WORK PLAN FOR FOREST VEGETATION MANAGEMENT

R & D UNDER THE CANADA-ALBERTA AGREEMENT

1985-86 to 1989-90

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Compiled by:

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INTRODUCTION

A forest vegetation management project is being conducted within the Canada-Alberta Forest Resource Development Agreement, under Program Activity B. Sub-program B.3 (Forestry Research, Development and Demonstration). It is a joint program of the Northern Forestry Centre (CFS) and the Research and Reforestation and Reclamation Branches of the Alberta Forest Service, with shared roles in planning, management and implementation (see Appendix I). A listof all cooperators is given in Appendix II.

The project started in the fall 1985, with a collection of pre-treatment data in 1986, to be followed by scheduled treatments and 3 years of post treatment measurements, terminating in 1989-90. A detailed schedule of work and reporting plans for the project is given in Appendix III and a budget in Appendix IV.

TITLE

Silvicultural, economic and environmental impact assessment of selected methods of site preparation and crop release in areas designated for softwood production in Alberta.

LOCATION, LAYOUT, AND TREATMENTS

PRIMARY TEST SITE

The primary test site is located on two separate cut blocks within the Procter and Gamble Forest Management Agreement area, about 21 km south of the Grande Prairie pulpmill, in Improvement District 16 (NTS Big Mountain Creek Sheet) (see map, Figure 1). The site is within the mixedwood forest complex of Alberta, representative of a significant problem area for softwood

reforestation. The ecosystem association is white spruce, viburnum/Aralia. Further details about this ecosystem, including productivity, are available from Corns and Annas (1985)[1].

Treatments are being tested for conifer release (Method I) and site preparation (Method II). The method I blocks were established in 1985 on a 3-year old aspen cutover (cutblock 4004, harvested March 1983) and Method II blocks on a 2-year old aspen cutover (cutblock 4007, harvested July 1983). Both are regrowing rapidly to a mixture of aspen, poplar, saskatoon, chokecherry, herbs and grasses. Treatments were allocated randomly within blocks and replicaated three times. Treatments are as follows:

Conifer Release - Method I

	Treatment	Timing
1.	Control	
2.	Mechanical ROME disc	Spring 1987
3.	Mechanical (Disc Trencher) followed by PRONONE 10 G @ 1 kg ai/ha	Spring 1987/ Spring 1989
4.	Mechanical (Disc Trencher) followed by PRONONE 10 G @ 2 kg ai/ha	Spring 1987/ Spring 1989
5.	Mechanical (Disc Trencher) followed by manual (brush saw)	Spring 1987/ Spring 1989

Site Preparation - Method II

	Treatment	Timing
1.	PRONONE 10 G @ 4 kg ai/ha	Fall 1986
2.	PRONONE 10 G @ 2 kg ai/ha	Fall 1986
3.	PRONONE 10 G @ 4 kg ai/ha followed by mechanical (Disc Trencher)	Fall 1986/ Spring 1987

[1] Corns, I.G.W. and R.M. Annas. 1986. Field guide to forest ecosystems of west-central Alberta. Can. For. Serv., North. For. Cent., Edmonton, Alberta.

4.	PRONONE 10 G @ 2 kg ai/ha followed by mechanical (Disc Trencher)	Fall 1986/ Spring 1987
5.	Control	
6.	Mechanical - ROME disc	Spring 1987
7.	Mechanical - Disc Trencher	Spring 1987

Both white spruce and lodgepole pine are being tested on the site. The planting stock was produced by the Alberta Forest Service (AFS) as plug +1 spruce and container-grown lodgepole pine. All stock was given an array of morphological and physiological tests before planting.

All planting was done following mechanical treatments in Spring 1987, on both release and site preparation areas.

Sample plots were laid out within each treatment plot, and sub-plots within sample plots. All square and circular assessment plots are 25 m^2 in size. Transect plots are 0.5 x 5 m in size (see Figure 2).

The test site was surveyed by Pedology Consultants of Edmonton in August/September 1985 and they produced a detailed soils report which was used to locate blocks and treatment plots in the most homogenous areas from a soils perspective[2]. Soils are predominantly moderately well drained Gleyed Solonetzic Luvisols with a silt-loam surface texture and a clay subsoil texture.

SATELLITE SITES

There are three satellite sites, located at Calling Lake, Webberville, and Hines Creek, to study effects of a variety of chemical and

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[2] Pedology Consultants. 1985. Soil survey of two cutblock test areas and detailed analysis of blocks within the test areas. Report prepared by A.G. Twardy and J.V. Dowgray for Canada-Alberta Forest Research Development Project 95 p.

mechanical treatments on aspen sucker development, and one site near Edson to assess aspen seedling ingress. Details are given in Appendix V.

PROJECT COMPONENTS AND OBJECTIVES

The project involves research into three aspects of forest vegetation management: (1) silviculture, (2) economic assessment, and (3) environmental impact of herbicides used in forest vegetation management, as follows:

Silviculture

Economics

Environment Impact and Residue Chemistry of Forestry Herbicides.

Objectives for each project component are as follows:

SILVICULTURE (CFS and AFS)

CFS:

- Assess effects of selected manual, mechanical, chemical and combined site preparation and softwood release treatments upon the growth and development of the softwood crop on designated mixedwood sites in Alberta.
- Assess effect of selected manual, mechanical, chemical and combined site preparation and softwood release treatments upon the growth and development of competing vegetation, particularly aspen and grass species, on designated mixedwood sites in Alberta.

AFS (FRB):

- Develop strategies to effectively control aspen development in areas designated for softwood production; develop techniques for suppressing density of aspen suckering and for controlling ingress by seeding-in.

ECONOMICS (CFS)

- Assess economic aspects of selected manual, mechanical, chemical and combination treatments applied in vegetation management in Alberta for purposes of preparing cost-effectiveness and risk-benefit analysis for vegetation management programs. Cost-effectiveness and risk-benefit analyses can be developed with the understanding of application costs, treatment effectiveness and product values.

ENVIRONMENTAL IMPACT AND RESIDUE CHEMISTRY (CFS)

- Develop environmental impact and residue data on herbicides used operationally for vegetation control in Alberta.
- Determine the fate of herbicides in the forest ecosystem, by studying herbicide deposition (Pronone granule distribution), active ingredient (a.i.) release from granules, persistence of herbicides in soil, foliage, and water, lateral and downward movement, degradation, and absorption/desorption characteristics in selected forest soils under field and laboratory conditions.
- Evaluate the influence of herbicide application and other silvicultural practices on the structure, composition and dynamics of forest plant communities.
- Determine the influence of herbicide application and other silviculture practices on the long-term stability of nutrient balance and the biological (mycorrhizal associates, N-fixation, decomposition) control of tree nutrition.

RESEARCH PROCEDURES BY COMPONENT

SILVICULTURE (CFS and AFS)

Silviculture R & D is being conducted by the CFS (in-house) and by the Forest Research Branch (AFS) by contract.

CFS research focusses on field assessment of efficacy, crop tolerance and crop growth aspects of the treatments being tested.

CFS research follows protocols established by Herring and Pollack (1985)[3], and accepted by the Expert Committee on Weeds (ECW) Western Silviculture Group. Assessment is based on 30-25 m^2 sample sub-plots within a given treatment. There are 450 sub-plots for silvicultural assessment on Method I, and 540 on Method II, for a total of 990 overall.

Buffer strips between treatment sample plots average 40 m.

Assessments for herbaceous, woody and crop species were conducted for all sub-plots in the summer of 1986 to obtain baseline (pre-treatment) data, and will be repeated after 1, 2, 3 and 5 growing seasons following treatment.

Data loggers were established in May 1986 to measure air temperature, relative humidity, incident light and rainfall as well as soil moisture and temperature at two depths, within each type of treatment plot on the Method II area for the 1986 pretreatment season and for five subsequent seasons. Appendix VI illustrates the design and layout of the environmental monitoring system.

AFS research is aimed at a better understanding of aspen suckering processes, particularly factors and conditions which could be used for suppressing density and vigor of suckering. The work is being done on the primary test site, on satellite sites, and in the laboratory. AFS field research employs comparable protocols to CFS silviculture R & D for 25 m^2 circular aspen sucker density assessment plots as well transect excavation

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[3] Herring, L.J. and J.C. Pollock. 1985. Experimental design protocols for forest vegetation management research: Level B trials - first approximation. Internal report of B.C. Ministry of Forests. RR 84013-H.Q.

plots (0.5 x 5 m each) to map and analyze aspen root details for root size and distribution and sucker origin. Pre-treatment assessments were done in 1986 with repeat assessments planned in subsequent years as described for CFS work on the primary test site.

Details of experimental procedures and assessments for satellite R & D areas are given in Appendix V. One site (Edson) is set up to study the extent and seriousness of aspen seedling ingress as a competitor for softwood crop trees. Laboratory R & D is aimed mainly at determining the effects of drought, frost, and segmentation on aspen sucker vigor and density.

ECONOMICS (CFS)

Economics studies are focussing on site preparation and release treatments not only on the primary test site but also on satellite plots selected by the AFS for purposes of silviculture testing of treatment equipment such as the logarithmic sprayer for herbicide application, using standard economic analysis techniques such as cost-effectiveness, risk-benefit, and marginal cost analysis.

Protocols for this work are based on standard field procedures modified by the experiences gained in conducting similar studies in an agricultural context.

ENVIRONMENTAL IMPACT AND RESIDUE CHEMISTRY (CFS)

The procedures used in the environmental impact and residue chemistry component of this project are as follows:

Plant Community Changes

Thirty 5 x 5 m sub-plots were permanently established in each treatment plot for sampling vegetation. Refer to protocols and ECW standard

noted under Silviculture. The study will investigate response of all woody and herbaceous species to treatments. The response parameters measured are frequency, density, cover and presence. The sub-plots were sampled before treatment in 1986 and after the first year (1987) and will be resampled 2, 3, and 5 years after application of treatments. The data are being analyzed using standard vegetation analysis techniques.

Residues in Soils, Vegetation and Water

Foliage was sampled from 2 crop species, 3 target species, 3 low shrubs and grasses and 3 ground vegetation species from 5 sub-plots in each treatment. The sampling was done once before treatment and will be repeated several times after application of the treatment. The foliage is kept frozen until analyzed for herbicide residue by methods developed by the Northern Forestry Centre of the CFS.

Due to the irregular size and shape of Pronone 10G granules, the amount of hexazinone coated on and released from individual granule varies. Therefore, application is spotty. Two types of soil sampling are being performed: 1) precision sampling from spots treated with individually spiked granules calculated to the compatible rate for the treatment plot, and to 4 depths, including 0-10, 10-20, 20-30, and 30-35 cm from the surface of forest floor, and 2) random sampling by pooling 45-50 cores of 2.5 cm diameter at two depths, 0-10 and 10-20 cm from the surface. Type 1 method is conducted in 18 subplots, 3 each per plot treated with chemical only (Plot No. 1 and 2) from all Blocks (I, II, and III) in the Method II area (sampling started in August 1986). Type 2 method is conducted in 6 treatment plots as described above (sampling started in the summer 1987). The protocols for soil sampling, shipping, storage, and analysis are similar to the published CFS methods (Feng

and Klassen 1986; Feng 1987)[4]. Granule deposition rates and profiles were monitored at 2 transects (40 m each) per treatment plot (6 plots as described above). The rate of a.i. release from moistures (rainfall and dew) under field conditions were also monitored from the 6 plots described above. The analysis of soil texture and nutrient status will be accomplished from existing project funding.

Surface and ground water were sampled by the Alberta Environment with the method jointly developed by the Alberta Environment and NoFC (Appendix VII), and analyzed by NoFC by using an unpublished NoFC method.

Mycorrhizae and Nutrient Cycling

Effects of PRONONE on growth of 5 species of mycorrhizae (Hebeloma crustuliniforme, Laccaria laccata, Suillus tomentosus, Thelephora americanum and T. terrestris) were studied under laboratory and field conditions during 1985 and 1986 as part of a CFS PDF program. The growth of these mycorrhizae in association with lodgepole pine and white spruce was studied in response to application of PRONONE using standard culture methods.

A nutrient cycling study is being conducted on the herbicide treated sites as a part of ongoing CFS R & D. The work is aimed at determining the influence of herbicide treatments on nutrient balance and on biological and chemical control of tree nutrition, via assessment of N fixation, decomposition, pH changes and cation and anion availability. Additional detail is given in Appendix VIII.

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[4] Feng, J.C.; Klassen, H.D. 1986. Forestry field and laboratory manua for herbicide residue sampling, sample processing and reporting. Can. For. Serv., For. Pest Manage. Inst. Inf. Rep. FPM-X-72.

Feng, J.C. 1987. Persistence, mobility and degradation of hexazinone in forest silt loam soils. J. Environ. Sci. Health. B22:221-233.

Fish and Wildlife

Impacts on fish were minimized by locating the project and handling materials to prevent such impacts.

Impacts on wildlife, particularly on ungulates will be limited to assessing residues in ungulate browse and forage supplies which will be sampled and analyzed in the course of the environmental impact assessment. The scale of the treatment is too small (total of 45 ha of which 24 ha will be chemically treated over the life of the project) to provide a meaningful assessment of habitat change for ungulates.

The most meaningful mammal study on the project area would be a study of possible toxicity to small mammals, and a study of population impacts of chemical treatment upon small mammals. Such studies are particularly important because of the position of small mammals in the food chain. The plans for a small mammal study include:

a. update of a literature survey of toxic effects of hexazinone upon mammals;

b. assessment of levels of chemical residues within water, vegetation and soils on the chemically treated area;

c. test for chemical residues in selected tissues (kidneys and livers) of small mammals (mice);

d. a survey of population changes of small mammals as affected by chemical treatments on the project area (acute toxicity and habitat change impacts).

Items a) and b) will be accomplished from existing project funding and items c) and d) are being addressed by a consultant with support from the Wildlife Toxicology Fund. See protocols in Appendix IX.

REPORTING

Research results for this project will be published following analysis and interpretation of data at intervals over the next 3 or 4 years. Results of mycorrhizal R & D should be published in 1987. Annual reports on herbicide work will be made to the Expert Committee on Weeds (ECW) at regular annual meetings. See publication plans by year in Appendix III.

FOREST VEGETATION MANAGEMENT R&D PROJECT
CANADA-ALBERTA AGREEMENT
GRANDE PRAIRIE, ALBERTA

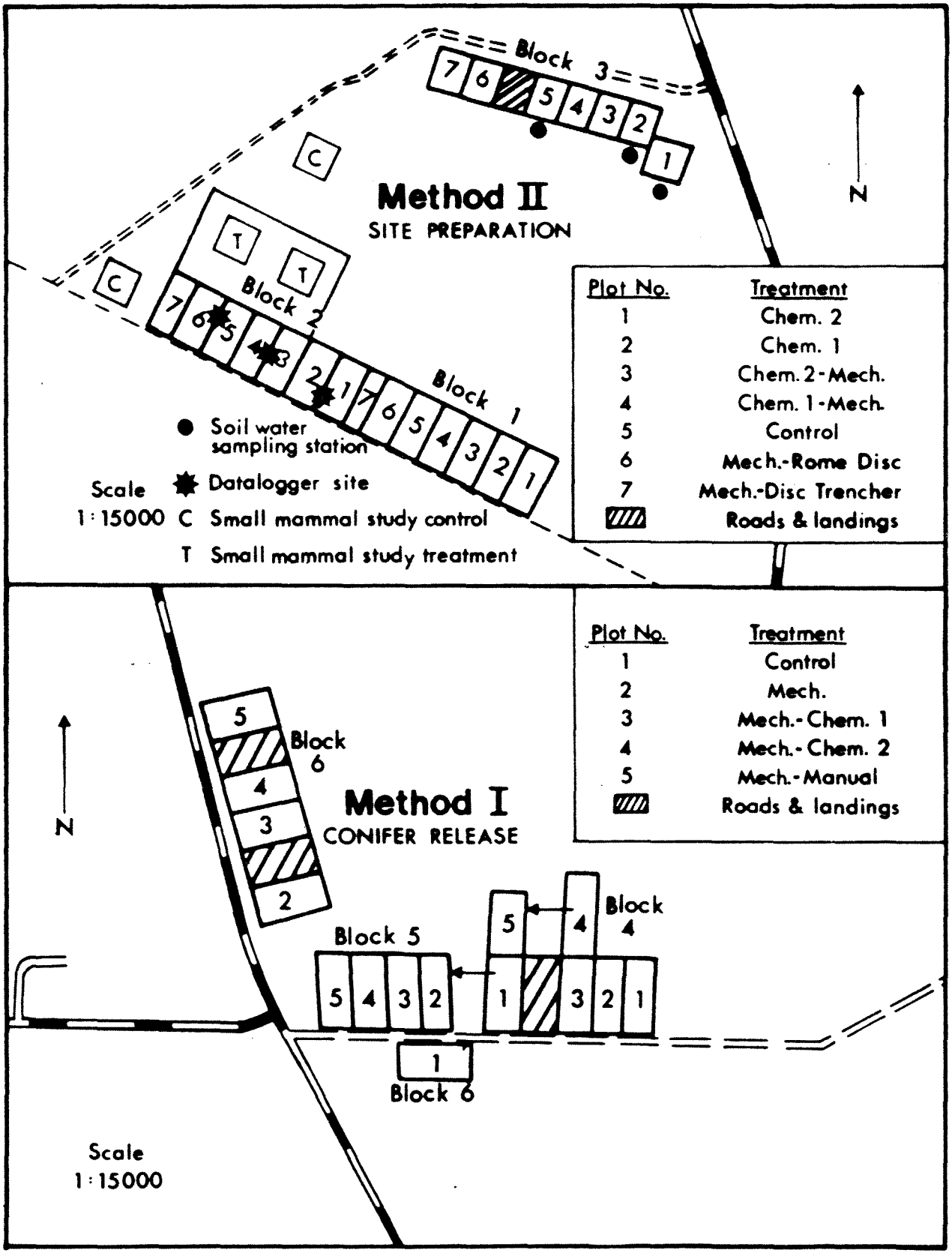
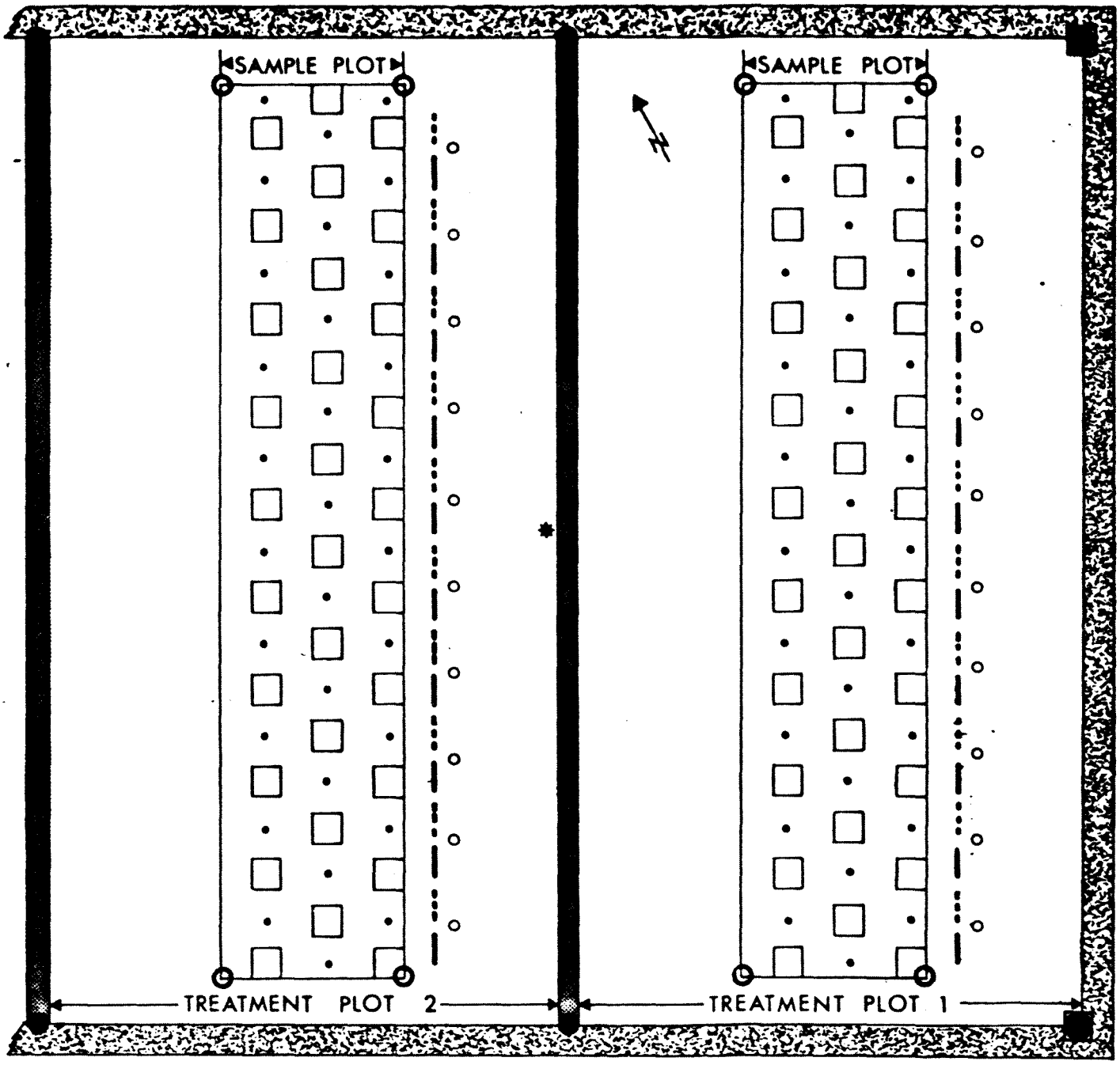


FIGURE 2

EXAMPLE OF SAMPLE PLOTS AND SUBPLOTS WITHIN TREATMENT PLOTS METHOD II- BLOCK 1



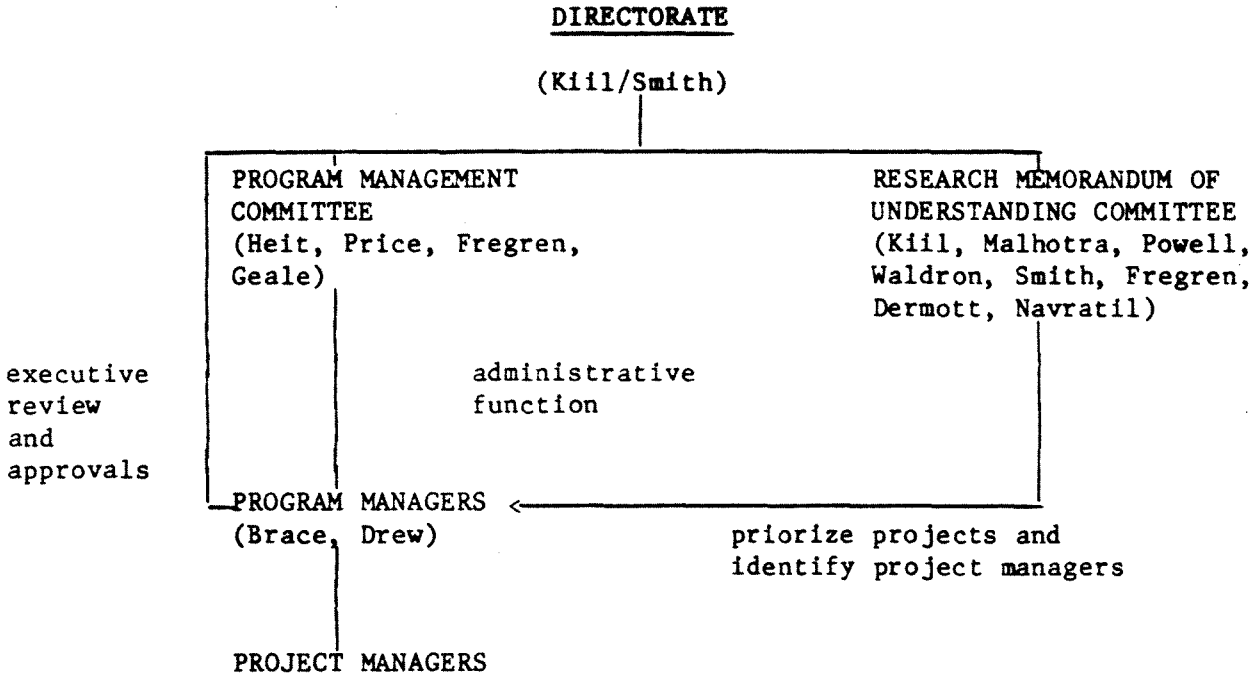
- Environmental assessment subplot
- Silvicultural assessment subplot
- Root excavation subplot A
- Root excavation subplot B
- Aspen assessment plot
- Data log recorder
- Red treatment plot post
- Yellow corner post
- Blue sample plot post
- Brushsaw cleared 3m. wide
- Cat. cleared 5m. wide

SCALE

0 10 20metres

APPENDIX I

DIRECTION MANAGEMENT AND IMPLEMENTATION FOR FOREST VEGETATION MANAGEMENT R & D PROJECT - CANADA-ALBERTA FRDA



- Brace, Silviculture R & D - CFS (NoFC - Coordinating role)
- Navratil, Silviculture R & D and Aspen Synecology - AFS (FRB)
- Sidhu, Environmental Impact and Residues with Alberta Environment - CFS (NoFC)
- Boylen, Economics R & D - CFS (NoFC)

TEAMS

Facilitating Team - administrative role for on-site detail

John Drew	Director AFS - R & R, AFS HQ
Lorne Brace	CFS - Project Coordinator, NoFC
Mort Timanson	AFS Supt. - Grande Prairie Forest
Brian MacDonald	Procter and Gamble - Chief Forester, Grande Prairie

Implementation Team - on-site work

Lorne Brace	CFS - Project Coordinator, NoFC
Stan Navratil	AFS - FRB, Acting Director
Garry Ehrentraut	AFS - R & R - Silviculture Forester, AFS HQ
Dave Cook	AFS Management Forester - Grande Prairie Forest
Pat Wearmouth	Procter and Gamble - Silviculture Forester, Grande Prairie

Public Affairs Team - preparation and execution of public information plan

John Drew	AFS-R & R - Director, AFS HQ
Mort Timanson	AFS Supt. - Grande Prairie Forest
Louise Behan	AFS - Public Affairs Officer, AFS HQ
Eric Jerrard	Procter and Gamble - Public Relations Chief, Grande Prairie
Brian MacDonald	Procter and Gamble - Chief Forester, Grande Prairie
Lorne Brace	CFS - Project Coordinator, NoFC
Robert Newstead	CFS - Project Leader, Tech. Transfer and Information, NoFC

ROLES

DIRECTORATE	- ensure that the intent and terms and conditions of the Agreement are carried out
	- approve work plans and coordinate activities
	- establish advisory and coordination subcommittees as required
	- provide annual Ministerial reports
RESEARCH MEMORANDUM OF UNDERSTANDING COMMITTEE	- priorize project submissions and identify project managers (status: complete)
PROGRAM MANAGEMENT COMMITTEE	- review Project Authorizations and contracts, fit with administrative and financial requirements of the Agreement and recommend for approval
	- authorize expenditures under Agreements
	- monitor and report on financial and administrative status of projects
PROGRAM MANAGERS	- identify technical priorities at the sub-program level and focus budgets
	- review and approve work plans for technical content, timing and budgets, and interface with the PROGRAM MANAGEMENT COMMITTEE
	- review submissions and reports and liase with DIRECTORATE
PROJECT	- develop and implement approved plans with full responsibility for action, accounting and reporting
	- coordination role to CFS Silviculture (Brace)
TEAMS	- roles as indicated

APPENDIX II

LIST OF PROJECT COOPERATORS AND ROLES IN FOREST VEGETATION MANAGEMENT R & D PROJECT - CANADA-ALBERTA FRDA

Environmental Impacts and Residue Chemistry:

Dr. S. Sidhu, Res. Sci., NoFC (CFS) Dr. P. Chakavarty, PDF, NoFC	- community structure change (field) - fate of herbicides and degradation products in vegetation and soils (fields and laboratory) - impact on mycorrhizae (field and lab)
Mr. J. Feng, Res. Sci., NoFC (CFS)	- rate and deposition studies (field) - residue analysis on soils, vegetation and water (lab)
Mr. W. Inkpen, Res. Biol., Pesticides Chemicals Branch, Alberta Environment	- sampling of soil and water and surface water, on and off site in field
Dr. P. Sims, Director Mr. C.B. Powter, Res. Manager Research Management Div., Alberta Environment	- project review on environmental aspects

Efficacy, Crop Tolerance and Crop Growth:

Mr. L. Brace, Res. Sci., NoFC (CFS)	- field coordinator - effects of all treatments, including chemicals, on target and non-target species (field)
Dr. J. Drew, Director Alberta Forest Service, Reforestation and Reclamation Branch	- project manager for Alberta Forest Service component of joint project - provide seedlings and site preparation technology for site
Dr. S. Navratil, Res. Manager, Alberta Forest Service	- detailed study of aspen suckers and seedlings and their response to all treatments (field and laboratory)
Mr. Dave Cook, Man. Forester, AFS, Grande Prairie Mr. Garry Ehrentraut, Man. Forester, AFS, Edmonton Mr. Pat Wearmouth, Man. Forester, Procter and Gamble Cullulose, Grande Prairie	- develop operationally viable treatment schedule and provide field support for project

Fish and Wildlife Effects:

Mr. Hugh Wollis Coordinator, Habitat Assessment, Habitat Branch, Alberta Fish and Wildlife	- literature search of effects of hexazinone on mammals, fish and birds - field sampling for ungulate browse (choice of species/components) and interpretations of browse residue
Mr. David Penner Wildlife Biologist McCourt Management Ltd. (Funding by World Wildlife Fund)	- field sampling of small mammals for tissue analysis of herbicide residues and impact of habitat changes on small mammal populations

Economics:

Ms. D. Boylen Senior Economist NoFC (CFS)	- assess economics of all treatments for purpose of preparing cost-effectiveness and risk benefit analysis for vegetation management programs

Herbicide Application:

Mr. R. Wellman, Field Rep. Pfizer Corp.	- provision of advice on rates and application technology for herbicide

APPENDIX III

WORK PLAN SUMMARY BY YEAR FOR PRIMARY TEST SITE, SATELLITES AND RELATED R & D FOR FOREST VEGETATION MANAGEMENT R & D PROJECT
(Primary Test Site - Grande Prairie)

	Planning/Establishment	R & D	Reports
1985-86 Agreement:	1. Prepared project synopsis/authorization (CFS, AFS, (R&R and FRB) 2. Selected site (CS, AFS (R&R and FRB, G.F. Forest), P&G. 3. Contracted for Site/Soil Survey (FRB) 4. Prepared Work Plan, exp't design for field and greenhouse trials (CFS, FRB) 5. On-site block survey and plot establishment (CFS, FRB) 6. Initiated Committees/Teams (CFS, FRB) 7. Prepared action man for "Open House" and media contact via Public Info Team: Local Contact (Site) (AFS, P&G) Fact Sheets (CFS, AFS) Media Kits (CFS, AFS) Press Releases (CFS, AFS) Ministerial Briefing Notes (CFS, AFS) 8. Made application for Federal and Provincial Herbicide Research Permits (CFS) 9. Prepared Tox Fund Proposal in support if small mammal R&D (CFS) 10. Planned site prescriptions and stock requirements for site (FRB R&R, CFS)	1. Initiated pre-treatment assessment on plots in site preparation blocks (Baseline data) -sucker development and root studies (FRB) -efficacy and crop development (CFS, FRB) -herbicide residue and plant community changes (CFS, FRB) 2. Initiated literature survey and laboratory/greenhouse studies of effects of segmentation drought and cold on aspen sucker development related to G.P. test site (FRB) 3. Initiated literature search and report on cost-effectiveness and risk-benefit analysis of herbicides used in forestry (CFS) 4. Collected operational veg. man. data (R&R) 5. Initiated planting stock production for G.P. Site (FRB, R&R)	1. Work plan - file report (CFS, AFS (FRB & R&R) 2. Soil Survey Report - Pedology Consultants (FRB) 3. Media Kit - Open House (AFS, CFS) 4. Technical proposal to Tox Fund (CFS, McCourt Management Consulting) 5. Annual progress report on studies for control of aspen in areas designated for softwood production in Alberta (FRB)

WORK PLAN SUMMARY BY YEAR FOR PRIMARY TEST SITE, SATELLITES AND RELATED R & D FOR FOREST VEGETATION MANAGEMENT R & D PROJECT
(Primary Test Site - Grande Prairie)

	Planning/Establishment	R & D	Reports
1986-87 Agreement:	1. Conducted open house in Grande Prairie (AFS, (R&R, Public Affairs) with CFS Support (Scientific) 2. Press Contact: -Science Journal (CFS) -Envir. Law Soc. and other groups (CFS) 3. Prepared Ministerial Briefing Notes (CFS, AFS) 4. Established soil water sampling stations (Alta Envir) 5. Calibrated aerial and ground herbicide applications equipment at Grande Prairie and Nisku (CFS, FRB, R&R and G.P. Forest) 6. Planned physiological and morphological tests for growing stock (FRB) 7. Prepared and negotiated contract for aerial application of herbicide (R&R) 8. Obtained necessary provincial research permit (CFS, R&R, FRB) 9. Initiated plans for contracting site preparation and planting of site (FRB, R&R, G.P. Forest, CFS) 10. Prepared site prep. contract (R&R) 11. Prepared planting contracts for G.P. Site (FRB)	1. Completed all pre-treatment assesment of sample plots on both site preparation and release areas (II and I) for silviculture and environment (CFS, FRB) 2. Applied herbicide on site preparation area (II) (R&R, CFS, G.P. Forest) 3. Collected pre and post herbicide application samples of water, vegetation, sediment and soil (CFS) 4. Initiated herbicide residue analysis of soil, water,sediment and plant tissue at NoFC (CFS) 5. Installed dataloggers on site preparation area (II) (CFS) 6. Conducted physiological and morphological test on planting stock (FRB) 7. Continued field/greenhouse studies of effects of segmentation, drought and cold on aspen sucker development (FRB). 8. Completed literature search on cost effectivenss and risk-benefit analysis in forestry herbicides (CFS) 9. Collected additional veg. man. cost data (R&R)	1. Report to expert committee on weeds (ECW) in Regina on herbicide deposition patterns (CFS) 2. Report in "Science Journal" on G.P. R&D (CFS) 3. Final work plan incorporating all protocols from co-operating agencies. 4. Annual progress report on studies for control of aspen in areas designated for softwood production, including field and lab/greenhouse results to date. 5. Prepare progress report on entire project for Senior Development Officer (CFS) 6. Began preparation of report on economic analysis of forestry herbicides use (CFS) 7. Continue preparation of review report on Environment/Harvesting/Site preparation for control of aspen Suckering (FRB)

WORK PLAN SUMMARY BY YEAR FOR PRIMARY TEST SITE, SATELLITES AND RELATED R & D FOR FOREST VEGETATION AND MANAGEMENT R & D PROJECT
(Primary Test Site - Grande Prairie)

	Planning/Establishment	R & D	Reports
1986-87 Agreement continued	12. Obtained material and prepared contract to manufacture tree cages for hare control (FRB, G.P. Forest)	10. Supervised contract to make tree cages for hare control (G.P. Forest)	

WORK PLAN SUMMARY BY YEAR FOR PRIMARY TEST SITE, SATELLITES AND RELATED R & D FOR FOREST VEGETATION MANAGEMENT R & D PROJECT
(Satellite Test Areas)

	Planning/Establishment	R & D	Reports
1985-86 Agreement:	1. Designed satellite experiments A to F (FRB) 2. Began reconnaissance of potential satellites sites A (Calling Lake), B(Peace River) and C(Edson Area) and selected sites A and B (FRB) 3. Did reconnassance of aspen ingress study area in Edson Forest (FRB) 4. Set up instruments to measure root-zone temperatures on A-mechanicaly treated (double disked) sites (FRB) 5. Applied for herbicide permits for satellites A, B, and C (FRB)	1. Literature survey relevant to aspen sucker development and seedling ingress initiated (FRB)	1. Annual progress report by FRB cited under G.P. Primary Test Site.

WORK PLAN SUMMARY BY YEAR FOR PRIMARY TEST SITE, SATELLITES AND RELATED R & D FOR FOREST VEGETATION MANAGEMENT R & D PROJECT
(Satellite Test Area)

	Planning/Establishment	R & D	Reports
1986-87 Agreement:	1. Applied again for herbicide permits for satellites B and C (FRB)	1. Pretreatment assesment and treatment completed on Satellite A (Calling Lake) (FRB)	1. Annual progress report by FRB cited under G.P. Primary Test Site. (FRB)
	2. Established satellites A, B, and C, modifying B. (Detail available) Satellite C now located at Hines Creek. (FRB)	2. Collected pre and post herbicide application samples of soil on Satellite A and initiated herbicide residue analaysis (FRB)	
	3. Established soil temperature monitoring stations on Satellite A (FRB)	3. Pretreatment assessment done on parent stand of satellite B but no treatment on B or C (FRB)	
	4. Designed and planned aspen ingress (FRB)	4. 50 plots established and measured on aspen ingress study near Edson (FRB)	
	5. Log-sprayer R&D planned (FRB, R&R)	5. Site selection for velpar log-sprayer trial (R&R)	

WORK PLAN SUMMARY BY YEAR FOR PRIMARY TEST SITE, SATELLITES AND RELATED R & D FOR FOREST VEGETATION MANGEMENT R & D PROJECT
(Non-Agreement-CFS)

	Planning/Establishment	R & D	Reports
1985-86 Non-Agreement	1. Planned establishment and staffing of herbicides residue laboratory at NOFC (CFS) 2. Planned study of effects of herbicides on mycorrhizae in pine and spruce seedlings - field and laboratory (Post -Doctoral Fellow-CFS)	1. Began set up and testing of herbicide residue equipment at NoFC (CFS) 2. Initiated field and lab research on effects of herbicides on mycorrhizae in pine and spruce (CFS) 3. Initiatd literature review on environmental effects of Hexazinone and Roundup in Forestry use.	1. Prepared documents on residue analysis protocol for herbicide (CFS)
1986-87 Non-Agreement	1. Refined herbicide residue analysis protocols (CFS)	1. Completed field and lab analysis of herbicide effects on mycorrhizae (CFS)	1. Prepared file reports on literature review of environmental effect of Hexazinone and Roundup in Forestry (CFS) 2. Prepared scientific reports on *in vivo* effects of Pronone on mycorrhizae on spruce and pine seedlings (greenhouse and field tests), and on *in vitro* effects of Roundup, Hexazinone and Triclopyr, on selected mycorhizal species (lab).

WORK PLAN SUMMARY BY YEAR FOR PRIMARY TEST SITE, SATELLITES AND RELATED R & D FOR FOREST VEGETATION MANAGEMENT R & D PROJECT
(Primary Test Site - Grande Prairie)

	Planning/Establishment	R & D	Reports
1987-88 Agreement:	1. Prepare supporting documentation for continuation of Wildlife Toxicology Fund support for small mammal study on Area II (CFS)	1. Supervise contracts for site preparation and planting on site preparation and conifer release areas (II and I) (FRB, R&R, G.P. Forest, CFS) 2. Collect 1st year post-treatment data on areas I and II: -aspen sucker development and root studies (FRB) -efficacy and crop tree studies (CFS) -vegetation (Community change) studies (CFS) 3. Collect water, soil, sediment, and vegetation samples for herbicide residue analysis on area II (CFS, Alta. Envir) 4. Maintain and operate data loggers (CFS) 5. Conduct herbicide residue analysis at NOFC-all materials (CFS) 6. Install protective cages on crop trees (CFS)	1. Report preliminary results of post-application monitoring on area II for residues in soil, sediments, water and vegetation (CFS) 2. Report of 2nd year results of small mammal study from contractor to Wildlife Tox Fund. 3. Present herbicide R&D results and report on Ponone to Expert Committee on Weeds (ECW)-1987 annual meeting (CFS) 4. Prepare annual progress report on control of aspen in areas designated for softwood production, covering all FRB R&D (FRB) 5. Information report on economic analysis of forestry herbicide use (CFS) 6. Preliminary report on cost analysis of forest veg. man. (CFS)

WORK PLAN SUMMARY BY YEAR FOR PRIMARY TEST SITE, SATELLITES AND RELATED R & D FOR FOREST VEGETATION MANAGEMENT R & D PROJECT
(Primary Test Site - Grande Prairie)

	Planning/Establishment	R & D	Reports
1987-88 Agreement: continued		7. Complete lab/greenhouse R&D on environmental factors affecting aspen suckering (FRB) 8. Evaluate and interpret results of stock quality test (FRB) 9. Continue collection and analysis for veg. man. cost data (CFS, R&R) (may include logarithmic sprayer)	7. Prepare progress reports on entire project to Senior Development Officer (CFS) 8. Publish info Report Environment/Harvesting/Site preparation for control of aspen suckering (FRB)

WORK PLAN SUMMARY BY YEAR FOR PRIMARY TEST SITE, SATELLITES AND RELATED R & D FOR FOREST VEGETATION MANAGEMENT R & D PROJECT
(Satellite Test Areas)

	Planning/Establishment	R & D	Reports
1987-88 Agreement:	1. Continue plot establishment of aspen ingress study (Whitecourt) (FRB) 2. Design velpar log-sprayer trial, develop protocol and plan field assessments (FRB)	1. Plant crop trees and do 1st year post-treatment assessment on Satellite A. (FRB) 2. Continue herbicide residue sampling of soil on Satellite A (FRB) 3. Apply herbicide treatments on Satellite B and C and also mechanical treatment on B (FRB) 4. Initiate data processing and interpretation of aspen ingress study (FRB) 5. Data processing and interpretation of satellite aspen suckering results (FRB) 6. Pre-treatment post-treatment assessment on velpar log-sprayer R&D (R&R, FRB)	1. Annual progress report of FRB cited under G.P. Primary Test Site (FRB)
1988-89 Agreement:	1. Continue plot establishment of aspen ingress study (FRB)	1. Measure 2nd year post-treatment on satellite A and 1st year on satellites B and C (FRB) 2. Remeasure and identify site units of aspen ingress plots (FRB) 3. Data processing and interpretation of aspen suckering results (FRB) 4. First year post-treatment assessment on velpar log-sprayer R&D (R&R, FRB)	1. Annual progress report of FRB cited under G.P. Primary Test Site (FRB)

WORK PLAN SUMMARY BY YEAR FOR PRIMARY TEST SITE, SATELLITES AND RELATED R & D FOR FOREST VEGETATION MANAGEMENT R & D PROJECT
(Satellite Test Areas)

	Planning/Establishment	R & D	Reports
1989-90 Agreement:	N/A	1. Measure 3rd year post-treatment results for satellite A and 2nd year for B and C (FRB) 2. Complete processing/interpretation of results from aspen ingress study (FRB) 3. Data processing and interpretation of satellite aspen suckering data (FRB) 4. Second-year post-treatment assessment of log-sprayer R&D (FRB, R&R)	1. Annual progress report of FRB cited under G.P. Primary Test Site (FRB) 2. Final reports on satellite A and aspen ingress plots to be prepared (FRB)

WORK PLAN SUMMARY BY YEAR FOR PRIMARY TEST SITE, SATELLITES AND RELATED R & D FOR FOREST VEGETATION MANAGEMENT R & D PROJECT
(Primray Test Site-Grande Prairie)

	Planning/Establishment	R & D	Reports
1988-89 Agreement:	1. Prepare permit request for chemical treatment on conifer release area (I) (CFS, R&R) 2. Prepare contracts for chemical and manual release on conifer release area (I) (R&R)	1. Collect 2nd year post-treatment data on area I and II: -aspen sucker development and root studies (FRB) -efficiency and crop trees studies (CFS) -vegetation (community change) studies (CFS) 2. Collect 2nd year water, soil, sediment and vegetation samples for herbicide residue analysis on area II (CFS, Alta. Envir.) 3. Conduct herbicide residue analysis-all materials (CFS) 4. Maintain and operate data loggers on area II and summarize and interpret data (CFS) 5. Data processing and interpretation of field and lab aspen suckering data (FRB) 6. Continue collection and analysis of veg. man. cost data (CFS,R&R)	1. Prepare 2nd year report on post-application monitoring of herbicide residues on area II (CFS) 2. Report herbicide R&D results on Pronone to ECW (CFS) annual meeting. 3. Prepare annual progress report on control of aspen in areas designated for softwood production (FRB) 4. Report on results of stock quality tests (FRB) 5. Prepare progress reports on entire project to Senior Development Officer (CFS)

WORK PLAN SUMMARY BY YEAR FOR PRIMARY TEST SITE, SATELLITES AND RELATED R & D FOR FOREST VEGETATION MANAGEMENT R & D REPORT
(Primary Test Site - Grande Prairie)

	Planning/Establishment	R & D	Reports
1989-90 Agreement contract:	N/A	1. Supervise contract for spring chemical and manual treatment on conifer release area (I) (CFS, R&R) 2. Collect 1st season data for chemical treatment on area I on soils, sediments, water and vegetation for residue analysis (CFS, Alta Envir) 3. Collect 3rd year water, soil, sediment and vegetation sample for herbicide residue analysis on area II (CFS, Alta Envir) 4. Conduct herbicide residue analysis - all materials (CFS) 5. Collect 3rd year post-treatment data on areas I and II: -aspen sucker development and root studies (FRB) -efficacy and crop tree studies (CFS) -vegetation (community change) studies (CFS) 6. Maintain and operate data loggers on area II and summarize data (CFS)	1. Prepare 3rd year report on post-application monitory of herbicide residues for area II and 1st year for area I (CFS) 2. Prepare final report on factors affecting aspen suckering in field (include satellites) and lab/greenhouse (FRB) 4. Prepare final reports on efficacy and crop tolerance and community change on area II (CFS) 5. Prepare preliminary report on efficacy, crop tolerance and community change on area I (CFS) 6. Prepare final report on economic assessment of costs of veg. man. (CFS) 7. Prepare final status report to Senior Development Officers (CFS)

WORK PLAN SUMMARY BY YEAR FOR PRIMARY TEST STIE, SATELLITES AND RELATED R & D FOR FOREST VEGETATION MANAGEMENT R & D PROJECT
(Primary Test Site - Grande Prairie)

	Planning/Establishment	R&D	Reports
1989-90 Agreement: continued	N/A	7. Complete lab/greenhouse R&D on environmental factors effecting aspen suckering (FRB) 8. Complete collection and analysis of forest veg. man. cost data (CFS, R&R)	

APPENDIX IV

RESOURCES FOR VEGETATION MANAGEMENT PROJECT AND RELATED R & D ($X1000 and PYs)

	1985-86					1986-87					1987-88					1988-89					1989-90					TOTALS
	CFS			AFS		CFS			AFS		CFS			AFS		CFS			AFS		CFS			AFS		
	Silv.	Econ.	Envir.	FRB	R&R	Silv.	Econ.	Envir.	FRB	R&R	Silv.	Econ.	Envir.	FRB	R&R	Silv.	Econ.	Envir.	FRB	R&R	Silv.	Econ.	Envir.	FRB	R&R	
A). O & M																										
Agreement	15	-	15	34	-	41.5	-	96.8	83	15	44	-	86.8	62	25	15	-	58.8	60	-	20	-	68.6	58	9.5	886.0
Non-Agree	10	-	10	8.8	-	10	-	10	14.7	-	14	-	32	15	12	12	-	37	15	12	12	-	30	15	12	281.5
B). Capital																										
Agreement	-	-	-	15	-	22	-	36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	73.0
Non-Agree	-	-	-	-	-	-	-	250	-	-	-	-	46	-	-	-	-	50	-	-	-	-	-	-	-	346.0
TOTALS:																										
Agree:	15	-	15	49	-	63.5	-	132.8	83	15	44	-	86.8	62	25	15	-	58.8	60	-	20	-	68.6	58	9.5	879.0
Non-Agree:	10	-	10	8.8	-	10	-	260	14.7	-	14	-	78	15	-	12	-	87	15		12	-	30	15	-	627.5[1]
C). PYs																										
Agreement:																										
Prof.	-	-	-	1.0	-	-	-	-	1.0	-	-	-	-	1.0	-	-	-	-	1.0	-	-	-	-	1.0	-	5.0
Tech./Student	-	-	-	-	-	0.7	-	1.0	-	-	0.7	-	1.0	-	.5	0.5	-	1.0	-	.5	0.5	-	1.0	-	.5	7.5
Term	-	-	0.5	-	-	-	-	0.6	0.5	-	-	-	0.6	0.5	-	-	-	-	0.5	-	-	-	-	0.5	-	5.5
Non-Agreement:																										
Prof.	0.5	0.1	0.7	0.2	0.1	0.5	0.1	1.6	0.2	0.1	0.4	0.2	1.6	0.2	0.1	0.5	0.2	1.6	0.2	-	0.5	0.2	1.6	0.2	0.1	11.5
Tech./Student	0.5	-	0.7	0.1	-	0.5	-	1.8	0.1	-	1.0	0.1	1.8	0.1	-	1.0	0.1	1.8	0.1	-	1.0	0.1	1.8	0.1	-	12.7
Term	-	-	-		-	-	-	0.5	-	-	-	-	0.5	-	-	-	-	0.5	-	-	-	-	0.5	-	-	1.2
TOTALS:																										
Agree:	-	-	0.5	1.0	-	0.7	-	1.6	1.5	-	0.7	-	1.6	1.5	-	0.5	-	1.0	1.5	-	0.5	-	1.0	1.5	-	14.5
Non-Agree:	1.0	0.1	1.4	0.3	0.1	1.0	0.1	3.7	0.3	0.1	1.4	0.3	3.7	0.3	0.1	1.3	0.3	3.7	0.3	-	1.3	0.3	3.7	0.3	0.1	26.7[2]

[1] Does not include A-base salaries of $55,000 from Tax Fund for Small Mammal R&D and includes substantial increases in projected capital and O&M for CFS Envir. for 1987 to 1990.

[2] Does not include 1.6 PY P.D.F. in first 2 years (CFS)

APPENDIX V

SATELLITE SITES TO COMPLEMENT VEGETATION MANAGEMENT R & D ON THE PRIMARY TEST SITE, GRANDE PRAIRIE

Calling Lake: Satellite Trial A

The objective of this trial is to test various chemical and mechanical site preparation treatments in the control of aspen sucker development on areas where aspen has been previously cut and piled. This could simulate the aspen conversion situation encountered via the MOF projects.

The site preparation treatments were completed in the fall of 1986. They are: Rome disc, martiini plow, straight blade, and hexazinone spraying (aerial simulating). Martiini plowing was done on 2 treatment areas one of which will be released with hexazinone when and if necessary.

The trials is set out in 4 replicate blocks of 5 treatment blocks and 1 control block. Within each block are 20 plots which will be assessed yearly for aspen sucker density and condition.

Soil temperature profiles are being monitored on the control, marttiini, disc and blade sites of replicate one.

The herbicide application permit stipulated that careful soil residue monitoring would have to be undertaken for the next few years (an unexpected expense).

Pre-treatment base line data was collected and will be condensed and analyzed.

Peace River Satellite Trial B

The original tentative plan for Satellite trial B has been altered. The trial is now designed to compare 6 preharvest chemical applications

- glyphosate hack and squirt at 2 rates
- hexazinone spotgun at 2 grid densities
- liquid hexazinone hack and squirt vs. tablet injection

and 3 discing trials

- single pass
- double pass
- 2 passes at different times of the same year

for efficacy of aspen sucker density control after cutting and piling of a young pure aspen stand. The results of this trial may be useful in developing stand conversion strategies.

This trial was established in the same design as Satellite trial A. The parent stand has been assessed and the application is scheduled for spring 1987 followed by 2 years of post-treatment assessment.

Hines Creek: Satellite Trial C

This trial is designed to test 4 preharvest single-tree chemical applications for efficacy in post-harvest aspen sucker control in a mature mixed-wood stand. The chemical applications to be tested are:

- Swedish injector gun - hexazinone tablets - recommended dose
- Swedish injector gun - hexazinone tablets - 2 x recommended dose
- Modified hack and squirt application of hexazinone liquid
- Modified hack & squirt application 2,4-D

Treatments are replicated 4 times. Application is scheduled for spring 1987 followed by 2 years of post-treatment assessment.

Edson Forest - Aspen Ingress Study

The aspen ingress study is designed to define the extent and severity of aspen seedling competition faced by softwood crop trees. Fifty plots were established in the Edson forest. These plots determine the number of aspen seedlings and their height and age relative to crop trees. More plots are to be established and all plots will be monitored each year until 1989.

APPENDIX VI

AUTOMATED ENVIRONMENTAL MONITORING SYSTEM FOR FOREST VEGETATION MANAGEMENT R & D PROJECT - PRIMARY TEST SITE, GRANDE PRAIRIE - CANADA-ALBERTA FRDA

Automated electronic environmental monitoring equipment was installed at the Grande Prairie herbicide test site in May of 1986 prior to any chemical or mechanical treatments of the plots.

There are 3 identical monitoring stations located as indicated in Figure 1 on the borders between adjacent treatment plots. The positions were chosen for similar height, species composition and density of surrounding vegetation.

Each station is equipped with a silicon pyranometer, an atmospheric temperature/relative humidity sensor and a tipping-bucket rain gauge as shown in Figures 2 and 3. Soil conditions 15 m from the plot borders on both sides of the stations are monitored at 15 and 30 cm depth in 3 places using copper-constantan thermocouples and Coleman fiberglass soil moisture sensors. Sensor monitoring is performed by a Campbell Scientific 21X data logger augmented by a custom manufactured analog signal multiplexer which time-shares the soil sensors. All other sensors are wired directly into the micrologger. The 21X is programmed to report hourly averages of air temperature, relative humidity and solar radiation computed from 50 one-minute samples. Soil temperature and moisture are sampled twice daily at noon and midnight. Precipitation totals are also reported at noon and midnight. Mass data storage is on an audio cassette tape recorder located inside the subenclosure with the data logger and multiplexer. As backup for the tapes, each data logger has sufficient memory to hold 3 month's data as long as continuous power is maintained.

Data from the tapes is dumped to a microcomputer via a translator where it is sorted into files by data type and date. The data will be ported to the VAX minicomputer and printed copies of daily data summaries will also be made available upon request.

FIGURE 1 AREA MAP

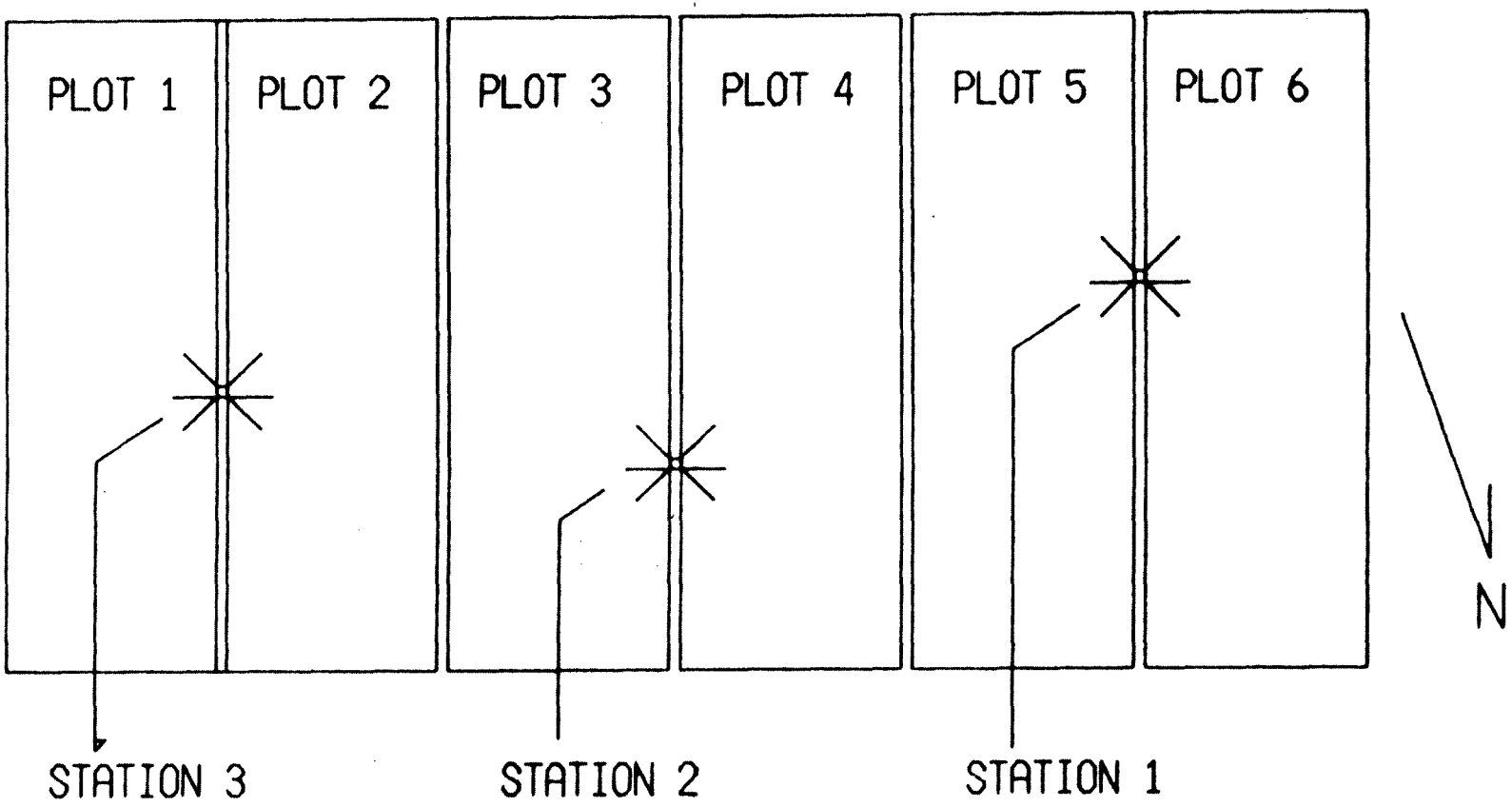


FIGURE 2 STATION LAYOUT

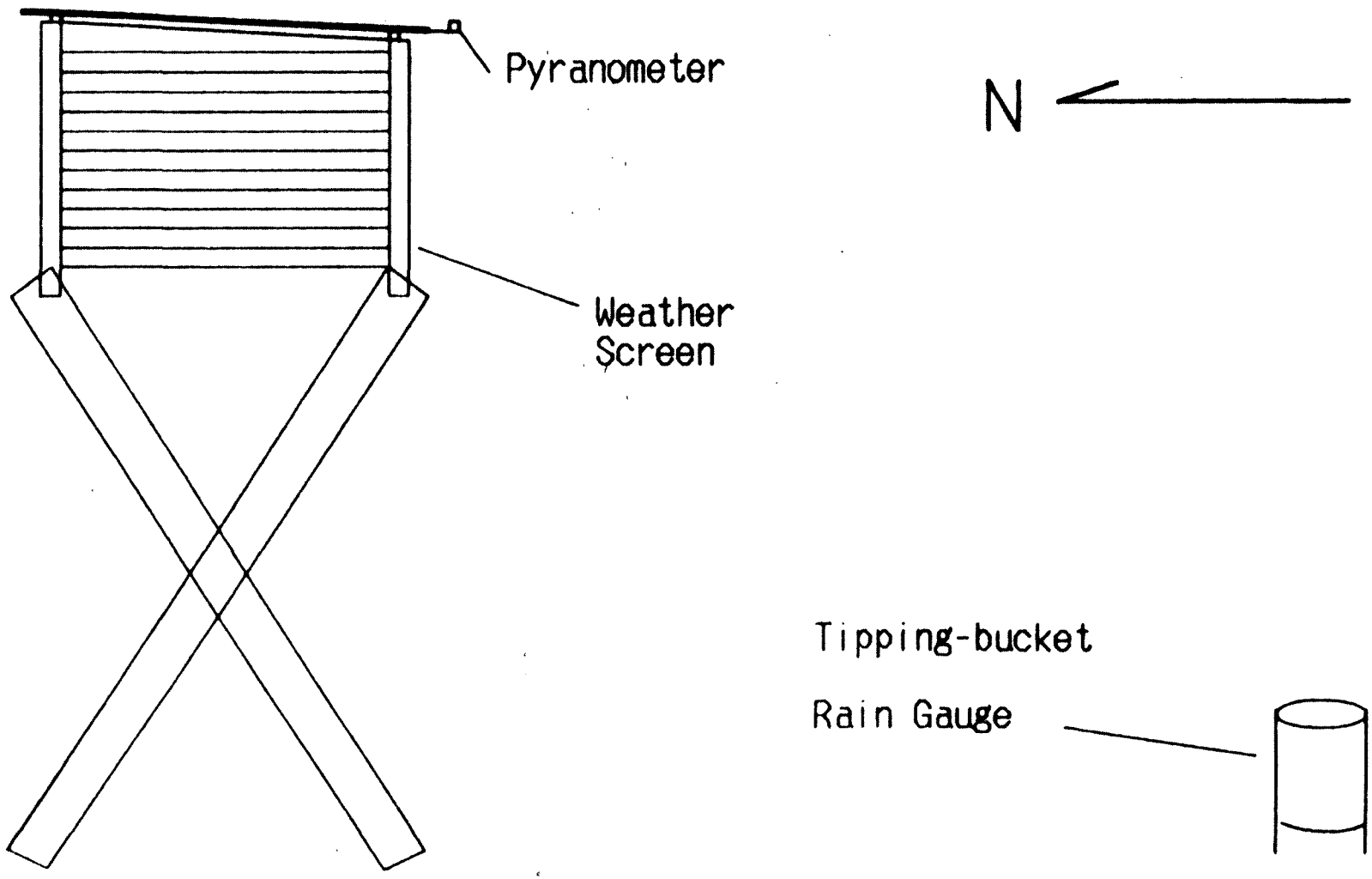
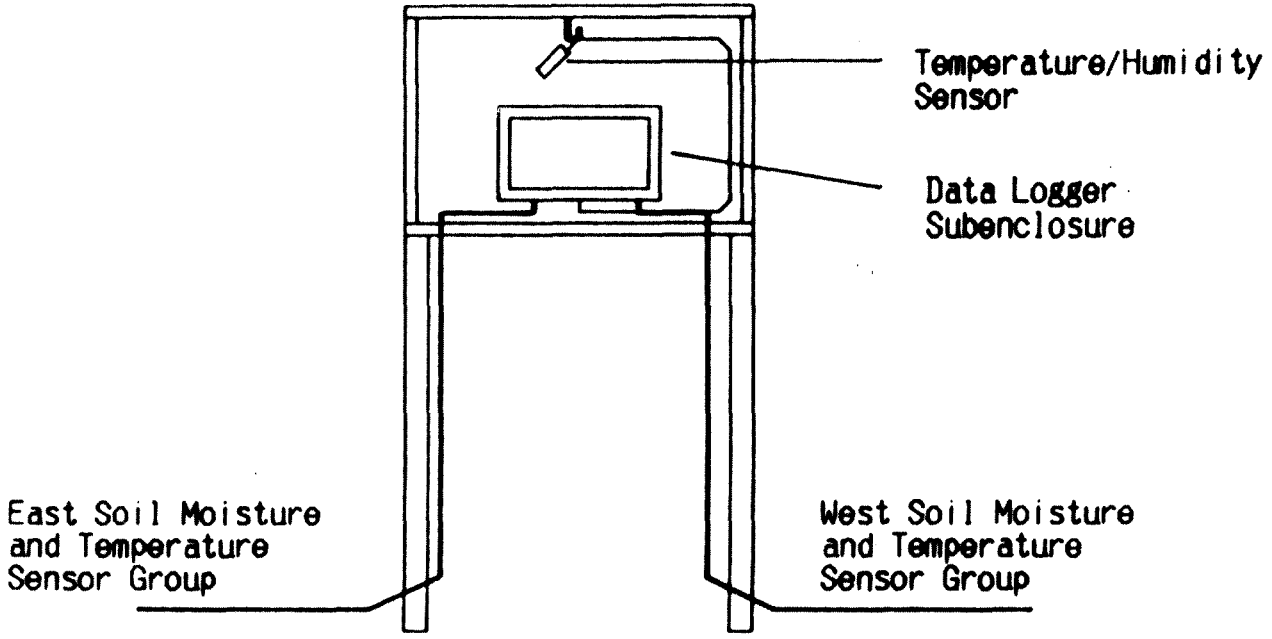


FIGURE 3 WEATHER SCREEN INTERNAL LAYOUT



APPENDIX VII

WATER SAMPLING PROTOCOLS FOR THE FOREST VEGETATION MANAGEMENT R & D PROJECT, GRANDE PRAIRIE - CANADA-ALBERTA FRDA

OBJECTIVES

To study the persistence, degradation as well as lateral and downward movement of hexazinone within the soil free water from a surface application (1986) of granular Pronone 10G.

To study the movement, persistence and degradation of hexazinone within surface waters along the local drainage system.

METHODOLOGY

To study hexazinone characteristics and movement in the soil free water, three soil pits were constructed. The location of the pits within the Method II site is indicated in Figure I. All three sites were constructed on the south end of the plots as the drainage and slope extend to the south. Soil pit X_1 was located 1 m inside the treatment area, X_2 was 4 m inside and X_3 was 4 m inside the treatment plot. The soil pits were constructed as indicated in Figure II and III using a backhoe to create a smooth vertical face. A coring drill was used to make 45 cm horizontal tunnels for the 60 X 5 cm PVC perforated pipes. Dry topping grouting was mixed and used to close up and stabilize the hole opening after pipe insertion. Grouting was used to prevent surface waters from trickling down the pit face and flowing along the PVC pipe and into the perforated 1 cm openings. Finally a snow fence was installed around the perimeter of the soil pit to prevent personnel and wildlife from falling into the pit as well as to prevent wildlife damaging the plastic bottles on the face of the pit.

Sampling dates were and will be as follows:

1. December 17/86 a composite sample from each pit was collected. Every bottle held approximately 0.5-1.0 cm of water so only one composite, all horizon sample could be taken from each pit.
2. Sampling will continue as water accumulates in the bottles. When sufficient water drains in the bottles (3 cm+), a composite sample will be taken from each horizon in each pit, to determine the extent of hexazinone penetration within the soil structure.

To study the movement, persistence and degradation of hexazinone within surface waters, designated sampling sites were established along the surface water drainage system as indicated in Figure IV. The description of the sample collection points are as follows:

1. Sampling site 1 is at the origin of a small intermittent stream which drains the collection area for the method II blocks. The site is located 34 m from the northeast corner of the sprayed mammal study area (not shown in the diagram, this area is located immediately north of blocks 1 and 2 in Method II).
2. Sampling site 2 is on the southeast corner of the beaver dam on the intermittent stream. This site is approximately 2.2 km downstream from collection point 1.
3. Sampling site 3 is on the intermittent stream immediately before the second and third beaver dams. This site is approximately 3.4 km downstream from collection point 1.
4. Sampling site 4 is on Campbell Creek, upstream 100 m from where the intermittent stream flows into Campbell Creek. This site is approximately 4.5 km downstream from collection point 1.

5. Sampling site 5 is on Campbell Creek on the east edge of the 4th beaver dam. This site is approximately 6.25 km downstream from collection point 1.
6. Sampling site 6 is on Campbell Creek at the intersect of the creek and the grazing reserve cutline road. This site is approximately 7.3 km downstream from collection point 1.
7. Sampling site 7 is at the point where Campbell Creek flows into Bald Mountain Creek. This site is approximately 8.5 km from collection point 1.

Sampling proceeded from the expected lowest concentration (site 7) to the expected highest concentration (site 1) of hexazinone. Water soil samples were collected in the following manner:

1. Water sampling - Capped 500 ml polyethylene bottles were submerged 5 cm under water, with the cap facing upstream. The cap was removed, the bottle was allowed to fill to within 2 cm of the top, and the cap replaced. The bottle was then removed from the water and labelled appropriately. Duplicate samples were collected.
2. Sediment sampling - Wearing disposable gloves, surface sediments were collected from within 30 cm of the water's edge using a disposable paint stir stick. The sediment was squeezed through a 20 cm square fibreglass screening to remove as much water as possible from the sample. The sample was then put in 1 L plastic bags, and labelled. Duplicate samples were also collected. The disposable gloves, stir sticks and fibreglass screening were replaced after each sampling site.

All samples were then double bagged, frozen and sent for analysis. Sampling dates were and will be as follows for surface water sampling:

1. A pretreatment sample taken August 28/86 (treatment August 29/86).
2. 77.5 mm of rainfall fell in September/86, therefore, sampling was delayed until the rain stopped (approximately October 14/86. All 7 sites were sampled.
3. Future samples will be taken 24-48 hours after occurrence of a rainfall in excess of 12.5 mm.

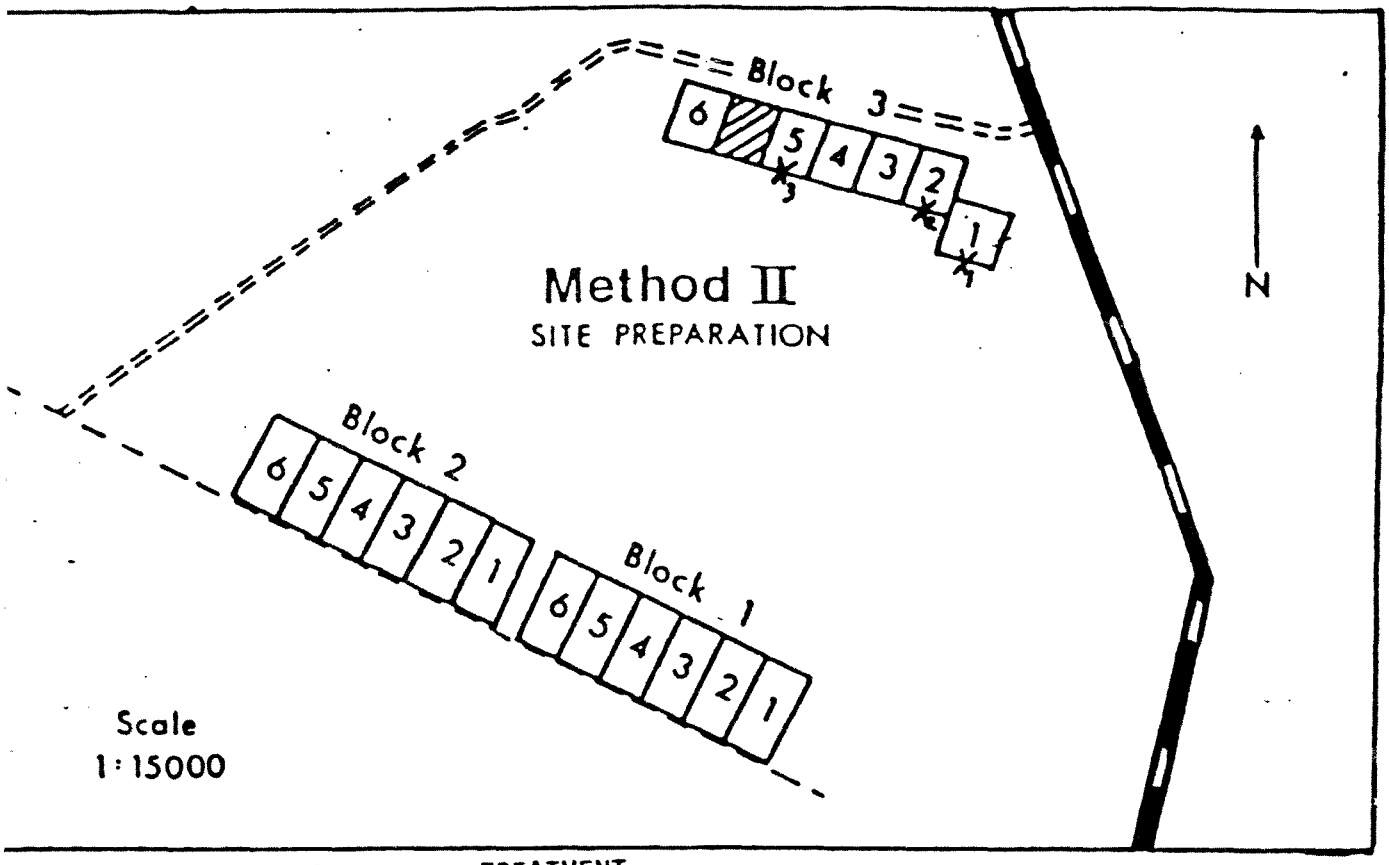
FIGURE 1

FOREST VEGETATION MANAGEMENT R & D PROJECT

CANADA-ALBERTA AGREEMENT

BRANDE PRAIRIE, ALBERTA

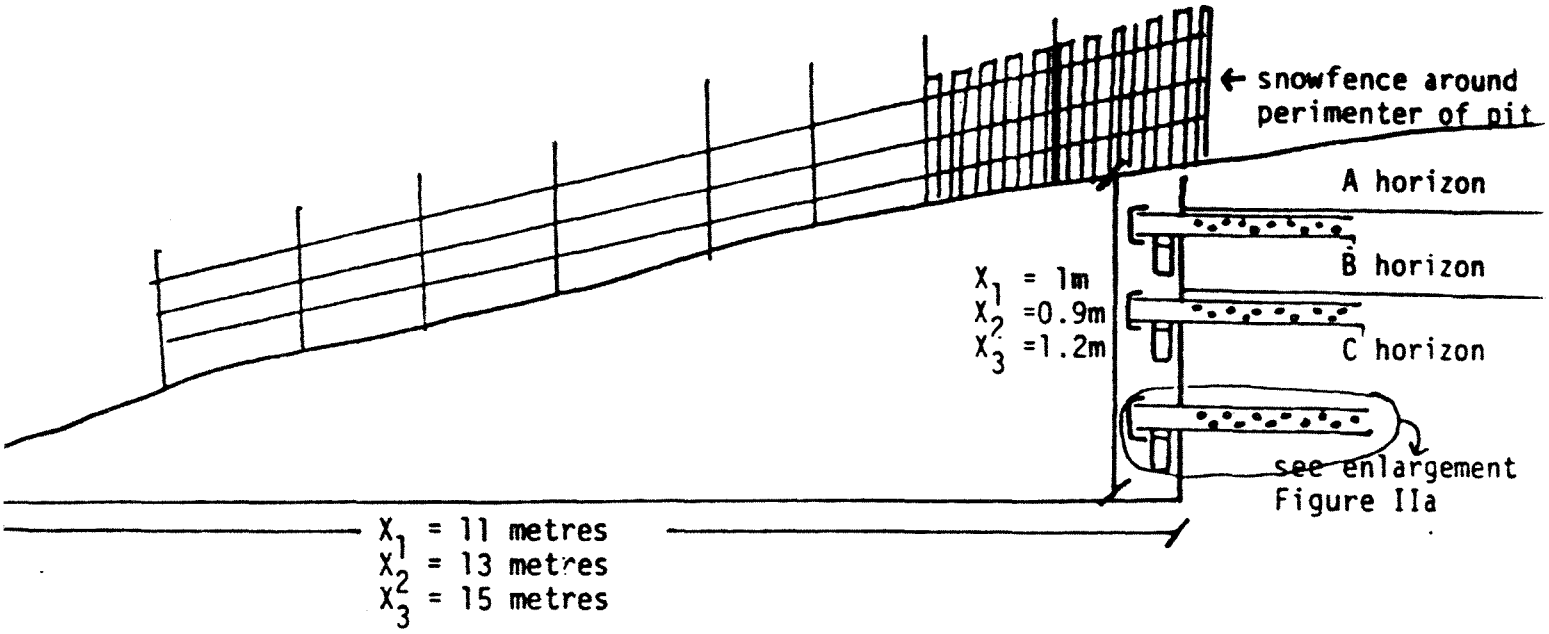
METHOD II SITE PREPARATION



PLOT NO.	TREATMENT
1	4kg. A.I. hexazinone/hectare
2	2kg. A.I. hexazinone/hectare
3	4kg. A.I. hexazinone/hectare + mechanical treatment
4	2kg. A.I. hexazinone/hectare + mechanical treatment
5	control
6	mechanical treatment only
▨	roads & landings
$X_{1,2,3}$	location of soil pits

FIGURE II

CROSSECTION OF SOIL PITS



SLOPE OF THE LAND AT THE SOIL PITS

X_1 = 7.5%
X_2 = 2.1%
X_3 = 1.2%

* length of the soil pit was determined by the slope of the land - the greater the slope, the shorter the pit needed to be to get proper drainage

. the depth of the soil pit was determined by the depth of the A and B horizon

FIGURE IIa
ENLARGEMENT OF THE PVC PIPE INSTALLATION

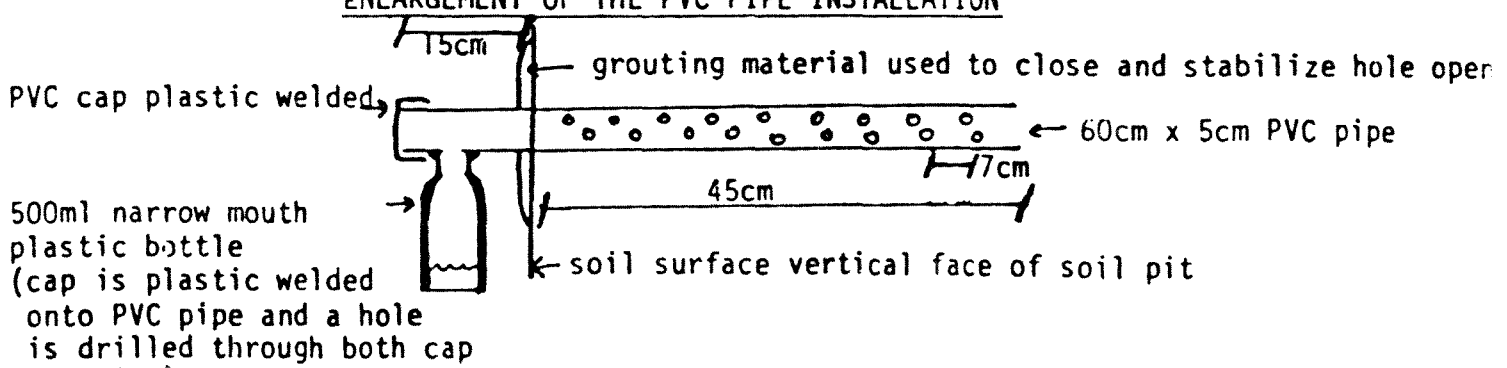


FIGURE III

FRONT VIEW (VERTICAL FACE) OF SOIL PITS

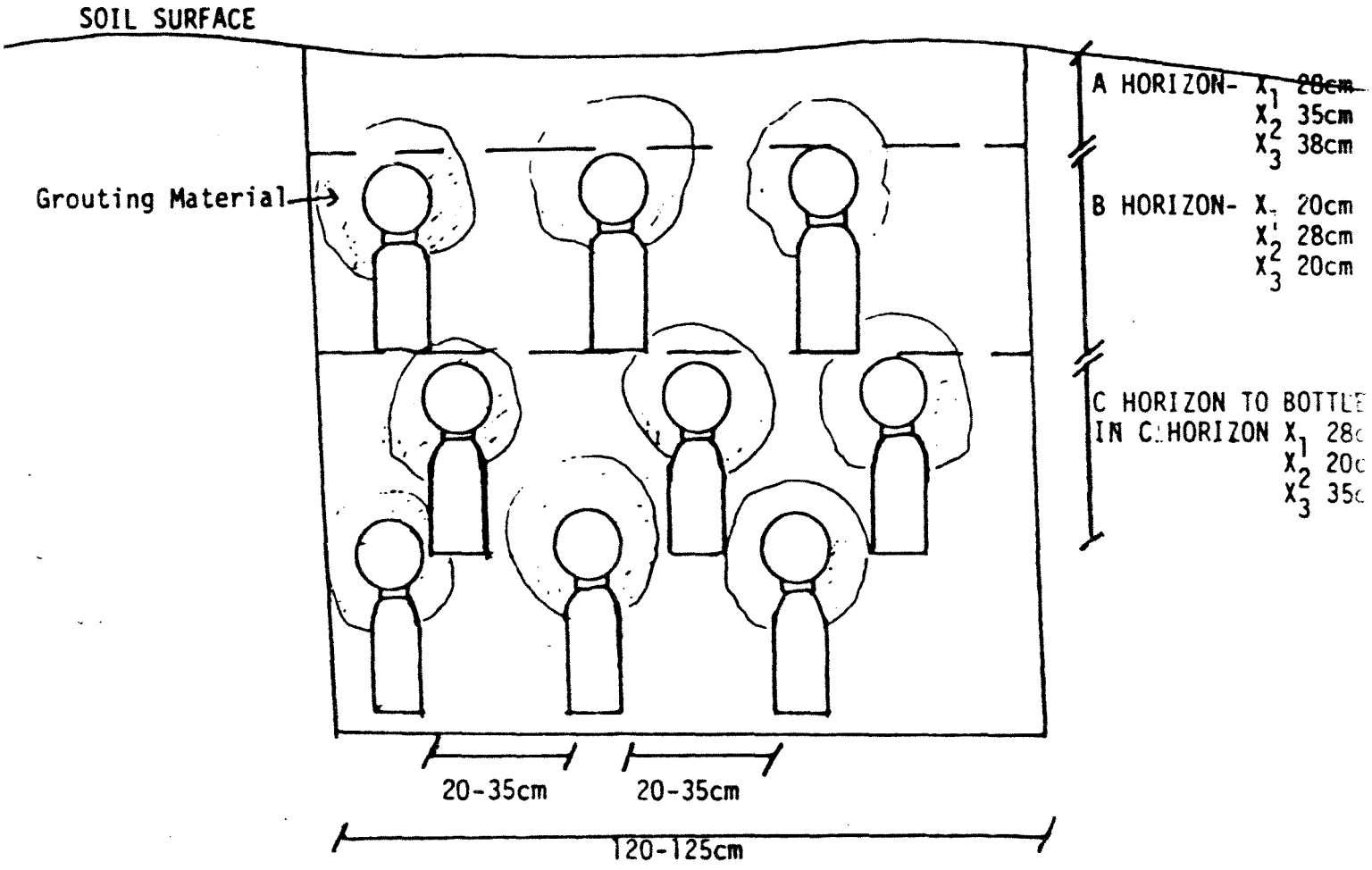


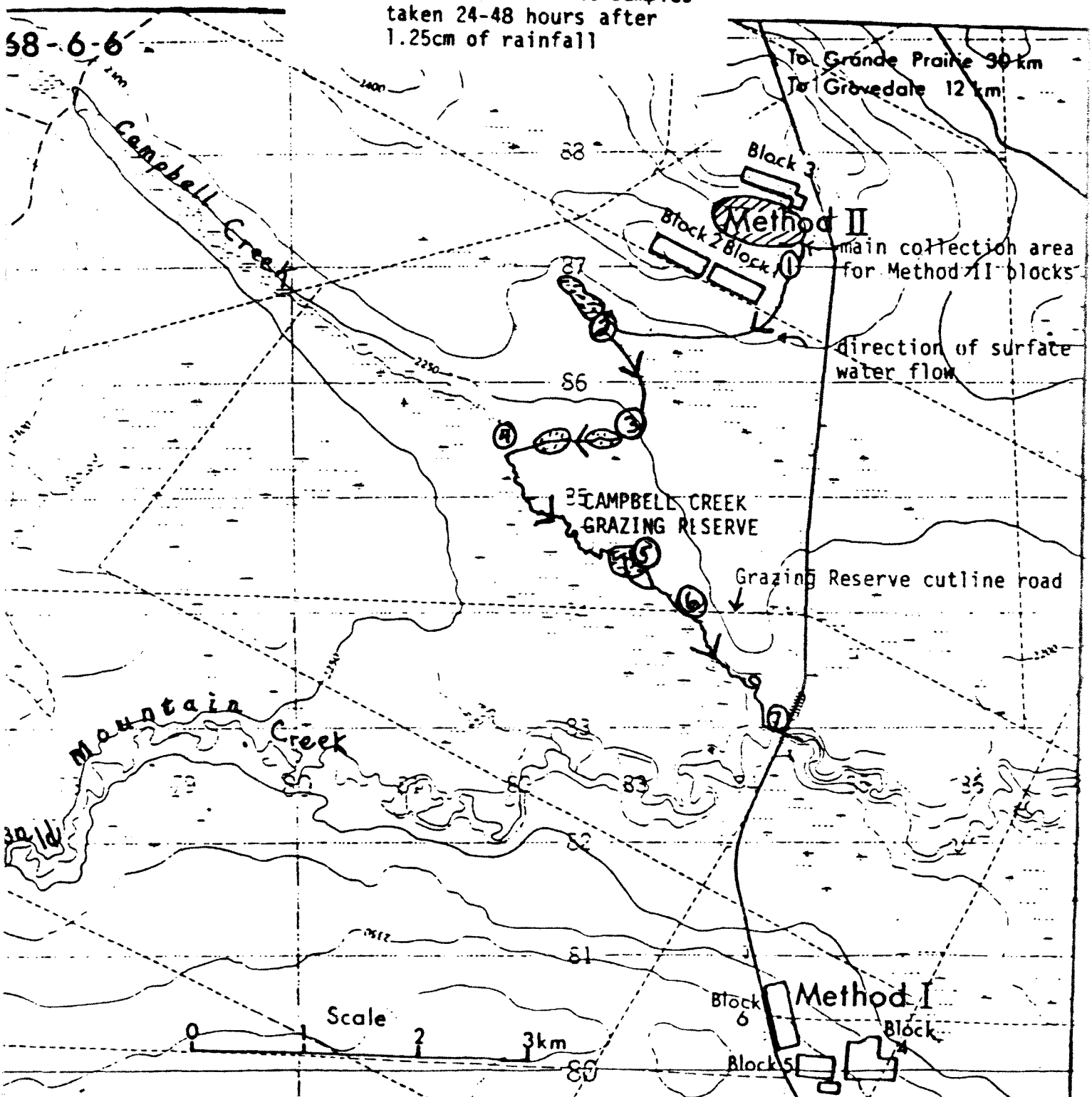
FIGURE IV

FOREST VEGETATION MANAGEMENT R&D PROJECT

CANADA-ALBERTA AGREEMENT

GRANDE PRAIRIE, ALBERTA

1-6 - Sample Collection Points
water and sediment samples
taken 24-48 hours after
1.25cm of rainfall



APPENDIX VIII

EFFECT OF PRONONE ON NUTRIENT CYCLING AND LITTER DECOMPOSITION

Purpose:

To determine (i) if the herbicide Pronone can affect the dynamics of N, P, and S transformations in surface organic horizons and (ii) if litter decomposition in the field is effected directly by herbicide application or by herbicide caused changes in vegetation.

Methods:

(a) Plot Establishment and Layout - Fifteen 8 X 8 m plots were established in an aspen-dominated clearcut May 25-27, 1987 (see Figures 1 and 2).

(b) Herbicide Application - Five plots will be left as controls, five treated with 2 kg a.i./ha, and five with 4 kg a.i./ha of the herbicide Pronone. Preweighed quantities of Pronone will be hand-applied to each of sixty-four 1.5 X 1.5 m portions of each plot to achieve uniform distribution. The application is planned for the spring of 1988.

(c) Soil Sampling - Baseline soil chemical conditions will be determined in 1987 prior to the herbicide application. Two sets of soil samples will be taken. The initial soil sampling was done June 23-25, 1987 and a second set will be taken in September. Monitoring will continue for two years (minimum), through the summer of 1989. The soil was sampled by horizon to the depth of the B_{nt} (B_t) horizon. Extractable and total nutrient concentrations will be determined on all samples. Elements to be analyzed include N, P, and S along with the basic cations Ca, Mg, K, and Na. Moisture content, pH, and Mn will also be determined. Standard

methodology (many developed in this lab) will be used for the total and extractable determinations. Further fractionating of N, P, and S components will be considered to provide further information on the nutrient dynamics.

(d) Litter Fall Collectors - Litter fall collectors 20 X 20 cm (2.5 cm walls) will be set up at 20 locations in August and tested. If the installation and initial litter fall results are promising an additional 40 collectors (make 20 per treatment) will be installed this fall.

(e) Litter Decomposition Study - Litter bags of 1-mm nylon mesh (15 X 15 cm) will be used to determine the decomposition rate of litter in the field. In addition polyethlene bags containing soil may be used to provide field mineralization rates for N.

(f) Zero Tension Lysimeters - Zero tension lysimeters were set up at 60 subplots (20 per treatment) in May and June. The lysimeters are at the LFH-mineral soil interface. The bottles are changed following any significant rainfall events.

Additional laboratory studies are planned for this winter in the growth chamber.

FIGURE 1

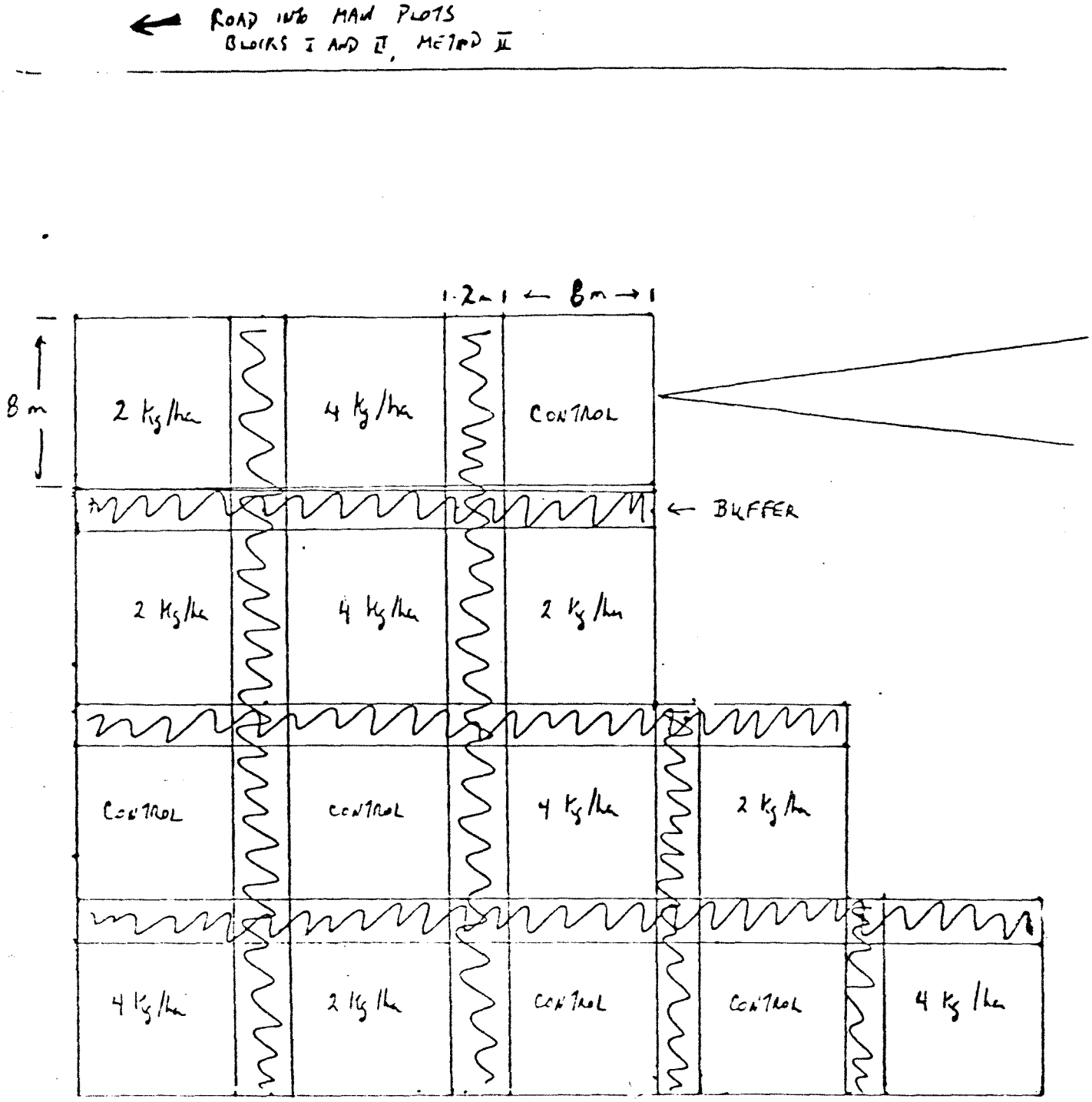
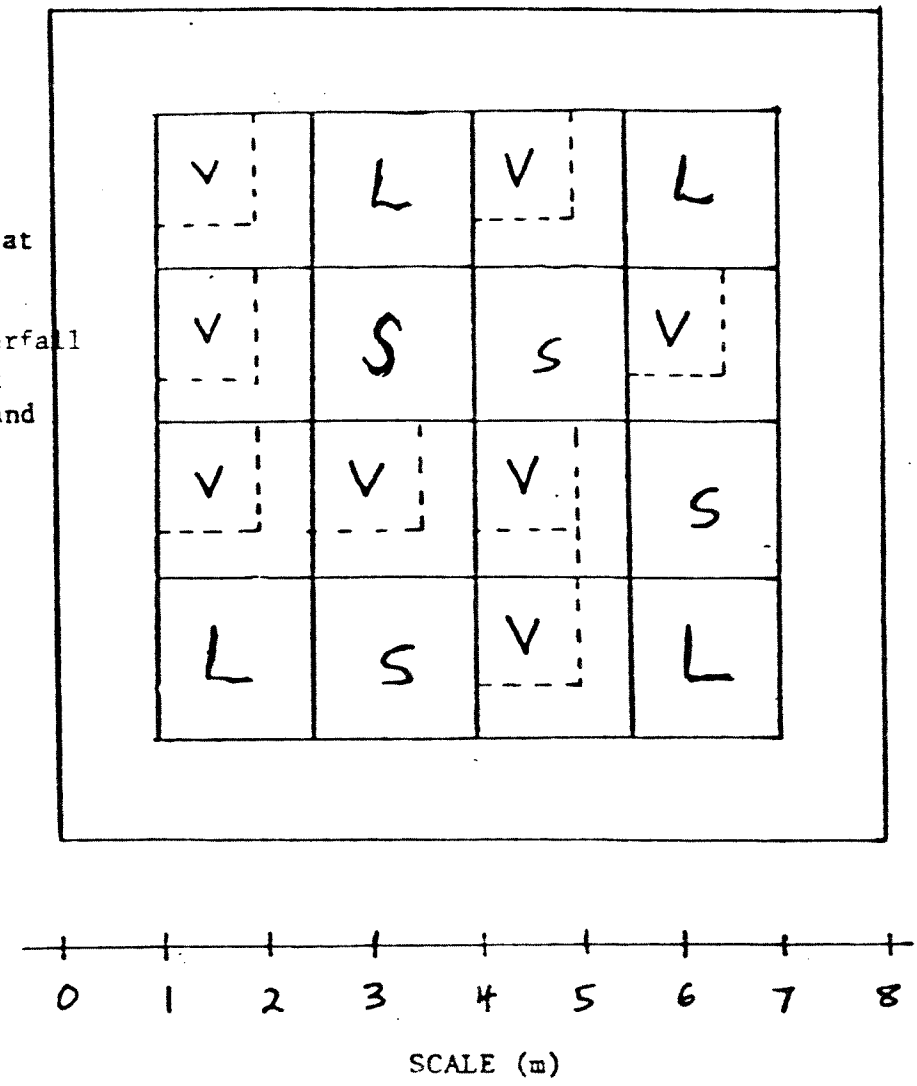

ROAD INTO MAIN PLOTS
BLOCKS I AND II, METHOD II
1.2m
8m
8m
2 Kg/ha
4 Kg/ha
CONTROL
BUFFER
2 Kg/ha
4 Kg/ha
2 Kg/ha
CONTROL
CONTROL
4 Kg/ha
2 Kg/ha
4 Kg/ha
2 Kg/ha
CONTROL
CONTROL
4 Kg/ha

FIGURE 2

PLOT LAYOUT EXAMPLE

Legend

V - vegetation quadrat (dashed line)
S - soils subplot
L - Lysimeter & litterfall
N.B. - point-quadrat estimates in left-hand column.



APPENDIX IX

PROTOCOLS MANUAL FOR QUALITY CONTROL AND PROCEDURES: MONITORING EFFECTS OF PRONONE 10G HERBICIDE ON SMALL MAMMALS UNDER FIELD CONDITIONS ON FOREST VEGETATION MANAGEMENT R & D PROJECT - GRANDE PRAIRIE

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1.0 INTRODUCTION

This manual provides a detailed outline of procedures and protocols that are designed to provide quality control for the small mammal monitoring program to assess the effects of Hexazinone (PRONONE) herbicide under field conditions.

The small mammal monitoring study is coordinated to support a "Forest Vegetation Management Project", which is being developed and conducted within the Canada-Alberta Forest Resource Development Agreement, under Program Activity B; Sub-program B.3 (Forest Research, Development and Demonstration). It is a joint program of the Northern Forestry Centre (CFS) and the Research and Reforestation and Reclamation Branches of the Alberta Forest Service, with shared roles in planning, management, and implementation.

The small mammal monitoring study is supported by the Wildlife Toxicology Fund/World Wildlife Fund and Alberta Fish and Wildlife Division.

The procedures outlined in this manual will be revised when necessary to incorporate any new considerations for refinement of methodologies and techniques required to provide a scientifically sound documentation of small mammal populations and any tissue residues of Hexazinone.

2.0 OBJECTIVES

The objectives of the research are:

a. to obtain an estimate of pre-treatment population levels of small mammals, particularly mice and voles, on the vegetative management project area at Grande Prairie in the summer and fall of 1986.

b. to measure small mammal population characteristics through a four-year period from 1986 through 1989, covering a complete natural population cycle, to determine herbicide treatment effects on the small mammal populations.

c. to monitor small mammal populations, reproductive success, behavior and species composition to determine if any changes may be treatment-related and to tie such observations to forage and tissue analysis data and habitat change data being obtained in the source of the main experiment on the vegetation management research area.

d. to collect samples of representative small mammal species for tissue analysis of Hexazinone residues to establish potential uptake, persistence and possible consequences of the use of Hexazinone herbicide on the food chain.

3.0 METHODOLOGIES

3.1 Study Approach

The field study is designed to examine four main types of potential effects that application of hexazinone may have on resident populations of small mammals.

a. Acute toxic effects: Assessed by monitoring small mammal population abundance and behavior immediately before and following herbicide application.

b. Chronic and sub-chronic toxicity effects: Assessed by monitoring small mammal population abundance, reproductive success and behavior during three subsequent summer seasons.

c. Effects of habitat change: Assessed by monitoring the relative abundance and species composition of small mammals and correlation of captures with habitat at trapping stations.

d. Detection of herbicide residues to determine uptake, persistence, and possible consequences in the food chain.

The underlying hypothesis is that although PRONONE herbicide has been shown to have no major toxic impact and no significant bio-accumulation was found in small mammals under laboratory conditions.

The present state of knowledge of the effect of PRONONE herbicide (Hexazinone) on smaller mammals is limited to laboratory studies to determine chronic oral toxicity to rats and rabbits, and mutagenecity in rats and hamsters. These research results are available from registration data submitted to Agriculture Canada, Pesticide Division, and are considered acceptable as a basis for registration. Results of such tests are summarized in a recent DuPont publication on the use of hexazinone (DuPont 1984), and are summarized along with data for a variety of forestry herbicides in a recent publication by Walstad and Dost (1984). These authors note that toxic effects of forest herbicides on wildlife have not been scientifically documented to date and the impacts appear to the limited primarily to habitat change. In cases where herbicide residues have been detected in the bodies of wildlife, levels have been so low that toxicity effects on other animals in the food chain would be expected to be below chronic or sub-chronic toxicity levels established for laboratory animals.

There appears to be a lack of research on the possible effects of PRONONE (Hexazinone) on small mammals under field conditions and interpretation of such information would be dependent on a reliable estimate of population levels on both treated and control areas and detection of herbicide residues in animal tissues. This is of particular interest in boreal forest on cold, fine-textured northern soils (on the boreal forest site near Grande Prairie) where persistence and mobility of Hexazinone may be different than that established for more southern habitats.

3.2 Population Monitoring

3.2.1 Sampling Design for Live-Trapping

The location of two control and two experimental live-trapping grids on the Method II Study Area are shown in Figure 1.

The sampling design for small mammal monitoring includes two sets of paired plots. These are spatially separated form the treatment Blocks, to provide two spatial control plots and two experimental or treatment plots. Each plot contains a grid of 56 live-traps arranged in 7 rows by 8 columns, with trapping stations at 15-m intervals. Plots are spaced a minimum of 80-m apart to limit inter-plot movements by small mammals.

The experimental plots received an application of hexazinone herbicide on August 28, 1986 at a rate of 4 kg a.i./ha (the maximum rate of treatments under investigation). In addition to the trapping grid, herbicide application included an 80-m buffer around the experimental plots to include the home ranges of animals captured in the grid.

Small mammal trapping will be conducted for eight consecutive trap-nights per trapping session (i.e. a nine-day period). This duration of trapping is based on monitoring studies in the Swan Hills that found about 90%

of trappable, resident deer mice and red-backed voles are accounted for by at least day seven of a trapping program (Penner 1986). This trapping effort permits a high level of precision in population estimates for these species. Meadow voles are less susceptible to capture, however, and the data requires analysis for population estimates if these species occur on the site.

3.2.2 Live-Trapping Schedule

1986	Pretreatment	- mid-summer	July 23-30
	Pretreatment	- late summer	August 19-27
	Post-treatment	- late summer	August 29 to September 5
1987-89	Post-treatment	- early summer	June 20-30
	Post-treatment	- mid-summer	July 20-30
	Post-treatment	- late summer	August 20-30

3.2.3 Live-Trapping Procedures

Small mammal species composition and population characteristics will be monitored by standard live-trapping techniques. One Sherman live-trap will be placed at each trapping station, baited with whole oats and peanut butter, furnished with polyester "quilt batting" for nesting material and protected with a shade cover where necessary. All traps will be examined for small mammal captures twice each day between 0700-1000 hours and 1800-2100 hours. Each captured animal will be given an individual number designated by a metal ear tag and toe clipping and released at the point of capture. The following data will be recorded for each capture: species, identification number, general physical condition (health), breeding status, sex, age, weight, location of capture (grid and trapping station), and behavior. Behavioral responses of animals to handling and upon release will be systematically

assessed by indices of "responsivity" and "alertness" adapted from techniques used by Bildstein and Forsyth (1979) Table 1.

Trap fatalities will be marked by toe-clipping and preserved in ethanol.

Small mammal capture data will be analyzed for species composition, relative abundance indices, known population densities, and estimated population density by Jolly's method of the Lincoln Index for each trapping grid. Data analysis will include basic statistical comparisons between replications and between experimental and control plots for each parameter of population characteristics, health, and behavior. The analysis and format of data presentation will facilitate statistical comparison between baseline conditions and monitoring after herbicide application.

3.2.4 Habitat Monitoring

The habitat of the control and experimental plots will be measured for each trapping station in mid-summer each year of the program by the modified Braun-Blanquet cover estimate technique. Plant cover categories (total, woody, graminoid, forb, herbaceous litter, woody litter, and bare ground) and the plant species present in two plots (20 x 50 cm) one metre from each trapping station will be measured. Data will be analyzed to provide correlation-coefficients of vegetative cover with captures of each species. Mean cover and plant species composition (frequency) from each grid will provide a quantitative description of habitat change on experimental grids to assess its effect on small mammal populations.

3.3 Small Mammal Sampling for Tissue Analysis

3.3.1 Sampling Design

a. The target species (in order of priority) are: deer mouse, shrews, red-backed voles, and jumping mouse.

b. The liver and kidney are the tissues in which hexazinone concentrates. Sample size for tissue chemical analysis is a minimum of 5 grams wet weight. Therefore, composite samples are required to ensure adequate weight.

c. Small mammal samples will be collected at two locations for treatment plots and two locations for a control plot. Treatment plots used will have the 4 kg a.i./ha of hexazinone application.

d. Locations for trapping are shown in Figure 1.

e. Target sample size of small mammals of each species of microtines per plot is 10 individuals.

f. DOA (trap mortality) shrews were collected from all population monitoring grids. Whole animals are placed in plastic vials and frozen in the field camp.

3.3.2 Sampling Schedule (All Post Treatment)

1986	10 days post-treatment	September 4-6
	30 days post-treatment	September 25-30
1987-89	early-summer	June 25
	mid-summer	July 25
	late-summer	August 25

3.3.3 Collection Procedures

Small mammals will be collected by snap-trapping to ensure immediate death (hexazinone is readily excreted and thus the advantages of live-trapping to allow selective animal sacrifice is outweighed by the potential for hexazinone excretion).

At each collection site, up to 100 snap-traps will be set. Traps will be baited with peanut butter. Traps will be checked twice each day at 0800 and 1900 hours to ensure the collection of "fresh" specimens.

Collected specimens will be immediately dissected for removal of liver and kidney tissues. Dissection equipment include a cork board, pins, dissecting scissors, and tweezers.

Tissues will be stored in plastic vials and immediately cooled on ice. Specimens will be frozen in the field camp.

Precautions will be taken to ensure that specimens are not contaminated. This will include use of new plastic vials and animal handling with surgical gloves.

3.3.4 Transport and Storage

1. Specimens will be kept frozen and protected from light throughout storage and during transportation to the analysis lab.
2. Transportation of specimens to Wastex Industries Inc. will be by Purolator Courier Services, who guarantee delivery within 24 hours.
3. Specimens will be transported on dry ice, packed in an insulated container.
4. Transportation package will include copies of the Wildlife Collection Permit, Customs Declaration Forms, and a description of contents.

3.3.5 Tissue Analysis

Tissue analysis for Hexazinone and major metabolites will be conducted by Wastex Industries Inc. (28 South Hanover Street, Pottstown, Pennsylvania, U.S.A.).

Procedures and method of tissue analysis are not currently available. Such will be appended in a revision to the Protocols Manual.

4.0 REFERENCES CITED

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Table 1. Behavioral response of small mammals to capture, handling and release.

Classification	Behavioral response
1. Normal	Animals respond with an "alertness" or tenseness to handling, they appear cautious and apprehensive during handling and release; upon release, the animals seek escape cover.
2. Torpid-heat exhaustion	Prolonged confinement in the live-trap during hot weather may result in dehydration and exhaustion; the animals appear weak, exhibit a staggering gait, reduced alertness, and caution; voles may feed on herbaceous vegetation upon release.
3. Torpid-hypothermia	Prolonged confinement during low temperatures or wet conditions (dew, rain or urine-soaked bedding) may result in hypothermia; animals feel cold (i.e. low body temperature), act sluggish, and may be in a curled position, animals have a wobbling or staggering gait, upon release are slow in seeking escape cover.
4. Abnormal (a description for each occurrence) - tremors or convultions - unexplained bleeding/ hemorrhaging	Responses that do not meet the above criteria; animals are not torpid but exhibit one or more of: increased irritability or responsivity to stimuli; hyperactive or excitable during handling; decreased alertness; susceptibility to hand capture upon release.