoe	sowthistle, annual	vetch
croton	mallow, Venice	pusley, Florida	spanishneedles	waterplantain
dandelion	marshelder	radish, wild	sunflower	witchweed
dock				wormwood

USE DIRECTIONS

Generally, the lower dosages given will be satisfactory for young, succulent growth of sensitive weed species. For less sensitive species and under conditions where control is more difficult, the higher dosages will be needed. Apply FORMULA 40 during warm weather when weeds are young and growing actively. Use enough spray volume for uniform coverage by ground or air application. If only bands or rows are treated, leaving middles unsprayed, the dosage per crop acre is reduced proportionately. **Do not apply where spray drift may be a problem due to proximity of susceptible crops or other desirable plants. Read and follow all Use Precautions given on this label.**

To Prepare the Spray, mix FORMULA 40 only with water, unless otherwise directed on this label. Add about half the water to the mixing tank, then add the FORMULA 40 with agitation, and finally the rest of the water with continuing agitation. Note: Adding oil, wetting agent or other surfactant to the spray may increase effectiveness on weeds, but also may reduce selectivity to crops resulting in crop damage.

Use with Liquid Fertilizer: FORMULA 40 may be combined with liquid fertilizers suitable for foliar application to accomplish weeding and feeding of corn, small grains, sorghum and grass pastures in one operation. Use FORMULA 40 in accordance with recommendations for these crops given in the following text and table. Use liquid fertilizer at rates recommended by supplier or local extension service specialist. To prepare the spray, FORMULA 40 must first be premixed with water. For liquid nitrogen fertiliser use a premix consisting of 1 part of FORMULA 40 and 4 parts of water; for other liquid fertilizers use 1 part of FORMULA 40 with 50 to 60 parts of water. Add the premix to the fertilizer while maintaining continuous agitation during both mixing and spraying operations. Apply the spray the same day it is prepared; do not store. **NOTE: Always premix FORMULA 40 with water before adding to the liquid fertiliser.**

WEED CONTROL IN ASPARAGUS: See Table for recommended use rates. To control wild morningglory and certain other broadleaf weeds apply in about 60 gallons of water per acre for ground application and about 12 gallons per acre for aircraft application. Apply on actively growing weeds, usually in April or May. If spears are present, treat immediately after cutting. Make no more than 2 applications during the harvest season and these should be spaced at least one month apart. Spears contacted by the spray may be malformed. These spears should be cut immediately and discarded. Post-harvest spraying should be only by ground rig using drop nozzles to avoid spraying the fern.

WEED CONTROL IN SMALL GRAINS NOT UNDERSEEDED WITH A LEGUME (Barley, Oats, Rye, Wheat): See Table for recommended use rates. Spray after grain begins tillering and before the boot stage (usually 4 to 8 inches tall) and weeds are small. **Do not apply before the tiller stage nor from early boot through the milk stage.** To control weeds that will interfere with harvest or to suppress perennial weeds, preharvest treatment can be applied when the grain is in the dough stage. Best results will be obtained when soil moisture is adequate for plant growth and weeds are growing well. Note: Do not permit dairy animals or meat animals being finished for slaughter to forage or graze treated grain fields within 2 weeks after treatment.

WEED CONTROL IN CORN: See Table for recommended use rates. **Preemergence** — Apply to soil anytime after planting but before corn emerges. Do not use on very light, sandy soil. **Emergence** — Apply just as corn plants are breaking ground. **Postemergence** — Apply to emerged corn. When corn is over 8 inches tall use drop nozzles to keep spray off corn foliage. Do not apply from tasseling to dough stage. Injury to corn is most likely to occur if FORMULA 40 is applied when corn is growing rapidly under high temperature and high soil moisture conditions. In such situations, use the low rate of ½ pint per acre. After application, delay cultivation for 8 to 10 days to allow the corn to overcome any temporary brittleness. NOTE: Hybrids vary in tolerance to 2,4-D. Some are easily injured. Spray only varieties known to be tolerant to 2,4-D. Consult the seed company or your Agricultural Experiment Station or Extension Service Weed Specialist for this information. **Preharvest** — After the hard dough or denting stage, apply by air or ground equipment to suppress perennial weeds, decrease weed seed production, and control tall weeds such as bindweed, cocklebur, dogbane, jimsonweed, ragweed, sunflower, velvetleaf, and vines that interfere with harvesting. **NOTE: Do not forage or feed corn fodder for 7 days following application.**

WEED CONTROL IN SORGHUM (MILO): See Table for recommended use rates. Treat only after the sorghum is 6 inches high and preferably before it is 15 inches high. Do not treat during the boot, tasseling or early dough stages. Reduce spray drift by keeping the boom and spray nozzles as low as possible. If crop is taller than 8 inches, use drop nozzles to keep the spray off the leaves. Temporary crop injury can be expected under conditions of high soil moisture and high air temperatures. If it is necessary to apply FORMULA 40 under these conditions, use no more than ⅔ pint per acre. NOTE: Hybrids vary in tolerance to 2,4-D. Some are easily injured. Spray only varieties known to be tolerant to 2,4-D. Consult the seed company or your Agricultural Experiment Station or Extension Service Weed Specialist for this information.

WEED CONTROL IN RICE: See Table for recommended use rates. Apply in the late tillering stage of rice development, at the time of first joint development (first to second green ring), usually 6 to 9 weeks after emergence. Do not apply after panicle initiation, after rice internodes exceed ½ inch, at early seedling, early panicle, boot, flowering or early heading growth stages. Do not use in rice paddies where shellfish are of economic importance or where flood water is used for irrigation of other crops. NOTE: Some rice varieties under certain conditions can be injured by 2,4-D. Therefore before spraying consult local Extension Service or University specialists for appropriate rates and timing of 2,4-D sprays.

WEED CONTROL IN SUGAR CANE: See Table for recommended use rates. Use up to 4 applications per year in accordance with state recommendations. NOTE: Do not apply within 6 weeks before harvest. For grass control, use DOWPON* M or Dow Sodium TCA Herbicides in addition to FORMULA 40. Always read label directions and precautions for the use of these products before using them with FORMULA 40.

WEED CONTROL IN STRAWBERRIES: See Table for recommended use rates. To control many broadleaf weeds in established or old strawberry plantings apply in 25 to 50 gallons of water per acre in early spring when the strawberries are dormant or immediately after the last picking. Do not apply unless possible injury to the crop is acceptable. Follow recommendations of State Extension Weed or Horticultural Specialists to fit local conditions.

AMOUNT OF FORMULA 40 TO USE IN CROPS

by air or ground application

NOTE: Do not apply when weather conditions favor drift from treated areas. Read complete directions and precautions before using.

CROP	DOSAGE PER ACRE: Normal rates (usually safe to crop)	DOSAGE PER ACRE: Higher rates for special situations[2] (more likely to injure crop)
SMALL GRAINS		
Spring Postemergence		
wheat, barley, rye	½ to 1½ pints	2 to 3 pints
oats	½ to 1 pint	1½ to 2 pints
Preharvest (dough stage)		
wheat, barley, oats	1 to 2 pints	2 to 3 pints
CORN[1]		
Preemergence	2 to 4 pints	
Emergence[1]	1 pint	1½ pints
Postemergence[1]		
up to 8 inches tall	½ to 1 pint	
8 inches to tasseling (use only directed spray)	1 pint	1½ to 2½ pints
Preharvest	1 to 2 pints	
SORGHUM (milo)[1]		
Postemergence		
6 to 8 inches tall	⅔ to 1 pint	
8 to 15 inches tall (use only directed spray)	1 pint	1½ to 2 pints
RICE	1 to 2½ pints	2 to 3 pints
SUGAR CANE		
Fall, after harvest or planting	2 to 4 pints	
Spring, once or twice before close-in	2 to 4 pints	
Summer, up to 6 weeks before harvest	2½ pints	
ASPARAGUS	1½ to 2 quarts	
STRAWBERRIES	1 to 1½ quarts	

[1]Corn and sorghum varieties vary in tolerance to 2,4-D; some are easily injured. Before spraying, get information on 2,4-D tolerance of specific varieties and spray only those known to be resistant to 2,4-D injury. If plants are more than 8 inches tall, use directed spray and keep spray off corn and sorghum foliage.

[2]These higher rates may be needed to handle difficult weed problems in certain areas such as under dry conditions especially in western areas. **However, do not use unless possible crop injury will be acceptable.** Consult State Agricultural Experiment Station or Extension Service weed specialists for recommendations or suggestions to fit local conditions.

WEED CONTROL IN ESTABLISHED GRASS PASTURES AND RANGELANDS: Use at 2 to 4 pints per acre. Apply preferably when weeds are small and growing actively before the bud stage. Do not use from early boot to milk stage where grass seed production is desired. Do not use on newly seeded areas until grass is well established. Do not use on bentgrass, alfalfa, clover, or other legumes. **NOTE: Do not graze dairy cattle in treated areas for 14 days after application. Remove meat animals from freshly treated areas for 7 days before slaughter. Withdrawal is not needed if 2 weeks or more have elapsed since application. Do not cut treated grass for hay within 30 days after application.**

CONTROL OF SOUTHERN WILD ROSE: On rangelands, roadsides and fence rows use 1 gallon of FORMULA 40 plus 4 to 8 fluid ounces of an agricultural surfactant per 100 gallons of water and spray thoroughly as soon as foliage is well-developed. Two or more treatments may be required. On rangeland, apply at a maximum rate of 6 quarts per acre per application as a spot treatment so the overall rate is no more than 3 quarts per acre. **See NOTE on Grazing Restrictions in grass pastures section above.**

WEED CONTROL IN GRASS SEED CROPS: Use 1 to 4 pints per acre in spring or fall. Do not apply from early boot to the milk stage of the grass. Spray seedling grass only after the five-leaf stage, using ¾ to 1 pint per acre to control small seedling weeds. After the grass is well established, higher rates, up to 4 pints, can be used to control hard-to-kill annual or perennial weeds. Do not use on bentgrass unless grass injury can be tolerated. **See NOTE on Grazing Restrictions in grass pastures section above.**

BROADLEAF WEED CONTROL IN NON-CROPLAND GRASS AREAS SUCH AS LAWNS, GOLF COURSES, CEMETERIES AND PARKS, AIRFIELDS, ROADSIDES, VACANT LOTS, DRAINAGE DITCH BANKS: Use 1 to 3 quarts of FORMULA 40 per acre in the amount of water needed for uniform application. Treat when weeds are young and growing well. Usually 2 quarts per acre will provide adequate weed control. Do not use on dichondra or other herbaceous ground covers. Do not use on creeping grasses such as bent except for spot treating nor on freshly seeded turf until grass is well established. Reseeding of lawns should be delayed following treatment. With spring application, reseed in the fall; with fall application, reseed in the spring. Legumes are usually damaged or killed. Deeprooted perennial weeds such as bindweed and Canada thistle may require repeated applications.

SPOT TREATMENT IN NON-CROP AREAS: To control broadleaf weeds in small areas with a hand sprayer, use ¼ pint of FORMULA 40 in 3 gallons of water and spray to thoroughly wet all foliage.

TREE INJECTION TREATMENT: To control unwanted hardwood trees such as elm, hickory, oaks and sweetgum in forest and other non-crop areas, apply FORMULA 40 herbicide by injecting 1 ml of the undiluted product through the bark around the trunk at intervals of 1 to 3 inches between edges of the injector wounds. For harder to control species such as ash, maples and dogwood use 2 ml of undiluted FORMULA 40 per injection site. Continuous cuts around the trunk often provide improved control. Also, cuts near the ground level may be more effective than at higher levels. Treatments can be made at any season, however, effectiveness may be less during winter months. Maples should not be treated during the spring sap flow.

USE PRECAUTIONS

AVOID CONTACT WITH 2,4-D SUSCEPTIBLE CROPS AND OTHER DESIRABLE BROADLEAF PLANTS — FORMULA 40 herbicide is injurious to most broadleaf plants. Therefore, do not apply directly to or otherwise permit even minute amounts (as in spray mist) to contact cotton, grapes, tobacco, fruit trees, vegetables, flowers, ornamentals or other desirable plants susceptible to 2,4-D. Do not use in or near a greenhouse.

DO NOT APPLY IN THE VICINITY OF COTTON, GRAPES, TOBACCO, TOMATOES OR OTHER DESIRABLE 2,4-D SUSCEPTIBLE CROPS OR ORNAMENTAL PLANTS.

DO NOT SPRAY WHEN WIND IS BLOWING TOWARDS SUSCEPTIBLE CROPS OR ORNAMENTAL PLANTS.

AVOID SPRAY DRIFT — Applications should be made only when there is no hazard from spray drift since very small quantities of the spray, which may not be visible, may severely injure susceptible crops during both growing and dormant periods. Use coarse sprays to minimize drift since, under certain weather conditions, fine spray droplets may drift a mile or more. The spray thickening agent NALCO-TROL[1] may be used with this product to aid in reducing spray drift. If used follow all use recommendations and precautions on the product label.

[1]NALCO-TROL — Trademark of NALCO Chemical Company.

GROUND EQUIPMENT — With ground equipment, spray drift can be lessened by keeping the spray boom as low as possible; by applying 20 gallons or more of spray per acre; by using no more than 20 pounds spraying pressure with large-droplet producing nozzle tips; by spraying when wind velocity is low; and by stopping all spraying when wind exceeds 8 miles per hour. Do not apply with hollow cone-type insecticide or other nozzles that produce a fine-droplet spray.

AERIAL APPLICATION — With aircraft, drift can be lessened by applying a coarse spray; by using no more than 20 pounds spray pressure at the nozzles; by using straight stream nozzles directed straight back; by using a spray boom no longer than ¾ the wing span of the aircraft; and by spraying only when wind velocity is less than 6 mph.

Do not apply by aircraft when an air temperature inversion exists. Such a condition is characterized by little or no wind and with air temperature lower near the ground than at higher levels. The use of a continuous smoke column at or near site of application is suggested to indicate a temperature inversion by layering of the smoke and to indicate direction and velocity of air movement.

Violent windstorms may move soil particles. If 2,4-D is on these particles and they are blown onto susceptible plants, visible symptoms may appear but serious injury is unlikely. The hazard of movement of 2,4-D on dust is reduced if treated fields are irrigated or if rain occurs shortly after application. Do not contaminate irrigation ditches or water used for irrigation or domestic purposes.

Do not store near fertilizers, seeds, insecticides or fungicides. To avoid injury to desirable plants, do not store, handle or apply other agricultural chemicals with the same containers or equipment used for FORMULA 40 except as specified on this label. Excessive amounts of 2,4-D in the soil may temporarily inhibit seed germination or plant growth.

Local conditions may affect the use of herbicides. Consult your Agricultural Experiment Station or Extension Service weed specialists for advice in selecting treatments from this label to best fit local conditions.

Be sure that use of this product conforms to all applicable regulations. **Apply this product only as specified on this label.**

NOTE: FORMULA 40 herbicide, exposed to subfreezing temperatures, should be warmed to at least 40°F and mixed thoroughly before using.

Rinse equipment and containers and dispose of wastes by burying in non-crop areas away from water supplies. Containers should be disposed by punching holes in them and burying with wastes. Follow official local disposal regulations where required.

MONEY BACK GUARANTEE

FORMULA 40 herbicide is guaranteed by The Dow Chemical Company to the full extent of the purchase price:

1. To give satisfactory control of weeds listed on container when used as recommended.

2. To form a suitable spray mixture in any water fit for spray use.

NOTICE: Seller warrants that the product conforms to its chemical description and is reasonably fit for the purpose stated on the label when used in accordance with directions under normal conditions of use, but neither this warranty nor any other warranty of MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, express or implied, extends to the use of this product contrary to label instructions or under abnormal conditions, or under conditions not reasonably foreseeable to seller, and buyer assumes the risk of any such use.

THE DOW CHEMICAL COMPANY

AND SUBSIDIARIES

MIDLAND, MICHIGAN 48640, USA   ZURICH, SWITZERLAND   HONG KONG, BCC
CORAL GABLES, FLORIDA 33134, USA   SARNIA, ONTARIO, CANADA

* Trademark of THE DOW CHEMICAL COMPANY

10586-041-6   U976

APPENDIX 9

WEED SCIENCE AND TECHNOLOGY MP17

THE DOW CHEMICAL COMPANY

Weed Science & Technology

MP 17

COLLEGE OF AGRICULTURE
AGRICULTURAL EXTENSION SERVICE
UNIVERSITY OF WYOMING-LARAMIE
NOVEMBER 1973

SECTION II

Herbicide Selectivity

A selective herbicide is a chemical that is more toxic to one plant than to another. When such a herbicide is applied to a mixture of plants, some may be killed and others may be affected only slightly or not at all.

There are many factors which influence the selectivity and activity of herbicides. A knowledge of these factors is necessary to make proper herbicide selection and use. Selectivity is relative; it depends upon proper use of the specific herbicide.

The most important selectivity factors are (1) morphological or structural differences, (2) absorption, (3) translocation, and (4) physiological differences.

A. Structural or Morphological Differences

1. Structural Differences permit:

   a. selective application of herbicides

   b. protection of the plants meristematic region from herbicidal injury

   c. involvement of plant surface differences or orientation of plant parts which may affect spray retention and herbicide absorption.

2. Tall plants, with chemically tolerant stems, permit easy application of herbicides to weeds near the ground level.

   a. Chemicals are frequently applied to weeds and brush under tall trees without injury to them.

   b. Drop nozzles are utilized to spray weeds in sensitive crops such as cotton, corn, and sorghum. Selectivity is dependent upon placing the chemical near the ground line and only in contact to the stems of crop plants.

   c. Sprayers are also built with shields to protect the crop plants.

3. Location of the plants' growing points may be important.

   a. Broadleaved plants have exposed growing points at the tips of the shoots and in the axil of the leaves.

   b. In contrast, the growing points of cereals (monocotyledons) are located at the base of the plant and are protected by the surrounding leaves. In some cases they are actually below the soil surface.

4. Grasses develop from lateral growing points which are usually protected.

   a. Grass stems elongate from the nodes, each node having meristematic tissue; the nodes are usually protected by a leaf sheath.

5. Perennial plants are often dormant during the winter months.

   a. At that time winter annuals can be controlled before the perennial crop emerges.

   b. Deep-rooted plants are often tolerant to chemicals which remain primarily in the soil surface. Shallow-rooted weeds may be killed. Annual weed control in dormant alfalfa is a good example.

6. Waxiness, hairiness, or pubescence of a plant may prevent spray droplets from adhering to the leaf.

   a. If the chemical droplets adhere, they may dry on wax scales or on the hair without coming in contact with the leaf epidermis, thereby preventing absorption.

   b. Hairiness may also increase herbicidal effectiveness - the hair may become saturated, increasing the quantity of the chemical spray held on the surface and reducing run-off.

B. Absorption

Absorption is the movement of a material into the plant from an external source (usually the leaves and roots).

1. To be effective, herbicides must enter the plant.

   a. Some plant surfaces absorb the herbicide quickly. Other plant surfaces absorb the chemical slowly, if at all.

   b. The chemical nature (oily, volatile, etc.) of the herbicide is also involved. Therefore, differential absorption or selective absorption may account for differences in plant responses.

2. Initial leaf penetration may take place through the leaf surface or through the stomates.

   a. The volatile fumes of some herbicides and some solutions enter through the stomates.

   b. Of far greater importance is the direct penetration of the leaf surface.

   c. On the leaf surface the herbicide must penetrate the cuticle layer and cell walls.

d. Polarity of the leaf surface and herbicide used is important. The waxy cuticle and cellulose of the plant leaves and stems are non-polar. Most organic substances are non-polar. Included in the non-polar group are oils and waxes, 2,4-D acid, 2,4-D esters, etc. Polar compounds include water, amino acids, salts of 2,4-D, etc. Non-polar compounds (2,4-D ester) tend to be absorbed into the leaves faster than the polar herbicides (amine of 2,4-D).

3. The addition of a wetting agent may reduce selectivity of the herbicide.

   a. A wetting agent tends to equalize foliar herbicide absorption in all types of plants.

   b. Wetting agents may reduce the selectivity of the herbicide if the selectivity is dependent upon selective foliar absorption.

4. Increase in temperature is usually associated with more rapid absorption.

   a. Within limits, the rate of such chemical processes tend to double with each increase of 17° F.

5. Roots absorb many herbicides from the soil.

   a. In general, roots are best adapted to absorbing polar substances, and absorb non-polar substances very slowly if at all.

   b. Upon contact with the soil, non-polar substances may be changed to polar substances.

   c. Tordon, Banvel and TBA are examples of root-absorbed compounds.

6. Rapidly-growing cells have a rapid rate of respiration.

   a. The factors that favor rapid growth of roots also favor rapid nutrient absorption.

   b. The rate of herbicide absorption from the soil is similarly affected.

C. Translocation Differences

1. Translocation of herbicides is a major problem in the control of weeds with below ground reproductive organs (deep-rooted perennials).

2. Translocation of herbicides within the plant involves the following:

   a. Translocation through the phloem (food conducting tissue).

   b. Translocation in the xylem (water and mineral conducting tissue).

   c. Translocation in space between the cells (intercellular).

   d. Movement of herbicides may take place from one of these systems to another system within the plant.

3. Translocation through the phloem

a. Translocation is usually in the general direction of moving from the leaves toward the roots.

b. Phloem tissues are composed of living cells. Extremely toxic chemicals kill the cells, stopping translocation. Excessive rates quickly immobilize or kill the phloem cells - stopping translocation.

c. Translocation is most rapid and most effective when large amounts of food reserves are being moved toward the roots. This usually occurs after full leaf development.

d. Calculations show that 2,4-D moves from the leaves to roots at rates up to 40 inches per hour.

e. Low rates of chemical, with repeated application, usually give better results, because plants are killed slowly.

f. Uniform application is more important than the amount of carrier used.

4. Translocation in the xylem

a. Herbicides move from the soil through the roots and upward along with the transpiration stream of water and soil nutrients.

b. A herbicide absorbed in a lateral leaf may be first translocated in the phloem to the xylem, then carried upward in the xylem.

c. Conductive tissue of the xylem is non-living, therefore, very toxic chemicals can be absorbed from the soil and translocated to all parts of the plant.

d. Absorption and translocation may continue even though the roots are killed.

e. Experiments indicate that the following three conditions must exist for translocation downward through the xylem to be effective. (1) a water deficit within the plant; (2) herbicide must render the tissues permeable between points of application and the xylem; and (3) plant must be exposed long enough to permit herbicide to penetrate.

5. Intercellular translocation

a. Non-polar substances may move through the plants' intercellular spaces.

b. Oils may be absorbed by the plant through the cuticle, epidermis, bark, stomata and even injured roots.

c. Oils move in any direction -- up, down, or radial.

d. It is generally believed that the oil moves principally through intercellular spaces. The 2,4-D esters in kerosene act similarly.

D. Physiological Differences

1. Scientists only partially understand the physiological differences which account for selective herbicidal toxicity.

2. Differences in enzyme systems, response to pH changes, cell metabolism, cell permeability, variation in chemical constituents, and polarity may be involved.

3. A change in one or more of these may either stimulate or block certain biochemical processes.

4. Enzyme reaction may be blocked in one plant species but not in another.

5. Activation of an inactive chemical into an active compound (2,4-DB) being an example.

6. Decomposition of a herbicide into a harmless compound. One of the best examples is the ability of corn to decompose simazine.

7. The basic fundamentals of photosynthesis and respiration are important in understanding how herbicide affects plants. Entire textbooks are available and are too lengthy to include in this outline.

E. Types of Toxicity

1. Two types of toxicity to plant tissue, acute and chronic have been shown through research.

   a. Acute means "intense" or "penetrating"; thus rapid killing of the plant. Contact herbicides usually produce acute toxicity.

   b. Chronic means of "long duration" or continuing for a long time. Chronic toxicity may show little visible effect for a week or longer. Growth regulators usually produce chronic toxicity.

F. Concentration (Rate) of the Herbicide

1. The rate of application may determine whether the herbicide inhibits or stimulates the plants.

2. Under many conditions, 2,4-D may speed up the rate of respiration and cell division, but in excessive rates may immediately slow down the rate.

3. The concentration of the herbicide at a vital location in the plant at any one given time may determine the herbicide effectiveness.

4. Crop yields generally increase where herbicides have effectively controlled weeds. While there is a possibility of herbicide stimulation, the increase in yield is probably a result of less competition.

SECTION III

Factors Influencing Effectiveness of Foliar-Applied Herbicides

The application of a herbicide to the leaves of weeds is a direct way of getting the chemical into the plant and eventually to the "site of action." It is common knowledge that populations of the same species of plants receiving the same herbicide, under similar conditions do not react similarly. If this is the case, there must be something influencing the uptake and movement of the herbicide reaction of the plant to the herbicide, or other factors of application which may influence the effectiveness.

For a foliage-applied herbicide to be effective it must successfully follow the chain of events listed below.

1) reach the plant
2) be retained on the leaf
3) penetrate the leaf
4) move to the site of action
5) remain toxic long enough to exert its action.

A. Reaching the Plant

This factor is many times overlooked in practical field situations.

1. There are at least three ways the proper amount of herbicide fails to reach the leaves ----

   a. Spray drift is the movement of the spray particles including the carrier from the target area.

      1. Spray drift is more common with air application and where smaller droplets are produced.

      2. Large nozzles and lower pressures will reduce the potential of drift.

   b. Volatilization is the change of a herbicide from the solid or liquid state into a gaseous form.

      1. Several herbicides are of such a volatile nature that significant losses of the herbicide can occur.

      2. It is important to recognize the difference between spray drift and volatility and select non-volatile compounds where movement of the gaseous phase may cause crop damage.

c. "Canopy" effect - or in common terms, shading by taller plants.

1. Often an overlying canopy can intercept, not only contact herbicides, but also translocated herbicides, and the herbicide fails to reach or contact smaller plants underneath the canopy resulting in poor control.

B. Retention On The Leaf

Once the herbicide comes in contact with the leaf, it must be retained on the surface long enough to be absorbed. Several factors can be involved in retention.

1. Morphology of the plant -- where the leaves are upright or horizontal-- may determine whether the spray remains on the leaf or runs off.

2. Whether the leaf is waxy or non-waxy. (Garlic leaf vs. mustard leaf)

3. Characteristics of the spray solution - these can be altered by the addition of additives or "adjuvants". Wetting agents can often act as sticking agents when used in low volumes of water.

4. Volatility may be important - some herbicides may evaporate too rapidly for adequate retention time.

5. Sprays composed of small droplets and applied at high pressure and low volumes increase retention.

C. Loss

The herbicide may be deposited on the leaf surfaces only to be removed by rainfall. Salts of various herbicides may be lost after the spray solution evaporates, leaving free crystals on the surface. High temperatures lead to loss of volatile materials. Exposure to light may result in chemical breakdown before absorption can occur.

D. Absorption Into The Foliage

The absorption or uptake of a herbicide is influenced by many factors. Herbicides can enter the leaves either through the lower or upper surfaces. Usually the lower surfaces are more permeable than the upper surface. The herbicide can penetrate the leaf through the stomates or directly through the cuticle. The relative importance of the two routes of penetration is open for debate and differences of opinion are common. The absorption depends upon species involved and the environmental conditions (light, humidity, whether the stomates are open or closed). The formulation of the herbicide is also important.

Four important things can happen after the herbicide is retained on the leaf.

1. It can remain on the surface as a crystal or a liquid. This happens to many salt formulations when the water carrier evaporates.

2. It can enter the cuticle and remain dissolved in the non-polar portion. This can happen with weed oils.

3. It can enter and move in the aqueous phase along cell walls to the vascular system. Amitrole and dalapon are examples.

4. It can enter and move directly into living cells and through them to the vascular system. 2,4-D is a good example.

The absorption of herbicides is a very important concept relating to the activity of foliar applied herbicides. The distances the herbicide must move in getting into the leaf are very small. However, the composition and character of the leaf surface may be a very significant barrier to the entry of herbicides. This one factor can contribute to failures when herbicide activity is dependent upon absorption and translocation.

E. Translocation

Foliage applied herbicides can either be of the contact-type which kill only the tissues with which they come in contact or the systemic herbicides which must move from the point of application to other parts of the plant. The systemic herbicides include such compounds as 2,4-D, amitrole, and dalapon.

An important concept in relation to translocation deals with the symplast and apoplast.

1. The symplast refers to the total interconnected protoplasm of all plant cells functioning as a unit. This includes phleom, living cells, the plasmodesmata (strands of protoplasm connecting living cells), etc.

2. The apoplast consists of non-living tissues and water surrounding the symplast. This includes the xylem and secondary walls. Herbicides can move short distances by simple diffusion, but for the true systemic action they must move in either the xylem or phloem. Certain herbicides move entirely in one or the other, where some can move in those of the tissues.

3. The "source to sink" concept is a concept very important in understanding translocation.

   a. The sink refers to a site within the plant at which sugars are being used either to form storage materials or in active metabolism. Sugars tend to move from the areas of the leaf where they are manufactured (source) toward the sink, and in the process can carry 2,4-D and other compounds along. Since most translocation of herbicides from the leaves occurs in the phloem, which is living tissue, rapid burning of the leaves and stems can be detrimental to translocation. Toxic herbicides or high rates of application simply kill the tops of plants with little movement to the roots.

F. Deactivation

A herbicide may be readily absorbed and as soon as it reaches the living protoplasm of a plant it is subject to decomposition, or it may be incorporated in the cells. In either case, the concentration of active herbicide in the plant tissue is reduced.

G. Cellular Sensitivity

The final response of a plant to a herbicide is at the cellular level. Different tissues of the plant vary widely in sensitivity to a herbicide. Newly developing cells are usually affected by low concentrations; mature plants develop tolerances.

SECTION IV

Factors Influencing Effectiveness of Soil Applied Herbicides

A herbicide may be applied to the soil for the purpose of killing, selectively in agriculture or unselectively on industrial sites. Despite the variability in performance of soil applied herbicides they are used on a large scale. Therefore, it is very important that factors contributing to performances be fully understood.

A. Factors Influencing the Effectiveness of a Herbicide

1. Herbicides applied to the soil are directly affected by soil characteristics. Those applied to the foliage are less affected by soil differences.

2. The numerous soil factors, the many different kinds of herbicides, the large number of plant species, and climatic variations make the study of herbicides in soils very complex.

3. Herbicides are applied directly to the soil as:

   a. Preplant treatments
   b. Preemergence treatments
   c. Postemergence treatments
   d. Soil sterilants

4. Some chemicals are applied to the surface while others require incorporation.

5. Since most annual weeds germinate in the upper 1/2 inch of soil, the success of preemergence treatments depends upon the presence of high concentrations of the herbicide in this zone.

6. If germinating seeds in the soil surface are killed, the surface may remain weed-free for a period of time after the chemical has disappeared. Many weed seeds will not germinate if buried deeply in the soil.

7. For effective sterilization the herbicide must remain active in the rooting zone to kill both germinating seeds and deep-rooted plants.

B. Persistence in the Soil

The length of time that a herbicide remains active or persists in the soil is extremely important as it relates to the length of time weed control may be expected. Residual toxicity is also of paramount importance as it relates to phytotoxic after-effects that may prove injurious to succeeding crops or plantings.

1. Herbicides may disappear faster with large amounts of water that provide heavy leaching and with repeated cultivation or mixing of the soil.

2. In some cases fertilizers can be added to reduce injurious after-effects.

3. The use of charcoal in reducing phytotoxicity is becoming a popular practice.

4. Seven factors affecting the persistence of herbicides in the soil are:

   a. Microorganism decomposition
   b. Chemical decomposition
   c. Adsorption on the soil colloids
   d. Leaching
   e. Volatility
   f. Photo-decomposition
   g. Loss by cropping

C. <u>Microorganism Decomposition</u>

The principal microorganisms in the soil are algae, fungi, and bacteria which must have food for energy and growth. Organic compounds of the soil provide this food supply, except for a very small group of organisms that feed on inorganic sources. Some chemicals are readily decomposed (utilized by microorganisms), whereas others resist decomposition.

1. Microorganisms immediately attack organic substances applied to the soil and can increase in numbers. This hastens decomposition. Microorganisms can be quite specific for certain herbicides. It is also possible that the increase in microorganism activity from an initial application of a herbicide will result in more rapid breakdown of subsequent applications and require higher rates of application to obtain similar results. Organisms may also die when the food supply is gone.

2. Other factors besides the food supply may quickly affect the growth and multiplication of microorganisms. These are temperature, water, oxygen, and nutrient supply.

   a. Most soil organisms are nearly dormant at 40° F, with 75 to 90° F being most favorable.

   b. Most organisms go dormant or die without water and are very sensitive to an adequate supply of oxygen.

   c. Deficiency of nutrients, such as nitrogen, phosphorous or potash may reduce growth.

3. Thus, warm, moist, well-aerated, and fertile soil is most favorable to microorganisms and under ideal conditions can most quickly decompose organic herbicides.

4. Herbicides may remain toxic for extended periods of time if the soil is cold, dry, poorly aerated, or other conditions are unfavorable to the microorganisms.

5. The usual rate of herbicide application is not expected to change the organism population to a great extent.

   a. The herbicide may benefit one group of organisms and injure other groups.

   b. When the herbicide is decomposed, the microorganism returns to "normal".

   c. Herbicides vary in their persistence. Most chemicals used on cultivated crops disappear in less than 6 months; some such as atrazine persist longer.

D. <u>Chemical Decomposition</u>

Very unstable compounds are obviously of little value for killing plants by soil application and root uptake. They could not survive while the slow means of transfer available carried them to their site of action through the very reactive moist soil. <u>Incorporation</u> (mechanically mixing into the soil) of such unstable compounds helps to off-set this property. Compounds that are resistant to chemical decay for longer than one cropping season can create problems to subsequent sensitive crops and therefore may be of little value in selective weed control.

1. Chemical decomposition destroys some herbicides and activates others. Examples of chemical decomposition include:

   a. Dalapon which will slowly hydralize in the presence of moisture, rendering it ineffective as a herbicide

   b. Sesone which is decomposed to 2,4-D.

E. <u>Adsorption on Soil Colloids</u>

The primary effect of adsorption of herbicide on the soil particles is to reduce, sometimes to a very small fraction of the whole, the concentration of herbicide freely available in the soil water.

1. Observations in research work have shown the following:

   a. Soils high in organic matter require large amounts of preemergence and soil sterilant herbicides for weed control.

   b. Soils high in clay content require more herbicide than sandy soils for preemergence or soil sterilant weed control.

   c. Soils high in organic matter and clay content tend to hold the herbicide for a longer time than sandy soils and the adsorbed herbicide may be released so slowly that the chemical is not effective as a herbicide.

d. A certain amount of herbicide is required to saturate the adsorptive capacity of the soil. Above this "threshold level" heavier rates will greatly increase the amount of chemical in the soil solution, and thus increase herbicidal toxicity to plants.

F. Leaching

Leaching is the downward movement of a substance in solution through the soil.

1. The movement of a herbicide by leaching may determine its effectiveness as a herbicide, may explain selectivity, or may account for its removal from the soil.

2. Most preemergence herbicides are applied to the soil surface and are dependent upon rainfall to leach them into the upper soil surface or germinating weed seed zone.

3. Weed seeds germinating in the chemical impregnated zone are killed. Large seeded crops planted below the area of high herbicidal concentration escape injury.

4. The extent to which a herbicide is leached is determined principally by:

   a. Solubility of the herbicide in water

   b. Amount of water passing through the soil

   c. Adsorptive relationships between the herbicide and the soil.

5. In general herbicides which are completely water soluble are most easily leached. But some water soluble herbicides may react with various parts of the soil and form a molecule which is relatively stable.

G. Volatility

Loss of evaporation is probably more significant than is generally realized for many surface-applied herbicides. In a temperate summer, if the soil surface could remain moist, water would be lost at a rate of about 200 tons/acre/month from the soil only.

1. All chemicals, both liquids, and solids, have a vapor pressure.

   a. The evaporation of water is an example of a liquid, and the vaporization of naphthalene (moth balls) is an example of a solid that will vaporize.

   b. At a given pressure, vaporization of both liquids and solids increases as temperatures rise.

2. Herbicides may evaporate and be lost to the atmosphere as volatile gases. This can result in poor weed control and/or damage to susceptible crops.

3. The herbicide may move into a porous soil as a volatile gas.

   a. EPTC (eptam) is thought to move as a volatile gas. Adsorbed by the soil, EPTC may effectively kill certain germinating weed seeds.

4. Rain or irrigation water applied to a dry or moderately dry soil will usually leach the herbicide into the soil, or aid in its adsorption by the soil.

   a. Once adsorbed by the soil, loss by volatility is usually reduced.

   b. Where rainfall or immediate irrigation is not common, incorporation assists in reducing losses.

H. <u>Photodecomposition</u>

Photodecomposition, or decomposition by light, is reported for some herbicides. Chemicals applied to the surface are frequently lost, especially if they remain for an extended period without rain. There is always the possibility of herbicide loss caused by photodecomposition. However, do not overlook other factors which may account for the loss.

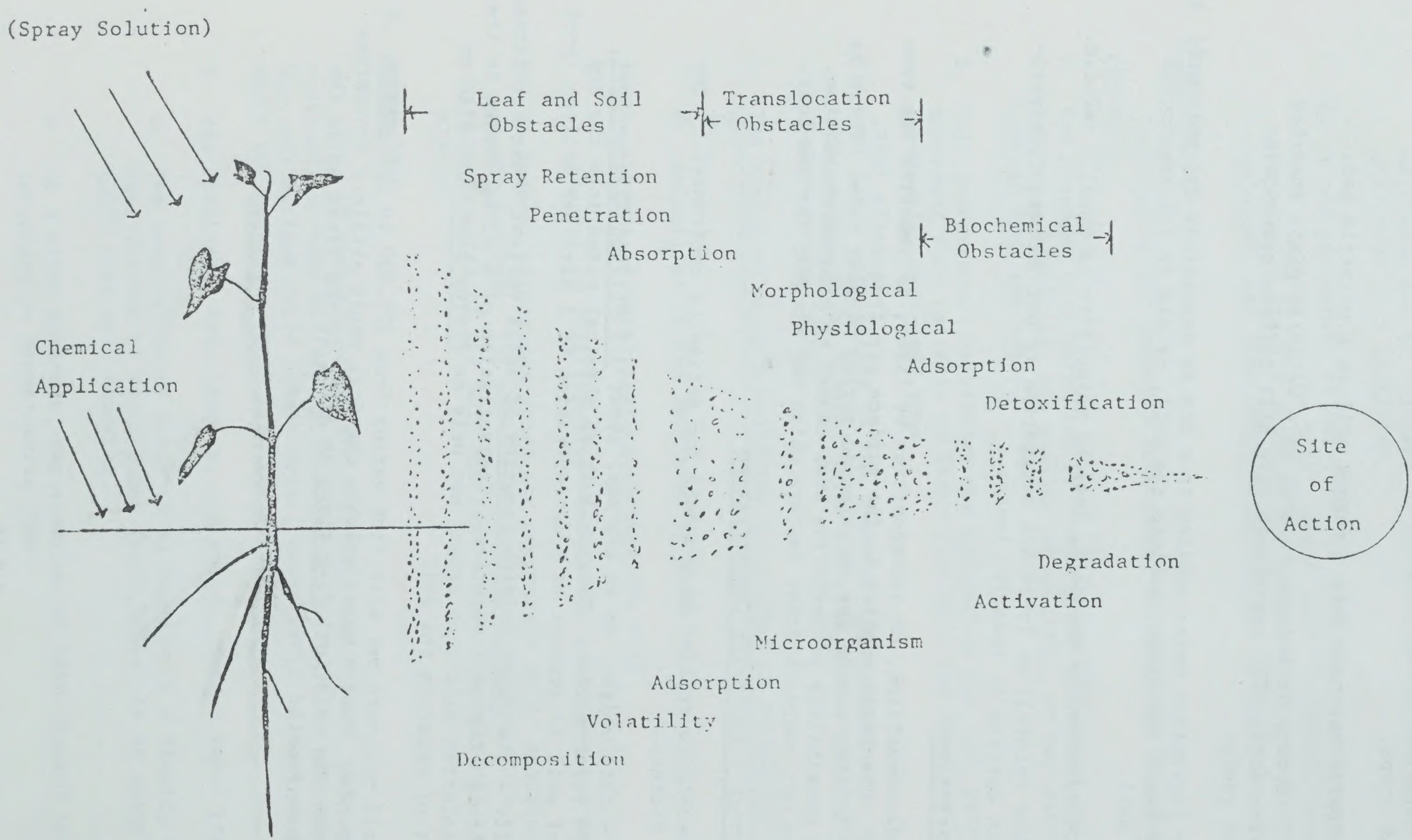
I. <u>Soil Treatment - Herbicide Concentration</u>

Any herbicide applied to the soil for action is confronted by two important factors.

1. First - soil weighs, on an average, about <u>3.5 million lb/acre foot</u>, 300,000 lb/acre inch. Thus, 3.5 lb of chemical mixed into the top foot of soil is present at a concentration of 1 part per million (ppm).

2. Secondly - the <u>water holding capacity</u> of soils varies. Most herbicides act through the soil solution. Concentration of a given dosage in the soil solution will thus depend not only on <u>fixing power</u> but also on amount of water in the soil.

   a. Soil moisture per acre foot varies from 300,000 to 1.5 million pounds. Thus a water soluble chemical would attain a concentration (in solution) <u>five times</u> as great in the first as in the second soil.



Obstacles Which Determine the Concentration of Toxic Material at the Site of Action

APPENDIX 10

PESTICIDE APPLICATION, EQUIPMENT, CALIBRATION, AND MAINTENANCE MP26

APPENDIX 10

APPLICATION EQUIPMENT, CALIBRATION AND MAINTENANCE

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SECTION III

Calibrating Chemical Applicators

Most pesticides must be applied at very precise rates if satisfactory results are to be obtained. Applying too little will result in poor control while too much pesticides may injure crops and livestock or produce unwanted residues which make soils, plants, or animal tissues unusable. *Correct application rate is one factor which the operator can control.*

Accurate application of chemical pesticides depends on accurate calibration of the application equipment. Calibration means to determine the output of the equipment under controlled and precise conditions.

A. Calibrating Spray Equipment

Speed and *pressure* are two variables that affect all types of spray equipment. Changing either speed or pressure at any time during a spraying operation will change the application rate. Both must be maintained at a constant level throughout the spraying operation.

1) *Speed.* Spraying equipment should be calibrated at the same speed to be used in the field. A change in speed of only 1 mph from the calibration speed can cause an underspray or overspray of 20% or more. The spray rate for speeds other than the calibration speed can be calculated, if necessary, in the following manner:

$$\text{Calculated spray rate} = \frac{\text{Calibrated speed (mph)} \times \text{Calibrated spray rate (gpa)}}{\text{New speed (mph)}}.$$

EXAMPLE

A sprayer calibrated at 5 mph sprayed at the rate of 15 gallons per acre. How much spray will it apply if drive at 3 mph?

$$\frac{5 \text{ mph} \times 15 \text{ gpa}}{3 \text{ mph}} = 25 \text{ gpa (a 67\% increase)}.$$

Most newer tractors are equipped with a ground speed-tachometer combination. These are satisfactory speed indicators except where drive wheel slippage is excessive. If the spray equipment is not equipped with a satisfactory ground speed indicator, ground speed can be determined by checking the time required to drive between two stakes 88 feet apart. The speed is determined from the formula:

$$\text{Speed (mph)} = \frac{60}{\text{Time required to travel 88 feet (seconds)}}.$$

EXAMPLE

The time required to travel 88 feet is 24 seconds. The traveling speed of the equipment is:

$$\frac{60}{24} = 2\frac{1}{2} \text{ mph.}$$

The following table shows the time required to travel 88 feet at different speeds.

Time required to travel 88 feet (seconds)	Speed (mph)
60	1
30	2
20	3
15	4
12	5
10	6

For speeds greater than 6 mph, more accurate results will be obtained if the distance traveled is doubled or tripled. Multiply the top of the equation by the same factor used to increase the distance.

Caution--When determining speed by the above method the trial should be made from a running start in the field where the spraying will be done or where conditions are similar. The sprayer should be equipped with a throttle which can be returned to the same position for spraying that was used in determining speed. Speedometers on pickup trucks are not sufficiently accurate for precision ground speed control. Trucks with mounted sprayers should be equipped with a hand throttle and an engine tachometer to obtain accurate speed control.

2) *Selecting desired speed.* Calibration curves furnished by the manufacturer for their nozzle tips will give the operator some clue as to the ground speed, pressure, and nozzle opening size needed for a given rate of application. An operator may have occasion to apply a specific rate (gallons per acre). Lacking the manufacturers ratings he can determine mathematically the necessary ground speed for the desired application rate using the following formula.

$$\text{Required speed (mph)} = \frac{\text{fluid ounces per minute (one nozzle)} \times 46.4}{\underset{\text{(inches)}}{\text{nozzle spacing on boom}} \times \underset{\text{(gal. per acre)}}{\text{desired application rate}}}.$$

EXAMPLE

You want to deliver 9 gallons of spray per acre. The nozzles are spaced 20 inches apart on the boom. You collect the discharge from one nozzle for 1 minute and it measures 16 ounces. To deliver 9 gallons of spray per acre your speed will be:

$$\text{Speed} = \frac{16 \times 46.4}{20 \times 9} = 4.1 \text{ mph.}$$

3) *Application uniformity*. There are several ways to calibrate spraying equipment but all depend on one factor for accuracy--*uniform application*. Before attempting to calibrate any sprayer, check the nozzles on the unit individually to see if they are delivering approximately the same amount of spray.

Check nozzle tips by placing containers of the same size and shape under each nozzle and operate the sprayer at the normal pressure. If the containers fill unenvenly or too fast, look for worn tips. A plugged nozzle or screen will cause a container to fill slowly. Measuring the output of each nozzle will also indicate if they are performing evenly. Replace the tip if the variation is over 5%. Replace all tips if the flow is 20% greater than the manufacturers rating.

4) *Select proper pressure*. Most nozzle orifices have been machined to give the most effective spray pattern at pressures of 30 to 40 psi. Pressures higher than this produce a large number of fine droplets and increase the potential of having the herbicide moved from the target area by drift. Conversely, low pressures can create large droplets, weak spray patterns, and poor coverage. Any time it is necessary to change the spray rate to an extent that cannot practicably be done within the recommended pressure range, a different set of nozzles should be selected. Always use the same pressure for spraying that was used for calibration.

B. Calibration of Hand Sprayers

Spray equipment with single nozzles or three to four nozzle booms are used by the homeowner for lawn and garden care and also by the researcher for eastblishing experimental plots. Single high pressure nozzles are also widely used on rights-of-way spray operations, and spot treatments by Weed and Pest District personnel and by farmers and ranchers. Accurate calibration of this type of equipment is very simple but seldom done. Over application is a common occurrence.

1) *Compressed air sprayer*.

Step 1. Mark out a square rod (16-1/2 ft. x 16-1/2 ft.)

Step 2. Put a known amount of water in the spray can, (2 quarts is usually enough)

Step 3. Pump the sprayer to 30-40 lbs pressure if it has a pressure guage. If not, count the number of strokes used to pump up the sprayer.

Step 4. Spray the square rod, walking at the same speed you plan to use in spraying the plot or yard.

Step 5. Measure the water remaining in the spray can and subtract this amount from the original amount. Be as accurate as possible.

Step 6. Compute the rate of application per acre by the following formula:

* gallons per acre = amount sprayed out (cups) x 10

There are 160 square rods per acre and 16 cups per gallon. By dividing 16 into 160 constant 10 used in the formula is obtained.

EXAMPLE

You find that 4 cups of water are applied to 1 square rod. The application rate is 4 x 10 = 40 gallons per acre.

2) *High pressure hand gun.* Single nozzle, high pressure equipment is calibrated utilizing time required (in seconds) to spray a 1 square rod plot. Accuracy is increased if the plot is marked out on the species of plant to be sprayed.

After determining the time required (in seconds) to spray the square rod plot, catch the spray from the nozzle for the same amount of time required to spray the square rod plot and measure. The rate of application is determined by the same formula used above.

C. Calibration of Boom Sprayers

1) *Refill method.* The refill method is probably the simplest of the many methods available for calibrating boom-type sprayers.

Step 1. Measure the *effective* spray width of the boom. This is the width covered by the spray at ground level. measure in inches (for the nozzles

Step 2. Divide the effective width of the boom into 43,560 (square feet/acre) to determine the distance the sprayer must travel to cover an acre. Measure this distance on the ground to be sprayed. Since the distance required to spray is usually quite large, the common practice is to reduce the course to a fraction of an acre, i.e. 1/10 or 1/16 acre.

Step 3. Fill the spray tank and adjust the *pressure* (30-40 psi for most uses) and the tractor or applicator speed to the *speed* to be used in the field.

Step 4. Fill the spray tank to a known reference line and spray the measured distance.

Step 5. Measure carefully the amount of water required to refill the tank to the reference line. It is desirable to make two to three runs to obtain more accurate calibration. Returning the sprayer to exactly the same spot each time it is refilled will also increase accuracy.

Step 6. Multiply the number of gallons required to refill the tank to the previously designated reference line by the reciprocal of the fraction of an acre sprayed (1/10, 1/6, 1/4, etc.) to determine the delivery rate in gallons per acre at the speed and pressure utilized.

EXAMPLE

A sprayer with a 20 foot effective spray width is calibrated on 1/10 of an acre and requires 4 gallons of water to refill the tank after the calibration run.

Step 1. 20 feet effective boom width

Step 2. $\frac{43,560}{20}$ = 2,178 linear feet necessary to cover one acre
1/10 of an acre = 218 linear feet

Step 3. 4 gallons of water is required to refill the tank

Step 4. 4 x 10 = 40 gallons per acre

2) *Nozzle method.* The nozzle method of calibration is a quick and accurate way to calibrate any sprayer as long as the ground speed is known and can be accurately controlled. It can be used to calibrate in the shop or in the farm yard and is valuable as a quick check for nozzle wear. By using this method it is possible to accurately predict the spray rate at any controlled speed.

The nozzle method requires checking only one nozzle on the sprayer, but assumes all nozzles are delivering the same amount. Check all nozzles at first to be sure they are delivering nearly the same amount of spray. The nozzle method is based on the formula:

$$\text{Spray rate (gals. per acre)} = \frac{\text{one nozzle output (ounces per minute) x 46.4*}}{\text{one nozzle coverage (inches) x speed (miles per hour)}}.$$

Step 1. Set the *pressure* the same as is to be used in the field and catch the water from *one nozzle* for *one minute*--measure water carefully.

Step 2. Measure coverage of a nozzle in *inches*. On a boom sprayer, *the coverage is the same as the nozzle spacing on the boom.*

Step 3. Multiply the amount (ounces) of water pumped in one minute (from Step No. 1) by 46.4 (a constant).

Step 4. Multiply the forward speed of the sprayer (miles per hour) by the nozzle spacing (inches).

---

*This constant applies to delivery measured in ounces, derived as follows:

$$\text{Constant} = \frac{\text{43,560 square feet/acre x 12 inches/foot}}{\text{88 feet/minute (1 mph) x 128 ounces/gallon}} = 46.4.$$

Constants to use when the delivery is measured in other units are:

milliliters - 1.57 pints - 742.5 gallons - 5940.

Step 5. Divide the answer obtained in Step No. 3 by the answer in Step No. 4. This is the gallons of water the sprayer is delivering per acre.

EXAMPLE

A sprayer has 16 nozzles spaced 18 inches apart and the boom covers a 24 foot swath. When operated at 40 psi, one nozzle delivers 40 ounces of water in 1 minute. The sprayer is to be operated at 4 mph. What is the application rate?

Step 1. 40 ounces per minute (measured)

Step 2. Nozzle spacing = 18 inches

Step 3. 40 ounces x 46.4 = 1,856

Step 4. 4 mph x 18 inches = 72

Step 5. $\frac{1,856}{72}$ = 25.8 gallons per acre applied

Caution--Be sure all nozzles are delivering at nearly the same rate when using this method of calibration.

3) *Another refill method.*

Step 1. Fill the sprayer tank to the very top or to some mark.

Step 2. Spray exactly 660 feet (40 rods) at the same speed and pressure to be used when spraying.

Step 3. Return to the exact starting position and refill the tank to the starting level, measuring in gallons the amount of water used.

Step 4. Calculate the application rate as follows:

$$\frac{\text{gallons used x } 66^{*}}{\text{width of spray swath in feet}} = \text{gallons per acre sprayer is applying.}$$

EXAMPLE

After spraying a swath 12 feet wide and 660 feet long, 8 gallons of water are required to refill the sprayer. The application rate is:

$$\frac{\text{88 gallons used x 66}}{\text{spray swath (12 feet)}} = \text{44 gallons per acre.}$$

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*A constant derived by dividing 43,560 square feet/acre by 660 feet sprayed and represents the width required to spray 1 acre.

D. Calibrating Band Applicators

Preemergence spraying (spraying after the crop is planted but before it comes up) or preplant spraying (application before the crop is planted) are becoming widely used practices in cultivated crops. Many of the herbicides used are expensive and one way to overcome the problem of cost is to apply the chemical as a *band spray*. Band spraying is the application of the herbicide in a band, usually about 1/3 to 1/2 as wide as the row spacing, immediately over the crop row, leaving the area between the crop rows unsprayed. In this way, only 1/3 to 1/2 as much material is used per cropped acre as when full coverage spraying is used; with a resultant saving in chemical cost. The area between the rows can be cultivated clean to reduce the weed infestation.

When application rates are recommended for weed control chemicals, such as 2 pounds per acre, this much active ingredient is to be applied to the area covered by spray. With full coverage spraying the entire field would receive this amount of chemical, but with band spraying only the sprayed band receives chemical at this rate. Thus, if 14 inch bands were sprayed on 42 inch rows, for every acre of cropland treated only 1/3 of an acre will be sprayed. Therefore, if 2 pounds per acre of chemical were recommended, *2 pounds of active ingredient would be applied to each acre actually sprayed* but only 2/3 pounds of chemical would be required to treat an acre of cropland.

The purpose of calibration is to determine the amount of spray applied to the band area. This figure is used to determine the amount of chemical to mix with carrier (water) in the tank. The concentration is figured exactly the same way as it would be if the spray was full coverage.

1) *Calibration.* As with full coverage spraying, calibration is very important. The margin of selectivity or safety of preplant or preemergence herbicides on such crops as sugar beets, fieldbeans, and corn, is sometimes narrow and accurate application is quite necessary.

Calibration can be done with various calibration jars on the market, or by using various other methods.

a. *Refill method.*

1. Measure off a known distance, such as 300 or 400 feet.
2. Fill the sprayer tank with water to a known mark. Spray the measured area at the *same speed and pressure* that would be used in the field.
3. Refill the tank to the known mark, measuring carefully the amount of water used.

4. Calculate the gallons per acre (gpa) sprayed by the following formula:

$$\frac{43{,}560 \times \text{gallons used}}{\begin{matrix}\text{distance} \\ \text{traveled} \\ \text{(feet)}\end{matrix} \times \begin{matrix}\text{band width} \\ \text{(in feet)}\end{matrix} \times \begin{matrix}\text{no. of} \\ \text{bands}\end{matrix}} = \text{gpa.}$$

EXAMPLES

If 1/2 gallon of water were sprayed on a 300 foot strip in two 14 inch bands, the acre rate would be:

$$\frac{43{,}560 \times .5}{300 \times 1.2 \times 2} = 30 \text{ gpa sprayed.}$$

If the same amount of water was sprayed on two 6 inch bands the acre rate would be:

$$\frac{43{,}560 \times .5}{300 \times .5 \times 2} = 72.6 \text{ gpa sprayed.}$$

b. *Nozzle method.* The nozzle method described for a boom sprayer can also be used to calibrate a band sprayer. The formula is:

$$\text{Spray rate (gpa)} = \frac{\text{nozzle output (ounces per minute)} \times 46.4}{\begin{matrix}\text{nozzle coverage (inches)} \times \text{speed (mph)} \\ \text{(band width)}\end{matrix}}.$$

Step 1. Adjust the pressure to the amount that will be used in the field and collect the spray from each nozzle for 1 minute and measure. (If all nozzles deliver equal amounts as they should, only one nozzle needs to be measured.)

Step 2. Measure the band width (coverage) in inches.

Step 3. Substitute the values from Steps 1 and 2 into the formula and calculate the gallons per acre sprayed on the band.

EXAMPLES

If the nozzle delivers 36 ounces of water in 1 minute at 30 pounds pressure and the speed to be used is 3 mph, the spray rate on a 14 inch band will be:

$$\frac{36 \times 46.4}{14 \times 3} = 39.8 \text{ gpa.}$$

In the above example if the band width were reduced to 7 inches the spray rate *on the band* would be:

$$\frac{36 \times 46.4}{7 \times 3} = 79.8 \text{ gpa.}$$

Changing the width of the band has a pronounced effect on the spray rate and thus on the concentration of chemical in the spray tank. It should be pointed out, however, that if the speed and row spacing remain the same in the two examples, the amount of water used per crop acre will also remain the same.

E. Calibration of Granular Applicators

Granular applicators can be calibrated in a manner similar to those for sprayers. The amount of granules applied by applicators depends on the size of the metering opening, speed of travel, field roughness, and the flow rate of the granule which is affected by size, shape, and density of the granules, temperature, and humidity. Because of such variables, it is difficult to predict a certain rate at a certain setting. Use the manufacturer's instructions as a guide, but run a check by actually catching the granule discharge per row from a measured area.

1) *Field calibration.*

(Use the following calibration steps:)

1. Adjust orifice (delivery openings) on applicator unit(s) at manufacturer's setting and fill hopper(s) with granules to be applied.

2. Set tractor or unit speed as it will be operated in the field.

3. Operate the unit over a measured distance of several hundred yards in a freshly prepared seedbed. Collect the ganules from each discharge tube. All should be delivering equal amounts.

4. Accurately weigh the amount of chemical delivered by each outlet.

5. Calculate the area that would have been treated over the course. Multiply individual band width (in feet) times number of rows times distance covered (in feet). This value equals the area of the measured treated course, in square feet.

6. From No. 4 and No. 5 calculate the amount of granules applied per acre (application rate) as follows:

$$\text{Pounds/A (granules)} = \frac{43{,}560 \times \text{pounds granules applied over course}}{\text{area of measured course in square feet}}$$

This value is pounds per acre (lb/A) of granular formulation applied. To determine amount of active ingredient applied, multiply lb/A by percent active ingredient and divide by 100 as follows:

$$\text{Lb/A} = \frac{\text{lb/A granules} \times \text{percentage active ingredient}}{100}$$

7. Complete calibration by repeatedly adjusting and testing until desired quantity of granules are delivered. Record the proper setting for future reference.

EXAMPLE

A granular applicator treats bands 1 foot wide on three rows (3 rows x 1 foot = 3 feet treated). When driven over a distance of 870 feet each tube delivers 4/10 pound of granules (3 rows x 4/10 pound = 1.2 pounds) at the setting used.

$$\text{Lb/A} = \frac{43{,}560 \times 1.2 \text{ lb granules}}{3 \text{ ft.} \times 870 \text{ ft.}} = 20 \text{ lb/A granules.}$$

If the active ingredient concentration of the granules was 20%, the rate of active material applied per acre would be:

$$\text{Lb/A} = \frac{20 \text{ lb/A granules} \times 20}{100} = 4 \text{ lb/A active ingredient.}$$

2) *Shop Calibration.* PTO driven granular applicators can be calibrated in the shop by calculating the distance that will be traveled in 1 minute, then collect granules for 1 minute with the applicator running at field speed. Values obtained in this manner can be substituted in the above formulas.

EXAMPLE

The application will be run at 3 mph in the field and the amount of granules collected in 1 minute at this speed is 1/8 pound per tube on a three row distributor. The band width will be 12 inches. The application rate will be:

$$\frac{43{,}560 \times 0.375}{3 \times (3 \times 88)^*} = 20.6 \text{ lb. formulation per acre.}$$

3) *Calibrating granular insecticides.* The label on some granular insecticides recommends applying so many ounces of formulation per 1,000 feet of row. Calibration is complete when the desired amount of formulation is collected in the prescribed distance.

Many companies offer calibration tubes for their materials which can be attached to the distributor tube and will give a direct reading for that particular formulation. *These tubes can be used only for the designated chemical.*

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*From page V-14, mph x 88 feet at 1 mph = feet per minute.

F. Computing Chemical Concentration

1) *Liquid formulations.* The label on all liquid herbicides states the number of pounds of acid equivalent or active ingredient per gallon of concentrate. The most common formulation is 4 pounds active ingredient or acid equivalent per gallon. However, there are some formulations that contain 2.0, 3.3, and 6.0, pounds per gallon.

From calibration, the amount of spray applied per acre has been determined. By dividing capacity of the sprayer tank (in gallons) by the spray rate (gallons per acre) the number of acres a tank will spray can be calculated. Enough chemical (active ingredient = a.i.) is then added to the tank to spray that many acres at the recommended rate.

Another way to think of the problem is that for every acre's worth of water added to the tank, an additional acre's worth of active ingredient must also be included.

The formula shown below can be used to determine the amount of chemical to be added to a sprayer tank to obtain the desired application rate.

$$\text{Chemical to be added} = \frac{\text{no. acres sprayed x chemical rate (lb. a.i./acre)}}{\text{chemical concentration (lb. a.i./gallon)}}.$$

Acres/Tank

EXAMPLE

How many gallons of a herbicide with 2 pounds active ingredient per gallon should be added to 50 gallons of water for a 10 gallon per acre sprayer to apply the chemical at the rate of 1/1/2 pounds per acre?

$$\text{Acres covered} = \frac{\text{50 gal}}{\text{10 gal/A}} = \text{5 acres capacity.}$$

$$\text{Chemical needed} = \frac{\text{5 acres x 1.5 lb/acre}}{\text{2 lb. a.i./gal}} = \text{3.75 gal.}$$

a. *Band application.* When figuring chemical for band application, the spray rate *on the band* is used to determine acreage covered by a tank of water. The chemical added is then based on the banded area sprayed and not the cropped area.

2) *Wettable powders and granules.* These materials have active ingredients expressed as a percentage of the total weight and may vary from 5% to 80% active ingredient. A simple formula used to calculate the amount of commercial product required is as follows:

$$\frac{\text{Application rate (lb. a.i./acre)}}{\text{Percentage active ingredient (expressed as a decimal)}} = \text{weight of formulation required.}$$

For example, if you have a herbicide that is 80% active ingredient and you wish to apply 2 pounds/acre active ingredient then:

$\frac{2.0}{.80} =$ 2.5 lb. of commercial formulation is needed to give 2 lb. of active ingredient per acre.

3) *Small plot square rod basis.* When calculating chemical amounts for small plot work, very small quantities are used. The values listed below plus those in Appendix Tables 1 and 2 will be useful for making these calculations.

1 acre	=	160 sq. rods
1 quart	=	946 cc. or ml.
1 gallon	=	3,784 cc. or ml.
1 gallon	=	4 quarts
1 pound	=	453.6 grams
1 pint	=	16 ounces
1 ounce	=	29.56 cc. or ml.
1 acre	=	43,560 sq. feet

EXAMPLE

You want to apply 1 pound/acre active to a lawn for dandelion control and the liquid material you have contains 4 pound/gallon active ingredient. Each quart therefore contains 1 pound active.

$$\frac{946 \text{ ml/lb. a.i.}}{160 \text{ sq. rods/A}} = 5.9 \text{ ml/sq. rod to give a rate of 1 lb/A.}$$

80% active wettable powder

$$\frac{1.0 \text{ lb. active needed}}{.80 \text{ active material}} = 1.25 \text{ lb. of formulation to give 1.0 lb. active.}$$

1.25 x 453.6 = 567 g. to equal 1 lb. active.

$$\frac{567 \text{ g/lb. a.i.}}{160 \text{ sq. rods/A}} = 3.5 \text{ g/sq. rod - 1 lb/A.}$$

SECTION IV

Sprayer Maintenance and Cleaning

Most trouble with sprayers can be traced to foreign matter that clogs screens and nozzles and sometimes wears out pumps and nozzles. The following suggestions will help reduce maintenance problems and prolong sprayer life.

1. *Use clean water.* As a rule of thumb use water that looks clean enough to drink. Water pumped directly from a well is best. Water from ponds or stock tanks will probably contain enough small particles to plug nozzle screens even though it looks clean. If it is necessary to use pond water, filter it before filling the tank.

2. *Keep screens in place.* A sprayer system usually has screens in three places; a course screen on the suction hose, a medium screen between the pump and the boom, and a fine screen in the nozzle. The nozzle screen should be fine enough to filter particles which will plug the tip orifice. A 100 mesh screen is normally adequate for nozzles. Screens should be in place at all times with one possible exception. When wettable powders are used it is difficult to keep them 100% in suspension and nozzle screens may have to be removed to prevent excessive clogging.

3. *Never use a metal object to clean nozzles.* To clean, remove the tips and screens and clean them in water or a detergent solution using a soft brush. The orifice in a nozzle tip is a precision machined opening. A thrust from a pin, knife or other metalic object can completely change the spray pattern and capacity of the tip.

4. *Flush sprayers before using them.* New sprayers may contain large amounts of metallic chips and dirt from the manufacturing process. Sprayers which have been idle for a while may contain bits of rust and dirt. Remove the nozzles and flush the sprayer with clean water. Clean *all* screens and nozzles thoroughly before trying to use the sprayer.

5. *Clean sprayer thoroughly after use.* After each day's use, thoroughly flush the sprayer with water, inside and out, to prevent corrosion and accumulation of chemicals. Be sure to discharge cleaning water where it will not contaminate water supplies, streams, crops, or other plants and where puddles will not be accessible to children, pets, livestock, or wildlife.

When changing chemicals or when finished spraying for the season, clean the sprayer thoroughly both inside and out. Some chemicals, such as 2,4-D, are particularly persistent in the sprayer and must be removed completely to prevent possible crop damage from other spraying operations. In other cases, chemical reaction may cause coagulation or loss of effectiveness of the chemical. For thorough cleaning between chemicals or at the end of the season, the following procedure is recommended.

a. Remove and clean all screens and tips in kerosine or a detergent solution using a soft bursh.

b. Mix one box (about 1/2 lb.) of detergent with 30 gallons of water in the tank. Circulate the mixture through the bypass for 30 minutes, then flush it out through the boom.

c. Replace the screens and nozzle tips.

d. Fill the tank about 1/3 to 1/2 full of water and add 1 quart of household ammonia to each 25 gallons of water. Circulate this mixture through the system for 5 minutes, allowing some to go out through the nozzles. Keep the remainder of the solution in the system overnight, and then run it out through the nozzles.

e. Flush the system with a tank full of clean water by spraying through the boom with nozzles removed.

6. *Prepare the system for off season storage.* When the pump is not in use, fill it with a light oil and store it in a dry place. If the pump has grease fittings, lubricate them moderately from time to time. Over lubrication can break seals and cause the pump to leak. Remove nozzles and screens and place them in a light oil for storage. Store the sprayer, hoses and booms in a dry shed.

APPENDIX 11

CONTROLLING DRIFT OF HERBICIDES

APPENDIX 11

Controlling Drift of Herbicides

by L. E. Warren

Pesticides contribute enormously to the quantity and quality of food, feed, fiber, wildlife habitat, and the environment. The U.S. farmer now produces food for himself and over 50 others; the U.S. has the highest standard of living in the world and can help feed nations abroad by exporting not only our produce but our technology. Part of this technology is the effective and safe use of the various pesticides needed in a wide variety of situations.

All pesticides marketed in the United States are subjected to very extensive and detailed testing for efficacy in the intended use, toxicity of different types, and potential impact on the environment. This process will take from five to 10 years from discovery of activity to marketing for one crop use, and cost 10 to 15 million dollars. Regulation of pesticide use by federal and state agencies is very extensive and continues to increase the cost. Some of this regulation seems warranted, however, to ensure proper care in application of these materials and prevent undesirable consequences from their use.

Chemicals were applied to about 65 million acres by nearly 5,000 aircraft in the United States during 1964 (5); there must be somewhat more of both in 1975. Aerial equipment permits much more timely and extensive applications to crops or treatments of inaccessible sites. However, extra care must be exercised to prevent off-target problems which could result in over restriction of aerial application. One case of poor judgment can reflect adversely on the whole industry.

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The labels and other literature produced by pesticide marketers and several state and federal agencies provide detailed information on the characteristics of these chemicals and instructions on their use. Proper application of these products to achieve the desired results without injury to property elsewhere is important. Serious losses can be sustained because of off-target crop or animal damage, illegal residues in produce or water, air or soil contamination. Of course, any reduction in the intended pesticide on the target may reduce control. These problems can develop because of improper application of sprays or from vaporization of compounds afterward. Since I am familiar with herbicides and they provide a variety of characteristics to illustrate the problems and procedures of confining pesticides to their target areas, my presentation will involve the volatility and drift of herbicides.

Many different herbicides are applied by air or ground equipment to control weeds and woody plants in fields, forests, roadsides, and rights-of-way. Some application methods can result in movement of small particles to off-target areas as the spray falls.

The movement of herbicides in the air to off-target sites can result also from vapors that may form after application of certain herbicide formulations. It is necessary to distinguish between the two sources (spray drift and vaporization) and eliminate or reduce the extent of both to acceptable minimums.

Spray *drift* is defined as that part of the spray that moves out of the target area in fine droplets formed at the atomizer and depositing on adjacent property. The target area is the contiguous property intended for treatment. *Vaporization* is the volatilization of herbicide molecules from the falling or fallen drops. The volatilities of herbicide products are known and appropriate formulations usually can be used that will not produce unacceptable off-target effects. Some aspects of volatility will be discussed briefly. The amount of drift can be affected by many factors, most of which can be controlled or adjusted to by the applicator. The more important aspects of drift will be explored in greater detail.

Volatility

The vaporization potential of a herbicide can be assessed by its vapor pressure in relation to air temperature, the liquid spray surface-to-herbicide-mass ratio (Q value), the surface supporting it, size of the treated area, and air flow (40,46). The effect on plants from exposure to the vapor phase of herbicides is more from fumigant action rather than liquid contact on leaf surfaces.

Some soil active herbicides will volatize so rapidly that they require incorporation very quickly after reaching the soil. This action may result in a loss of activity in the intended target area, but usually would not present an off-target hazard. Other herbicides, because of their nature, are marketed in different forms which may include some with high enough vapor pressures that off-target effects can be produced.

2,4-D (2,4-dichlorophenoxy acetic acid) is an example of a systemic herbicide that is formulated as inorganic or organic salts, both water and oil soluble, and as esters which are oil soluble and water emulsifiable. Very small amounts can injure certain crops, such as cotton, grapes, sugar beets, etc., and many aesthetic plants.

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The vapor pressure of the salts of 2,4-D (as well as other phenoxy or picolinic acid compounds) is very low; bioassays in greenhouse and field studies have established the lack of off-target effects from vaporization of these salt forms (20, 35,40,61).

2,4-D is marketed also as esters formed from two to eight carbon or carbon plus oxygen alcohols, some of which are included in Table 1. The esters of 2,4-D with two to four carbon chains have the highest vapor pressures and significant amounts can volatize from treated areas at temperatures of 60°F or higher. These short chain esters are called "high volatile" (H.V.). The longer carbon chain esters are formed from six to eight carbon or carbon-oxygen alcohols and have significantly lower vapor pressures (20,27). Que Hee and Sutherland (40) found that smaller spray drop sizes (more droplet surface area) resulted in more volatilization of 2,4-D esters; the iso-octyl ester of 2,4-D, with a large spray drop surface, volatilized much more than did the n-butyl ester in larger drops.

The effect of temperature on vapor pressures from data by Jensen and Schall (27) is shown in Table 1; the figures for 25°C. are representative of temperatures under field conditions. The vapor pressure of the six to eight carbon chains are ¼ to ½ those of the n-butyl ester, for example. Zimmerman *et al.* (61) showed, by plant bioassays, that the low volatile esters, which gave about the same weed control, were many times safer than the H.V. esters. Field studies have confirmed that these ester forms can move off-target, but that the hazard is slight unless the surface temperature during the first few days rises above about 95°F. Off-target effects may accumulate under lower temperatures when treating larger acreages with fine sprays over a few days when stable air movement is predominantly in the direction of problem areas.

High volatile forms can cause damage to susceptible plants for some distance outside the treated area under particularly stable air conditions, especially if large acreages are treated in a short period of time and day temperatures are above 60°F (46). For example, effects from vaporization of 2,4-D as either high or low volatile esters will be more pronounced downwind from a 640 acre field than from a 40 acre field. Usually volatilization of ester forms will occur only for three to four days after application because the ester chain hydrolyzes off leaving the acid radical on the plant or other surfaces; the acid should react readily with salts on the plant or soil surfaces and be essentially non-volatile. The vapor pressure of 2,4-D acid appears to be about that of the low volatile esters (24).

TABLE 1
Vapor Pressures of 2,4-D Esters

Ester	Structure	mm Hg Temperature, °C 25°	187°	250°
ethyl	—C—C	.0011	18	150
2-propyl	C —C—C	.0014	17	140
n-butyl	—C—C—C—C		9.2	88
4-heptyl	C —C—C—C—C—C—C		5.0	56
n-heptyl	—C—C—C—C—C—C—C	.0002	2.9	40
2-octyl	C —C—C—C—C—C—C—C		3.1	40
ethyl-hexyl	C_2 —C—C—C—C—C—C		2.9	37

—From Jensen and Schall (27)

Drift

Basically, the drift problem involves: (1) the number of driftable fine particles produced; (2) their movement after leaving the dispenser; (3) the type and rate of pesticide; and (4) the nature and location of potential off-target hazards.

Herbicides can be applied as sprays, dusts, granules or pellets. Dusts have been very difficult to confine to the target areas because of very fine particle size, and are used very little to apply herbicides. Properly formulated granule and pellet products without dust present no drift problems. However, most solid products have some fine particles that are not removed before packaging or develop in handling and these fines can drift. This problem may be sporadic, but should be considered when applying these materials.

The main purpose of this presentation is to consider the problem of spray drift related to herbicides which are applied as aerial or ground sprays using a wide variety of dispensers and carriers. The factors that affect off-target movement of spray droplets will apply generally to solid particles of similar size and density. Space will permit consideration of only some of the results of extensive research and data as needed to review the better systems for reducing drift to nonhazardous amounts. Yates and Akesson (57), contributors to a recent book entitled "Pesticide Formulations," provide an excellent and much more inclusive discussion of the theoretical or research background of the various aspects of drift.

The hazards from off-target drift depend on (1) nature of the hazard, such as water, plant species, growth stage, etc.; (2) legal pesticide tolerances in crops; (3) distance from the application site; (4) wind direction and air stability; (5) type, form, and rate of the herbicide; and (6) the carrier. Serious economic loss or contamination of water supplies can result from uncontrolled drift.

Herbicides require certain coverage or drops per unit area of leaf surface for efficient phytotoxic effect; the coverage requirements vary with the individual herbicide, carrier or adjuvants and the plants to be treated. Nontranslocated herbicides, such as dinoseb products, usually require better coverage than for systemic materials, such as 2,4-D or picloram. Several researchers (7,12,35) have shown, in greenhouse studies, that toxic effects of herbicides on foliage increase as drop size is decreased from 800 to 100 microns[1] (μm) diameter. However, Ashford (6) has found that field applications of 2,4-D to weeds in wheat produced similar results with 200 and 100 μm droplets. He assumes that impaction of the smaller droplets on weed leaves is poorer because of difficulty in penetrating the boundary layer of air around the leaf. Potts (39) shows that impaction of droplets on solid surfaces is closely related to the size of both the drops and deposit area and air speed at that point, as indicated in Table 2. It is evident that some very small drops do get through.

Hurtt (25) reported that effects of 2,4,5-T on tree seedlings was about five times greater with 125 μm compared to 500 μm drops but that 250 μm droplets produced only slightly less effect than did the 125 μm size. Behrens (7) concluded that maximum efficiency of phenoxy herbicides on cotton and mesquite was achieved when spray droplets were less than 3100 μm apart, which would provide a coverage of about 72 droplets per square inch. The data showed, however, that better kill of mesquite was obtained with 575 drops of 200 μm per square inch than with 72 drops of 400 μm size per square inch; the spray volume was the same in each case. Also, at a deposition rate of 72 drops per square inch, more mesquite tissue was killed as drop size increased from 200 to 800 μm. Cotton did not respond appreciably to increased coverage over 72 drops per square inch. Picloram, amitrol, dicamba, and other compounds that are translocated more readily than phenoxies may require fewer contacts per unit leaf area.

McKinlay et al. (34) found that paraquat, a non-translocated herbicide, caused more leaf kill with 100 μm droplets than 350 μm, provided the concentration and spray volume were adequate. Commercial nozzles with a normal range of drop sizes and a VMD of about 450 μm produced good leaf kill with a volume rate of 6 gpa.

Of course, weed or brush foliage surfaces may contain much more area than the horizontal plane over the treated site. Bouse (10) reports that penetration of two, three or more foliage canopies may be better with larger droplets but coverage of the lower leaves was better with the smaller droplets. As indicated above, good plant control with systemic herbicides is possible with 200 μm droplets. Fisher et al. (19) have shown that control of mesquite with ¼ lb. of 2,4,5-T per acre was as good at volume rates of ½ gpa as at 4 gpa, all having average drop sizes over 200 μm. These results, and many others, indicate that spray coverage requirements vary considerably with the plant species, size and condition, and herbicide type and carrier. The operator should determine these requirements and use spray volumes and atomization to provide adequate coverage of plant surfaces with *no unacceptable* off-target drift.

[1]25,400 microns = 1 inch.

The movement of fine airborne spray particles out of the target area, which we defined as "drift", is dependent on a large number of influences; several are itemized for aerial applications in Table 3. Drift from ground applications is affected similarly, but usually to a lesser degree. Significant amounts of drift from this source is possible (33).

The spray carrier can be water, oil, oil-water emulsion, invert emulsion, foam, or thickened water. Yates and Akesson (56) have shown that introduction of oily additives or surface tension reducing agents will result in smaller drops, as presented in Fig. 1 on page 36.

Several viscosity increasing agents and other spray modifiers to increase drop size, such as invert emulsions, hydroxyethyl-cullulose, Norbak* particulating agent, Nalco-Trol**, and foams have been introduced to reduce drift. These will be discussed later.

TABLE 2
Minimum Air Velocity for Efficient Deposition for Droplets and Objects of Various Sizes

Width of Objects, ins.	Droplet Size—microns dia. 25	50	75	100	125	150	300
	Air Speed—Miles per Hour						
⅛	4	1.2	0.7	0.8	1.0	1.4	5.5
¼	8	2.2	1.2	1.1	1.3	1.6	5.7
½	16	4	2.1	1.6	1.6	1.8	5.8
1	32	8	3.9	2.6	2.2	2.3	5.9
2	64	16	7.5	4.6	3.5	3.1	6.0
3	96	24	11	6.6	4.8	4.0	6.1
4	128	32	15	8.6	6.0	4.9	6.2
8	256	64	28	16	11	8	6.3

—From Bell Helicopter Manual (8)

Spray Drop Size

Spray droplets are measured as drop diameters (micrometers or microns, μm), but a droplet with twice the diameter of another has eight times the volume or mass. The smaller droplet has about ¼ the surface of the larger droplet and

* Registered trademark of The Dow Chemical Company, Midland, MI.

** Registered trademark of Nalco Chemical Co., Oak Brook, IL.

TABLE 3

Factors Affecting Drift of Aerially Applied Herbicides

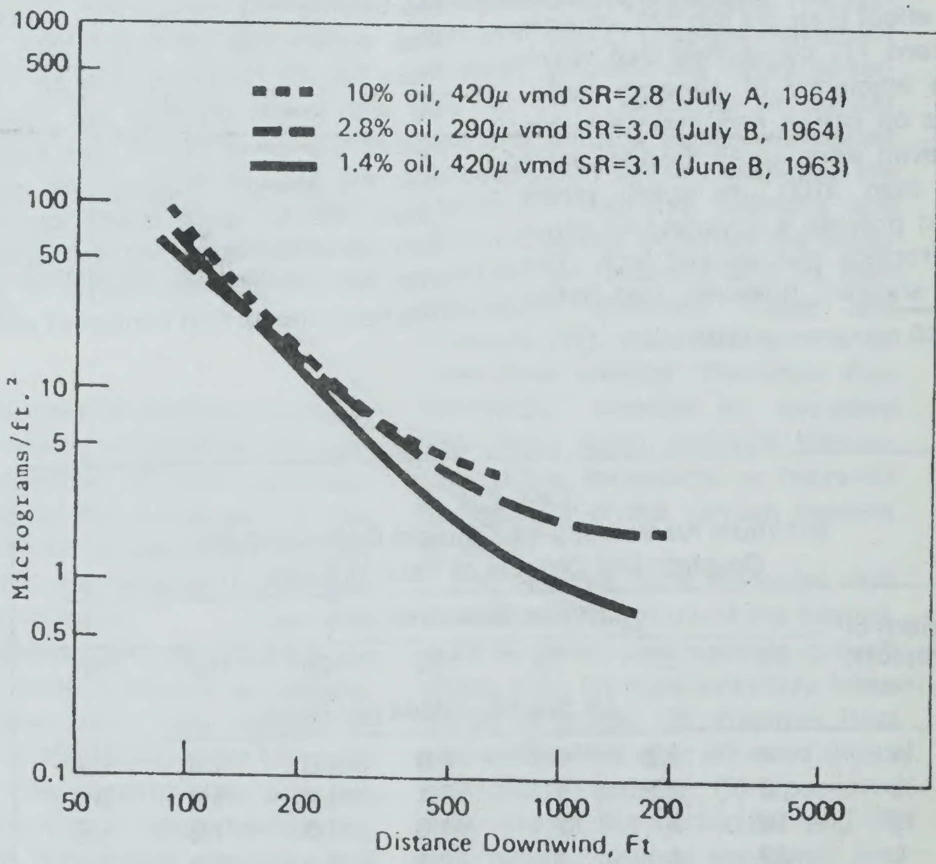
1. Spray drop size spectrum, as affected by:
   a. Herbicide—formulation and rate.
   b. Type of carrier—water, oil-water, oil, etc.
   c. Viscosity of spray.
   d. Nozzle type, capacity and pressure.
   e. Nozzle orientation to airstream.
   f. Speed of aircraft.
2. Spray Movement as affected by:
   a. Nozzle location cf. ship center.
   b. Boom location in relation to the wing or rotor.
   c. Height of release of the spray.
   d. Flight path—level, rising, falling or turning.
   e. Air stability (vertical movement).
   f. Size of treated area.

therefore will respond 16 times more to the force of air movements aloft. These characteristics accentuate the drifting tendency of the smaller droplets. Potts (38) has computed the number of droplets of different sizes produced by one gallon of spray and the consequent densities per square inch are shown in Table 4. These drop sizes are in diameters of freely falling droplets and spots on collectors, such as cards, may be two to six times larger.

Droplet size is very important in drift; water droplets in various components of the atmosphere and their drifting potential are noted in Table 5 (2,29). These figures were based on terminal velocities of drops in stable air with no change in drop size. Broadcast herbicide sprays usually contain a drop size range of less than 10 to about 2000 μm, depending on the desired spray coverage and drift hazard conditions. Droplets in the size range of 20-30 μm or smaller remain suspended (fog); in herbicide sprays, these droplets may be nearly invisible in the air. Of course, these, as well as larger droplets, are subject to air movement as well as vaporization loss. The larger droplets are moved less horizontally but still may move considerable distances; note

Figure 1

REGRESSION LINES INDICATING EFFECTS OF DROPLET SIZE AND OIL CONTENT ON DRIFT DEPOSITS



. . From Yates and Akesson (56)

that 100 μm droplets can move laterally 48 feet in a three mile per hour wind while falling 10 feet. Some applications to utility lines or forest sites are made 100 to 300 feet above the ground, which magnifies the drift potential greatly.

Research has shown that there is a rapid decrease in drift potential of drops as they increase to about 150 or 200 μm. Thereafter, with larger drops, there is much less change in the drift potential. The size where this change occurs is larger with higher wind speeds, but lies in the range of 150 to 200 μm

TABLE 4
Size and Number of Droplets per Square Inch from One Gallon Liquid Applied Uniformly over One Acre

Droplet Diameter Microns (μm)	No. Droplets per Square Inch	Centimeter
25	80,625	12,497
50	9,224	1,430
100	1,164	180
150	347	54
200	142	22
300	43	6.7
1,000	1	0.16

25,400 μm = 1 inch. —Adapted from Potts (38).

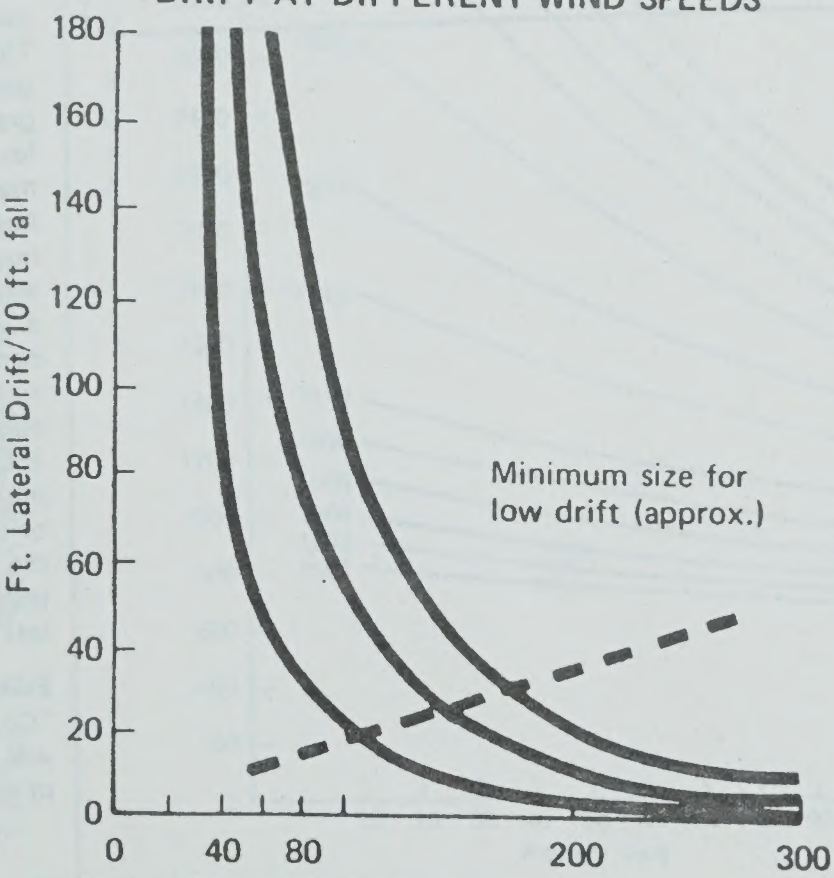
TABLE 5
Spray Droplet Size and its Effect on Spray Drift

Droplet Diameter, microns	Type of Droplet	No. Droplets/ Sq. In. from 1 gal. spray/A	Time Required to fall 10 ft. in Still Air	Distance Droplet Travels in Falling 10′ with 3 mph wind
5	Fog	9,000,000	66 minutes	3 miles
20	Very fine sprays	143,190		1,109 feet
50	Fine sprays	9,224		178 feet
100	Mist; fine aircraft spray	347	10 seconds	48 feet
240	Medium aircraft spray	78		
400	Coarse aircraft spray	18	2 seconds	8.5 feet
1,000 (1/25″)	Moderate rain, very coarse spray	1.1	1 second	4.7 feet

—Adapted from Klingman (29), Potts (38) and Akesson and Yates (2).

Figure 2

RELATION OF SPRAY DROP SIZE TO DRIFT AT DIFFERENT WIND SPEEDS



. . From Byrd (13)

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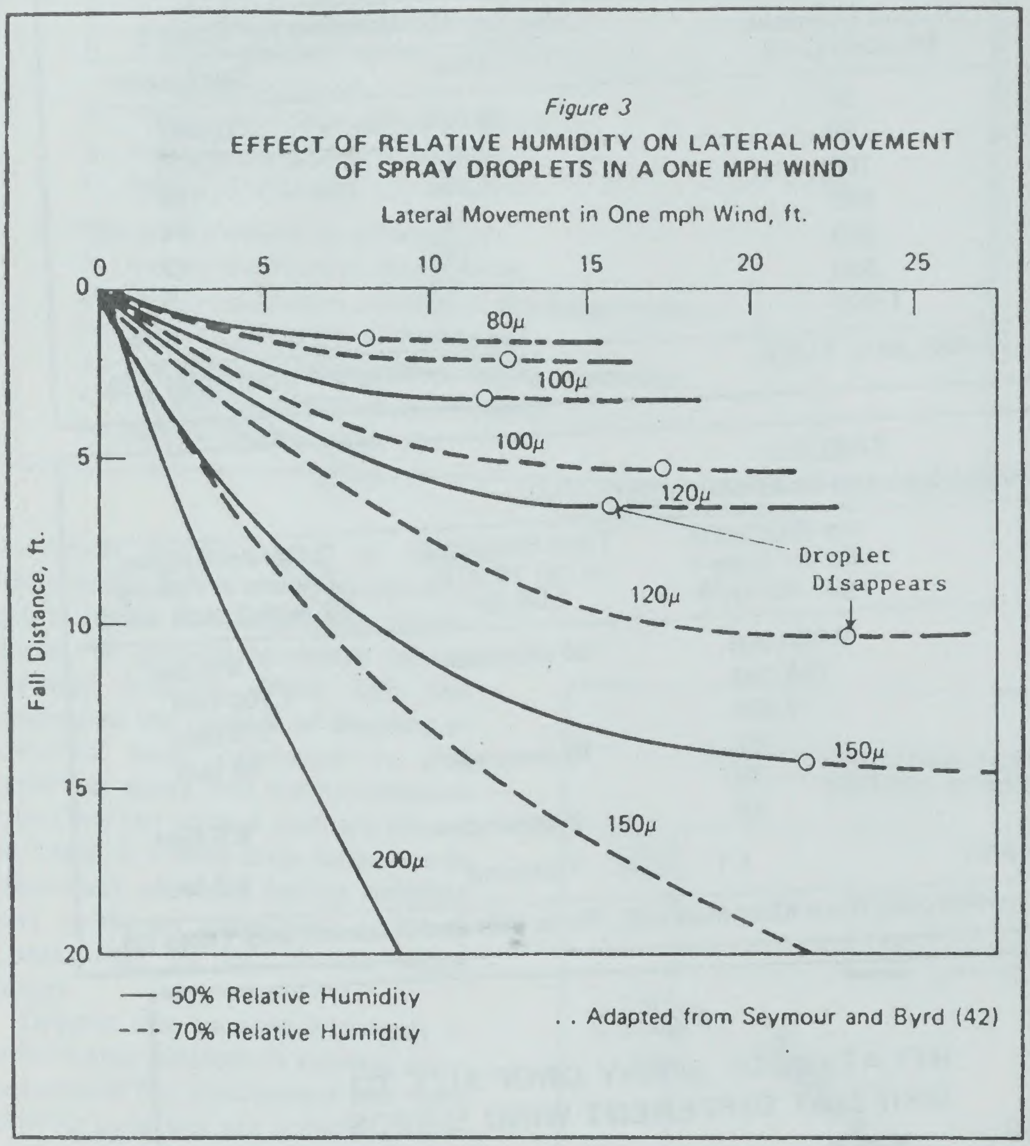

for speeds of one to eight miles per hour (13,16); Fig. 2 shows this relationship based on theoretical fall rates for terminal velocities and no change in original drop size. Drift is decreased greatly by increasing drop sizes to about 150 to 200 μm, and much less after that.

With water carriers, spray drop size may decrease during fall because of evaporation unless a non-evaporative film, such as oil, surrounds the drops. Smaller droplets falling into air of relative humidity less than about 80 percent may evaporate before hitting the target (19,42). Fig. 3 shows the effects of evaporation on water droplets 80 to 200 μm in diameter falling through stable air with a 50 percent and 70 percent relative humidity with a one mile per hour crosswind. These disappearance rates will increase with any vertical component or delay in fall.

Note that in air at 50 percent relative humidity, the 80 to 120 μm drops disappear with less than a seven foot drop; the smaller droplets disappear sooner. The herbicide in these drops will become very small aerosols and will not fall out until picked up in falling rain. The 200 μm drops may reach the ground, but will certainly be progressively smaller and more subject to drift. The droplets evaporate more slowly in 70 percent relative humidity and faster in lower relative humidity. It is evident, then, that as water droplets fall through air with a water deficit (less than 100 percent RH), they will be decreasing in size and will become increasingly subject to drift. Droplets over about 150 μm will resist vaporization much more than smaller sizes. Addition ot oils or surfactants will not affect the evaporation rate appreciably unless the oil film surrounds the droplets as with an invert emulsion (57).

Editor's Note: Part II of the series "Controlling Drift of Herbicides" will be published in the April issue of the *World of Agricultural Aviation*.

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Controlling Drift of Herbicides

by L. E. Warren

Effects of Spray System Conditions on Drop Size

Liquid velocity induced by pressure increases as it is forced through an orifice. There frequently is some turbulence in the nozzle or spray atomizer that also exerts breakup forces on the liquid. As the liquid leaves the nozzle, it may be spread into a fan or a hollow or solid cone pattern that creates thin sheets of liquid which, exposed to the air, are broken up by the shear forces between liquid and air. These stressed liquids develop waves in the sheets or threads, and due to the air shear are broken up, which results in many larger drops with many satellite or small droplets. Internal deflecting vanes which induce a cone, fan, or any deviation from a solid stream, increases spray break-up. Circular orifices without swirl plates produce a minimum spread of liquid and therefore the largest drop sizes. As the average drop size is decreased, the range is also narrowed due to increased action on large drops (see Fig. 4); but a very high energy requirement is needed to break up small drops, hence they remain.

Drop sizes in sprays change significantly and inversely with pressures, as shown in Fig. 4 (43). Pressures in the range of 20 to 35 psi at the nozzle are usually adequate to produce the desired spray pattern and will result in fewer small drops and hence less drift.

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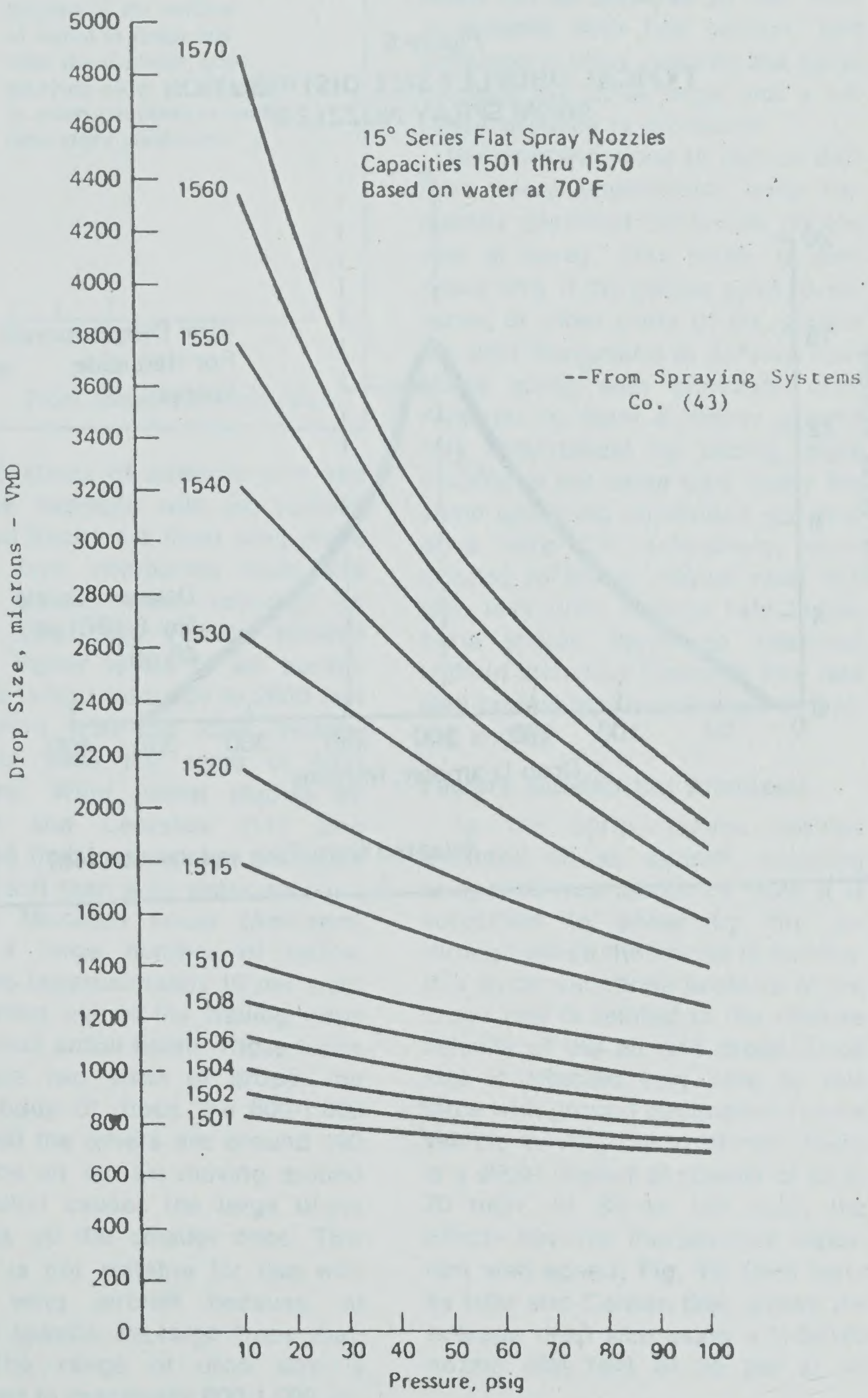
Figure 4

SPRAY PARTICLE SIZE vs PRESSURE



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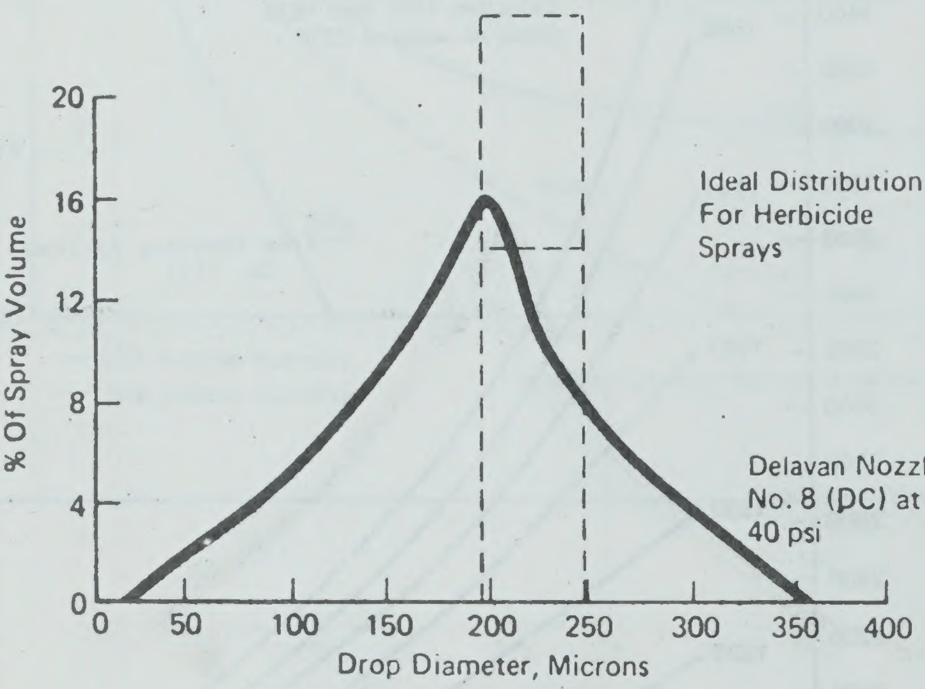
When liquids are atomized, they form a wide range of drop sizes. A typical distribution of drop sizes from a pressurized nozzle is indicated in Fig. 5.

As discussed above, a drop size of about 200 μm for herbicides would provide good coverage with essentially no drift or loss during fall. The pattern shown by the dashed lines (Fig. 5) would be close to ideal. Certain mechanical or electrical devices that will produce uniform drops in the range of 150 to 250 μm are being developed (51), but until they or other systems become available, allowance for the wide drop size spectrum will be a necessary consideration. In drift hazard situations, the mean drop size of the spray must be increased so the amount in fine particles (less than 50 to 100 μm) will be below levels that may cause significant off-target effects.

Certain devices have been developed to reduce drift, such as the Microfoil[1] boom, the Raindrop[2] nozzle and Direct-A-Spray[1]. These will be discussed later.

Figure 5

TYPICAL DROPLET SIZE DISTRIBUTION FROM SPRAY NOZZLES



. . Adapted from Tate and Janssen (45)

Because of the wide range of drop sizes in sprays, various statistical averages are used to identify a given spray distribution. The size median used most frequently is one at which half the spray *volume* is in drops above and half below this size; it is called the "Volume Median Diameter" (VMD). There are many more drops in the smaller half of the spray. Another term is the "Number Median Diameter (NMD), which indicates the size at which half the *number* of droplets produced is larger or smaller. Drop size frequency data are available for most atomizers, and the drift potential can be estimated by noting the percentage of spray volume or number in the sizes below 100 or 150 μm using a cumulative graph of the spray volume in the different size ranges, as indicated in Fig. 6 (43, 60). The accuracy of such measurements in the very small drop range is less than with larger sizes, and other forces affect the actual amount of drift; but the drop spectrum is an important starting point.

Tate and Janssen (45) found that generally the mean drop sizes of sprays from cone, fan, or deflector nozzles were essentially the same if the fan or cone angles were about equal (Fig. 7), although variations in nozzle internal geometry causes deviations from this base (Fig. 9). The drop size is also almost directly proportional to the flow rate at equal pressures, as plotted in Fig. 7. Drop size data for various nozzles by Spraying Systems Company (43) indicate that the wider angle fans or cones produce smaller droplets, as plotted in Fig. 8. Other data and experience show that a jet (round orifice) will produce the largest size drop for a given flow rate and pressure because there is less shear at the liquid-air interface (2). Also, certain nozzles, such as the Spraying Systems Company's Low Pressure (LP) nozzles, can produce a good pattern at pressures from 10 to 20 psi. Spraying Systems type TG and GG solid cone (full jet) nozzles produce larger drops than fan or hollow cone nozzles with equal cone or fan angles, flow rates and pressures (43), as shown in Fig. 9.

[1] Registered trademarks of Amchem Products, Inc., Ambler, Pennsylvania.
[2] Registered trademark of Delavan Mfg. Co., West Des Moines, Iowa.

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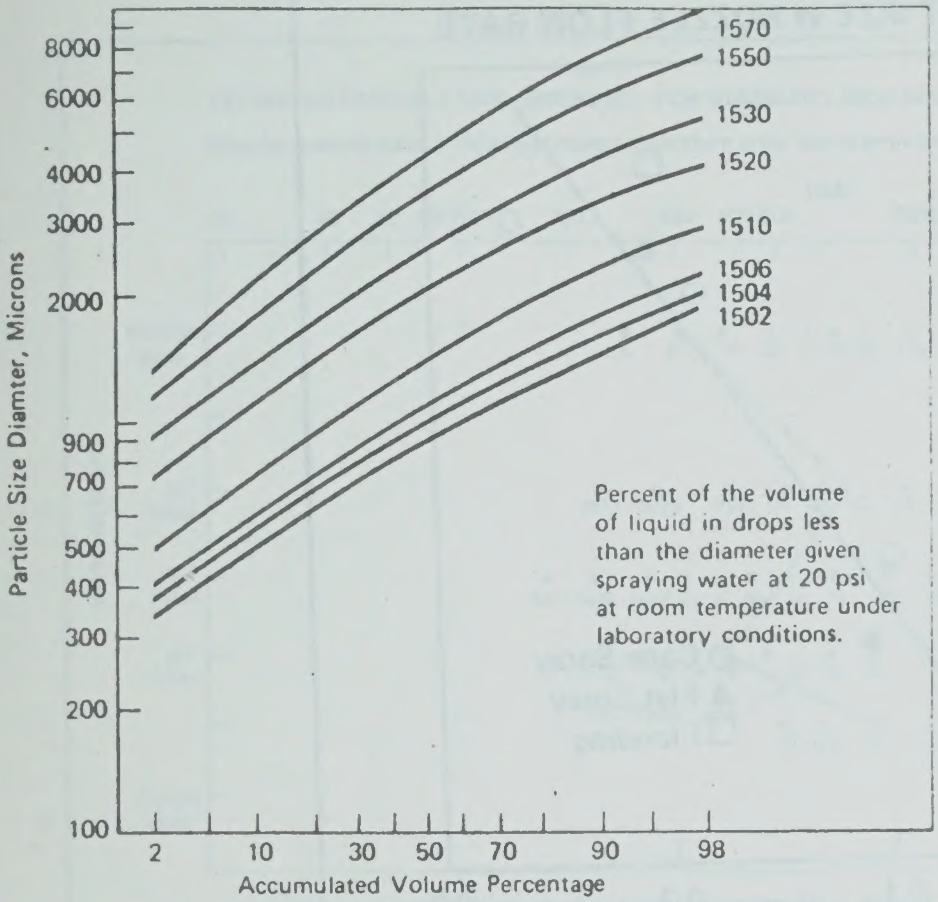
Figure 6

PARTICLE SIZE vs VOLUME PERCENTAGE FOR 15° FLAT SPRAY NOZZLES



. . From Spraying Systems (43)

The Raindrop nozzle recently introduced by Delavan Manufacturing Company apparently reduces the range of particle size by providing a chamber outside the metering orifice to induce coalescence of the small drops. Data from manufacturers' tests indicate that, with a VMD spray size of 195 µm, 16 percent of the volume was in drops smaller than 100 µm with a regular hollow cone nozzle (DC4-25); the Raindrop nozzle with a VMD of 410 µm produced only 0.8 percent of the volume in less than 100 µm sizes (17) at the same flow rates.

Foam nozzles are special aspirators with fans, jets, or other patterns that are used with certain foaming agents that incorporate air to expand the spray volume 300 to 600 percent (11, 23, 52). Because of this "air emulsion," droplets are lighter than solid water drops and would be much more subject to drift. The coverage may be better than with a similar liquid volume of spray; however, Ashford (6) reports that in field tests with 2, 4-D and paraquat, weed control with the foam system was poorer than with standard nozzles.

Evaluations of airborne drift and surface deposits with jet nozzles pointed back on a fixed wing plane at 90 mph comparing foam and water carrier were reported by Yates (55). The results showed much higher levels of air burden and as fallout from 165 to 2600 feet downwind with the foam system. Outputs were the same in both systems. Wind tunnel studies by Bouse and Leerskov (11) also showed that foam sprays produced more drift than with water carrier.

The Microfoil boom (Amchem) uses a large number of hollow needles (approximately 10 per inch) projecting out of the trailing edge of a small airfoil boom. These tubes produce two sizes of drops; the main body of drops are 800-1,000 µm, and the others are around 100 µm. The air stream moving around the airfoil causes the large drops to pick up the smaller ones. This boom is not suitable for use with fixed wing aircraft because, at higher speeds, the large drops shatter. The range of drop size is reduced to practically 800-1,000 µm, and drift is minimal if the orientation to the direction of flight is correct. However, the drop size is too large for efficient herbicide action, even for translocated materials, with low volume (5 gpa or less) applications. Flow rate through the small tubes (0.013 to 0.028") is affected by viscosity of the spray, and adjustments in calibration are necessary for temperature changes with oil carriers. Also, extensive filtering of the spray is required to prevent plugging the small tubes.

Amchem has also developed a rotating device for ground sprayers called the "Direct-A-Spray," that meters the liquid to short tubes turning fast enough to throw the drops out as much as 24 feet. Drift is minimal with this system, and coverage is fairly uniform; but spray droplets are quite large and a full range of sizes is produced.

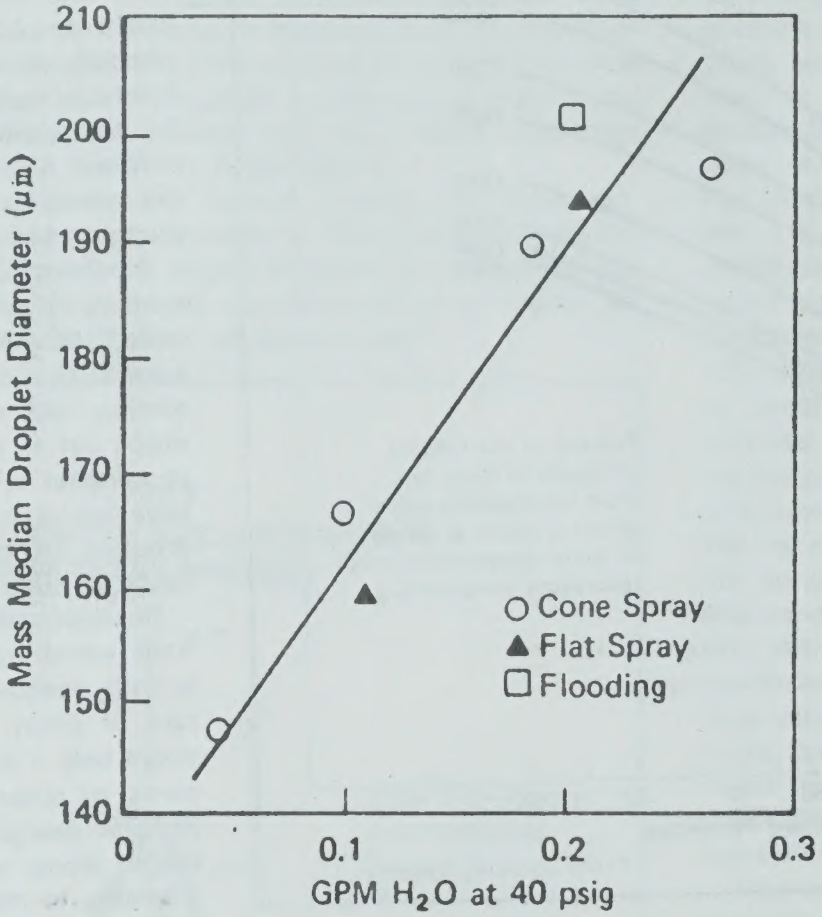
Recommendations to reduce drift from aerial applications have frequently specified increased volume rate of spray. This factor is pertinent only if the nozzle sizes, pressures, or other parts of the system are also designated to achieve coverage along with minimum drift. Attempts to meet a higher volume rate requirement by adding more nozzles of the same type under the same operating conditions will produce *more* drift; conversely, fewer nozzles (a lower volume rate) will give *less* drift. Volume rate limitations should never be specified without including minimum flow rate with certain type nozzles and mounting angles.

Factors Outside the Atomizers

As the spray leaves nozzles mounted on an aircraft, traveling at speeds over about 25 mph, it is subjected to shear by the air through which the nozzle is moving; this force will cause breakup of the drops and is related to the relative velocity of the air and drops. Drop size is affected very little by this force with ground application from a vehicle moving five to 10 mph; there is a slight impact at speeds of 10 to 20 mph. At 30 to 120 mph, the effects become increasingly important with speed; Fig. 10, from work by Isler and Carlton (26), shows the average drop size using a U-50120 nozzle (flat fan) at 25 psi at air

Figure 7

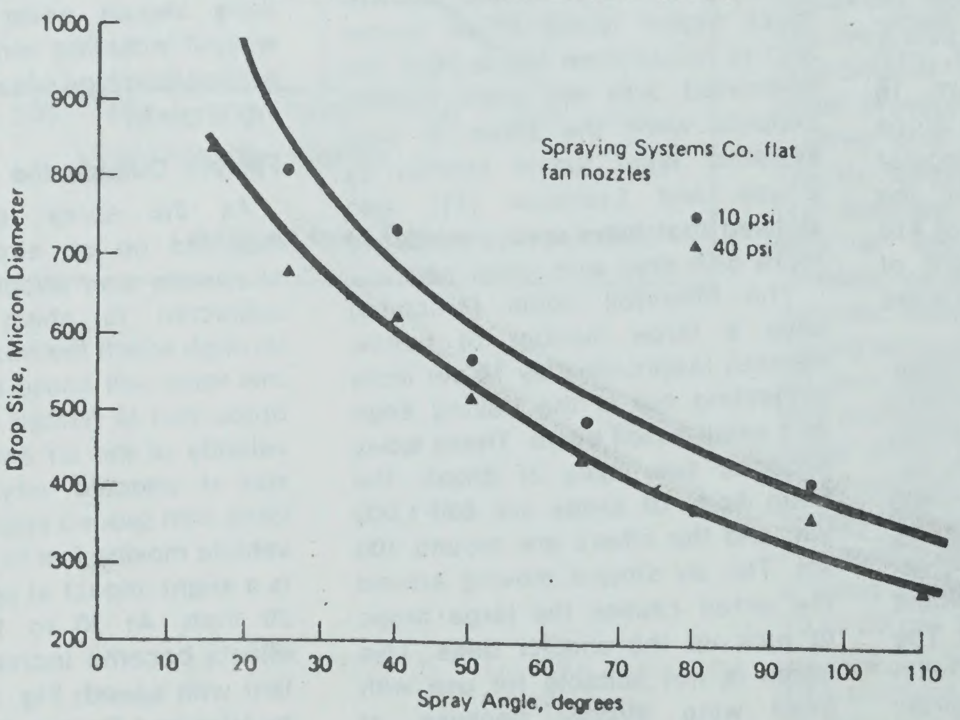
DROPLET SIZE vs NOZZLE FLOW RATE



. . From Tate and Janssen (45)

Figure 8

RELATION OF DROPLET MVD, SPRAY ANGLE AND PRESSURE WITH WATER AT FLOW RATE OF 0.2 GPM

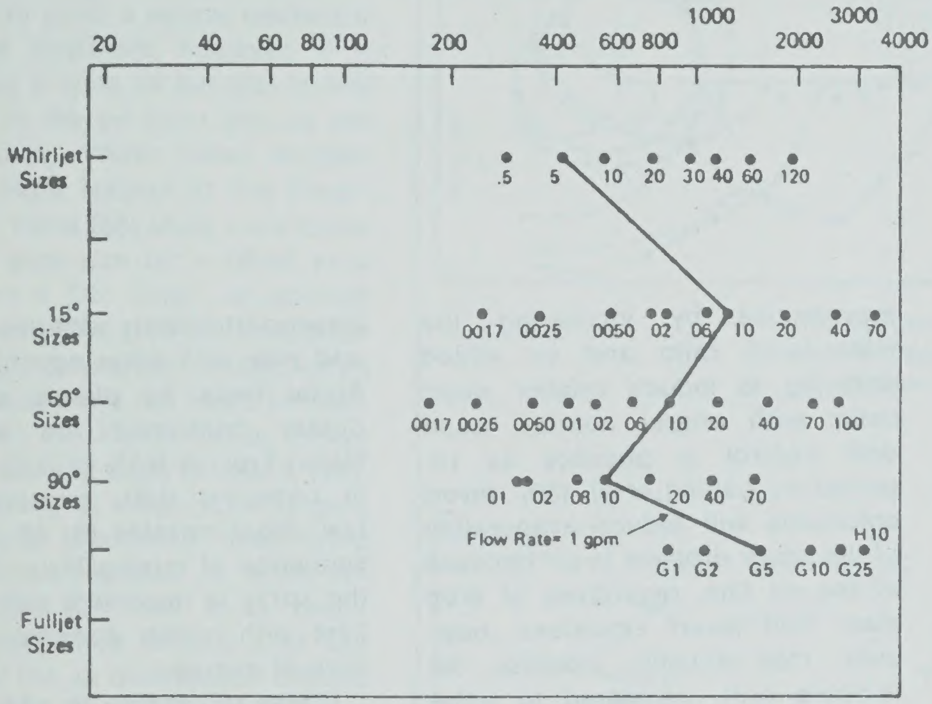


. . Adapted from Spraying Systems Co. drop size charts (43)

Figure 9

ESTIMATED PARTICLE SIZE–(MICRONS)–FOR STANDARD SSCO NOZZLES

(Nozzles spraying water at 40 psig at room temperature under laboratory conditions)



M.V.D. Particle size data is based on volumetric measurements where 50% of the liquid sprayed is in drops smaller than the given number and 50% of the liquid is in drops larger than the given number.

. . From Spraying Systems Co. (43)

speeds from 80 to 200 mph. There was an inverse ratio of drop size to speed; a 250 percent increase in air speed caused a reduction to 40 percent the original drop size. As indicated in Fig. 3, the drops below about 150 μm are more subject to evaporation loss of water and the drifting potential below this range is at least 16 times the inverse ratio of the diameters.

Figure 10 also shows that the breakup of spray is much greater from nozzles pointing *forward* and down 45° from the flight line than from those directed *backward* and down 45°. The difference was about the same over the full range of air speeds and the drop size difference was quite significant. Changing the direction of the nozzle in relation to the direction of flight was found to have similar effect on drop size in many other tests with various types and size nozzles and carriers (60).

Usually, operators can adjust the orientation of the nozzles to the airstream as needed for the desired breakup. Aerial, as well as ground, applications of 2, 4-D and several other translocated herbicides within certain crop areas are closely regulated by several states (15, 36, 49). California regulations (15) require round orifices no smaller than 1/16 inch diameter pointed backwards and using pressures of less than 40 psi, except that on helicopters at less than 55 mph nozzles may be directed down 90° in relation to the flight line.

Editor's Note: Part III of the series "Controlling Drift of Herbicides" will be published in the May issue of the *World of Agricultural Aviation*.

by L. E. Warren

Spray Adjuvants to Reduce Drift

Usually drift of herbicides can be reduced to acceptable limits in most situations by using the proper nozzles, pressure, orientation to the airstream, and observing "safe" air stability conditions and distances to hazard areas. However, with some applications, these adjustments may not be adequate. Another factor affecting drop size is viscosity of the spray liquid. It is found that as viscosity increases, the drop size of sprays increases which can reduce drift. Several viscosity modifying systems, such as invert emulsions, hydroxyethylcellulose and Nalco-Trol** (Lo-Drift' or others) have demonstrated capability in reducing drift; several are described by Gratkowski and Stewart (22). Quite frequently these additives require changes in the pump, nozzles, or other parts of the system; their characteristics, requirements, and possible benefits should be considered carefully in relation to the drift control desired. Care must be taken to evaluate the total system needed for each agent. Detailed research has shown that while the average drop size (VMD) has increased, the range of sizes is usually also greater (58). Use of specific atomizers may alleviate this problem.

Invert emulsions produce a water-in-oil emulsion by using certain agents in the oil phase and by sequence of mixing. Viscosity can be increased to a consistency of mayonnaise by increasing the water-to-oil ratio and by added shearing to induce smaller water cells; with proper nozzles, good drift control is possible as reported by Laning *et al.* (30). Invert emulsions will reduce evaporation of the spray droplets in air because of the oil film, regardless of drop size. Thin invert emulsions, however, may actually increase detectable drift, compared to water carriers (42), because the nonevaporating fine droplets persist and fall out at some distance downwind. The spray can be tank mixed or flash-mixed in the line from tanks to the pump with the proper equipment. Positive displacement pumps are needed to control shear, maintain desired viscosity and move the thickened liquid uniformly. Considerable expertise in the technology of invert emulsion sprays is required to use these systems effectively.

Nalco-Trol is a polyvinyl water soluble polymer that increases spray viscosity but has other viscoelastic properties that also can decrease fine droplets.

Bode *et al.* (9) found that Nalco-Trol at four to eight ounces of product per 100 gallons of spray reduced drift with low shear nozzles to about one-tenth to one-third that with no thickener. Yates *et al.* (58) found that Nalco-Trol solutions through high shear nozzles, such as D6-46 hollow cone, produced a larger average drop size than with water alone, but there were more fines below 100 µm; the jet D6 orifice without a swirl plate, however, gave a marked reduction in fine drops. Increased shear in the nozzle increases spray breakup disproportionately with this product, and may with other agents as well. Aerial tests by planes and helicopter confirmed the effect of Nalco-Trol at 0.15 to 1.00 percent in reducing drift, especially with low shear nozzles (9, 48, 58). The sequence of mixing Nalco-Trol into the spray is important and solution time with higher concentrations is several minutes.

It was necessary to add an antifoam agent (such as Nalco No. 2151) at 0.1 to 0.2 percent (V/V) to sprays containing higher amounts of surfactant to prevent formation of bubbles at the nozzle (48). This product is the only drift control agent that is cleared for use with herbicides on cropland (18). All systems should be carefully calibrated for flow rate, drop size and spray distribution.

Hydroxyethylcellulose, marketed as Vistik' or HEC/B, is another nonreactive agent to increase viscosity. This product was included in tests by Yates *et al.* (58), which indicated that, at the rate of 0.6 percent, it is effective in materially reducing fine droplets. It is a powder that must be added to the solution carefully and five to 10 minutes are required to allow thickening; but it can be sprayed or transferred with any kind of pump. Availability in agricultural chemical markets is questionable.

Effects of Air on Atomization

Air velocity can affect spray particle size by shattering larger drops. As spray is emitted from nozzles moving through air, the liquid is subject to air blast that will break up droplets, as shown in

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' Product of Hercules, Incorporated, Wilmington, Delaware.

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Fig. 10. Nozzles can be oriented so the drops are traveling into, across or with the air flow past the aircraft. Of course, there will be more air shear and droplet breakup as the spray stream is directed into the air flow.

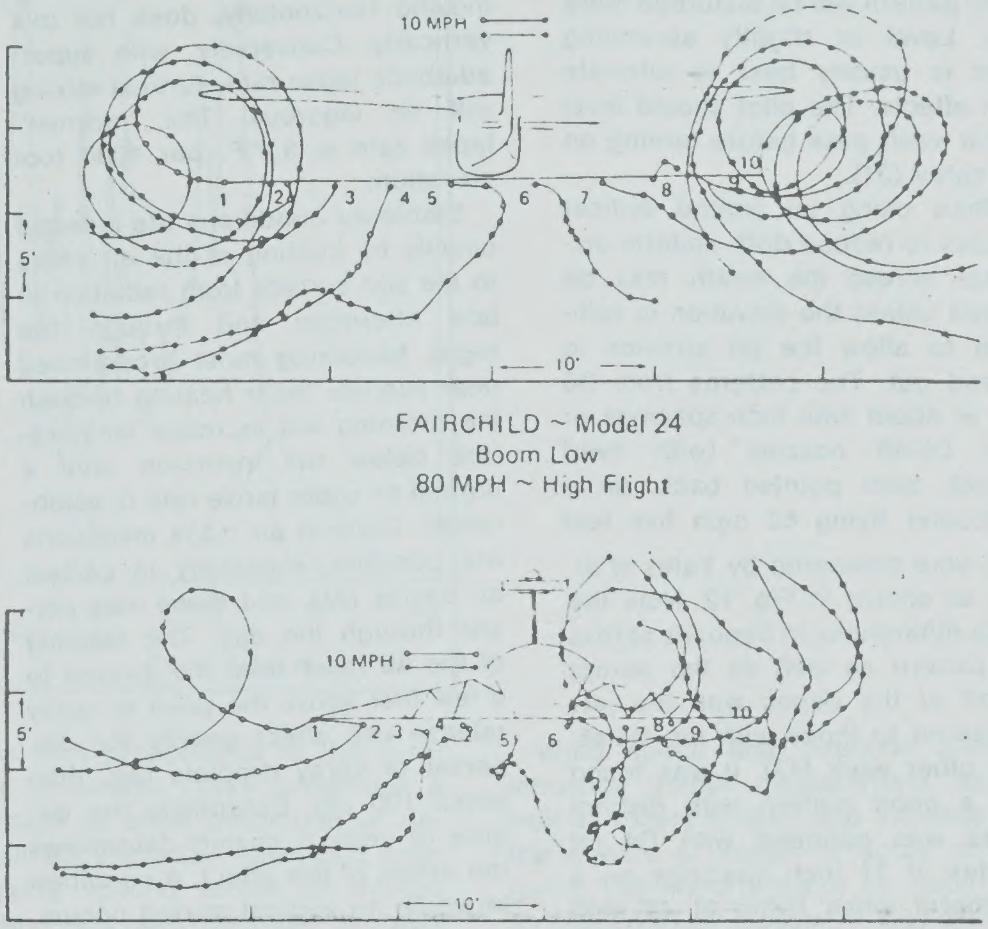


Figure 11

COMPARISON OF AIR CURRENTS IN WAKE OF A HIGH WING MONOPLANE AND A HELICOPTER

. . From Yates *et al.* (56)

For the largest drops, it is not enough to point a nozzle backward with the airstream, however, if it produces a cone or fan that is still subject to the air blast around the nozzle body. Wider cones or fans will be more subject to this shear. Data for Yates (56) show a distinctly smaller drop size for a D6-45 vs a D6-46 vs a D6 alone, all pointed back on a plane (150 μm vs 450 μm vs 900 μm drop sizes, respectively). These results are the basis for specifications in several states for jet nozzles pointed back to reduce drift.

The speed of a helicopter is generally less than with fixed wing craft, which reduces air shear on the spray; also, the spray boom can be mounted on the skid toe ahead of the air disturbance caused by the rotor. Nozzles on helicopters at speeds of less than about 55 mph can be pointed down with little more effect on spray breakup compared to pointing them back.

Drops larger than about 250 μm are subject also to shattering by falling through air (57); some droplets much smaller than 250 μm could be produced. Systems being developed to eliminate drift of herbicides have several reasons to seek the drop size range of 200 to 250 μm, as explained above.

Air currents induced by wings or rotors of aircraft can carry fine droplets aloft and increase drift considerably. Helicopters have significant rotor tip vortices which accentuate as the forward speed increases above about 25 mph. Yates *et al.* (58) determined how the air moves around agricultural aircraft; the lateral air streams induced by a Bell 47 helicopter at 55 mph and a fixed wing plane at 80 mph are shown in Fig. 11. The vortices of both wing tips are about equal; however, the right and left vortices of the helicopter vary greatly. This is caused by the forward and rear motion of the rotor on opposite sides. The strength of the vortices is reduced at speeds over about 40 to 50 mph (57). The airstreams for both craft become more horizontal with distance out from the center. Spray particles that become entrained in these airstreams can be carried aloft and be widely dispersed. Smaller drops less than about 100 μm are affected mostly in these vortices, but results by Yates and Akesson (57) showed 210 μm droplets become entrained if they are about three-fourths out from the center to the end of the wing. The weight and speed of the ship also influence the intensity of these airstreams. For these reasons, nozzles should be located no farther out than two-thirds to three-fourths of the distance from the center to the end of the rotor or wing.

On a helicopter, the spray boom can be located as far forward as possible to facilitate observation by the pilot; there may be a slight benefit in drift reduction if the spray drops are heavy enough to fall somewhat before the rotor wash reaches them (8). Some aerial applicators try to "push" the spray out as far as possible so they can fly wider swaths, such as in spraying sagebrush with 80 to 100 foot swaths. They must produce fine droplets and fly 20 to 30 feet above the target at higher speeds to accomplish that objective (8); drift and loss of herbicides would probably be increased considerably. Usually, the effecive swath width is 100 to 150 percent of the rotor or wing span (56).

These wing or rotor tip vortices are affected also by the attitude of the aircraft. The diagrams in Fig. 11 were for level flight. If the aircraft is climbing there will be more down wash and less tendency to pull spray up into the vortices. If the craft is descending, the wing or rotor tip vortices will pull more spray aloft; various portions of the spray pattern will be disturbed more also. Level or slightly ascending flight is usually best to alleviate both effects. The pilot should level off for each pass before turning on the spray (31).

When using jet (round orifice) nozzles to reduce drift, uniform dispersal across the swath may be limited unless the elevation is sufficient to allow the jet streams to spread out. The patterns from D6 jets at about nine inch spacings or with D6-46 nozzles (with swirl plates), both pointed back, on a helicopter flying 60 mph five feet high were compared by Yates *et al.* (56), as shown in Fig. 12. Note the sharp differences in deposits across the pattern as well as the abrupt cut-off at the edges with the jets compared to those with the D6-46.

In other work (47), it was found that a good pattern with distinct edges was obtained with D4 jet nozzles at 11 inch spacings on a helicopter when flying at 45 mph and 15 foot elevation. Usually, an elevation of 10 to 15 feet with smaller jet nozzles pointed down will avoid streaking if the nozzles are about 12 inches apart.

Air Stability

Since the movement of spray droplets after they leave the aircraft influence is dependent mostly on the general air movement and smaller drop sizes are affected more, it is important to consider these effects on drift potential. Air can move horizontally or vertically in response to local or air mass differences in density. Air temperature differences cause most of the change in air density; cooler air is more dense and tends to displace adjacent warmer air. Frank (21) describes five vertical temperature conditions relating to air pollution as diagrammed in Fig. 13. The condition where the temperature increases with elevation is called an "inversion;" the air, even when it is moving horizontally, does not mix vertically. Conversely, with superadiabatic lapse rate, vertical mixing will be vigorous. The "normal" lapse rate is 3.2°F. per 1000 foot elevation.

Stable air conditions are induced usually by cooling of the air close to the soil surface from radiation in late afternoon and through the night, becoming most pronounced near sunrise. Solar heating through the morning will increase temperature below the inversion until a normal or super lapse rate is established. General air mass inversions are possible, especially in certain air basins (21), and these may persist through the day. The stability of the air layer from the ground to a few feet above the point of spray release can affect greatly the dispersal of spray droplets less than about 100 μm. Essentially the degree of vertical mixing determines the extent of this effect. A condition in which no vertical mixing occurs, as under an inversion, is most conducive to off-target drift because the fine spray particles will continue to fall slowly and not be dispersed aloft. Conversely, good vertical mixing will carry droplets smaller than 20 to 30 μm aloft where they become greatly diffused and generally degraded by photodecomposition.

Surface insolation in the morning, which creates the unstable air, often develops irregular heating patterns, and small local rising air columns can affect the distribution of small droplets seriously. Aerial applications of 2,4-D to grain and sagebrush at volume rates of ½ to 4 gpa are usually stopped when air temperatures reach 70 to 85°F.; spray distribution is often erratic. Larger drop sizes could alleviate this problem, but not eliminate it unless a uniform drop size of about 200 μm is possible.

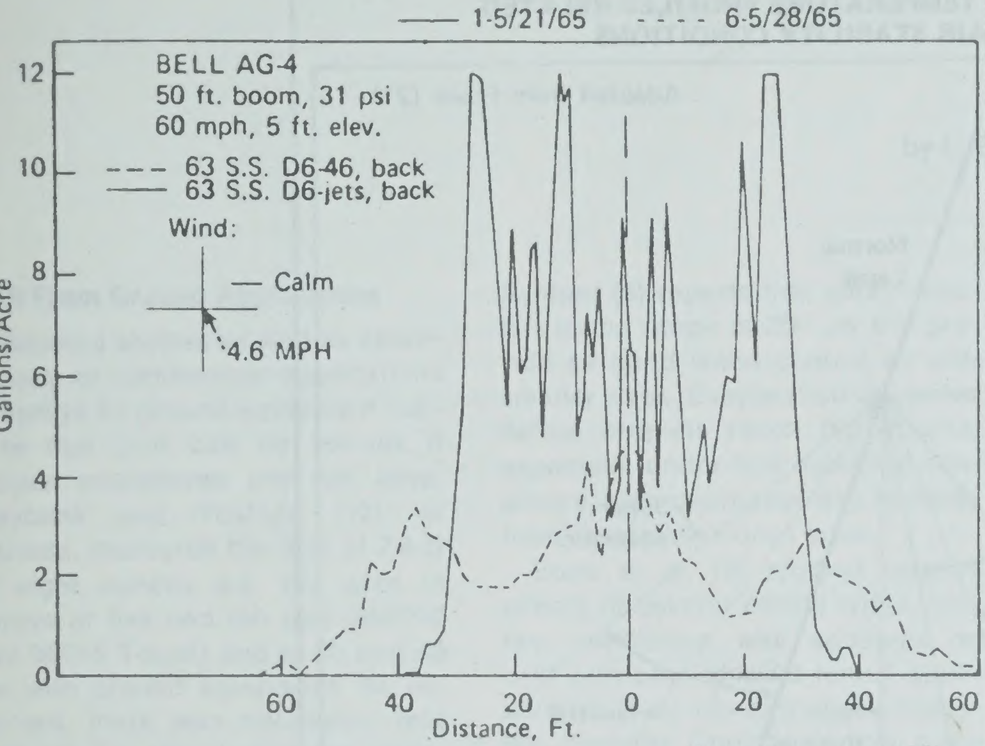
Air stability is affected also by wind speed in the lower levels of air. Yates *et al.* (60) developed a formula to quantitate the temperature and wind speed factors into a stability ratio (S.R.) number using the temperature differences from eight to 32 feet and the wind speed at 16 foot elevation. Prediction of the drift potential in the treatment area as influenced by air stability is facilitated. It also helps to relate different experimental drift control results so they can be compared more readily, even though wind speeds may vary.

Four different air lapse conditions and effects on spray dispersal are diagrammed in Fig. 14. Spray released below the top of an inversion is likely to persist and fall out over a greater distance than in any other type. Spray released above an inversion will fall through, perhaps erratically, but fines below 50 μm will be dispersed aloft. The degree of vertical mixing and consequent reduced fallout of fine drops is directly related to the strength of the lapse. In drift evaluations of pesticides, Akesson and Yates (2) found three times as much fallout of spray at 100 to 200 feet downwind in stable air compared to unstable air; at 1,000 to 2,000 feet, there were ten times more deposits in stable air as in unstable air.

Until the importance of air stability on drift was emphasized, operators assumed that "still," cool air provides the best conditions for drift reduction. This would be true if all the drops were larger than about 200 μm. For safety from drift hazard, the air should be moving in a definite direction and spray particles should be large enough that they will fall through the inversion readily and inside the target area. Significant fallout of spray has been observed several miles from the point of release under certain topographic and air stability conditions (3,46). Cool air can settle

Figure 12

SPRAY PATTERNS FROM D6 JET AND D6-46 NOZZLES



. . From Yates *et al* (23)

down a general slope for miles during night hours and carry any suspended spray droplets with it. In some cases, channeling of upslope stable air movements, such as in the Sacramento Valley of California, can carry herbicides many miles. In a study by Akesson and Yates (3), where a 10,000 acre block of rice was sprayed with propanil in a three day period, symptoms on plums were found over 50 miles beyond the last known application site.

Sometimes the air movement is so slight and variable that drift direction is difficult to determine from an aircraft. Some applicators, such as Johnson (28) in Delaware and Marple (32) in Washington, release a small smoke cloud close to the target to observe its movement before actual application of herbicides.

Tests by Akesson and Yates (2) to determine the effect of numbers of contiguous swaths shows increased drift with more swaths; however, the increase in drift was less than proportional to the number of swaths. They presented a formula to allow prediction of deposit accumulation downwind from varying upwind widths of treated area. Tests confirmed that deposits from 80 swaths were only 25 to 50 percent greater than with 20 swaths. Successive passes should be made upwind to stretch out the drift cloud and also reduce the chance of flying through fine spray remaining aloft.

The height of spray release is important in achieving good coverage and reducing the drift hazard. Best coverage in terms of uniform distribution and penetration is usually from three to ten feet above the target. Drift hazard with smaller drops usually is increased more than linearly with height of spray release, so a careful balance must be achieved in flying height to allow good distribution without hazardous drift. Of course, in applications to powerlines, forests, or range sites, much higher flight levels are used and extra care is needed to prevent drift.

Wind speed and direction can influence swath displacement as well as extent of drift, and increase the effects of height of spray release. The importance of air stability related to air movement was discussed above; nearly calm air can be more conducive to off-target drift hazards than with higher wind speeds. The distance and direction to off-target hazards always should be determined before application begins.

Editor's Note: The conclusion of the series "Controlling Drift of Herbicides" will be published in the June issue of the *World of Agricultural Aviation*.

Figure 13

VERTICAL TEMPERATURE PROFILES RELATED TO AIR STABILITY CONDITIONS

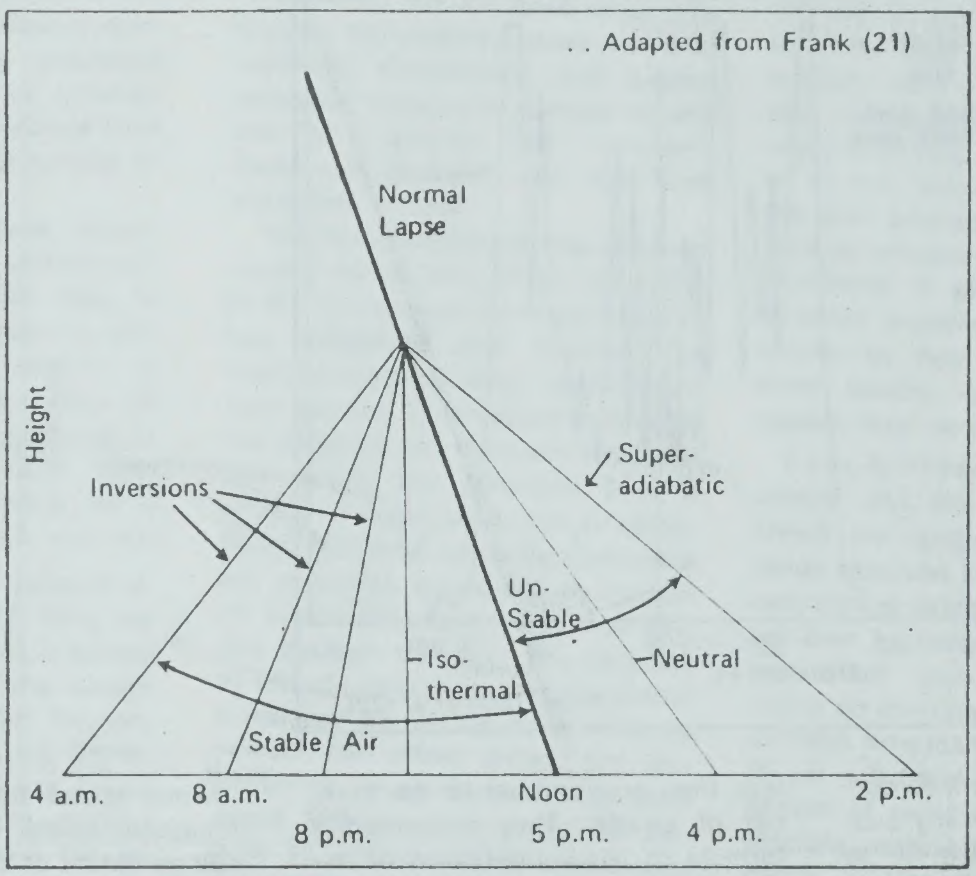
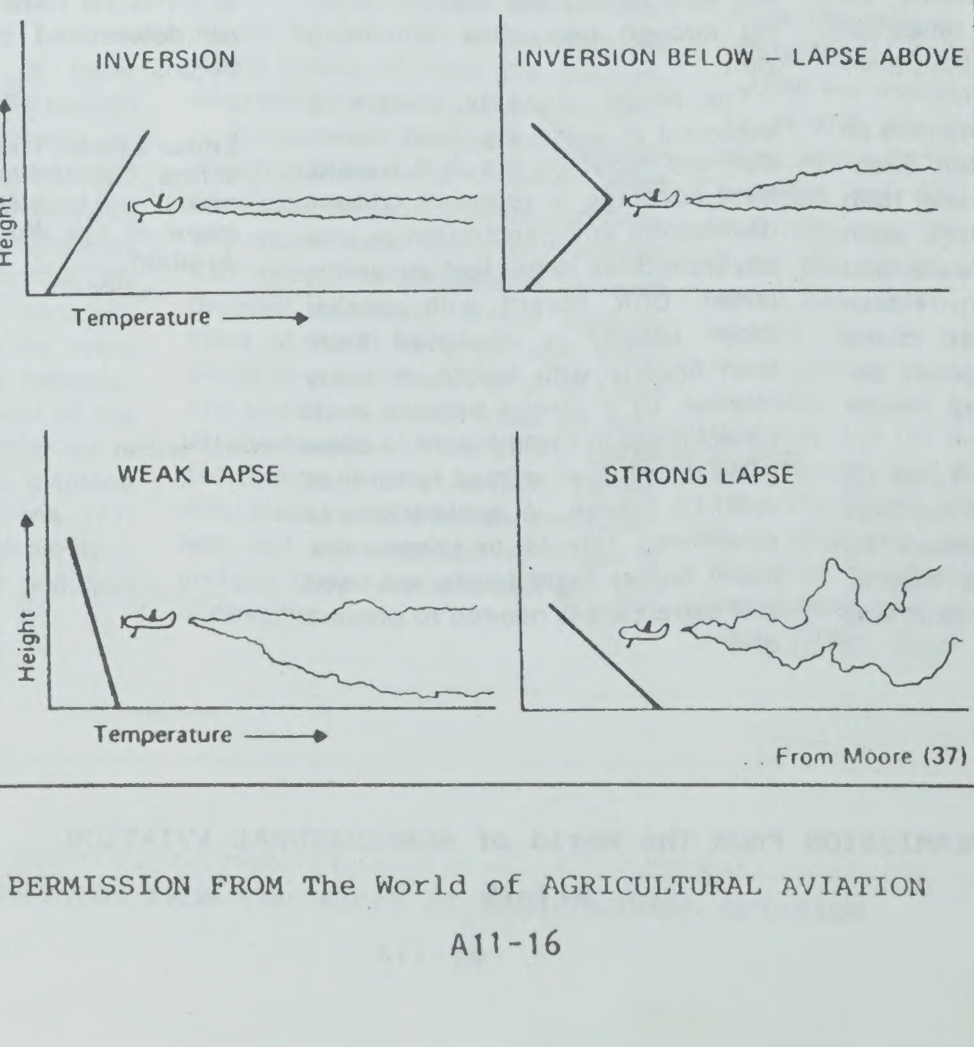


Figure 14

SCHEMATIC, VERTICAL PROFILES OF FINE SPRAY (OIL SMOKE) PLUMES RELEASED BY PLANE UNDER DIFFERENT THERMAL CONDITIONS



. . From Moore (37)

Conclusion

by L. E. Warren

Drift From Ground Applications

Detailed studies as well as observations of commercial applications of sprays by ground equipment indicate that drift can be serious if proper procedures are not used. Maybank and Yoshida (33), in Canada, measured the drift of 2,4-D at eight ounces a.e. per acre in sprays at five and ten gpa (650067 and 65015 Teejet) and at 25 and 40 psi with ground equipment. As expected, there was noticeably less drift off the target with the larger nozzles and lower pressure; it was highest for the higher pressure (40) psi and smaller nozzles (5 gpa). Also, they showed that airborne drift and fallout at different distances downwind increased as the area being sprayed was enlarged. Significantly the total amount of 2,4-D that would be deposited on a section of land downwind from a section sprayed with 2,4-D at eight ounces per acre in five gpa at 40 psi was 35 ounces per section, or 0.09 percent of the total applied. More was deposited closer to the sprayed field but there were still measurable amounts in the air at the one mile station.

Clearly, care must be taken to prevent drift from ground applications of herbicides, especially those that can affect plants at low exposures. Detailed analyses by Maybank and Yoshida (33) of spray deposits across a swath and resultant amounts of herbicide needed for good weed control indicate excessive rates are used to achieve desired results; this is the result of variations in spray deposit across the swath even with apparently uniform distribution as indicated above.

Ashford (6) reports that spray droplets in the range of 200 μm will provide as good weed control as with smaller sizes. Evaporation of carrier before droplets reach the ground, especially under low humidity conditions, also decreases any benefits from the smaller drop sizes.

Bode *et al.* (9) studied relative effects of several nozzle types, system conditions, and additives on drift with precise wind tunnel applications. They found that the Spraying Systems Company's low pressure (L.P.) flat fan and Delavan Manufacturing Company's Raindrop hollow cone nozzles gave much less drift than did the regular flat fan or the flooding (deflector) type. Lowering pressure at the nozzle with regular flat fan nozzles also gave reduced drift.

They found also that Nalco-Trol** at four to eight ounces of product per 100 gallons of spray reduced drift with low shear nozzles to about one-tenth to one-third that with no thickener.

Effect of Various Factors on Herbicide Drift

The different factors affecting droplet size and resultant movement off the target (drift) are summarized in Table 5. These factors do not have equal importance, and priorities could change with each

TABLE 5
Effect of Various Factors on Herbicide Drift

Less Drift ⟵	Factor	⟶ More Drift
Lower	A. Release Height	Higher
Lower	B. Wind Speed[1]	Higher
Faster	C. Droplet Fall Rate	Slower
Larger	1. Droplet Size	Smaller
Lower	a. Pressure	Higher
Jet	b. Nozzle Type[2]	Wide angle cone or fan
Larger	c. Orifice Size	Smaller
Lower	d. Air Shear on Spray	Higher
Higher	e. Surface Tension[3]	Lower
Higher	f. Relative Humidity[4]	Lower
Higher	g. Viscosity	Lower
Higher	2. Drop Density[5]	Lower
Less	D. Air Stability	Greater
	E. Aircraft Turbulence	
Slower	1. Speed	Faster
Clear	2. Aircraft Aerodynamics	Rough
Climbing	3. Flight Attitude	Falling
Closer	4. Nozzle Location on Boom cf. Center	Farther out
Smaller	F. Size of Treated Area	Larger

[1] Below speed at which air stability is reduced.
[2] Certain nozzle types can produce larger drops or narrower range.
[3] Higher oil or surfactant content reduces surface tension.
[4] Important with evaporative carriers (water).
[5] Oil carriers are lighter (less dense) than water.

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system and situation. The influence on amount or extent of drift is indicated for the change in each factor.

Operators generally should use the largest drop size that will provide adequate response to the pesticide. However, uniform spray distribution across the pattern and on foliage is more difficult to achieve with larger drops (10,59). The spray distribution pattern should be determined before actual application even for ground sprayers. Usually, spray cards or trays placed at one to two foot intervals, or rolls of adding machine tapes with suitable dye in the spray, will indicate the distribution across the swath and the drop size. Spray penetration of canopies must be determined on the actual application site. Several reports give details of good techniques to evaluate spray distribution.

Aircraft operators, as well as all operators of spray equipment, should be keenly aware that any time a nozzle is over or near a field, orchard, or garden there is a chance of spray drops reaching these nontarget areas. Great care should be exercised to prevent such accidental exposures. Ferrying or turning near or over susceptible plants or hazard areas should be avoided. Application of sprays with ground equipment also will require careful attention to systems to prevent drift.

The need to keep pesticides on the intended target is becoming more acute for several reasons. Confining drift from applications of herbicides, whether by ground or air, to the treated areas may be difficult, but eminent authorities, such as Akesson *et al.* (4), feel that this is "a realistic goal." Attention to all the pertinent details of equipment and application conditions required to achieve this goal will be generally beneficial and may relieve the industry from undue regulation.

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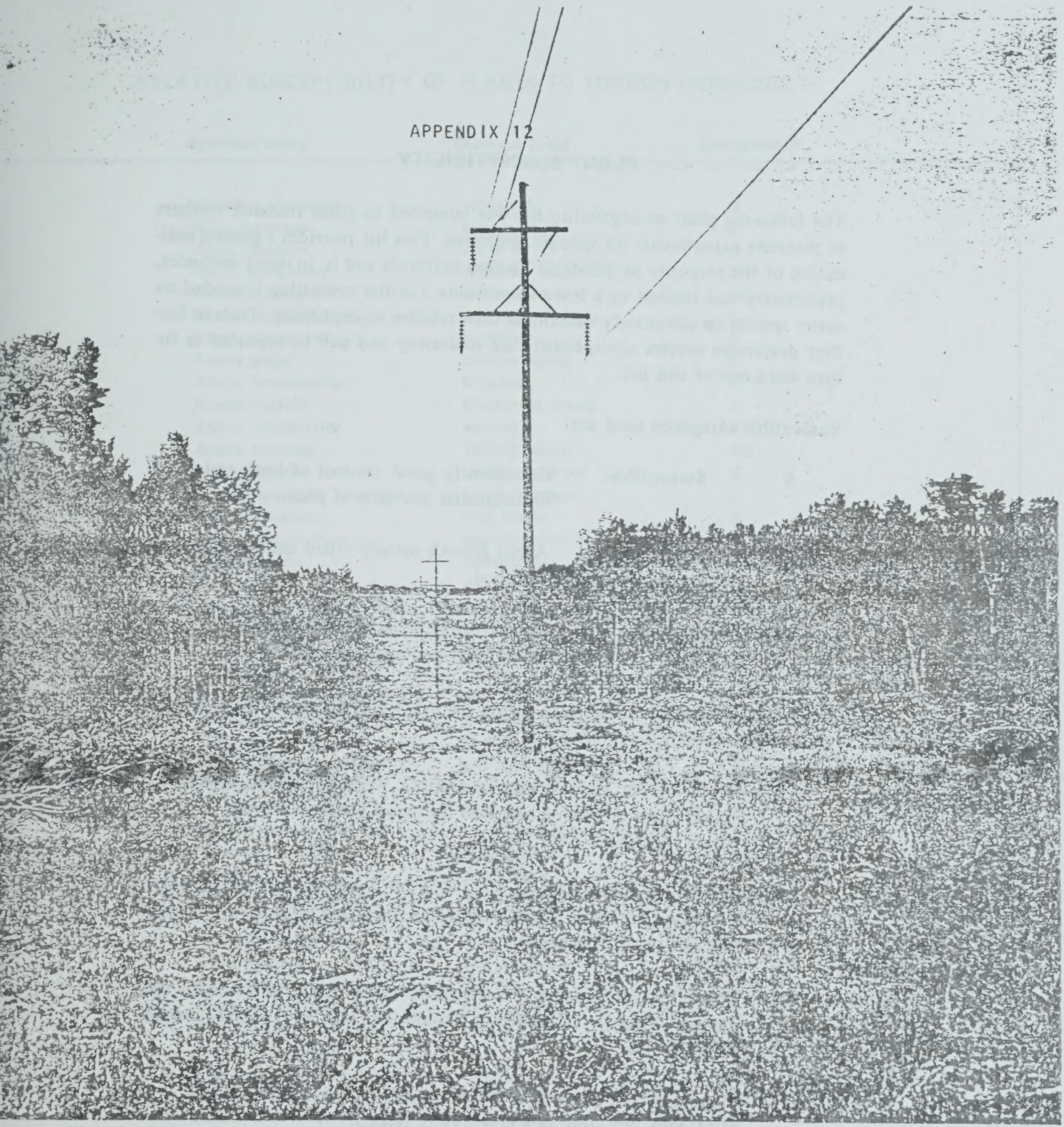
APPENDIX 12

TORDON HERBICIDE: RELATIVE PLANT SUSCEPTIBILITY

APPENDIX 12



TORDON® Herbicide: Relative Plant Susceptibility

DOW

PLANT SUSCEPTIBILITY

The following plant susceptibility list was compiled to guide research workers in planning experiments on specific problems. This list provides a general indication of the response of plants to Tordon herbicide and is, in many instances, preliminary and limited to a few observations. Further evaluation is needed on many species to adequately determine their relative susceptibility. Tests to further determine species susceptibility are underway and will be reported in future additions of this list.

Susceptible categories used are:

S –	Susceptible.	Consistently good control of both aerial and underground portions of plant.
MS –	Moderately susceptible.	Aerial growth usually killed and some control obtained.
R –	Resistant.	May be some foliar effect but no kill of aerial or underground portions of plants.

Scientific and common names of plants are listed wherever possible in accordance with the following references:

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RELATIVE SUSCEPTIBILITY OF PLANTS TO TORDON HERBICIDE

Botanical name	Common name	Susceptibility
Abutilon theophrasti	velvetleaf	S
Abies balsamea	balsam fir	S
Abies concolor	white fir	S
Abrus precatorius	precatory bean	S
Acacia arabica	prickly acacia	MS
Acacia bicornuta	two-horned acacia	S
Acacia farnesiana	huisache	S
Acacia greggi	catclaw acacia	S
Acacia harpophylla	brigalow	R
Acacia rigidula	blackbrush acacia	S
Acacia stenophylla	euming	S
Acacia tortuosa	twisted acacia	MS
Acacia villosa	yellow tamarind	S
Acanthospermum hispidum	bristly starburr	S
Acer circinatum	vine maple	S
Acer macrophyllum	biglcaf maple	S
Acer negundo	boxelder	MS
Acer rubrum	red maple	S
Acer saccharinum	silver maple	S
Acer saccharum	sugar maple	S
Achillea millefolium	common yarrow	R
Acrocomia mezicana	manaca	R
Adenostoma fasciculatum	chamise	S
Adenostoma sparsifolium	redshank chamise	S
Agropyron repens	quackgrass	MS
Agropyron trachycaulum	slender wheatgrass	R
Agrostis alba	redtop	R
Agrostis palustris	creeping bentgrass	R
Agrostis tenuis	colonial bentgrass	R
Agrostemma githago	corn cockle	S
Alhagi camelorum	camelthorn	S
Allanthus alitissima	tree-of-heaven	MS
Allium canadense	wild onion	MS
Allium vineale	wild garlic	MS
Alnus oregona	Oregona alder	S
Alnus rubra	red alder	S
Alnus rugosa	speckled alder	S
Aloysia lycioides	whitebrush	S
Alstonia constricta	quinine	S
Alternanthera philoxeroides	alligatorweed	MS
Alternanthera repens	khakiweed	R
Amaranthus albus	tumble pigweed	S
Amaranthus graecizens	prostrate pigweed	S
Amaranthus retroflexus	redroot pigweed	S
Ambrosia artemisiifolia	common ragweed	S
Ambrosia psilostachya	western ragweed	S

Ambrosia trifida	giant ragweed	S
Ampelopsis aborea	pepper-vine	S
Ampelamus albidus	honeyvine milkweed	S
Amsinckia douglasiana	Douglas fiddleneck	MS
Amsinckia hispida	yellow burrweed	S
Amsinckia intermedia	coast fiddleneck	MS
Andropogon scoparius	little bluestem	R
Andropogon virginicus	broomsedge	R
Anthemis cotula	mayweed	S
Apocynum androsaemifolium	spreading dogbane	MS
Arctium minus	common burdock	S
Arctostaphylos glandulosa	Eastwood manzanita	MS
Arctostaphylos viscida	whiteleaf manzanita	MS
Artemisia absinthium	absinth wormwood	S
Artemisia californica	California sagebrush	S
Artemisia dracunculus	green sagebrush	S
Artemisia frigida	fringed sagebrush	S
Artemisia ludoviciana (gnaphalodes)	prairie sage	S
Artemisia nova	black sagebrush	MS
Artemisia tridentata	big sagebrush	R
Artemisia verlotorum	St. Vincent weed	MS
Artemisia vulgaris	mugwort	S
Arundinaria tecta	switch cane	R
Asclepias eriocarpa	woollypod milkweed	MS
Asclepias fruticosa	narrow-leaf cotton bush	S
Asclepias latifolia	broadleaf milkweed	S
Asclepias syriaca	common milkweed	S
Aster pilosus	white heath aster	S
Astragalus bisulcatus	twogrooved milkvetch	S
Atriplex patula	spreading orach	S
Avicennia nitida	black mangrove	MS
Axyris amaranthoides	Russian pigweed	S
Aster ericoides	heath aster	S
Baccharis halimifolia	eastern baccharis	MS
Bambusa vulgaris	common bamboo	S
Bassia birchii	galvanised burr	MS
Bauhinia excisa	pata de vaca	MS
Berberis canadensis	American barberry	MS
Berberis vulgaris	European barberry	MS
Berkheya rigida	African thistle	MS
Berteroa incana	hoary alyssum	S
Betula alleghaniensis	yellow birch	S
Betula papyrifera	paper birch	S
Bidens bipinnata	spanishneedles	S
Bourreria spp.	strongbark	MS
Brassica campestris	wild turnip	R
Brassica kaber	wild mustard	MS
Bromus ciliatus	fringed brome	R
Bromus inermis	smooth brome	R

Bromus tectorum	downy brome	R
Bryophyllum pinnatum	leaf-of-life	S
Brunnichia cirrhosa	redvine	S
Baumelia lanuginosa	gum bumelia	S
Calamagrotis canadensis	bluejoint reedgrass	R
Callicarpa americana	American beautyberry	S
Calophylum calaba	Ceylon beautyleaf	MS
Camelina spp.	false flax	MS
Campanula rapunculoides	creeping bellflower	S
Campsis radicans	trumpet creeper	MS
Cannabis sativa	hemp	S
Capsella bursa-pastoris	Shepherdspurse	MS
Cardaria draba	hoary cress	MS
Carduus acanthoides	plumeless thistle	S
Carduus benedictus	blessed thistle	S
Carduus nutan	musk thistle	S
Carthamus lanatus	saffron thistle	S
Carpinus caroliniana	American hornbeam	S
Carya glabra	pignut hickory	S
Carya illinoensis	pecan	S
Carya ovata	shagbark hickory	S
Casearia hirsuta	wild coffee	MS
Cassia emarginata L.		R
Cassia occidentalis	coffee senna	S
Casuarina spp.	Australian pine	MS
Casuarina equisetiefolia	horsetail casuarina	S
Ceiba pentandra	ceiba	S
Celtis laevigata	sugarberry	S
Celtis pallida	spiny hackberry	S
Cenchrus tribuloides	sand-burr	R
Centaura calcitrapa	purplestar thistle	S
Centaura maculosa	spotted knapweed	S
Centaura melitensis	Malta starthistle	S
Centaura nigra	black knapweed	S
Centaura repens	Russian knapweed	S
Centaurea solstitialis	yellow starthistle	S
Cephalanthus occidentalis	common buttonbush	MS
Cerastium vulgatum	mouseear chickweed	S
Cercis canadensis	eastern redbud	MS
Cestrum parqui	willowleaf jessamine	MS
Chamaebatia foliolosa	bearmat	MS
Chamaedaphne calyculata	leatherleaf	S
Chenopodium album	common lambsquarters	S
Chondrilla juncea	rush skeleton weed	S
Chorispora tenella	blue mustard	R
Chrysanthemum leucanthemum	oxeye daisy	S
Chrysanthemum segetum	corn marigold	S
Chrysopsis villosa	gold aster	S
Chrysothamnus pulchellus	southwest rabbit-brush	S
Chrysothamnus parryi	parry rabbitbrush	MS
Chrysothamnus viscidiflorus	Douglas rabbit brush	S
Cichorium intybus	chicory	S
Cicuta maculata	spotted waterhemlock	S
Cirsium arvense	Canada thistle	S
Cirsium vulgare	bull thistle	S

Cissus sicyoides	waterwithe treebine	R
Coccoloba acuminata	uvero	R
Cleome serrulata	Rocky Mountain beeplant	S
Cochlospermum vitifolium	bombon	S
Commelina diffusa	spreading dayflower	R
Combretum farinosum	chupamiel	R
Condalia obovata	bluewood condalia	S
Conium maculatum	poison hemlock	S
Conringia orientalis	haresear mustard	R
Convolvulus arvensis	field bindweed	S
Convolvulus sepium	hedge bindweed	S
Cordia colococca	manjack cordia	S
Cornus drummondii	roughleaf dogwood	R
Cornus florida	flowering dogwood	S
Cornus stolonifera	redosier dogwood	S
Corylus americana	American hazel	S
Crataegus spp.	hawthorn	S
Crotalaria verrucosa	rattle weed	S
Croton lindheimeri	Lindheimer croton	S
Croton linearis	Spanish rosemary	R
Cryptostegia grandiflora	palay rubbervine	R
Cryptostemma calendula	cape weed	S
Cucurbita andreana	bitter pumpkin	MS
Curatella americana	chumico	R
Cuscuta campestris	field dodder	MS
Cynara cardunculus	artichoke thistle	S
Cynodon dactylon	Bermudagrass	MS
Cyperus esculentus	yellow nutsedge	R
Cyperus rotundus	purple nutsedge	R
Cytisus scoparius	scotch broom	S
Datura ferox	chamico	MS
Datura stramonium	jimsonweed	MS
Daubentonia texana	coffeweed	S
Daucus carota	wild carrot	S
Delphinium barbeyi	tall larkspur	S
Delphinium geyeri	Geyer larkspur	S
Descurainia pinnata	tansymustard	MS
Desmodium tortuosum	Florida beggerweed	S
Digitaria filiformis	slender crabgrass	R
Digitaria ischaemum	smooth crabgrass	R
Digitaria sanguinalis	large crabgrass	R
Diospyros texana	Texas persimmon	R
Diospyros virginiana	persimmon	S
Dipsacus sylvestris	teasel	MS
Distichlis stricta	desert saltgrass	R
Echinochloa crusgalli	barnyardgrass	R
Echinocystis lobata	wild cucumber	MS
Echites umbellata	devilspotato	S
Echium plantagineum	Paterson's curse	S
Echium vulgare	blue thistle	MS
Ehretia tinifolia	cherry Ehretia	MS
Eichhornia crassipes	waterhyacinth	S

Eleocharis obtusa	blunt spikerush	R
Emex australis	emex	S
Epilobium angustifolium	fireweed	R
Equisetum arvense	field horsetail	MS
Erica arborea	tree heath	S
Erica carnea	spring heath	S
Erigeron canadensis	horseweed	S
Erigeron strigosus	rough fleabane	S
Eriogonum fasciculatum	flattop Eriogonym	S
Erodium botrys	broadleaf filaree	MS
Eryngium hookeri	Hooker Eryngo	MS
Erysimum cheiranthoides	wormseed mustard	S
Eucalyptus gracilis	Yorrell eucalyptus	S
Eucalyptus radiata	gray peppermint eucalyptus	S
Eugenia myrtoides	boxleaf eugenia	R
Euonymus Fortunei	winter creeper euonymus	S
Euonymus occidentalis	western wahoo	S
Eupatorium adenophorum	crofton weed	S
Eupatorium capillifolium	dog fennel	S
Eupatorium odoratum	Christmasbush	R
Eupatorium riparium	river eupatorium	S
Euphorbia esula	leafy spurge	S
Euphorbia maculata	spotted spurge	R
Euphorbia marginata	snow-on-the-mountain	MS
Euphorbia serpyllifolia	thymeleaf spurge	R
Euphorbia supina	prostrate spurge	R
Eustoma spp.	prairiegentian	S
Fagopyrum tataricum	Tartary buckwheat	S
Fagus grandifolia	American beech	S
Ferula comunis	common giantfennel	S
Festuca spp.	fescue	R
Flemingia strobilifera	longleaf warrus	S
Forestiera texana	Texas forestiera	R
Forsythia intermedia	border forsythia	S
Franseria acanthicarpa	annual bursage	S
Franseria discolor	skeletonleaf bursage	MS
Franseria tomentosa	woolyleaf bursage	S
Fraxinus americana	white ash	MS
Fraxinus pennsylvanica	green ash	MS
Fumaria officinalis	fumitory	R
Galega officinalis	goatsrue	S
Galeopis tetrahit	hampnettle	S
Galium aparine	catchweed bedstraw	MS
Gaultheria shallon	salal	R
Gaultheria spp.	wintergreen	MS
Genista germanica	German woadwaxen	S
Genista spp.	woadwaxen	S
Geranium carolinianum	Carolina geranium	S
Gleditsia triacanthos	honeylocust	S
Glycyrrhiza lipidota	wild licorice	S
Gnaphalium spp.	cudweed	S
Gomphrena celosioides	gomphrena weed	S
Grindelia squarrosa	gumweed	MS
Guaiacum officinale	lignumvitae	S

Guazuma ulmifolia	guazimo	S
Gutierrezia dracunculoides	common broomweed	S
Gutierrezia sarothrae	broom snakeweed	S
Halogeton glomeratus	halogeton	R
Helenium microcephalum	littlehead sneezeweed	S
Helianthus annuus	sunflower	S
Helianthus ciliaris	Texas blueweed	MS
Heliconia spp.	platanillo	MS
Helicteres guazumifolia	cola de chanco	S
Heliotropium amplexicaule	clasping heliotrope	S
Heliotropium indicum	Indian heliotrope	R
Heterotheca subaxilaris	camphorweed	S
Hevea spp.	rubbertree	MS
Hibiscus palustris	swamp rosemallow	S
Hiliconia bihai	plantanillo	MS
Hoffmanseggia densiflora	hogpotato	MS
Homeria collina	one-leaved cape tulip	MS
Homeria miniata	two-leaved cape tulip	MS
Hordeum brachyantherum	meadow barley	MS
Hordenum leporinum	wild barley	S
Hymenoxys odorata	bitter rubberweed	MS
Hymenoxys richardsoni	Colorado rubberweed	MS
Hypericum androsaemum	tutsan	S
Hypericum perforatum	St. Johnswort	S
Hypochoeris radicata	spotted catsear	S
Hyptis suaveolens	san juanillo	S
Ilex crenata	Japanese holly	S
Ilex glabra	gallberry	MS
Ilex opaca	American holly	R
Ilex vomitoria	yaupon	MS
Inga fagifolia		R
Inula graveolens	stinkwort	S
Ipomoea purpurea	tall morningglory	S
Ipomoea triloba	campanilla	S
Isocoma wrightii	Rayless goldenrod	S
Iva ciliata	rough sumpweed	S
Iva axillaris	povertyweed	S
Iva santhifolia	marshelder	S
Jacquinia angustifolia	burriquita	MS
Juglans nigra	black walnut	S
Juncus roemerianus	needle rush	MS
Juniperus comunis	common juniper	MS
Juniperus compacta hicksi	Hicks juniper	MS
Juniperus deppeana	alligator juniper	S
Juniperus depressa	ground juniper	S
Juniperus horizontalis	creeping juniper	S
Juniperus monosperma	oneseed juniper	S
Juniperus scopulorum	Rocky Mountain juniper	MS
Juniperus utahensis	Utah juniper	S
Juniperus virginiana	eastern redcedar	S
Kalmia angustifolia	sheep laurel	S
Kalanchoc tubiflorum	mother of millions	S

Karwinskia humboldtiana	coyotillo	MS
Kochia scoparia	kochia	R
Lactuca canadensis	tall lettuce	S
Lactuca hirsuta	wild lettuce	S
Lactuca pulchella	blue lettuce	S
Lactuca scariola	prickly lettuce	S
Laguncularia racemosa	white mangrove	S
Lamium amplexicaule	henbit	S
Lantana camara	lantana	MS
Lantana montevidensis	creeping lantana	MS
Lappula echinata	European sticktight	S
Lapsana communis	nipplewort	S
Larix laricina	tamarack	S
Lathyrus silvestris	flat peavine	S
Lepidium latifolium	perennial pepperweed	R
Lepidium perfoliatum	yellowflower pepperweed	R
Leucaena glauca	leadtree	MS
Libocedrus decurrens	incense-cedar	S
Ligustrum vulgate	glossy privet	R
Liqustrum vulgate	European privet	MS
Linaria dalmatica	Dalmation toadflax	S
Linaria domingenses		R
Linaria vulgaris	yellow toadflax	S
Lippia nodiflora	mat lippia	S
Liquidambar styraciflua	sweetgum	MS
Liriodendron tulipifera	tuliptree	S
Lithocarpus densiflorus	tanoak	R
Lithospermum arvense	corn gromwell	S
Lonicera japonica	Japanese honeysuckle	S
Lupinus arboreus	tree lupine	MS
Lupinus argenteus	silvery lupine	S
Lychnis alba	white cockle	MS
Lycium andersoni	Anderson wolfberry	S
Lycium ferocissimum	African boxthorn	S
Lycopodium spp.	clubmoss	R
Lygodesmia juncea	skeletonweed	S
Lythrum salicaria	spiked loosetrife	S
Macadamia integrifolia	macadamia	S
Maclura pomifera	osageorange	MS
Magnolia virginiana	sweetbay magnolia	R
Mahonia trifoliolata	agarito	S
Malpighia glabra	Barbadoscherry	MS
Malva rotundifolia	dwarf mallow	S
Malva sylvestris	high mallow	S
Marrubium vulgare	white horehound	S
Mascagnia pubiflora		S
Matricaria chamomilla	German-camomile	S
Matricaria inodora	scentless mayweed	S
Matricaria maritima	false chamomile	S
Matricaria matricarioides	pineappleweed	S
Medicago lupulina	black medic	S
Medicago sativa	alfalfa	S
Melilotus alba	white sweet clover	S

Melilotus officinalis	yellow sweet clover	S
Miconia prasina		MS
Miconia sintenisii		S
Mimosa invisa	giant sensitiveplant	S
Mimosa pudica	sensitiveplant	S
Mirabilis nyctaginea	wild four-o'clock	S
Mitchella repens	partridgeberry	S
Mollugo verticillata	carpetweed	MS
Momordica charantia	balsampear	S
Morinda royoc	Royoc Indianmulberry	R
Morus rubra	red mulberry	S
Muhlenbergia schreberi	nimblewill	MS
Myrica heterophylla	evergreen bayberry	MS
Myriophyllum spicatum	eurasian watermilfoil	R
Nyssa sylvatica	blackgum	S
Oenothera biennis	common eveningprimrose	S
Onopordum acanthium	Scotch cottonthistle	S
Opuntia aurantiaca	orangered pricklypear	S
Opuntia leptocaulis	tasajillo	S
Opuntia monacantha	tree pear	S
Opuntia polycantha	plains pricklypear	S
Oxalis pes-caprae	Bermuda buttercup	R
Oxydendrum arboreum	sourwood	S
Oxytropis lambertii	lambert crazyweed	MS
Panicum virgatum	switchgrass	R
Papaver rhoeas	corn poppy	MS
Parkinsonia aculeata	retama	S
Parthenocissus quinquefolia	Virginia creeper	S
Paspalum dilatatum	dallisgrass	R
Paspalum urvillei	vaseygrass	R
Passiflora spp.	passion flower	S
Pastinaca sativa	wild parsnip	MS
Peltranda virginica	Virginia arrowarum	S
Prosopis faracata	perennial legume bush	S
Petitia domingensis	capa petitia	R
Philadelphus coronarius	sweet mockorange	S
Phleum pratense	timothy	R
Photinia arbutifolia	christmasberry	S
Phragmites comunis	common reed	R
Physalis spp.	groundcherry	S
Physalis heterophylla	clammy groundcherry	S
Phytolacca americana	pokeweed	S
Phytolacca octandra	eightstamen pokeweed	S
Picea abies	Norway spruce	S
Picea glauca	white spruce	S
Picea mariana	black spruce	MS
Picea pungens	blue spruce	S
Pinus banksiana	jack pine	S
Pinus contorta	lodgepole pine	MS
Pinus echinata	shortleaf pine	S
Pinus elliottii	slash pine	S
Pinus nigra	Austrian pine	MS
Pinus palustris	longleaf pine	S
Pinus ponderosa	ponderosa pine	MS

Pinus serotina	eastern white pine	S
Pinus radiata	Monterey pine	MS
Pinus sylvestris	Scotch pine	S
Pinus taeda	loblolly pine	S
Pinus virginiana	Virginia pine	S
Piscidia piscipula	Florida fishpoison-tree	MS
Pisonia aculeata	devilsclaw pisonia	S
Pithecellobium spp.	apes-earring	S
Pitecellobium dulce	sotacaballo	MS
Plantago lanceolata	buckhorn plantain	S
Plantago major	broadleaf plantain	S
Poa annua	annual bluegrass	R
Poa compressa	Canada bluegrass	R
Poa pratensis	Kentucky bluegrass	R
Polygonum aviculare	prostate knotweed	S
Polygonum coccineum	swamp smartweed	S
Polygonum convolvulus	wild buckwheat	S
Polygonum cuspidatum	Japanese knotweed	S
Polygonum hydropiperoides	mild smart weed	S
Polygonum lapathifolium	pale smartweed	S
Polygonum pensylvanicum	Pennsylvania smartweed	S
Polygonum persicaria	ladysthumb	S
Polygonum scabrum	green smartweed	S
Pontederia cordata	pickerelweed	S
Populus alba	white poplar	S
Populus balsamifera	balsam poplar	S
Populus balsamifera-var. subcordata	balm-of-Gilead	S
Populus deltoides	eastern cottonwood	S
Populus grandidentata	bigtooth aspen	S
Populus tremuloides	trembling aspen	S
Porlieria angustifolia	quayacan	R
Portulaca oleracea	common purslane	S
Potentilla anserina	silverweed cinquefoil	MS
Potentilla norvegica	rough cinquefoil	S
Potentilla recta	sulfphur cinquefoil	S
Prosopis calden	calden	R
Prosopis chilensis	cashaw	MS
Prosopis juliflora- var. glandulosa	honey mesquite	MS
Prosopis juliflora-var. juliflora	mesquite	S
Prunus armeniaca	apricot	S
Prunus emarginata	bitter cherry	S
Prunus pensylvanica	pin cherry	S
Prunus persica	peach	S
Prunus serotina	black cherry	S
Pseudotsuga menziesii	Douglas-fir (typical)	MS
Psidium guajava	guava	S
Psoralea spp.	scurfpea	S
Psychotria berteriana	wild coffee	S
Pteridium aquilinum v. latiusculum	eastern bracken fern	MS
Pueraria lobata	kudzu	S
Pyrus communis	common pear	S
Pyrus malus	apple	S
Quercus alba	white oak	MS
Quercus chapmanii	Chapman oak	MS
Quercus douglasii	blue oak	MS
Quercus dumosa	California scrub oak	MS

Quercus gambelii	Gambel oak	MS
Quercus incana	bluejack oak	MS
Quercus kelloggii	California black oak	R
Quercus laevis	turkey oak	MS
Quercus laurifolia	Laurel oak	MS
Quercus macrocarpa	bur oak	S
Quercus marilandica	blackjack oak	MS
Quercus myrtifolia	myrtle oak	MS
Quercus nigra	water oak	MS
Quecus phellos	willow oak	S
Quercus prinus	chesnut oak	MS
Quercus rubra	northern red oak	MS
Quercus stellata	post oak	MS
Quercus turbinella	shrub live oak	MS
Quercus virginiana	live oak	MS
Quercus virginiana var. maritima	sand live oak	MS
Quercus wislizenii	interior live oak	MS
Randia armata	crucito	R
Ranunculus repens	creeping buttercup	S
Raphanus raphanistrum	wild radish	R
Rhamnus californica var. ursina	California buckthorn	S
Rhizophora mangle	American mangrove	MS
Rhododendron spp.	rhododendron	MS
Rhus glabra	smooth sumac	S
Rhus laurina	laurel sumac	S
Rhus toxicodendron	poison oak	S
Rhus typhina	staghorn sumac	S
Richardia scabra	Florida purslane	S
Robinia pseudoacacia	black locust	S
Rosa arkansana	Arkansas rose	S
Rosa bracteata	Macartney rose	S
Rosa elganteria	sweetbrier rose	S
Rosa rubiginosa	wild rose	S
Rottboellia exaltata	Raoul grass	S
Rubus fructicosus	European blackberry	S
Rubus parviflorus	western thimbleberry	S
Rubus procerus	Himalaya blackberry	S
Rubus spectabilis	salmonberry	S
Rubus ulmifolius	elmleaf blackberry	MS
Rudbeckia serotina	blackeyedsusan	MS
Rumex acetosella	red sorrel	S
Rumex altissimus	pale dock	S
Rumex crispus	curly dock	S
Rumex obtusifolius	broadleaf dock	S
Sabal minor	dwarf palmetto	MS
Sabal palmetto	cabbage palmetto	MS
Sabal texana	Texas palmetto	MS
Salix interior	ditchbank willow	S
Salix nigra	black willow	S
Salsola kali var. tenuifolia	Russian thistle	S

Salvia reflexa	mintweed	S
Sambucus canadensis	American elder	S
Sambucus simpsoni	Florida elder	S
Sapindus spp.	soapberry	S
Saponaria officinalis	bouncingbet	MS
Saponaria vaccaria	cow cockle	S
Schaefferia frutescens	Florida-boxwood	MS
Schinus terebinthifolius	Brazil peppertree	S
Scirpus acutus	hardstem bulrush	R
Scirpus olneyi	olney bulrush	R
Scoparia dulcis	sweet broomwort	S
Senecio jacobaea	tansy ragwort	S
Senecio pterophorus	South African daisy	S
Senecio vulgaris	Common groundsel	S
Serenoa repens	saw palmetto	R
Sesbania exaltata	hemp sesbania	S
Setaria faberii	giant foxtail	MS
Setaria viridis	green foxtail	R
Sida carpinthifolia	escobilla	MS
Sida hederacea	alkali sida	MS
Silene antirrhina	sleepy catchfly	MS
Silybum marianum	milk thistle	S
Sisymbrium altissimum	thumblemustard	R
Sisymbrium officinale	hedge mustard	R
Smilax spp.	greenbrier	MS
Solanum auriculatum	violet nightshade	S
Solanum carolinese	horsenettle	S
Solanum ealaeagnifolium	silverleaf nightshade	S
Solanum ficifolium	gully bean	S
Solanum hirtum	huztomate	S
Solanum nigrum	black nightshade	S
Solanum nystrix	Afghan thistle	S
Solanum rostratum	buffalobur	S
Solanum tervum	terongan	S
Solidago nemoralis	gray goldenrod	S
Solidago rigida	rigid goldenrod	S
Sonchus arvensis	perennial sowthistle	S
Sonchus oleraceus	annual sowthistle	S
Sophora secundiflora	mescalbean	S
Spartium junceum	Spanish broom	MS
Specularia perfoliata	Venus lookingglass	R
Spergula arvensis	corn spurrey	S
Spiraea tomentosa	hardhack	S
Stachytarpheta jamaicensis	Jamaica falsevalerian	R
Stellaria media	chickweed	S
Striga asiatica	witchweed	S
Swainsona galegifolia	darling pea	S
Symphoricarpos albus	snowberry	MS
Symphoricarpos occidentalis	western snowberry	MS
Symphoricarpos vulgaris	bushbrush	S
Syringa vulgaris	common lilac	S
Tabebuia heterophylla	trumpettree	R
Tabernaemontana fuchsiaefolia	leiteiro	MS
Tenacetum vulgare	tansy	S

Taraxacum officinale	dandelion	S
Taxodium distichum	baldcypress	S
Taxodium distichum var. nutans	pondcypress	S
Taxus cuspidata	Japanese yew	S
Taxus media densaformus	densaformus yew	S
Thelesperma simpliecisolium	Thelesperma	S
Thlaspi arvense	field pennycress	S
Thalictrum venulosum	meadow rue	R
Thuja occidentalis	northern white cedar	S
Thuja orientalis	oriental arbovitae	S
Thuja plicata	western redcedar	S
Tilla americana	American basswood	S
Tilla heterophylla	white basswood	S
Tournefortia hirsutissima	Trinidad tournefortia	S
Tournefortia volubilis		S
Toxicodendron diversilobum	Pacific poison-oak	S
Toxicodendron quercifolium	poison-oak	S
Toxicodendron radicans	poison-ivy	S
Tragopogon porrifolius	common salsify	MS
Tragopogan major	western salsify	MS
Trapa natans	waterchesnut	R
Tribulus terrestris	puncturevine	S
Trifolium pratense	red clover	S
Trifolium repens	white clover	S
Tsuga canadensis	eastern hemlock	S
Tsuga heterophylla	western hemlock	S
Typha angustifolia	narrowleaf cattail	R
Typha latifolia	common cattail	R
Ulex europaeus	gorse	S
Ulmus alata	winged elm	S
Ulmus americana	American elm	S
Ulmus crassifolia	cedar elm	R
Ulmus parvifolia	Chinese elm	S
Ulmus pumila	Siberian elm	S
Ulmus rubra	slippery elm	S
Urechites lutea	hammock vipertail	S
Urtica dioica	stinging nettle	MS
Vaccinium angustifolium	lowbush blueberry	S
Vaccinium ovatum	box blueberry	S
Verbascum thapsus	common mullein	S
Verbena rigida	veined verbena	S
Verbena tenera	maynes pest	S
Vernonia altissima	tall ironweed	S
Vernonia baldwini	western ironweed	S
Veronica officinalis	common speedwell	MS
Vicia angustifolia	narrowleaf vetch	S
Vicia caroliniana -	Carolina vetch	S
Vicia faba	broadbean	S
Viola arvensis	field violet	MS
Vincetoxicum gonocarpos	anglepod milkvine	MS
Vitex agnuscastus	lilac chastetree	S
Vitis spp.	grape	S

Waltheria americana	Florida waltheria	S
Wedelia glauca	wedelia thistle	MS
Wyethia amplexicaulis	mulesears	MS
Xanthium orientale	Oriental cocklebur	S
Xanthium pennsylvanicum	common cocklebur	S
Xanthium pungens	noogoora burr	S
Xanthocephalum sarothrae	perennial broomweed	S
Xilopia fruutescens	malagueto	MS
Xylococcus bicolor	mission manzanita	S
Yucca filamentosa	Adamsneedle yucca	R
Yucca glauca	small soapweed	R
Zanthoxylum fagara	colima	S
Zanthoxylum flavum	yellow heart	MS
Zigadenus venenosus	meadow deathcamas	MS
Zizyphus mauritiana	India jujube	R

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APPENDIX 13

PLANTS OF WYOMING PROPOSED FOR ENDANGERED STATUS

APPENDIX 13

Plants of Wyoming Proposed for Endangered Status

These plant species are listed in the United States proposed list of Endangered and Threatened Species - Plants (Federal Register Vol 41, No. 117 - June 16, 1976, Pages 24524-24572):

Asteraceae	*Antennaria arcuata*	Pussytoes
Brassicaceae	*Arabis fructicosa*	(Fruit) rockcress
Brassicaceae	*Lesquerella fremontii*	Fremont's bladderpod
Brassicaceae	*Lesquerella macrocarpa*	(Largefruit) bladderpod
Fabaceae	*Astragalus proimanthus*	Milkvetch
Onograceae	*Gaura neomexicana* var. *coloradensis*	(Colorado Butterflyweed)

Antennaria arcuata Cronquist — Arching Pussy-toes

Asteraceae — Sunflower Family

Status: Proposed Endangered - Federal Register 41:24529, June 16, 1976

Description: Perrennial to 4 dm high, white-woolly, with conspicuous arching stolons; basal leaves, few, oblanceolate; stem leaves linear to oblanceolate, 1-6 cm long, gradually reduced upward; heads many, crowded at tip of stem; pistillate involucre 4-6 mm long, tomentose below, the bracts whitish above; staminate plants unknown.

Habitat: Meadows

Location: Fremont Co., Wyoming; Blaine Co., Idaho; Elko Co., Nevada

Collections: 8/06/1905 - Atlantic City near the Sweetwater River; 6,500 ft.
8/1977 - T. 28N., R. 99W., Sec. 5, SE¼SE¼, 7,345 ft.
T. 28N., R. 99W., Sec. 4, SW¼SW¼

Distinguishing Features: Arching stolons present, basal leaves few. Found on edge of sedge tufts.

References:
Cronquist, A., 1950. Leafl. West. Bot. 6:41-43.

Hitchcock, C. L., et al., 1955. Vascular plants of the Pacific Northwest. Part 5. Univ. Washington Press, Seattle, P. 32.

Arabis fructicosa A. Nelson Yellowstone Rockcress

Brassicaceae Mustard Family

Status: Proposed Endangered - Federal Register 41:24534, June 16, 1976

Description: Perennial; stems many from a branching base, to 8 dm. high, usually glabrous and glaucous; basal leaf blades oblanceolate or spatulate, 1-3 cm. long, 3-9 mm. wide, dentate or rarely entire, sparsely pubescent with minute dendritic hairs; stem leaves ovate to oblong, sessile, auriculate, glaucous, the lower sparsely pubescent and dentate, the upper entire and glabrous; sepals 2-3 mm. long; petals white to purplish, 5-7 mm. long; pedicels spreading-ascending, glabrous; fruits glabrous, mostly spreading, nerveless or nerved near base, 4-6 cm. long, 1.5-2 mm. wide; seeds narrowly winged, uniseriate.

Habitat: Dry roadsides

Location: Yellowstone National Park, Undine Falls

Collections: 7/06/1899 - Yellowstone National Park, Undine Falls

Distinguishing Features: Mature fruiting pedicels spreading-ascending; basal leaves ascending, not forming a flat rosette; seeds narrowly winged; fruit 1.5-2 mm. wide; seeds in 1 row in each locule; plants mostly 3 dm. or more high, below subalpine; fruits nerved at very base or nerveless

References: Nelson, A. 1900. Bot. Gaz. 30:190-191.

Rollins, R. C. 1941. Rhodora 43:379-380.

<u>Astragalus</u> <u>proimanthus</u> Barneby Precocious Milkvetch

Fabaceae Pea Family

Status: Proposed Endangered - Federal Register 41:24544, June 16, 1976

Description: Plant^ forming dense mats to 4 cm high, from a branched caudex and taproot; stipules hyaline, glabrous or nearly so dorsally; leaves all basal, 1-3.5 cm long, with mostly 3 leaflets, these obovate to elliptic-oblanceolate, 3-9 mm long, silvery-hirsuite on both sides; flowers sessile or nearly so in axillary pairs; calyx 8-10.5 mm long, densely white-hirsute, the tube 6-6.5 mm long, the teeth 2.4-4.2 mm long; petals white to yellowish; banner narrowly fiddle-shaped, 12-17 mm long; wings 11-16 mm long; keel 9.5-13 mm long; pod sessile, 7-10 mm long, 2.5-3 mm wide, somewhat laterally compressed, valves densely hirsutulous

Habitat: Clay or shale slopes and ridges

Location: Sweetwater Co., Wyoming

Collections: 6/13/1946 - 6 mi N of McKinnon
6/12/1961 - 3 mi N of McKinnon, 7,100 ft
5/31/1976 - 3 mi NW of McKinnon, 7,000 ft
6/02/1977 - T. 13N., R. 111W., SE¼, Sec. 33

Distinguishing Features: Most leaves with 3 leaflets; calyx tube 6-6.5 mm long; banner fiddle-shaped; petals glabrous on back

Reference: Barneby, R. C., 1964. Mem. N.T. Bot. Gard. 13:1152-1154.

Arabis fructicosa A. Nelson Yellowstone Rockcress

Brassicaceae Mustard Family

Status: Proposed Endangered - Federal Register 41:24534, June 16, 1976

Description: Perennial; stems many from a branching base, to 8 dm. high, usually glabrous and glaucous; basal leaf blades oblanceolate or spatulate, 1-3 cm. long, 3-9 mm. wide, dentate or rarely entire, sparsely pubescent with minute dendritic hairs; stem leaves ovate to oblong, sessile, auriculate, glaucous, the lower sparsely pubescent and dentate, the upper entire and glabrous; sepals 2-3 mm. long; petals white to purplish, 5-7 mm. long; pedicels spreading-ascending, glabrous; fruits glabrous, mostly spreading, nerveless or nerved near base, 4-6 cm. long, 1.5-2 mm. wide; seeds narrowly winged, uniseriate.

Habitat: Dry roadsides

Location: Yellowstone National Park, Undine Falls

Collections: 7/06/1899 - Yellowstone National Park, Undine Falls

Distinguishing Features: Mature fruiting pedicels spreading-ascending; basal leaves ascending, not forming a flat rosette; seeds narrowly winged; fruit 1.5-2 mm. wide; seeds in 1 row in each locule; plants mostly 3 dm. or more high, below subalpine; fruits nerved at very base or nerveless

References: Nelson, A. 1900. Bot. Gaz. 30:190-191.

Rollins, R. C. 1941. Rhodora 43:379-380.

ENDANGERED AND THREATENED FLORA OF WYOMING

<u>Astragalus proimanthus</u> Barneby Precocious Milkvetch

Fabaceae Pea Family

Status: Proposed Endangered - Federal Register 41:24544, June 16, 1976

Description: Plants forming dense mats to 4 cm high, from a branched caudex and taproot; stipules hyaline, glabrous or nearly so dorsally; leaves all basal, 1-3.5 cm long, with mostly 3 leaflets, these obovate to elliptic-oblanceolate, 3-9 mm long, silvery-hirsuite on both sides; flowers sessile or nearly so in axillary pairs; calyx 8-10.5 mm long, densely white-hirsute, the tube 6-6.5 mm long, the teeth 2.4-4.2 mm long; petals white to yellowish; banner narrowly fiddle-shaped, 12-17 mm long; wings 11-16 mm long; keel 9.5-13 mm long; pod sessile, 7-10 mm long, 2.5-3 mm wide, somewhat laterally compressed, valves densely hirsutulous

Habitat: Clay or shale slopes and ridges

Location: Sweetwater Co., Wyoming

Collections: 6/13/1946 - 6 mi N of McKinnon
6/12/1961 - 3 mi N of McKinnon, 7,100 ft
5/31/1976 - 3 mi NW of McKinnon, 7,000 ft
6/02/1977 - T. 13N., R. 111W., SE¼, Sec. 33

Distinguishing Features: Most leaves with 3 leaflets; calyx tube 6-6.5 mm long; banner fiddle-shaped; petals glabrous on back

Reference: Barneby, R. C., 1964. Mem. N.T. Bot. Gard. 13:1152-1154.

Gaura neomexicana ssp. coloradensis (Rydb.) Raven & Gregory
Colorado Butterfly-weed

Onagraceae Evening Primrose Family

Status: Proposed Endangered - Federal Register 41: 24556, June 16, 1976

Description: Biennial with several stems to 12 dm high; leaf blades lanceolate to oblanceolate, 2-15 cm long, 0.3-3 cm wide, entire to repand-denticulate; free hypanthium 5-10 mm long; sepals 7-13 mm long; petals reddish or pinkish to white, 5-14 mm long; style 19-25 mm long; fruit 6-8.5 mm long.

Habitat: Meadows

Location: Laramie Co., Wyoming; Weld and Larimer Cos., Colorado

Collections: 1899 - Pine Bluffs
8/13/1977 - T. 13N., R. 68W., Sec. 26, NE¼, 6500 ft

Distinguishing Features: Plants biennial; some leaves usually over 4 cm long; petals over 3 mm long

References: Rydberg, P. A., 1904. Bull. Torrey Bot. Club 31:572.

Munz, P. A., 1938. Bull. Torry Bot. Club 65:113-114.

Raven, P. H., D. P. Gregory, 1972. Mem. Torrey Bot. Club 23(1):1-96.

<u>Lesquerella</u> <u>fremontii</u> Rollins & Shaw   Fremont's Bladderpod

Brassicaceae   Mustard Family

Status: Proposed Endangered - Federal Register 41:24535, June 16, 1976

Description: Perennial with prostrate or decumbent stems to 15 cm long; basal leaf blades elliptic to rhombic, 0.5-4 cm long, 2-6 mm wide; stem leaves obovate to elliptic; sepals 3-5 mm long; petals 5-8 mm long, yellow; pedicels recurved, fruits subglobose to ellipsoid, slightly flattened contrary to partition, 5-8 mm long, valves pubescent inside and outside; styles 1.5-2 mm long; ovules 4-6 per locule.

Habitat: Rocky limestone ridges and slopes

Location: Fremont Co., Wyoming

Collections: 6/30/1947 - 5 mi E of Atlantic City, 8,200 ft
6/11/1977 - T. 30N., R. 98W., Sec. 31; 7,600 ft

Distinguishing Features: Pedicels in fruit uniformly recurved; fruits slightly flattened at most, not keeled on flattend sides; styles 1.5-2 mm long; valves pubescent inside and outside, sparsely so inside

Reference: Rollins, R. C. & E. A. Shaw. 1973. The genus Lesquerella (Cruciferae) in North America. Harvard Univ. Press.

ENDANGERED AND THREATENED FLORA OF WYOMING

Lesquerella macrocarpa A. Nelson Large-fruit Bladderpod

Brassicaceae Mustard Family

Status: Proposed Endangered - Federal Register 41:24535, June 16, 1976

Description: Perennial with decumbent stems to 20 cm long; basal leaf blades ovate or obovate to orbicular or oblanceolate, 0.5-3 cm long, 3-20 mm wide; stem leaves not reduced; sepals 3-5 mm long; petals yellow, 4-7 mm long; pedicels recurved in fruit; fruits globose, about 8 mm or more long, valves pubescent on outside, glabrous on inside; styles 1.5-3 mm long; ovules 2-4 per locule.

Habitat: Naked clay flats and ridges

Location: Sweetwater Co., Wyoming

Collections: 6/10/1900 - Bush Ranch, N edge of Steamboat Mtn.
6/21/1901 - 45 mi N of Point of Rocks
6/02/1977 - T. 24N., R. 102W., SE¼, Sec 35; 7,760 ft
- T. 24N., R. 100W., Secs. 19 and 30
- T. 24N., R. 101W., Sec. 17
- T. 24N., R. 102W., Sec. 12
- T. 27N., R. 100W., Sec. 28 SE¼SE¼
Sec. 27 SW¼SW¼

Distinguishing Features: Fruits inflated, pedicels uniformly recurved; basal leaf blades ovate or obovate to orbicular; valves of fruit sparsely pubescent on outside, glabrous on inside

References: Nelson, A., 1902. Bot. Gaz. 34:366-367.

Payson, E. B., 1920. Ann. Mo. Bot. Gard. 8:181.

Rollins, R. C. & E. A. Shaw, 1973. The genus Lesquerella (Cruciferae) in North America. Harvard Univ. Press.

E = Endangered, T = Threatened.
* Based on both known and potential distribution of the taxa; BIA = Bureau of Indian Affairs, BLM = Bureau of Land Management, BR = Bureau of Reclamation, FS = Forest Service, FWS = Fish & Wildlife Service, P = Private, PS = Park Service.
** Removed from list according to Smithsonian Institution.
*** Error, not presently known from Wyoming.

WYOMING PLANTS TO BE ADDED TO THREATENED LIST
(Confirmed by Smithsonian Institution, Jan. 18, 1977)

Family	Species	Lands Administered By	Map Reference
Brassicaceae	Draba pectinipila	BLM, BR, FS	S
Fabaceae	Astragalus drabelliformis	BLM	T
Polygonaceae	Eriogonum lagopus	BLM, PS	U
Saxifragaceae	Sullivantia hapemanii	BLM, FS, PS	V

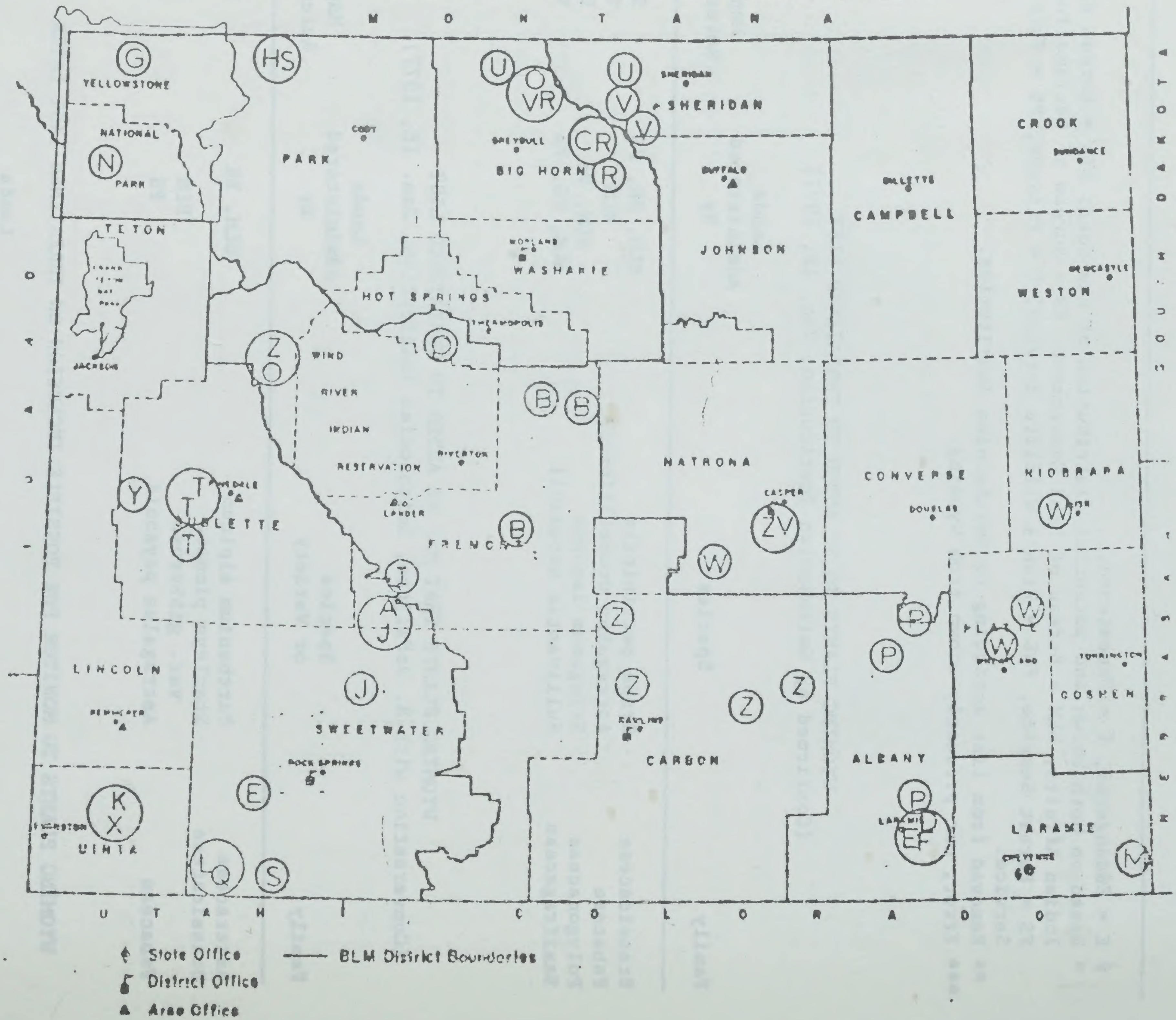
WYOMING PLANTS THAT MAY BE ADDED TO THREATENED LIST
(Conversation with R. DeFilipps, Smithsonian Institution, Jan. 18, 1977)

Family	Species or Variety	Lands Administered By	Map Reference
Asteraceae	Parthenium alpinum	BLM, BR	W
Brassicaceae	Stanleya pinnata var. gibberosa	BLM	X
Fabaceae	Astragalus paysonii	FS	Y

WYOMING PLANTS TO MONITOR FOR POSSIBLE INCLUSION ON THREATENED LIST LATER

Family	Species	Lands Administered By	Map Reference
Fabaceae	Astragalus simplicifolius	BLM	Z

COLLECTION LOCALITIES OF ENDANGERED AND THREATENED PLANTS



APPENDIX 14

CONCENTRATION CONVERSION CHART

Appendix 14

Concentration Conversion Chart

Acute and chronic oral toxicity tests of pesticides are generally performed using one of the following methods. For testing the toxicity of pesticides on aquatic organisms, the pesticide is mixed with water to make a liquid concentration in mg/l or ug/l. For testing terrestrial forms of life the pesticide is mixed in solid form in the feed or is fed by capsule to the test organism. The concentrations are expressed as mg/kg or ug/kg.

The following conversion chart will provide a better understanding of the concentrations reported by the researchers referred to in this environmental assessment record.

1 kilogram (kg) = 1000 grams (g)
1 gram = 1000 milligrams (mg)
1 milligram = 1000 micrograms (ug)
Therefore:
1 mg/kg = 1 part per million (ppm)
1 ug/kg = 1 part per billion (ppb)

1 liter (1) of water weighs 1 kg
1 liter = 1000 g
Therefore:
1 mg/1 = 1 ppm
1 ug/1 = 1 ppb

Additional Conversions:
1 percent (%) = 10,000 ppm
0.1% = 1000 ppm = 1000 mg/1
0.01% = 100 ppm = 100 mg/1
0.001% = 10 ppm = 10 mg/a
0.0001% = 1 ppm = 1 mg/1

English-Metric Conversions:
1 kg = 2.2 lbs.
1 lb = 454 g
1 1 = 0.264 gal.

Appendix 16

Concentration Conversions

Acute and chronic oral toxicity tests [illegible] were performed using one of the following methods. [illegible] of pesticides on aquatic [illegible], the pesticide [illegible] make a liquid concentration in mg/l or ug/l. For [illegible] forms of life the pesticide is mixed [illegible] by capsule in the test organism. The concentrations are expressed in mg/kg or ug/kg.

The following conversion chart will provide a [illegible] of the concentrations reported in the [illegible] environmental [illegible].

1 kilogram (kg) = 1000 grams (g)	Additional Conversions
1 gram = 1000 milligrams (mg)	[illegible]
1 milligram = 1000 micrograms (ug)	0.1% = 1000 ppm = 1000 mg/l
Therefore:	0.01% = 100 ppm = 100 mg/l
1 mg/kg = 1 part per million (ppm)	0.001% = 10 ppm = 10 mg/l
1 ug/kg = 1 part per billion (ppb)	0.0001% = 1 ppm = 1 mg/l
1 liter (l) of water weighs 1 kg	[illegible] Conversions
1 liter = 1000 g	1 kg = 2.2 lbs.
Therefore:	1 lb = 454 g
1 mg/l = 1 ppm	1 g = 0.035 oz.
1 ug/l = 1 ppb	