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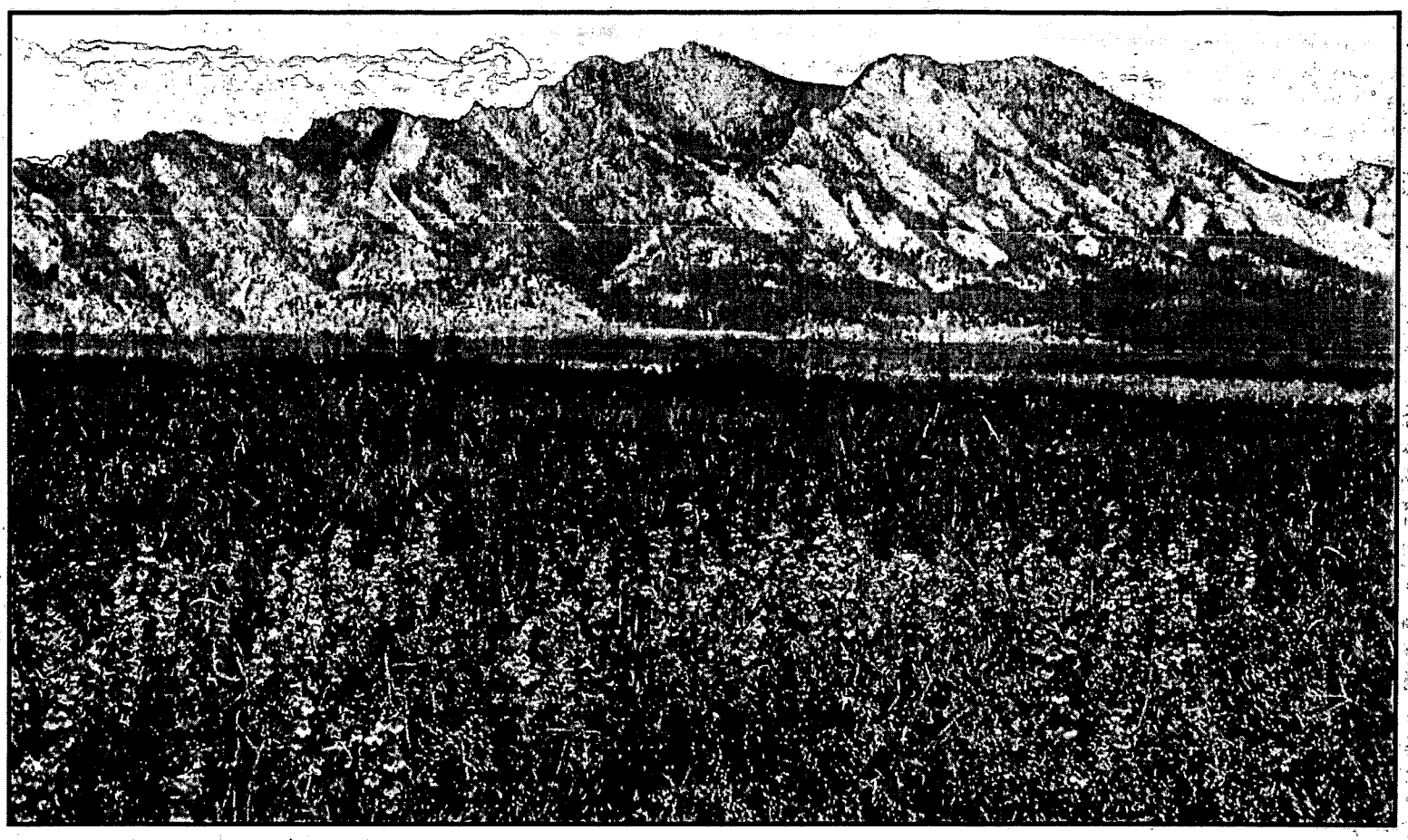

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Appendix B – Biocontrol Photo Monitoring

Appendix C – Project Revegetation Time-Series Monitoring Photographs

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Appendix D – High-Value Vegetation Permanent Photo Monitoring Time-Series Photographs

Appendix E – Industrial Area Vegetation Permanent Photo Monitoring Time-Series Photographs

Appendix F – 2004 RFETS Flora List

Appendix G – Weed Management and History at RFETS

Prepared by Professional Environmental Group, LLC for Kaiser-Hill Company, Inc., L.L.C.

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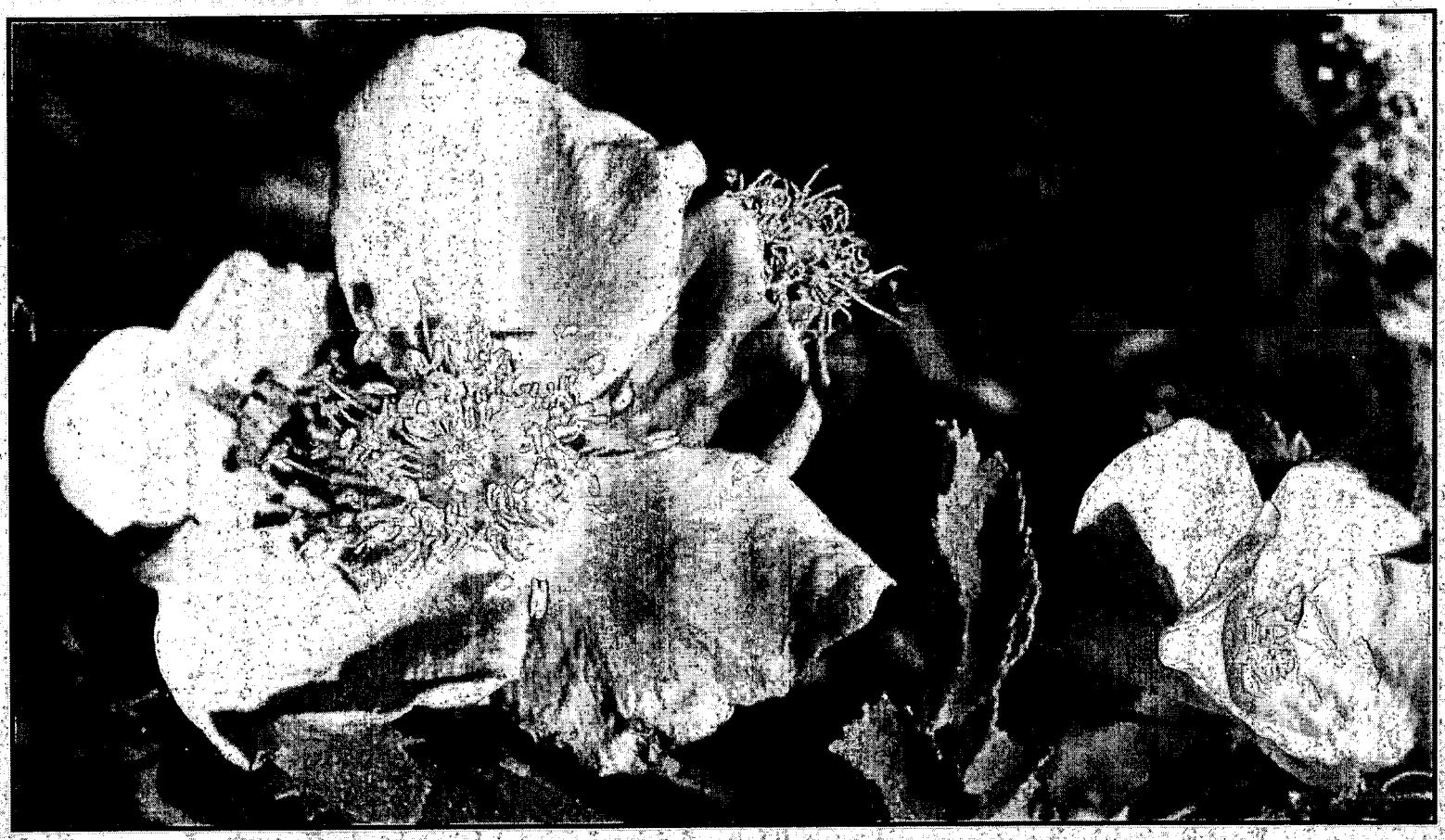

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ECOLOGY

2004 Annual Ecology Report for the Rocky Flats Environmental Technology Site

Prepared for
Kaiser-Hill Company, L.L.C., Golden, CO.

Prepared by
Professional Environmental Group, Arlington, OR.

June 2005

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Executive Summary

The Kaiser-Hill Company (K-H) Ecology Group conducts ecological monitoring of the Rocky Flats Environmental Technology Site's (the Site) ecological resources to ensure regulatory compliance and to preserve, protect, and manage those resources during cleanup and closure operations. Ecological monitoring is an integral aspect of determining whether the management objectives and goals for the wildlife and plant communities at the Site are being achieved. This report summarizes the results of the ecological monitoring that was conducted at the Site during 2004.

At an elevation of approximately 6,000 ft., the Site contains a unique ecotonal mixture of mountain and prairie plant species resulting from the topography of the area and its proximity to the mountain front. The Buffer Zone, the area surrounding the Industrial Area, is one of the largest remaining undeveloped tracts of its kind along the Colorado Piedmont. A number of plant communities present at the Site have been identified as increasingly rare and unique by the Colorado Natural Heritage Program (CNHP). These communities include the xeric tallgrass prairie, tall upland shrubland, wetlands, and Great Plains riparian woodland communities. Small inclusions of a number of other increasingly rare plant communities are also found on the Site. Many of these communities support populations of increasingly rare animals as well, including the federally protected Preble's meadow jumping mouse, and other uncommon species such as the grasshopper sparrow, loggerhead shrike, Merriam's shrew, black crowned night heron, hops blue butterfly and Arogos skipper.

A brief summary of the highlights from the 2004 field season is found below with detailed summaries and analyses for each field monitoring effort presented in the following chapters. In addition, an electronic version of the entire report and other monitoring results are contained on CD-ROM.

During 2003, an investigation to evaluate potential weed control techniques for smooth brome, a non-native grass was initiated. Smooth brome patches expand as circles and replace the native plant species on the prairie. One aspect of the investigation was to determine the growth rates of smooth brome circles. Initial results during 2003 showed no change in the size of the smooth brome circles, potentially resulting from the lack of precipitation received in 2003. However, from fall 2003 to fall 2004, both large and small smooth brome circles increased in size with the large circles increasing by almost 23% and the small circles by 135%. The increased moisture received in 2004 certainly contributed to the increase, but the data show how quickly the smooth brome can invade into the grasslands. This species is becoming increasingly problematic at the Site and on surrounding native areas.

The use of glyphosate (i.e. Roundup®) alone, glyphosate/shading, and shading alone, were evaluated as treatments to try and kill smooth brome. All three treatments showed initial good success in killing smooth brome over the course of the growing season in 2003. However, in 2004, differences in the treatments were apparent. All of the treatments showed some re-establishment of the smooth brome with the glyphosate only and glyphosate/shading treatments having the highest smooth brome re-establishment rates. The shading only treatment showed the lowest re-establishment of smooth brome of all the treatments. Successful establishment of native species (seeded in fall 2003) was observed in 2004. However, continued observations will determine how well the native species are able to re-establish the native prairie and how

significant a role the smooth brome seed bank will have with respect to the re-establishment of the native community

Diffuse knapweed is one of the principle noxious weeds at the Site. Various control measures, including herbicide applications and biocontrol insect releases, have been used to control the diffuse knapweed population on Site. Monitoring of the effectiveness of biocontrol insects released to help control diffuse knapweed was begun in 2001. Biological control measures are low cost, have a low impact to surrounding habitat and non-target vegetation, and provide long lasting effects on target weed species. Various species of biological control insects have been released on Site for control of diffuse knapweed. The biocontrol monitoring study was designed to focus specifically on the effects of the *Larinus minutus*, but has expanded to include other biocontrol insects that feed on diffuse knapweed on Site.

Results of this investigation indicate that the biological control insects have begun to show some effectiveness in controlling the diffuse knapweed population on Site. Some reduction in diffuse knapweed density and cover have been observed, in addition to a reduction the number of seeds produced per infested flowerhead. Because this species is an annual that relies on seed production to continue its presence, reducing the total seed production is an important means of achieving control. While the insects have helped reduce the seed production in some years, it is apparent that climate plays a role in the effectiveness of the biocontrol insects. During 2004, the increase in the number of flowerheads per plant was so great that the biocontrol insects were not able to effective lay eggs into each flowerhead. Thus some flowerheads had no seed reduction which resulted in a large overall increase in the amount of seed production at the study locations. Even with this however, the insects did reduce the amount of seed that would have been produced (because they did reduce the amount of seed production in many flowerheads), and thus are having some effectiveness. It will remain to be seen in the long-term how these biological control insects are able to effect the overall visual abundance of diffuse knapweed at the Site. The biocontrol insects are one of many tools in the weed control toolbox that can continue to be used to help control diffuse knapweed at the Site.

The sitewide wildlife surveys continued to document the presence of many of the significant wildlife species at the Site. Many of the more common species typical of the Site were observed, including: mule deer, prairie dogs, coyotes, red-tailed hawks, Swainson's hawks, great horned owls, and various waterfowl. Elk continued to use the Site in 2004 as a calving area in the late spring and summer. Annual variations in the relative abundance of different species from 2003 to 2004 were documented, but are expected given this type of survey. The diversity and abundance of wildlife species observed on surveys conducted in 2004 continued to verify the high quality of habitat available in the Buffer Zone at the Site.

The rare and imperiled plant species populations (as listed by the CNHP) at the Site appear to be healthy. All four rare species (mountain-loving, forktip three-awn, carrionflower greenbriar, and dwarf wild indigo) were observed during 2004 and appeared in good condition. Attempts to grow new populations of the forktip three-awn grass at new locations at the Site have proven successful. General observations of the native prairies and wetlands at the Site continued to suggest that the ecological resources of the Site remain of high quality and comprise a significant component of the larger surrounding regional ecosystem. However, several management concerns remain.

The threat from noxious weeds continues to be a high management priority. Several noxious weed species are problematic and are a threat to the long-term quality and sustainability of the plant communities at the Site. Diffuse knapweed, dalmatian toadflax, musk thistle, common mullein, and Canada thistle are the most significant noxious weed problems. Control efforts for some of these species have reduced the abundance of these species over the past several years,

shifting the abundance levels from high and medium infestation levels to the low and scattered levels. Given the scale of these infestations, however, continued integrated control efforts will be necessary for the foreseeable future. Other smaller infestations of newly discovered or recently invaded species like bouncing bet, Scotch thistle, Russian thistle, and others continue to be controlled by hand or spot chemical control with the goal of eradication. Control of newly discovered noxious weed species must be a high priority to prevent costly ecological and economic impacts later. In addition to herbicide applications in 2004, several biocontrol insects were released at the Site to help control several different noxious weed species. Insects were released to help control Canada thistle, bindweed, diffuse knapweed, musk thistle, and dalmatian toadflax.

Efforts continue to preserve and improve the quality of the ecological resources at the Site. As the Site becomes a National Wildlife Refuge after cleanup and closure, efforts to integrate more of a comprehensive, ecosystem approach to resource management must be continued to restore natural processes if long-term sustainability of the native communities is to be achieved. Recent management efforts have focused substantively on the noxious weeds themselves (due to Site restrictions), without addressing the underlying conditions that have lead to the stressed condition of the native communities and contributed to the large-scale weed invasions. Specifically, prescribed fire and grazing are both critical processes necessary for grassland health and management. As long-term management plans are developed for the National Wildlife Refuge, the use of these and other resource management tools should be included to provide the best chance for long-term sustainability of the ecosystems at the Site.

Dalamatian toadflax is a noxious weed at the Site that has been expanding across the grasslands over the past several years. An investigation continued in the south Buffer Zone at the Site to evaluate the impact of Tordon 22K® applied at application rates of one pint/acre and one quart/acre on dalmatian toadflax density. After the first growing season, dalmatian toadflax density in the one pint/acre treatment plot was reduced to approximately one third of that in the control plot. A second phase of the study was initiated in 2004 where dalmatian toadflax infestations were treated with Tordon 22K® applied at application rate of one quart/acre. Future evaluations will determine the effectiveness of this treatment and continue to monitor the longer term impacts of the earlier treatment.

Qualitative and quantitative monitoring was conducted at a number of revegetation locations at the Site during 2004. Photo monitoring and qualitative assessments were conducted at several smaller revegetation locations. Quantitative monitoring was conducted at six larger locations including: the new landfill, MST area, Solar Ponds, B886, B116, and incinerator areas. Results indicate that the vegetation is establishing well at most locations (helped by the abundance precipitation received in 2004), however, success criteria outlined in the Revegetation Plan have not been met as of 2004 at any of the locations monitored. This is not unexpected since for each of these locations it was only the first or second growing season since they had been seeded. In general, however, vegetation has begun to establish and is protecting the soil from erosion. Over the next few years the seeded species should become more established. There are no recommended changes to the management of these areas at this time.

The results of the 2004 frog vocalization survey showed a higher than average abundance of chorus frogs at the Site during 2004. In 2003, the frog abundance was the lowest it has been since the surveys began in 1998. The 2002 drought may have been a factor contributing to the low boreal chorus frog abundance in 2003. The 2004 survey results show that the frog populations survived, and have rebounded from the effects of the 2002 drought. The presence of the boreal chorus frogs at the Site, even after drought years, provides evidence of the resilience of this amphibian species. It is also evidence of a healthy aquatic ecosystem at the Site.

The ecological monitoring conducted in 2004 continues to verify the high quality ecological resources that exist at the Site. The investigations conducted are providing information useful for the management of the resources. Further details on each of the investigations discussed above are found in the chapters that follow and on the CD-ROM.

1. 2004 Smooth Brome Monitoring

1.1 Introduction

Smooth brome *(Bromus inermis)* is an exotic graminoid species that has been used for over a century across much of North America as a revegetation grass. Research has shown the species is an aggressive invader of native plant communities under certain conditions. It often invades native grassland communities, replacing the native plant species, reducing biodiversity, and lowering the wildlife habitat value of an area. The grass has been used in the past at the Rocky Flats Environmental Technology Site (Site) for numerous revegetation projects. For the past several years it has been prohibited for use in seed mixtures at the Site. However, numerous locations on the grassland have been invaded by the species and smooth brome circles are common at many locations in the Buffer Zone. When smooth brome becomes established at a location in a native plant community it typically reproduces vegetatively by underground rhizomes (horizontal underground stem tissue) and grows outwardly in a circle from the point of origin (Figure 1-1). As the circles expand outwardly the smooth brome out-competes native species for resources and the circle usually becomes a solid stand of smooth brome. To evaluate the effectiveness of weed control efforts on smooth brome the following investigation was conducted. The purpose of this monitoring effort is three-fold:

- Determine the rate of expansion of smooth brome circles.
- Evaluate the effectiveness of different control methods to kill smooth brome circles.
- Evaluate the effectiveness of revegetating dead smooth brome circles with native plant species.

1.2 Methods

The investigation was conducted in the south Buffer Zone at the Site, where a large number of isolated smooth brome circles of varying sizes had invaded the native mesic mixed grassland (Figure 1-1). The study area was situated on a northeast-facing slope. Each of the smooth brome circles that was evaluated during the investigation was mapped using a GPS unit in the field to assist with future relocation of the circles. The data was then downloaded and corrected for plotting locations on the map (Figure 1-2).

The monitoring of the expansion rates of smooth brome circles was initiated by measuring the size of smooth brome circles during 2003. These measurements provide the initial size of the circle and can be made annually and compared to previous years. A total of 12 smooth brome circles in the Buffer Zone were selected for evaluating expansion rates. Both large and small smooth brome circles were selected for measurement to see if size made any difference in expansion rates. A piece of rebar was staked in the center of each circle. Four measurements of the radius were made at each circle, from the center rebar to the most distant smooth brome culm (stem) along the edge of the circle in approximately each of the four cardinal directions. Distances were measured to the nearest centimeter. At each of the four most distant culms, a metal tag was attached to the ground using a nail. The nail holding the tag may be used for future monitoring to stay generally along the same line that was used for the original measurements. The mean radius for each circle was determined and the area of the circle calculated based on the mean radius. Expansion rate measurements were made in the spring and fall of 2003 and again in the spring and fall of 2004.

To evaluate the effectiveness of control methods for smooth brome, three treatments were used including; shading, glyphosate (Roundup®) applications, and glyphosate/shading applications. The purpose of the treatments was to determine which method best kills the smooth brome. A total of 15 smooth brome circles were treated (five for each treatment type). The shading treatment was done by placing black plastic sheeting over a smooth brome infestation for an entire growing season (late April/early May through November; Figure 1-3). Prior to placement of the black plastic sheeting, the diameter of the smooth brome circle was measured on two perpendicular lines running in the cardinal directions. The edges of the circle where the measurements were made were tagged with nails and metal tags as described above. The black plastic extended a minimum of 0.5 m beyond the edge of the smooth brome circle. The black plastic was held in place using metal stakes/staples and rocks. The plastic was placed on the ground in late April/early May 2003 and removed in November 2003.

Glyphosate applications were applied to selected brome circles in early May (both the spray only and the spray/shade treatments). Measurements of the brome circle diameters that received the glyphosate were made prior to the herbicide application as described above. Good coverage of the herbicide was applied to the green culms (stems) of smooth brome using a backpack sprayer with glyphosate mixed at a rate of 6 oz./gallon of water (18% concentration). Some of the sprayed only treatment circles received additional spot treatments of herbicide during the summer for 2003 if it appeared that not all the smooth brome had been killed.

The glyphosate/shading treatment consisted of a preliminary application of the herbicide in the spring, followed by shading for the remainder of the growing season. The application of glyphosate followed the methods outlined above with the exception that only one application was made prior to shading. After application of the glyphosate, the black plastic was applied as described above. The black plastic was placed on the smooth brome circle the same day as the glyphosate application was made.

After removal of the black plastic from the circles in November 2003, all the circles from each treatment were broadcast seeded with a native seed mix that included western wheatgrass (*Agropyron smithii*), blue grama (*Bouteloua gracilis*), side-oats grama (*Bouteloua curtipendula*), buffalo grass (*Buchloe dactyloides*), green needle grass (*Stipa viridula*), slender wheatgrass (*Agropyron caninum* [*A. trachyplurum*]), and blue flax (*Linum perenne*). The seed was raked to provide better soil/seed contact. Field notes were also made as to the condition of each circle prior to reseeding. Photographs were taken of each smooth brome circle prior to the start of the study and at the end of the season prior to reseeding to document the condition of the circle (Figure 1-4).

During 2004, the plots were visited three times, April, August, and October. In April and October measurements of the expansion rates were made and photographs were taken. Field notes were made during all three visits of what plants were growing and establishing on the treatment plots. Additional glyphosate spot applications were made in 2004 during the April and August visits when smooth brome plants were observed growing in the plots. Applications were made on the smooth brome plants only.

In August 2004, a list of the plant species found growing within each of the treated circles was recorded. The foliar cover of each species within the circle was recorded using a visual cover class system: 1 <= 5%, 2 = 6-25%, 3 = 26-50%, 4 = 51-75%, 5 => 76%. Midpoints of the cover classes were used for analyses: 1 = 3%, 2 = 15%, 3 = 37.5%, 4 = 62.5%, and 5 = 87.5%.

1.3 Results and Discussion

During 2003, the smooth brome circle expansion data showed little change in the overall size (area or radius) of the brome circles from late April/early May to November (Tables 1-1 and 1-2). No difference was observed in the expansion rates of small circles compared to large circles in 2003. Small circles were defined as those that were initially less than 4 m^2 in size. Large circles were those initially larger than 30 m^2 in size. The precipitation received from May through November 2003 was only 5.5 inches compared to the mean of 10.4 inches for the past 13 years at the Site. So the circles did not change much during the 2003 growing season. The lack of precipitation during most of the growing season after the start of the project may have contributed to the lack of increase in the size of the circles.

During the winter of 2003/2004, the area of both small smooth brome circles and large smooth brome circles increased in size (small circle increase = ~48%, large circle increase = ~9%; fall 2003 to spring 2004, Table 1-1). Throughout the 2004 growing season both small and large smooth brome circles continued to increase in area, probably due to the increased amount of precipitation received. During 2004, over 16.7 inches of precipitation was received from May through November, three times the amount received in 2003 (5.5 inches). From spring 2004 to fall 2004 the area of small smooth brome circles increased by ~60% while the large circles increased by 13% (Table 1-1). Throughout the duration of the investigation thus far (spring 2003 to fall 2004), smaller smooth brome circles have more than doubled in size (135% increase; Table 1-1), with nearly all the increase coming in 2004. Large circles have increased approximately 23% on average since the outset of the investigation. The increase in the area of small circles was approximately 2.8 m^2 (from 2.1 m^2 to 4.9 m^2) from spring 2003 to fall 2004. The increase in the area of large circles was approximately 16.6 m^2 (from 73.2 m^2 to 89.8 m^2) for the same time period. These substantial increases over the course of two growing seasons illustrate how quickly and aggressively smooth brome can invade into a native grassland and replace the native species. This is particularly problematic where many circles are present in an area and they can coalesce into larger circles in a short period of time.

The results of the three treatments – spraying, shading, and spraying/shading, showed excellent apparent initial die-off of the smooth brome for all three treatments by fall 2003. In all the circles of each treatment, all the smooth brome appeared dead, in addition to nearly everything else in most of the circles (Figure 1-4). Although some additional application of glyphosate was required in a few of the uncovered circles to completely kill the smooth brome by fall 2003, the timing of the herbicide application in the spring may have also had a role in the "good kill" of smooth brome that was observed. The glyphosate was applied on May 1 to the sprayed only plots, at the time when the brome was greening up and little else had started growing. So the herbicide largely only affected the brome. As a result, it was observed in the fall that in several of the sprayed only plots, native species such as side-oats grama, western wheatgrass, purple three-awn (*Aristida purpurea* ssp. *robusta*), white aster (*Aster falcatus*), and silky wormwood (*Artemesia dracunculus*) were already coming up and taking advantage of the lack of competition from the smooth brome. These species may not have been growing yet when the herbicide was applied in the early spring, so they were able to survive and come up, since the glyphosate only effects actively living and photosynthesizing plants. One noxious weed species that survived beneath the shaded only circles was musk thistle (*Carduus nutans*). Several rosettes were still alive after the plastic was removed. However, musk thistle was not present under the shaded circles that had been sprayed or in the sprayed only circles.

Although initial results seemed to indicate little difference between the treatments in their ability to kill the smooth brome, observations made during the second growing season suggested that some methods worked better than others. Initial results at the end of 2003 suggested that

spraying only worked just as well as shading only or spraying/shading (Figure 1-5; although some of the sprayed only plots had received additional herbicide applications during the summer of 2003). However, by spring 2004, differences were apparent between the treatments. The sprayed only treatment had an 80% frequency of smooth brome returning in the plots, while the covered only treatment showed only a 40% return of smooth brome. In May 2004, when the monitoring was conducted, any smooth brome found within any of the plots was sprayed to kill it. However, it is apparent that spraying alone still did not kill all the smooth brome because it was still present at 40% of the sprayed only plots in August 2004 and at 80% of these plots by October 2004 (Figure 1-5). Overall, the best treatment was seen in the covered only plots, where by October 2004, there was only a 20% return of smooth brome in these plots, compared to 40% and 80% in the sprayed/covered and sprayed only plots, respectively (Figure 1-5).

Although the smooth brome plants that were alive when the study began may have died as a result of the herbicide applications and/or shading, one of the key questions regarding the re-establishment of smooth brome revolves around the issue of the amount of seed left in the seed bank. Although the use of herbicides or shading may effectively kill the smooth brome initially at a location, if the seed bank is prolific in re-establishing a circle, then the effectiveness of the treatments under evaluation may be of little significance. How significant a role the seed bank plays remains to be seen.

How quickly and abundantly the native species are able to establish from the seed sown within the circles in the fall of 2003 is also a question of importance. Isolated circles of smooth brome were chosen for this investigation because it was thought that if the smooth brome in a circle surrounded by native grassland could be killed, the native community may be able to heal itself (with some help from the seeding of native species). A study conducted in the City of Boulder Mountain Parks in a stand of solid smooth brome showed that if smooth brome was present around the edges of a shaded plot, it continued to invade beneath the edges of the black plastic and weed barrier (Nelson and Armstrong, 2004). One of the goals of this present study was to determine whether the native grassland could re-establish in a previous circle of brome (with some help from reseeding).

Observations of the establishment of the seeded native species was very promising in 2004. Of the seven species seeded in fall 2003, six were found growing in the treated circles on August 3, 2004 (Table 1-3). Only buffalo grass was not found growing in any of the treated circles. Slender wheatgrass (a seeded species) was dominant of all the plants found growing in the treated circles with a mean foliar cover of 29% (Table 1-3). The best establishment of slender wheatgrass was found in the shaded only and sprayed/shaded plots. Interestingly, blue grama, side-oats grama, and green needle grass, were only found in the sprayed only plots which would suggest that perhaps the plants observed in 2004 were not from seed, but rather pre-existing plants that had not been affected by the herbicide application in spring 2003 because they were not growing at the time of the application. Common sunflower (*Helianthus annuus*; a native) and alyssum (*Alysum minus*: a non-native), both early successional species, were also abundant with 24% and 11% cover, respectively (Table 1-3). Although smooth brome was present in three of the plots in August 2004, the mean cover was only 0.6% (Table 1-3). As discussed above, however, the frequency of smooth brome increased in the plots by October 2004. No evaluation of the cover of smooth brome was conducted in October 2004. Continued observations of the plots are necessary to determine how the seeded species will be able to compete with any re-establishing smooth brome.

One interesting observation of the study was the edge effect that was evident around the perimeter of each of the treatments (Figure 1-6). At the edge of each treatment circle, whether it was a sprayed only circle or one of the treatments covered in plastic, there was a pronounced increase in the stature and abundance of several plant species as compared to the surrounding

landscape. The species common along the perimeter of the circles that exhibited this phenomenon included, musk thistle, common sunflower, white sage (*Artemesia ludoviciana*), wild lettuce (*Lactuca serriola*), alyssum, and western wheatgrass. A probable theory for this edge effect is the lack of competition from anything in the circle itself. Because the plants within the treatment circle were either killed by the herbicide or the shading, there was no competition for the moisture and nutrients that were still available in the circle. Thus the species along the edge of the circles were able to sequester these resources and grow considerably larger than the same species in the surrounding undisturbed grassland where competition for resources was higher among all the plants.

1.4 Conclusions

An investigation was begun to evaluate potential weed control techniques for smooth brome, a non-native grass. An evaluation was begun to determine the growth rates of smooth brome circles. Initial results during 2003 showed no change in the size of the smooth brome circles, potentially resulting from the lack of precipitation received in 2003. However, from fall 2003 to fall 2004, both large and small smooth brome circles increased in size with the large circles increasing by almost 23% and the small circles by 135%. The increased moisture received in 2004 certainly contributed to the increase, but the data show how quickly the smooth brome can invade into the grasslands.

The use of glyphosate, glyphosate/shading, and shading alone, were evaluated as treatments to kill smooth brome. All three treatments showed initial good success in killing smooth brome over the course of the growing season in 2003. However, in 2004, differences in the treatments were apparent. All of the treatments showed some re-establishment of the smooth brome with the glyphosate only and glyphosate/shading treatments having the highest smooth brome re-establishment rates. The shading only treatment showed the lowest re-establishment of smooth brome of all the treatments. Successful establishment by seeding of several native plant species was observed in 2004. However, continued observations will determine how well the native species are able to re-establish the native prairie and how significant a role the smooth brome seed bank will have with respect to the re-establishment of the native community

1.5 References

Nelson, J.K. and A. Armstrong. 2004. Unpublished data from smooth brome study in Chautauqua Meadow, City of Boulder Open Space and Mountain Parks, Boulder, CO.

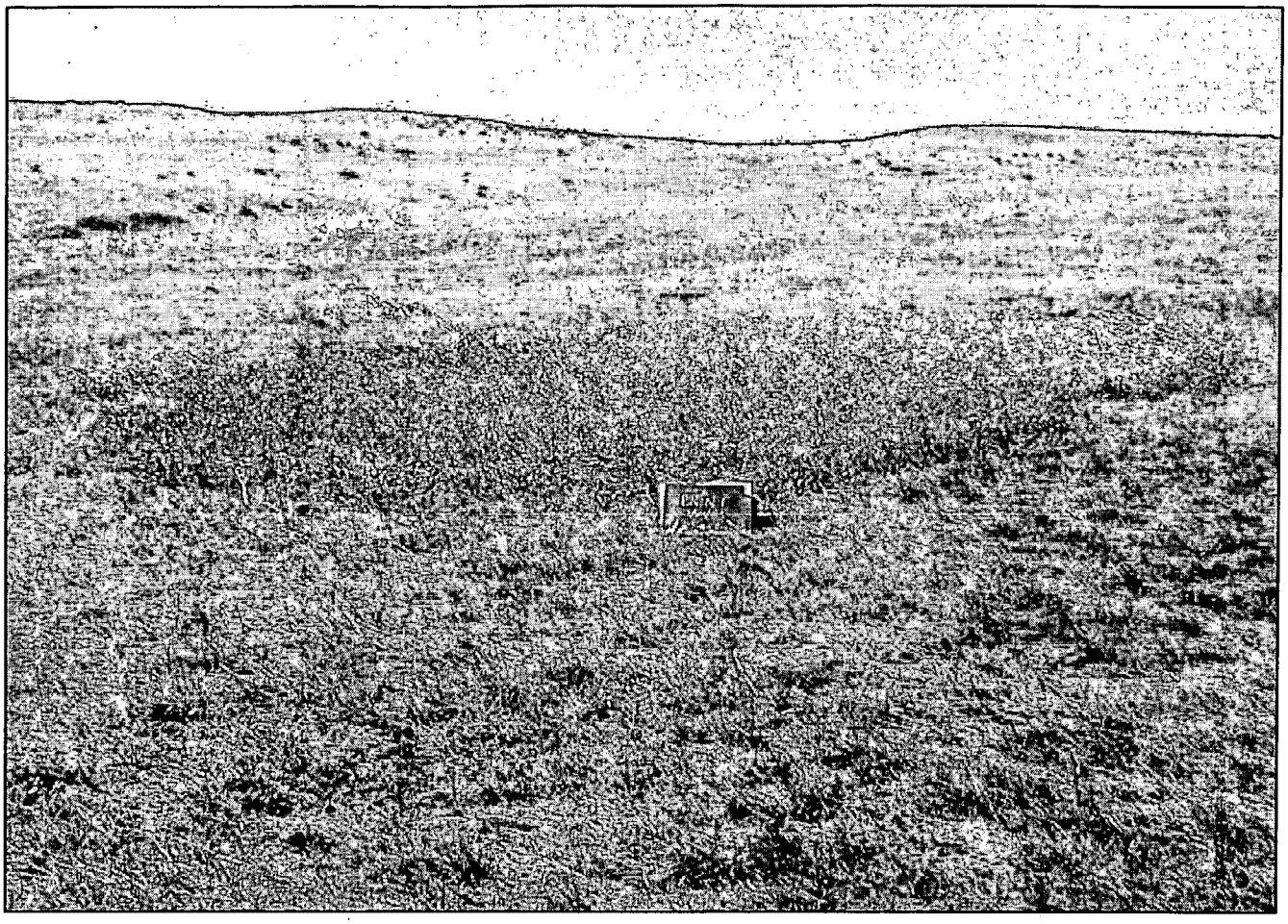
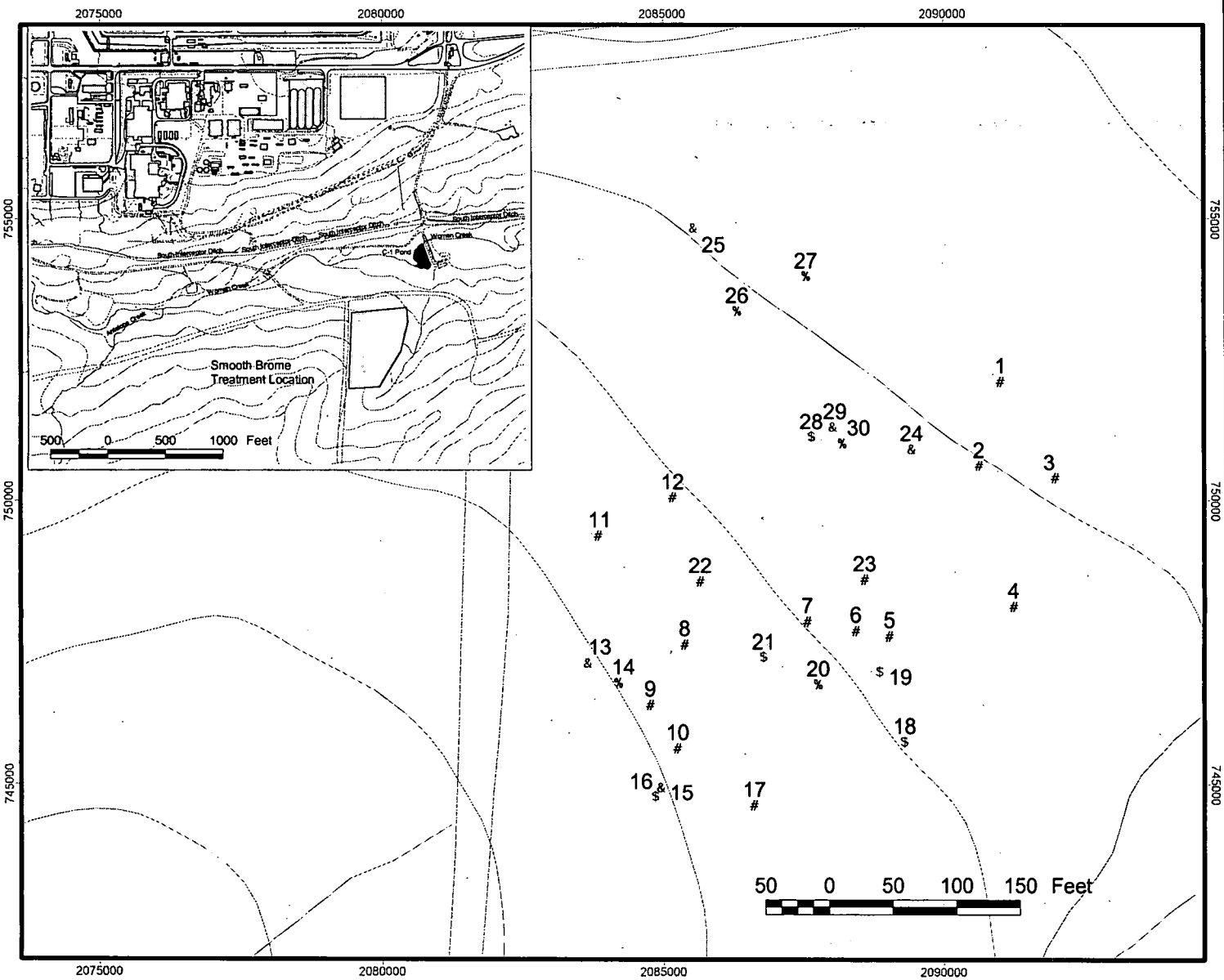


Figure 1-1. Smooth brome circle on native grassland.



Smooth Brome Weed Control Locations

Figure 1-2

Legend

- # Measurements Only
- % Covered Only
- $ Sprayed Only
- & Sprayed and Covered

Standard Features

- Buildings
- Demolished Buildings
- Lakes & ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft. intervals)

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas
Digitized from the orthophotographs. 1/95

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Professional Environmental Group

For: Kaiser-Hill Company, LLC

RFETS GIS Dept.
303-966-7707

MAP ID: 04-0005

April 12, 2004

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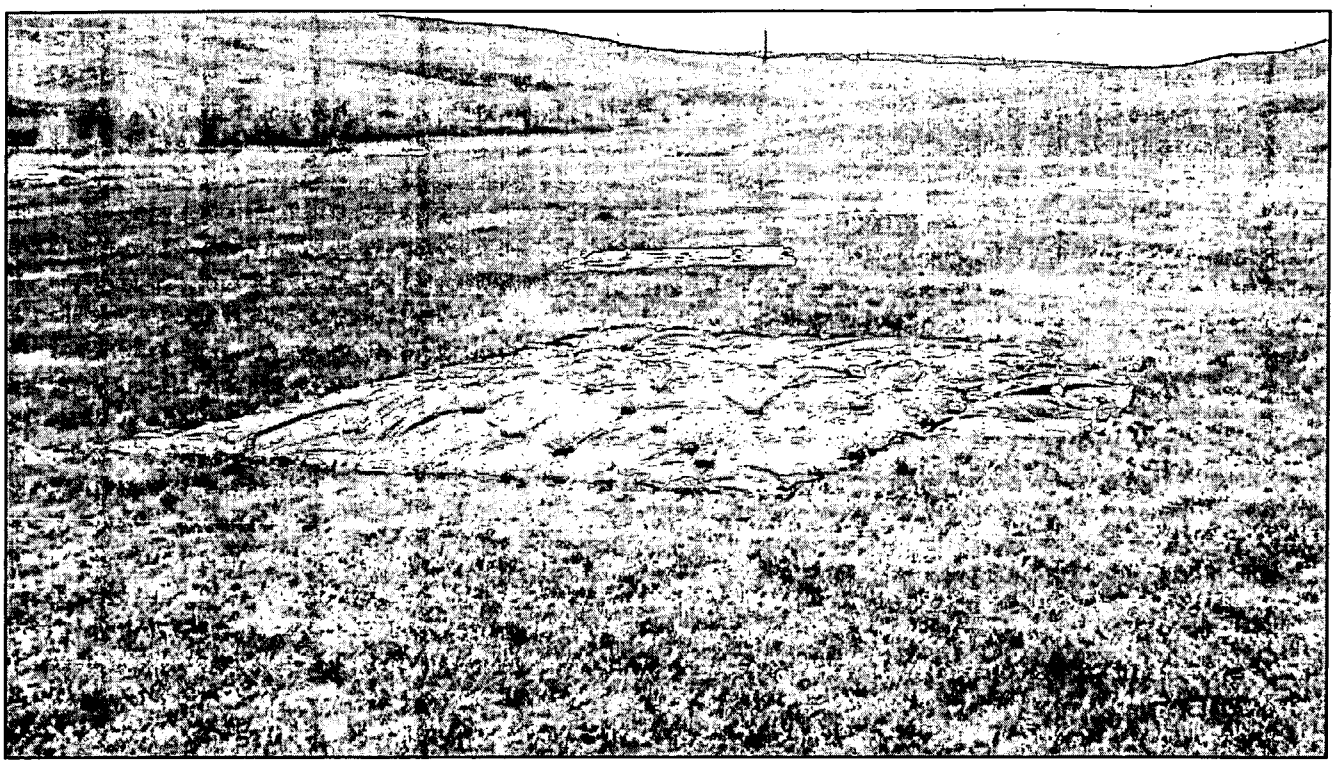

Figure 1-3. Finished shaded smooth brome circle. Rocks were used to help keep the black plastic from blowing away.

Figure 1-4. Sprayed circle with dead smooth brome at the end of the growing season in 2003.

Figure 1-5. Frequency (%) Of Plots Infested With Smooth Brome

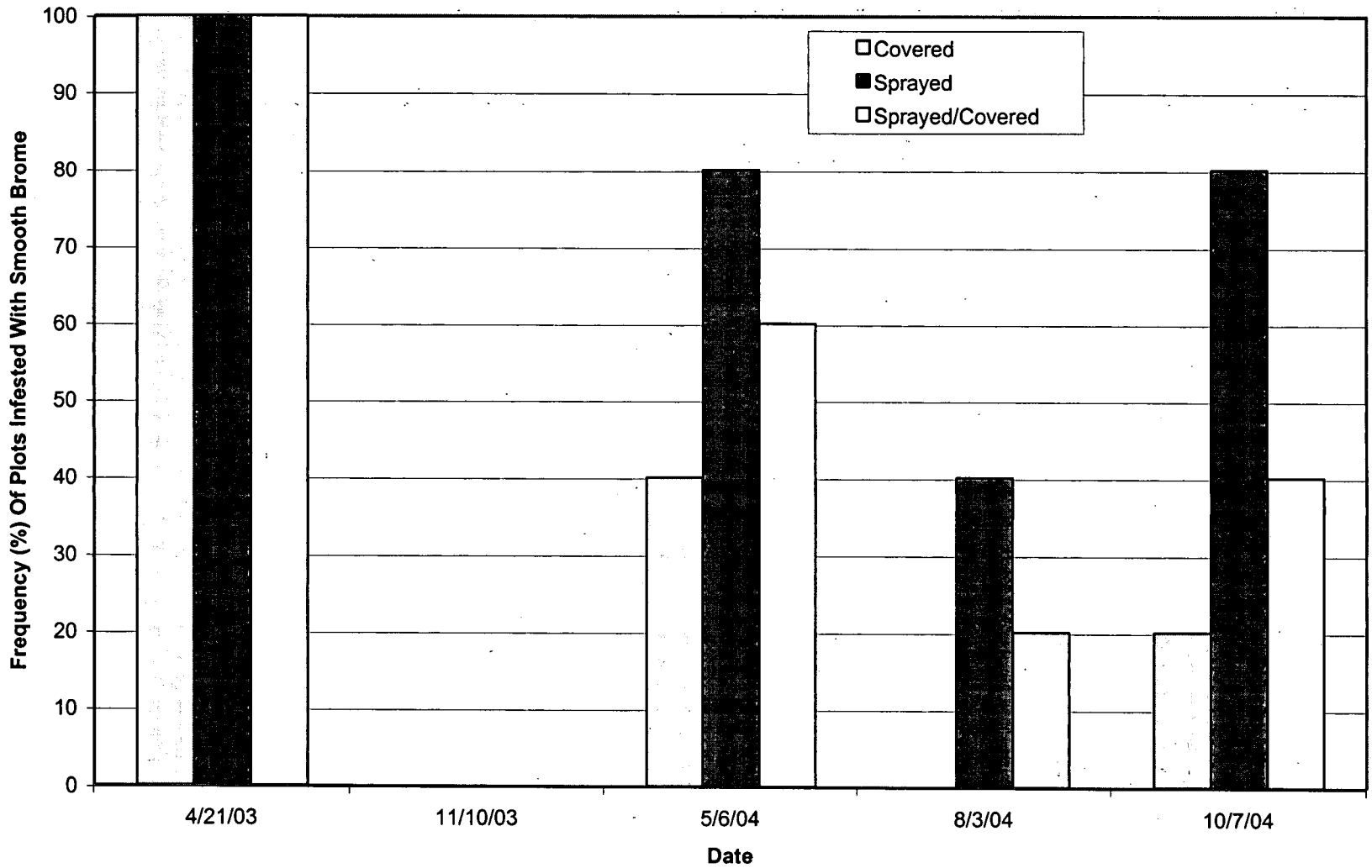

Figure 1-6. Edge effect around perimeter of circle. Lots of common sunflower.

Table 1-1. Smooth Brome Expansion Rates (Area)

Small Circles

	4/21/2003	11/10/2003	5/3/2004	10/8/2004	Spring 03 to Fall 03	Fall 03 to Spring 04	Spring 03 to Spring 04	Spring 04 to Fall 04	Spring 03 to Fall 04
BRIN Plot #	Circle Area (sq. meters)				Percent Change	Percent Change	Percent Change	Percent Change	Percent Change
1	1.4	1.4	2.0	4.6	0.0	42.9	42.9	130.0	228.6
2	2.9	3.0	4.2	8.6	3.4	40.0	44.8	104.8	196.6
6	3.8	3.8	5.4	5.7	0.0	42.1	42.1	5.6	50.0
7	0.7	0.7	1.2	2.2	0.0	71.4	71.4	83.3	214.3
8	1.0	1.0	1.9	3.3	0.0	90.0	90.0	73.7	230.0
12	2.7	2.5	3.7	5.0	-7.4	48.0	37.0	35.1	85.2
Mean	2.1	2.1	3.1	4.9	-0.8	48.4	47.2	59.8	135.2

Large Circles

	4/21/2003	11/10/2003	5/3/2004	10/8/2004	Spring 03 to Fall 03	Fall 03 to Spring 04	Spring 03 to Spring 04	Spring 04 to Fall 04	Spring 03 to Fall 04
BRIN Plot #	Circle Area (sq. meters)				Percent Change	Percent Change	Percent Change	Percent Change	Percent Change
3	64.4	64.5	69.5	80.3	0.2	7.8	7.9	15.5	24.7
4	34.6	35.2	34.3	38.8	1.7	-2.6	-0.9	13.1	12.1
5	54.0	54.2	61.2	68.0	0.4	12.9	13.3	11.1	25.9
9	93.6	93.4	101.1	112.7	-0.2	8.2	8.0	11.5	20.4
10	111.3	110.0	121.9	139.3	-1.2	10.8	9.5	14.3	25.2
11	81.1	80.3	90.0	99.9	-1.0	12.1	11.0	11.0	23.2
Mean	73.2	72.9	79.7	89.8	-0.3	9.2	8.9	12.8	22.8
Grand Mean	37.6	37.5	41.4	47.4	-0.3	10.3	9.9	14.5	25.9

Table 1-2. Smooth Brome Expansion Rates (Radius)

Small Circles

	4/21/2003	11/10/2003	5/3/2004	10/8/2004	Spring 03 to Fall 03	Fall 03 to Spring 04	Spring 03 to Spring 04	Spring 04 to Fall 04	Spring 03 to Fall 04
BRIN Plot #	Mean radius (cm)				Percent Change	Percent Change	Percent Change	Percent Change	Percent Change
1	67.0	67.0	80.5	121.3	0.0	20.1	20.1	50.7	81.0
2	96.0	98.5	116.3	165.5	2.6	18.1	21.1	42.3	72.4
6	110.5	110.5	130.8	135.0	0.0	18.4	18.4	3.2	22.2
7	48.8	47.8	61.0	84.3	-2.0	27.6	25.0	38.2	72.7
8	57.8	55.5	78.5	102.5	-4.0	41.4	35.8	30.6	77.3
12	92.8	89.3	109.0	126.8	-3.8	22.1	17.5	16.3	36.6
Mean	78.8	78.1	96.0	122.6	-0.9	22.9	21.8	27.7	55.5

Large Circles

	4/21/2003	11/10/2003	5/3/2004	10/8/2004	Spring 03 to Fall 03	Fall 03 to Spring 04	Spring 03 to Spring 04	Spring 04 to Fall 04	Spring 03 to Fall 04
BRIN Plot #	Mean radius (cm)				Percent Change	Percent Change	Percent Change	Percent Change	Percent Change
3	452.8	453.3	470.3	505.5	0.1	3.8	3.9	7.5	11.6
4	332.0	334.5	330.3	351.3	0.8	-1.3	-0.5	6.4	5.8
5	414.5	415.3	441.5	465.3	0.2	6.3	6.5	5.4	12.3
9	545.8	545.3	567.3	599.0	-0.1	4.0	3.9	5.6	9.7
10	595.3	591.8	623.0	666.0	-0.6	5.3	4.7	6.9	11.9
11	508.0	505.5	535.3	564.0	-0.5	5.9	5.4	5.4	11.0
Mean	474.7	474.3	494.6	525.2	-0.1	4.3	4.2	6.2	10.6
Grand Mean	276.8	276.2	295.3	323.9	-0.2	6.9	6.7	9.7	17.0

Table 1-3. Foliar Cover Summary of Reseeded Treated Smooth Brome Circles

					BRIN1 Plot Number															
					Shaded Only					Glyphosate Only					Glyphosate/Shaded					
Scientific Name	Speccode	Growth Form	Native	Cool/ Warm Season	14	20	26	27	30	16	18	19	21	28	13	15	24	25	29	Mean Cover
Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley	ALMI1	F	N				3.0	3.0	15.0	3.0	37.5	15.0	37.5	37.5	3.0	3.0	3.0		3.0	10.9
Anthemis cotula L.	ANCO1	F	N																3.0	0.2
Arabis glabra (L.) Bernh.	ARGL1	F	N				3.0													0.2
Camelina microcarpa Andrz. ex DC.	CAMI1	F	N			15.0	3.0	3.0						3.0			3.0	3.0	3.0	2.2
Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi	CANU1	F	N			3.0	15.0	3.0	3.0		15.0	3.0	3.0	3.0	3.0		15.0	15.0	3.0	5.6
Centaurea diffusa Lam.	CEDI1	F	N				3.0			3.0		3.0		3.0						0.8
Chenopodium album L.	CHAL1	F	N		3.0	3.0	3.0	3.0	3.0					3.0			15.0	3.0	3.0	2.6
Cirsium arvense (L.) Scop.	CIAR1	F	N				3.0							3.0						0.4
Erodium cicutarium (L.) L'Her.	ERCI1	F	N												3.0					0.2
Lactuca serriola L.	LASE1	F	N		3.0	15.0	3.0	15.0	15.0	3.0	15.0	15.0	3.0	3.0	3.0		3.0	3.0	3.0	6.8
Linaria dalmatica (L.) Mill.	LIDA1	F	N				3.0	3.0		3.0					3.0	3.0				1.0
Salsola iberica Senn. & Pau.	SAIB1	F	N					3.0										3.0		0.4
Sisymbrium altissimum L.	SIAL1	F	N						3.0			3.0	3.0	3.0		3.0	3.0	3.0		1.4
Thlaspi arvense L.	THAR1	F	N						3.0					3.0		3.0	3.0	3.0	3.0	1.2
Tragopogon dubius Scop.	TRDU1	F	N							3.0		3.0	3.0	3.0						0.8
Verbascum blattaria L.	VEBL1	F	N								3.0	3.0								0.4
Verbascum thapsus L.	VETH1	F	N		3.0			3.0				3.0					3.0			0.8
Artemisia dracunculus L.	ARDR1	F	Y											3.0						0.2
Artemisia ludoviciana Nutt. var. ludoviciana	ARLU1	F	Y		3.0						3.0		3.0		15.0		3.0		3.0	2.0
Asclepias pumila (Gray) Vail	ASPU1	F	Y															3.0		0.2
Aster falcatus Lindl.	ASFA1	F	Y											3.0	3.0					0.4
Chrysopsis villosa Pursh.	CHVI1	F	Y												3.0					0.2
Comandra umbellata (L.) Nutt.	COUM1	F	Y									3.0	3.0							0.4
Descurainia pinnata (Walt.) Britt.	DEPI1	F	Y			3.0		3.0							3.0	3.0	3.0	3.0	3.0	1.4
Grindelia squarrosa (Pursh.) Dun.	GRSQ1	F	Y							3.0						3.0				0.4
Helianthus annuus L.	HEAN1	F	Y		3.0	3.0	37.5	62.5	3.0	15.0	37.5	62.5	37.5	15.0	3.0	15.0	15.0	37.5	15.0	24.1
Linum perenne L. var. lewisii (Pursh.) Eat. & Wright	LIPE1	F	Y			3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		2.4
Physaria vitulifera Rydb.	PHVI1	F	Y										3.0							0.2
Polygonum ramosissimum Michx.	PORA1	F	Y									3.0	3.0		3.0					0.6
Psoralea tenuiflora Pursh.	PSTE1	F	Y				3.0	3.0			3.0	3.0	3.0	3.0	15.0	3.0		3.0		2.6
Ratibida columnifera (Nutt.) Woot. & Standl.	RACO1	F	Y											3.0						0.2
Silene antirrhina L.	SIAN1	F	Y											3.0						0.2
Sphaeralcea coccinea (Pursh.) Rydb.	SPCO1	F	Y		15.0							3.0			3.0				3.0	1.6
Vicia americana Muhl. ex Willd.	VIAM1	F	Y					3.0												0.2
Bromus inermis Leyss. ssp. inermis	BRIN1	G	N	C									3.0	3.0		3.0				0.6
Bromus japonicus Thunb. ex Murr.	BRJA1	G	N	C	3.0	3.0	3.0	3.0	3.0	15.0	3.0	15.0	15.0	3.0	3.0	15.0	3.0	3.0	15.0	7.0
Bromus tectorum L.	BRTE1	G	N	C		3.0														0.2
Poa compressa L.	POCO1	G	N	C														3.0		0.2
Agropyron caninum (L.) Beauv. ssp. majus (Vasey) C. L. Hitchc.	AGCA1	G	Y	C	3.0	37.5	37.5	37.5	37.5	3.0	3.0	15.0	15.0	15.0	37.5	37.5	37.5	62.5	62.5	29.4
Agropyron smithii Rydb.	AGSM1	G	Y	C	3.0	15.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.4
Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr	ARLO1	G	Y	C						3.0										0.2
Stipa viridula Trin.	STVI1	G	Y	C								3.0	3.0							0.4
Bouteloua curtipendula (Michx.) Torr.	BOCU1	G	Y	W						3.0	3.0	3.0	3.0							0.8
Bouteloua gracilis (H. B. K.) Lag ex Griffiths	BOGR1	G	Y	W							3.0	3.0	3.0	3.0						0.8
Rosa arkansana Porter	ROAR1	S	Y							3.0						3.0				0.4

Data from 8/3/2004.

2. Diffuse Knapweed Biological Control Monitoring

2.1 Introduction

Diffuse knapweed (*Centaurea diffusa*) is one of the principle noxious weeds at the Rocky Flats Environmental Technology Site (Site). A variety of control methods have been used to control diffuse knapweed at the Site, including biological, mechanical, and chemical control methods. Biological control measures are low cost, have a low impact to surrounding habitat and non-target vegetation, and may provide long lasting effects. The effectiveness of biological controls on diffuse knapweed populations at the Site is evaluated in this section.

Various species of biological control insects have been released on Site for control of diffuse knapweed, including *Larinus minutus*, *L. obtusus*, *Urophora affinis*, and *U. quadrifasciata*, all of which cause damage to the seeds of the knapweed. The other diffuse knapweed biocontrol insects that have been released and documented on Site (*Cyphocleonus achates* and *Sphenoptera yugoslavica)* cause damage to either roots or stems of the plant. Therefore, seed production is not directly effected by the latter group of insects. This study was designed to focus specifically on the effects of the *L. minutus*, a seedhead weevil, because the damage this insect causes is readily visible. *Larinus minutus* adult weevils lay their eggs in the flower heads, and the larvae feed on the seeds, thus reducing seed production in the plants.

Objectives of the study include:

- Evaluate changes in pre- and post-treatment diffuse knapweed cover and density at the release locations through time.
- Document visually, through photo monitoring, changes in diffuse knapweed populations at the release locations.
- Using flowerhead and seed counts, evaluate biocontrol insect impacts on diffuse knapweed seed production.

2.2 Methods

2.2.1 Location of Study Site

The Site is located in rural Jefferson County, Colorado, 16 miles northwest of Denver. The Site covers 6,266 acres, of which 5,868 acres forms an undeveloped Buffer Zone around the central, industrialized area. The Site adjoins undeveloped rangelands that are encroached by housing developments on the northeast and southeast. To the north, east, and northwest, public open-space lands border the Site. To the west of the Site are industrial sand and gravel mining activities and other potential sites for industrial use.

Herbicide applications for diffuse knapweed control at the Site have focused on upland areas away from wetlands and riparian habitats, the latter provides habitat for the Preble's Meadow Jumping Mouse (Preble's mouse; *Zapus hudsonius preblei*), a federally listed threatened species. As a result, infestations of diffuse knapweed have continued to increase in the drainage bottoms at the Site. Therefore, *L. minutus* were released in the drainage bottoms with the goal that these biocontrol insects would help control the diffuse knapweed at these locations and later would

spread to the upland areas. The original releases were located in areas with high diffuse knapweed abundance. Figure 2-1 shows the release locations of the *L. minutus* weevils. The biocontrol insects at release site one through five were released in 2001. Insects at release site six were released in 2002. Sampling was not conducted at release location 5 in 2004 because the area was treated with herbicides.

2.2.2 Density and Cover

At each of the six release locations chosen for monitoring (Figure 2-1), a total of 10 one square meter (m^2) quadrats were randomly located along lines radiating from the release point. Random locations were determined using random aspects and distances from a center flag placed at the release location. Distances consisted of whole numbers and were paced off from the center flag. At each release location, the maximum distance used did not exceed the boundaries of the knapweed infestation and did not exceed 20 meters from the center flag. Placement of the quadrat was done such that one side of the quadrat was roughly centered on, and perpendicular to the line paced from the center flag.

Within each of the quadrats, the cover and density of diffuse knapweed was measured and recorded. Cover was visually estimated by cover class (0 = 0%, 1 = <5%; 2 = 6-25%; 3 = 26-50%; 4 = 51-75%; 5 = >75%). Cover was estimated for plants that had a canopy within the quadrat frame, regardless of whether they were rooted within the quadrat frame. Diffuse knapweed density was counted and recorded as the number of adult, reproducing plants rooted within the quadrat frame. No counts of diffuse knapweed seedlings or rosettes were made.

Photographs at established photopoints were taken to visually document vegetation growth in the area of the release locations. Photographs were taken in the four cardinal directions from the center flag, and from a location looking back to the overall infestation, in order to visually document the level of infestation at the release locations. Photographs of the release sites are compared from year to year, to evaluate visual changes in the diffuse knapweed population. A full series of the photographs comparing vegetation from 2001 to 2004 is available in Appendix B on the CD-ROM.

2.2.3 Flowerhead Counts

To determine the number of flowerheads per plant at each of the study sites, 10 diffuse knapweed plants were collected at each of the six release locations on Site. Plants from the 2004 growing season were collected on 8/16/04 from outside a 25-meter radius circle centered on the release point in order to minimize effects to seed availability near the release location.

Average-sized plants were randomly selected per release site. Each plant was clipped at the base of the main stem and placed in a plastic bag, which was identified by site number. In October of 2004, the total number of flowerheads per plant were counted. This number was used to calculate number of seeds per square meter.

In previous years, the number of infected and un-infected flowerheads were counted by a visual inspection. Flowerheads were deemed infected if they showed exterior visual evidence of exit holes created by two different biocontrol species in the genus *Larinus*. However, this method was discontinued in 2004 because it did not accurately show the actual number of infected and uninfected flowerheads (KH 2004).

2.2.4 Seed Count per Flowerhead

To determine the average number of seeds per flower at each study site, flowerheads were collected from each release site. The word "seed" as used in this report, is defined as the achene

or fruit of the flower. Flowerheads were collected on 9/28/04 from plants selected at random outside a 25-meter radius circle centered on the release point. Collections were made outside the 25-meter radius to prevent impacts to the cover and density aspect of the study.

A part of the 2003 study tested the hypothesis that there would be a difference in seed production between randomly selected flowerheads, and flowerheads purposefully selected for lack of external insect damage. The data from this part of the study showed that there was no significant difference in seed production between the randomly versus purposefully collected flowerheads (KH 2004). Therefore in 2004 only flowerheads that did not show obvious external damage were collected.

Ten average sized plants were randomly selected at each release site. Ten flowerheads were snipped off from each selected plant and placed in an envelope marked with the release site name and plant number. In 2004, a total of 500 flowerheads were collected.

The number of seeds per flowerhead was counted on 10/19/04. Each flowerhead was cut open, and the number of mature, viable seeds in each flowerhead was counted (Figure 2-2). Evidence of insect damage was documented based on internal and external evidence from the flowerheads.

The species of insect and the number of insects present in each flowerhead were recorded. The following criteria were used for determining insect species:

> ***Larinus* ssp** (includes L. minutus as well as L. obtusus, Figure 2-3, Figure 2-4): the presence of adult weevils; the presence of a large gall that took up the majority of the flowerhead; the presence of an exit hole.
>
> ***Urophora affinis*** (Figure 2-5): the presence of a hard, teardrop-shaped gall with a larva inside.
>
> ***Urophora quadrifasciata*:** the presence of a white larva in the flowerhead not inside a hard gall. The flowerhead usually looked like an uninfected flowerhead (Figure 2-2) with a larva nestled between the papus.
>
> **Unknown insect** (Figure 2-6): evidence of some insect damage, but without the above-mentioned signs. The flowerheads usually had some detritus at the bottom of the flowerhead, with some evidence of seed consumption.

2.2.5 Data Analysis

Data were entered into an electronic database and quality checked before analysis was conducted. Data were summarized for individual release locations and for all locations combined. Density count data were summarized as the mean number of stems per square meter. Cover was summarized using the midpoints of each cover class. Descriptive comparisons were made between cover, density, and flowerhead count between years to examine potential change in time. Statistical analysis of the results was conducted when mean values varied enough to suggest a meaningful difference. The Mann-Whitney Rank Sum test was used to calculate for significant differences in results (SigmaStat 1997).

2.2.6 Photo-documentation

At the beginning of the study in 2001, photopoints were established to visually document changes in diffuse knapweed populations. Photographs were taken yearly at each release location. Visual documentation is an effective tool in showing diffuse knapweed cover changes over time.

2.3 Results

2.3.1 Cover and Density

The overall mean cover of diffuse knapweed plants at the five locations sampled in 2004 was 13.0% (Table 2-1). Release location LM5 was not sampled in 2004 because the area was treated with herbicides and location LM6 was established in 2002. These two locations are not included when making comparisons between years for the density and cover data. Excluding location LM5 and LM6 data, the overall mean cover of diffuse knapweed plants in 2004 was 12.9%. In 2001, 2002 and 2003, the overall mean cover for the four release locations was 25.2%, 11.2% and 15.8% respectively (Table 2-1).

The mean cover declined from 2001 to 2002, increased in 2003, and then declined again in 2004. The mean cover in 2004 was still slightly higher than in 2002. However, there is no statistacally significant decrease between the overall 2003 percent cover and the 2004 percent cover (P = 0.841). Figure 2-7 depicts visually the changes in mean cover from 2001 to 2004 at each release location. Of the five locations monitored in 2004, percent cover of diffuse knapweed decreased at two locations (LM2 and LM3) and increased at three locations (LM1, LM4, and LM6) from 2003 to 2004. Although the percent cover has been fluctuating since the study began, all five currently monitored locations have a lower percent cover of diffuse knapweed in 2004 than when these locations were initially established (2002 for LM6, and 2001 for the rest of the sites).

The overall mean density of diffuse knapweed plants at the five locations sampled in 2004 was 4.9 plants per square meter (Table 2-2). Excluding location LM5 and LM6 data, the overall mean density of diffuse knapweed in 2004 was 4.9 plants per square meter. In 2001, 2002 and 2003, the overall mean density for the four release locations was 11.1, 5.8 and 3.8 plants per square meter respectively.

Looking at individual release locations, the diffuse knapweed density data (Figure 2-8) shows generally the same trend as the cover data. Of the five locations monitored in 2004, density of diffuse knapweed decreased at two locations (LM2 and LM3) and increased at three locations (LM1, LM4, and LM6) from 2003 to 2004. However the difference between the 2003 density and the 2004 density was not statistically significant (P = 0.117). All five currently monitored locations have a lower density of diffuse knapweed in 2004 than when these locations were initially established (2002 for LM6, and 2001 for the rest of the sites).

2.3.2 Flowerhead Counts

The mean number of flowerheads per plant at all five locations monitored in 2004 was 454 flowerheads per plant (Table 2-3). This number is almost twice as high as it was in 2003 (242 flowerheads per plant, excluding LM5 for comparison between years). There was a statistically significant difference between the number of flowerheads per plant in 2003 and 2004 (P = <0.001). The 2003 number of flowerheads per plant is almost twice as high as it was in 2002, 131 flowerheads per plant. The mean number of flowerheads per plant has been nearly doubling since 2002. Except at location LM2, where the number of flowerheads decreased slightly from 2003 to 2004, the number of flowerheads per plant has increased at all locations from 2003 to 2004 (Figure 2-9).

2.3.3 Seed Counts/ Insect Effectiveness

The average number of seeds per flowerhead across all five locations monitored in 2004 was 3.08 seeds per flowerhead. This was almost six times higher than the 0.55 seeds per flowerhead observed in 2003 (Table 2-4, Figure 2-10). The difference between the 2003 data and the 2004

data was statistically significant (P = <0.001). The number of seeds per flowerhead increased at every release location between 2003 and 2004. The highest number of seeds per flowerhead was found at Location LM4.

The flowerheads were split into two groups (flowerheads with and without evidence of insect damage) and the average number of seeds per flowerheads for both groups was calculated. The average number of seeds per flowerhead for heads that showed some evidence of biocontrol insect damage was 0.37, 0.14, and 1.10 seeds/flowerhead in 2002, 2003 and 2004, respectively (Table2-5). The average number of seeds per flowerhead for flowers showing no evidence of insect damage was 2.48, 5.66 and 7.49 seeds/flowerhead in 2002, 2003 and 2004, respectively. In all three years, the number of seeds per flowerhead, for flowerheads with insect damage, was statistically lower than for those showing no insect damage (2002 = P<0.05, 2003 = P<0.001, 2004 = P<0.001).

In 2002, 74% of flowerheads had some evidence of insect infestation (Table 2-6, all species of biocontrol insect). In 2003, this number increased to 93%. In 2004, the number of flowerheads with some evidence of insect damage dropped to 69% (345 flowerheads out of 500 total flowerheads collected). The decrease in data from 2003 to 2004 was statistically significant (P = <0.001). Location LM5 had the lowest percentage of insect evidence in flowerheads for 2004 (63%), and LM2 had the highest (76%).

The 345 flowerheads (out of 500 total) that showed some form of insect damage in 2004, were split into four groups depending on the type of insect damage that was evident. The four types of insect damage groups included: *Larinus* spp., *U. affinis, U. quadrifasciata*, and unknown insect. Out of the 345 flowerheads that had insect damage only three flowerheads had evidence of more than one species of insect in one flowerhead. In one flowerhead, there was evidence of one *Larinus* spp., and one *U. affinis gall*. One flowerhead was found with two *U. quadrifasciata* larva and two *U. affinis*. And the third flowerhead was found with one *U. quadrifasciata* larva and two *U. affinis* galls. The other 342 flowerheads had evidence of only a single species of biocontrol insect.

There were about the same number of flowerheads with evidence of *U. affinis, U. quadrifasciata* and unknown insects (54, 58, and 56 respectively, Table 2-7). *Larinus* spp evidence was present in 180 flowerheads, which is more than the flowerheads in the other three categories combined.

There seems to be a pattern to where the higher abundance of the two species of *Urophora* can be found (Figure 2-11). The abundance of *Urophora* spp. (either separately or combined) seems to be higher at release locations where the abundance of *Larinus* spp. is lower and lower at relaese locations where the abundance of *Larinus* spp. is higher. At locations LM1, LM2 and LM4 where the number of Larinus spp., is highest (42, 41 and 40 respectively), the number of *Urophora* spp. is lower. But at location LM3 and LM6, where the number of *Larinus* spp. dips to 32 and 26, respectively, the number of *Urophora* spp. is higher. One possible explanation for this pattern could be that the *Larinus* spp. larva are known to consume everything in the flowerhead they occupy, including other larva (of their own or other species). Therefore, a higher number of *Urophora* spp. larva could have managed to survive at locations where there was a lower abundance of *Larinus* spp.

Not only was there a greater abundance of Larinus spp. than the other insect species, but the seed production in flowerheads with Larinus damage was lower than in flowerheads with damage of other insects (Table 2-8). The average number of seeds per flowerhead in flowerheads with Larinus damage was 0.04 seeds, with *U. affinis* damage was 1.57 seeds, with *U. quadrifasciata* damage was 3.90 seeds, and with unknown insect damage was 1.30 seeds. There is also less variance in seed production in flowerheads with Larinus damage (Figure 2-12). The average number of seeds in flowerheads with Larinus damage ranges from 0 to 0.08, whereas the range

for the average number of seeds for *U. affinis, U. quadrifasciata*, and unknown insect flowerheads was 1.14 to 2.67, 3.22 to 4.5, and 0.40 to 3.42 seeds, respectively.

2.3.4 Total Seed Production

Using knapweed plant density, the average number of flowerheads per plant and the average number of seeds per flowerhead, diffuse knapweed seed production per square meter was calculated. The average seed production for 2002, 2003 and 2004 (excluding LM5) was 825, 202 and 7,433 seeds per square meter, respectively (Table 2-9). Seed production increased at all release locations from 2003 to 2004. The largest increase in seed production was seen at location LM4 where the seed production increased 162 fold from 2003 to 2004.

2.3.5 Photo-documentation

Four years of photographs taken to visually document changes in diffuse knapweed populations are available in Appendix B on the CD-ROM. The photographs were taken yearly at each release location. An example of these photographs is shown in Figure 2-13. In Figure 2-13, photo (a) was taken in 2001, photo (b) in 2002, photo (c) in 2003, and photo (d) in 2004. All four photos were taken from the same location and looking in the same direction. The photos show a substantial decrease of diffuse knapweed cover from 2001 to 2003 (sage green colored plants). The photos also show a resurgance in knwpeed cover in 2004. Quantitative data from this site also show a decrease in knapweed cover from 2001 to 2003, and an increase in 2004. Visual documentation is an effective tool in showing diffuse knapweed cover changes over time.

2.4 Discussion

In general, the average cover and density of diffuse knapweed have declined at the release locations since the *L. minutus* were released (Tables 2-1 and 2-2). The greatest decline occurred initially the year after the releases were made and numbers have fluctuated around these lower levels since that time. Climate may have also had an affect initially on the cover and density of diffuse knapweed in 2002 as well. While not possible to separate out the effects of climate on this study, it would make sense that an increase in precipitation could result in greater plant density (resulting from increased germination of the seed bank) and plant cover (resulting from the increased water available for plant growth). During 2002, the year after the initial releases at LM1-LM5, a drought was experienced which showed substantial declines in vegetation cover at other locations on the prairie at the Site (K-H 2004). From 1992 through 2004, the total annual average precipitation was 15.57 inches. From 2002 to 2004, the total annual precipitation was 11.12 inches, 13.85 inches, and 23.49 inches, respectively. Average diffuse knapweed density bottomed out in 2003, the year after the drought in 2002. It began to rise slightly in 2004, paralleling the rise in precipitation, but still remains substantially below the original amounts, thus suggesting some impacts from the biocontrol insects. Average diffuse knapweed cover has not followed this pattern of paralleling the precipitation amounts, but still remains substantially below the original amounts, also suggesting some impacts from the biocontrol insects. The average number flowerheads per plant dropped in 2002 during the drought and continued to increase through 2003 and 2004, paralleling the increase in precipitation (Table 2-3). This increase in the number of flowerheads makes sense for an annual species that would try to maximize its reproductive ability during a good year. Overall the average number of seeds per flowerhead showed a delayed response, declining the maximum amount in 2003, the year following the drought, before rising dramatically in 2004, presumably in response to the increased precipitation (Table 2-4).

Split out by evidence of insect damage, the average number of seeds per flowerhead have steadily risen from 2002 to 2004 in flowerheads with no evidence of insect damage (paralleling the

increase in precipitation), while a delayed response is apparent in the flowerhead data for the average number of seeds per flowerhead showing evidence of insect damage (Table 2-6). Thus it is apparent from the data that the biocontrol insects are effective at reducing the seed production of affected flowerheads to some extent. The problem however, is that not all flowerheads on a plant are affected equally and the insects do not reduce seed production completely. The increased numbers of flowerheads per plant observed in 2004 at the Site, was apparently too great for the insects to keep up with and deposit eggs into each one. However, using the data from seed production from all flowerheads combined still shows a reduction in overall seed production, compared to the flowerheads with no evidence of insect damage. Therefore the biocontrol insects are having some effect at reducing seed production. What effect the insects will have in the long-term on the abundance of diffuse knapweed at the Site remains to be seen. While a reduction in the overall seed production has been seen and may have had some effect on reducing the visual abundance of diffuse knapweed at the Site, it has not reached the level of success seen during 2002 and 2003 on Boulder County Open Space to the north of the Site. Several releases of different biocontrol insects were made initially in 1997 at this location.

A comparison of data between these two locations shows that the number of seeds produced per flowerhead at the Site in 2003 as well as 2002, are comparable to the results from the Boulder Open Space site north of Rocky Flats (Seastedt et al, 2004). Results from the Boulder site show a number of 0.8 seeds per flowerhead in 2002, and 0.1 seeds per flowerhead in 2003. At the Site, there was a similar decrease in the number of seeds per flowerhead from 0.91 in 2002 to 0.55 in 2003. The lower number of seeds per flowerhead at the Boulder site, may be due to the fact that biocontrol insects have been present for a longer period of time at the Boulder site. At the Boulder site during 2002 and 2003, very little diffuse knapweed was visible throughout the release area (Nelson, 2004). However, in 2004, visual observations showed a dramatic increase in the amount of diffuse knapweed at the Boulder site, presumably as a result of the increased precipitation (Nelson, 2004).

So while the role of climate changes with respect to the effectiveness are not clearly understood, it is apparent that climate influences the effectiveness of the diffuse knapweed biocontrol insects. It is evident also that the biocontrol insects have had some effectiveness is reducing the seed production of the diffuse knapweed at the Site, which is an important step towards controlling this annual species which reproduces by seed. The use of biocontrol insects alone will not likely completely control diffuse knapweed at the Site or most locations along the Front Range where it is problematic, however, it is a tool in the toolbox of weed control methods that can be used where other methods are inappropriate or not feasible.

2.5 Conclusions

Biological control insects have begun to show some effectiveness in controlling the diffuse knapweed population on Site. Some reduction in diffuse knapweed density and cover have been observed, in addition to a reduction the number of seeds per infested flowerhead. It is apparent also that climate plays a role in the effectiveness of the biocontrol insects. During 2004, the increase in the number of flowerheads per plant was so great that the biocontrol insects were not able to effective lay eggs into each flowerhead. Thus some flowerheads had no seed reduction which resulted in a large overall increase in the amount of seed production. Even with this however, the insects did reduce the amount of seed that would have been produced, and thus are having some effectiveness. It will remain to be seen in the long-term how biological control insects affects the overall visual abundance of diffuse knapweed at the Site. The biocontrol insects are one of many tools in the weed control toolbox that can continue to be used to help control diffuse knapweed at the Site.

2.6 References

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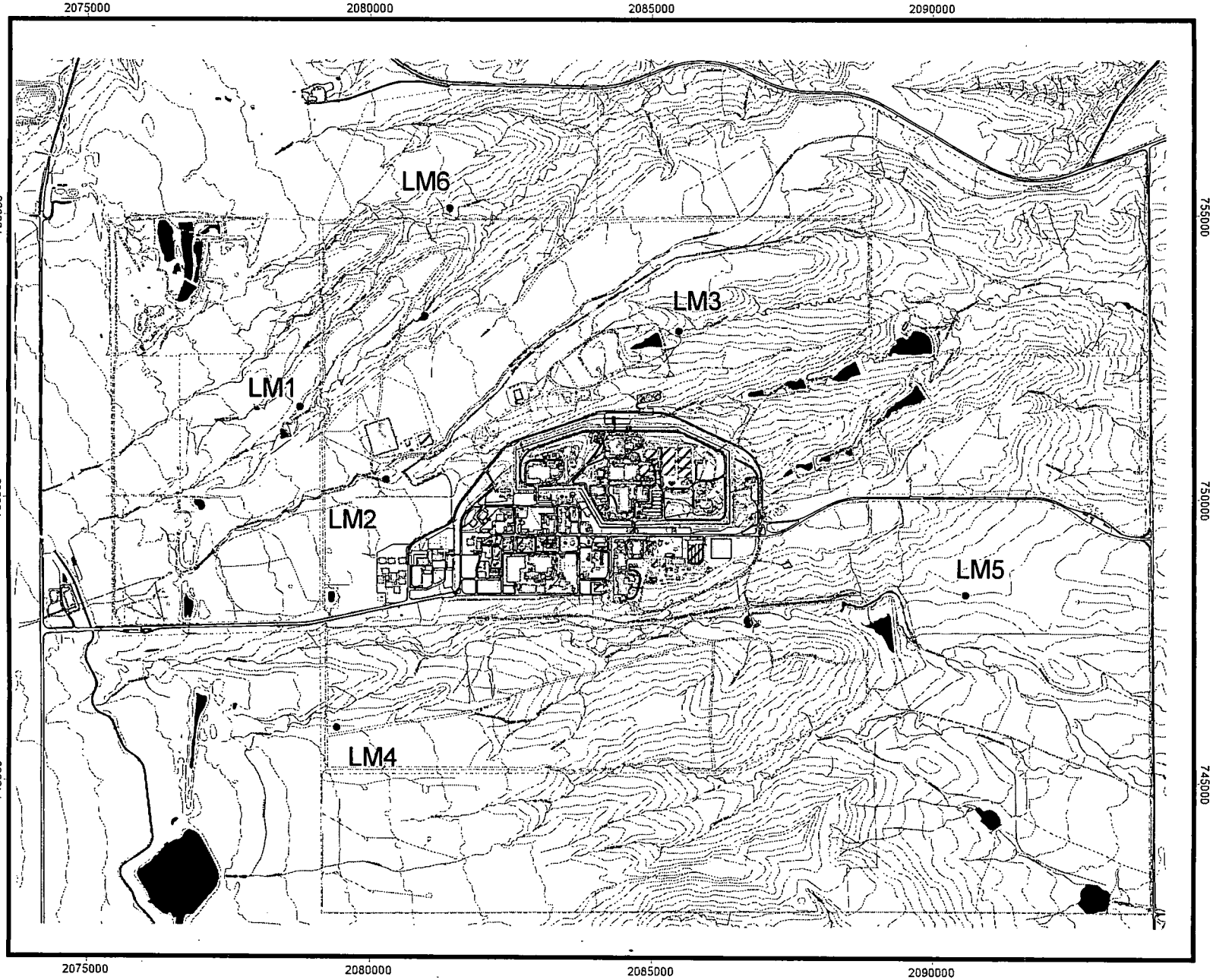
Seastedt, T.R., N. Gregory, and D. Buckner. 2003. Effect of biocontrol insects on diffuse knapweed (Centaurea diffusa) in a Colorado grassland. Weed Science 51:237-245.

SigmaStat. 1997. SigmaStat Statistical Software, Version 2.0. SPSS Inc.\Marketing Department, Chicago, IL.



Larinus minutus Biocontrol Study Locations at RFETS

Figure 2-1

LEGEND

- Larinus minutus biocontrol study locations

Standard Features

- Buildings
- Demolished Buildings
- Lakes & ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Trails
- Contours (20 ft. intervals)

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 series fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95.

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N

1:22628

1000 0 1000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: LABAT

For: Kaiser-Hill Company, LLC

RFETS GIS Dept. 303-966-7707

MAP ID: 02-0005

April 4, 2003

O:\Projects\FY2002\02-0005\biocontrol02.apr\Larinus minutus biocontrol study locations

Figure 2-2. Diffuse Knapweed flowerhead with no evidence of biocontrol insects. The phyllaries were pulled backwards and the seeds were pushed out from between the Pappus.

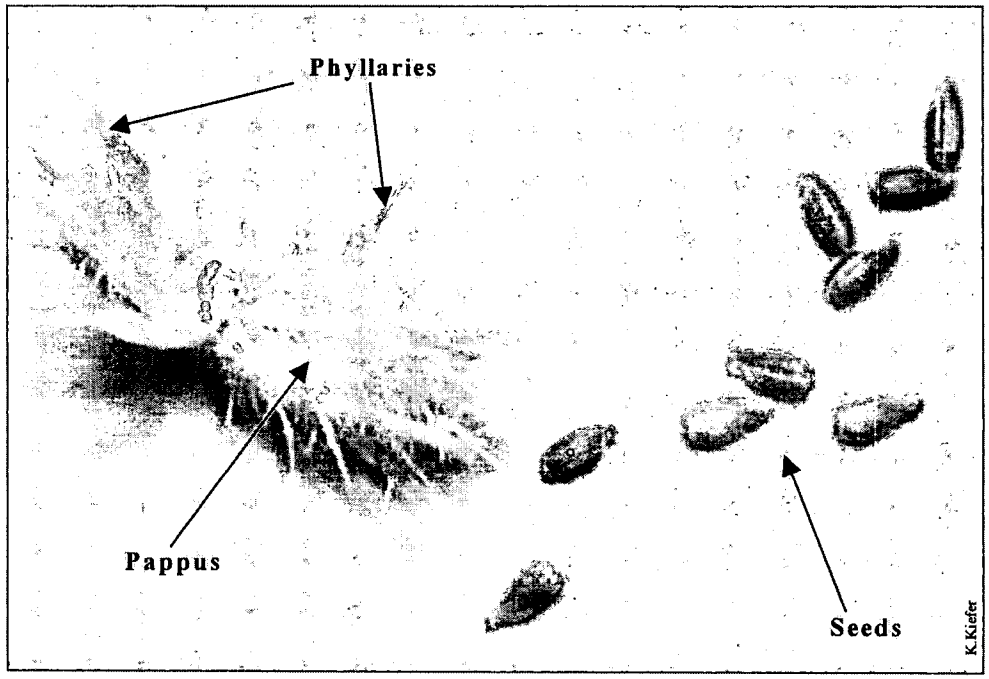


Figure 2-3. Larinus minutus weevil in a Diffuse Knapweed flowerhead. The flowerheads were cut lengthwise. In figure (a), the weevil is still inside its gall in the flowerhead. Note the "plug" (top of the corolla) that sat on top of the gall prior to cutting.

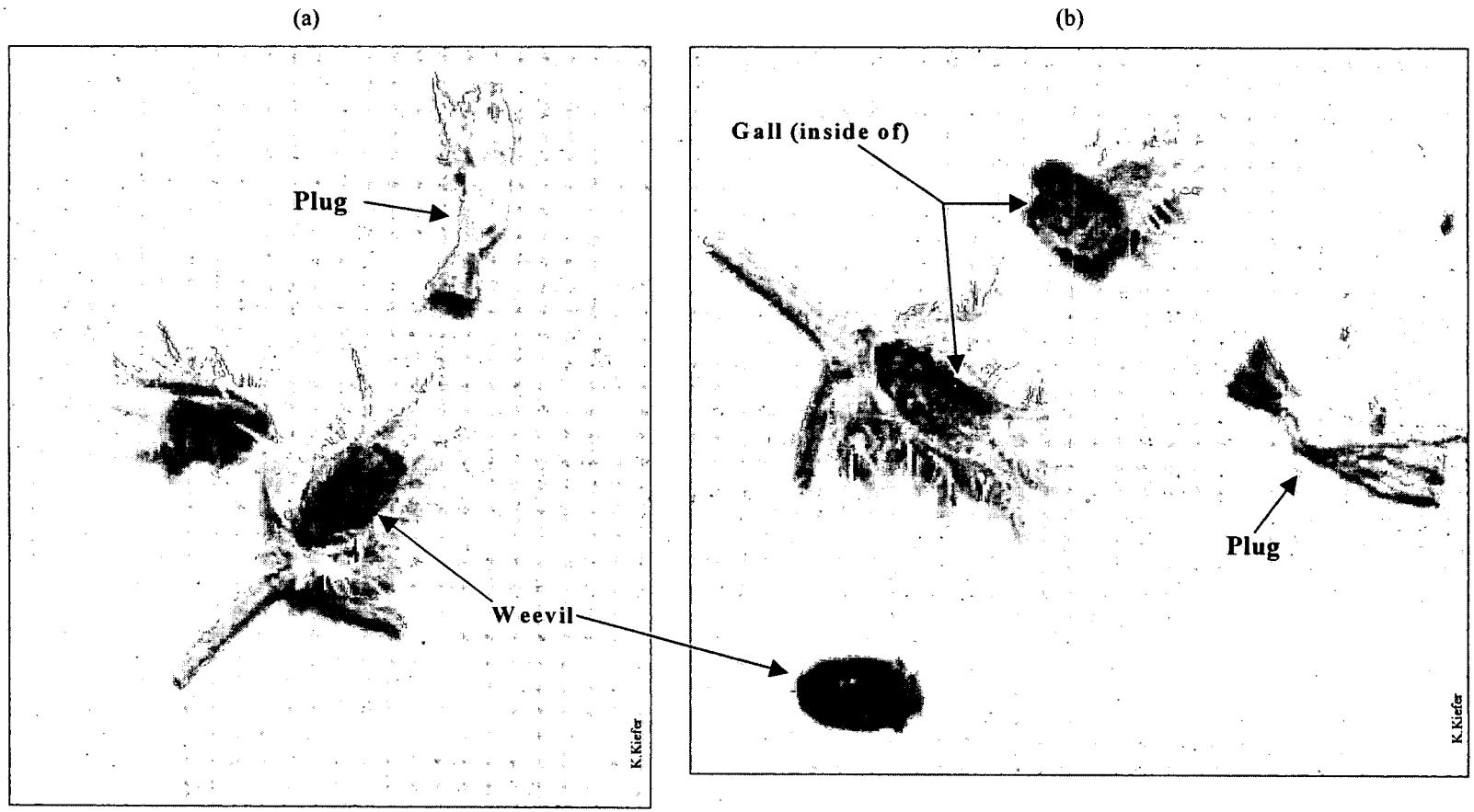
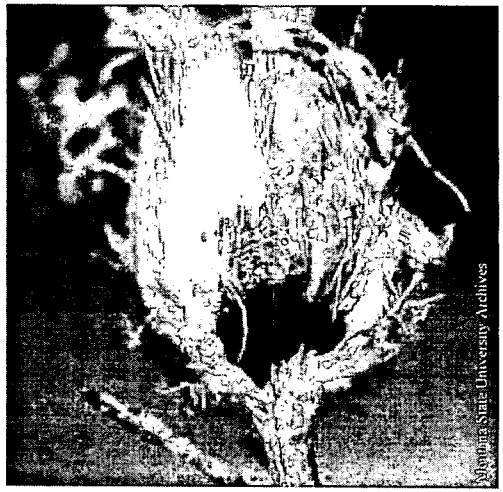


Figure 2-4. *Larinus minutus* (a) and *L. obtusus* (b) damage on Knapweed flowerheads.

(a)

Photo by Bob Richard, USDA-APHIS-PPQ
http://mtwow.org/Larinus-minutus-photos.html

(b)



PhotoCredit:
Montana State University Archives
Montana State University
www.forestryimages.org

Figure 2-5. *Urophora* fly gall and larva. The larva in (a) is still inside the gall. Note the presence of a few seeds.

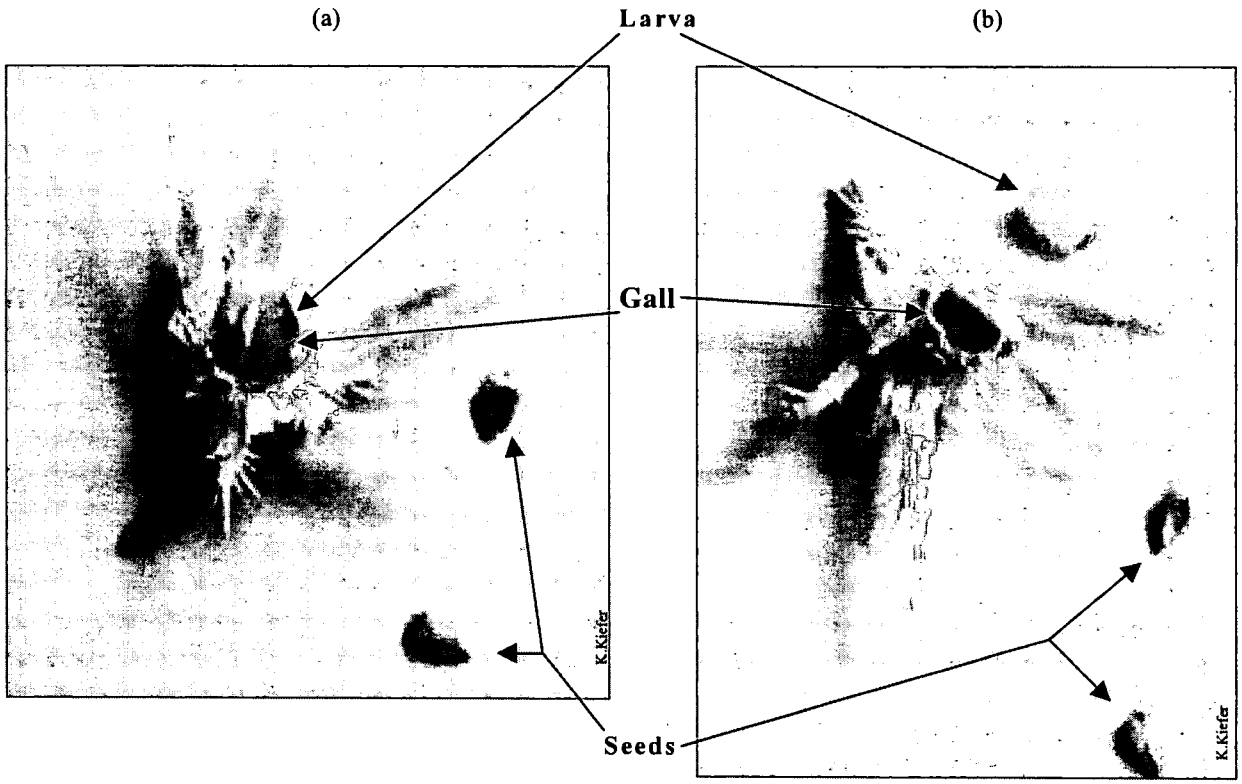


Figure 2-6. Insect feeding damage on Diffuse Knapweed flowerhead. The flowerhead is cut lengthwise. Note detritus and lack of seeds.

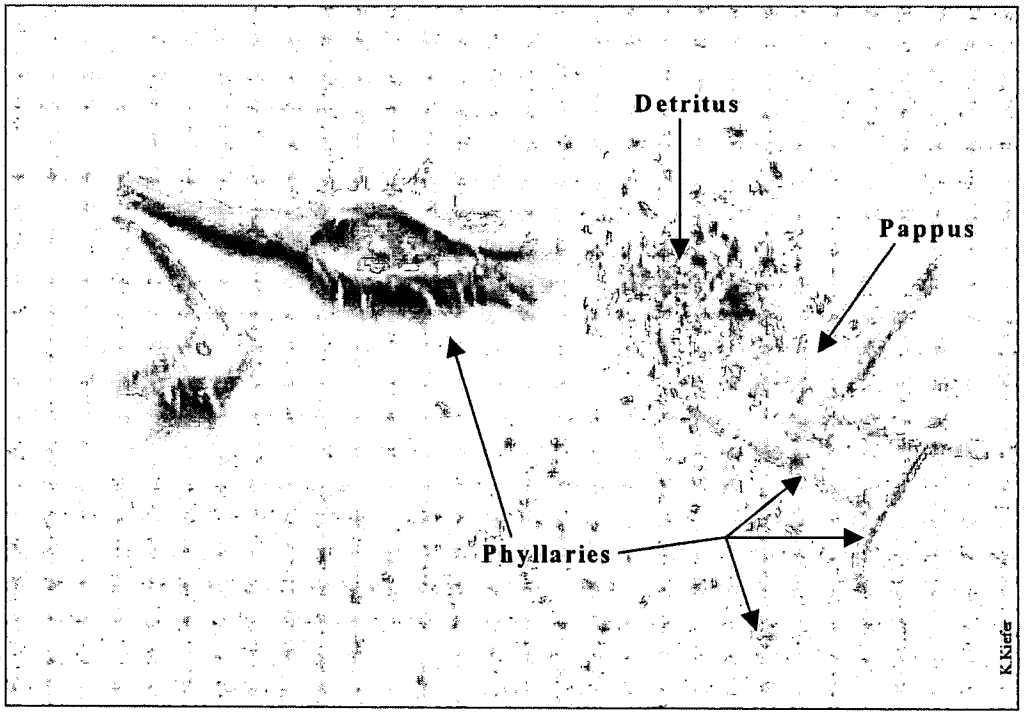


Figure 2-7. Diffuse Knapweed cover at biocontrol release locations.

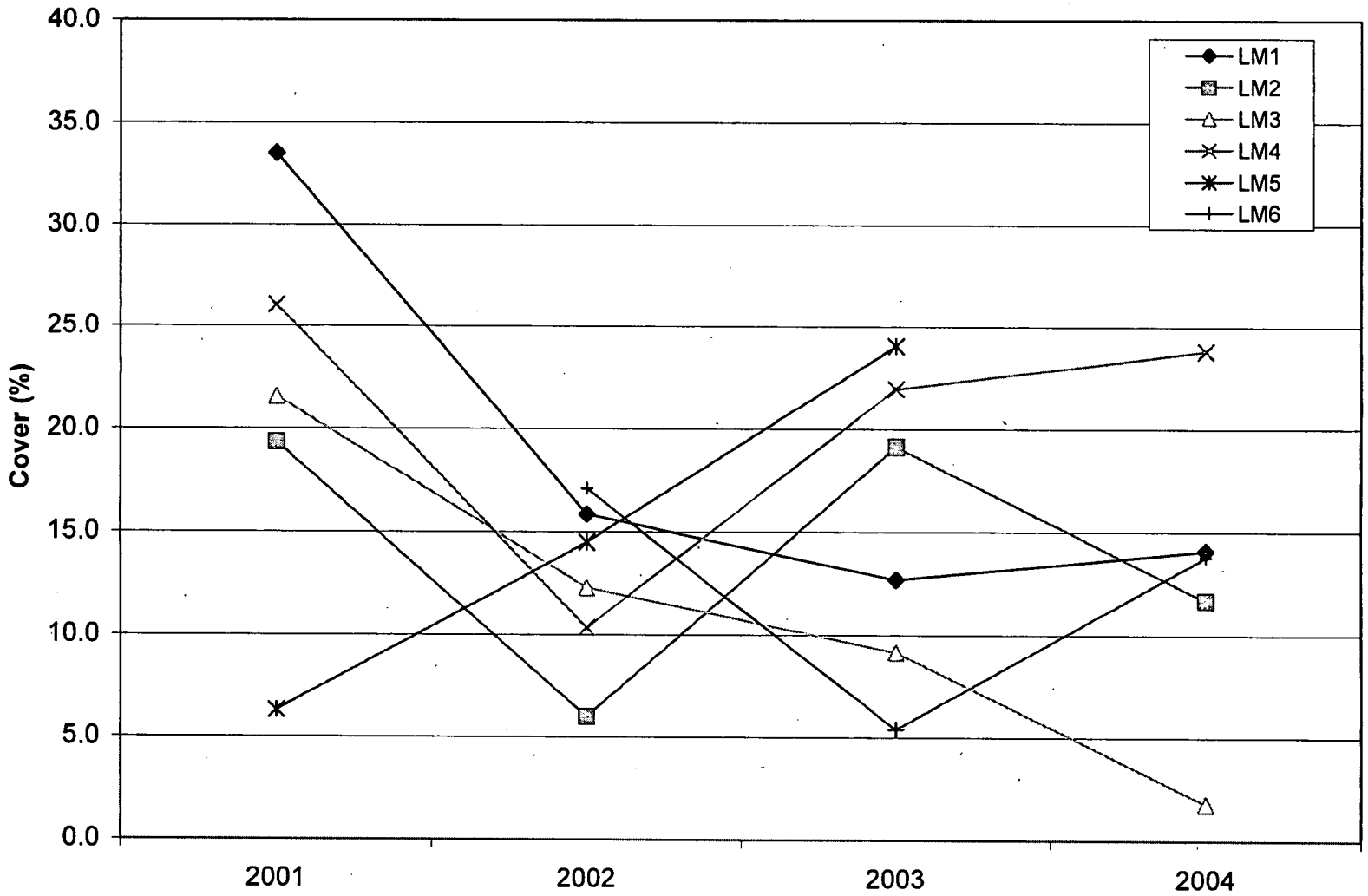


Figure 2-8. Diffuse Knapweed density at biocontrol release locations.

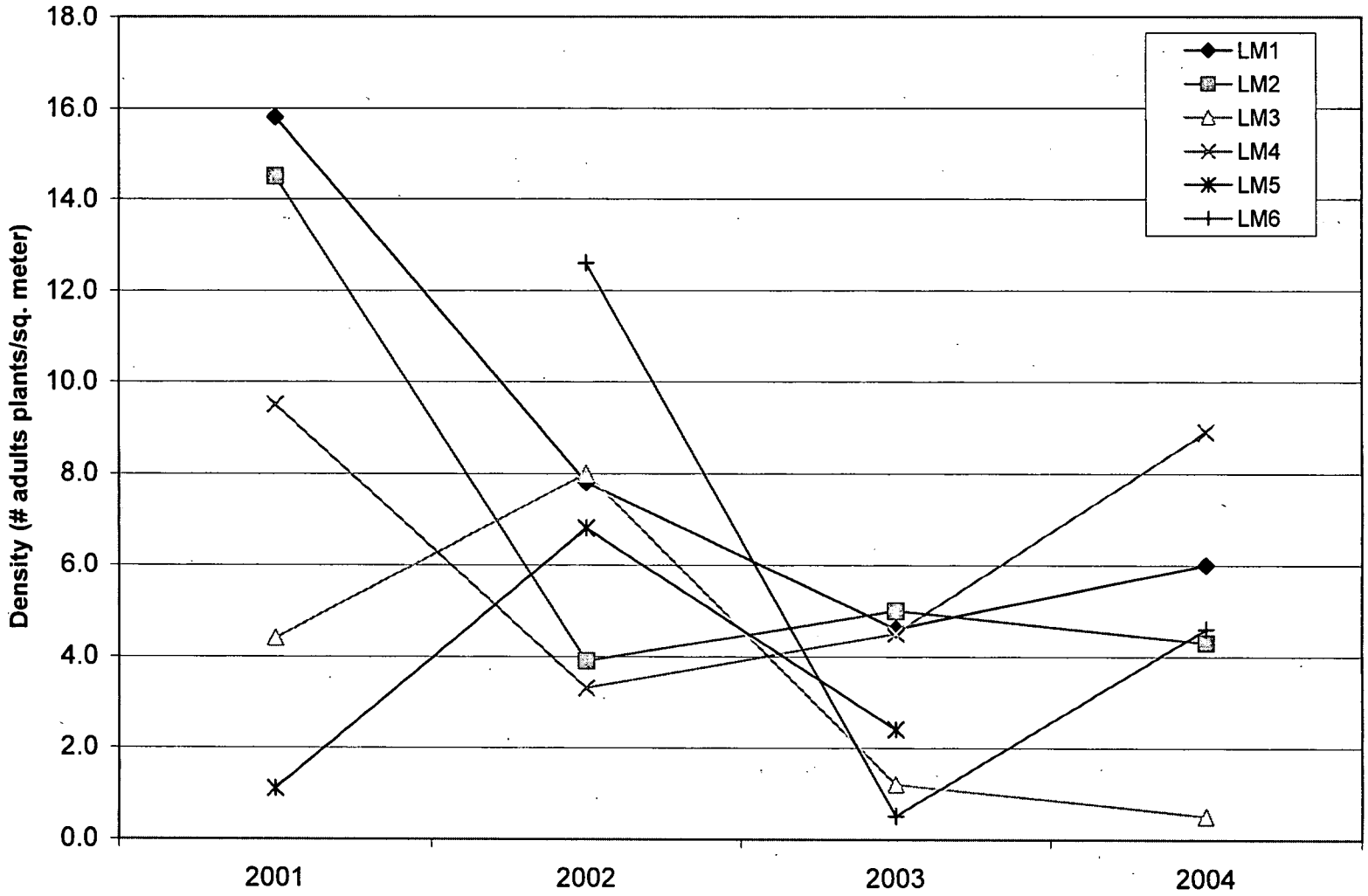


Figure 2-9. Average Diffuse Knapweed Flowerheads Per Plant at Biocontrol Release Locations in 2001-2004.

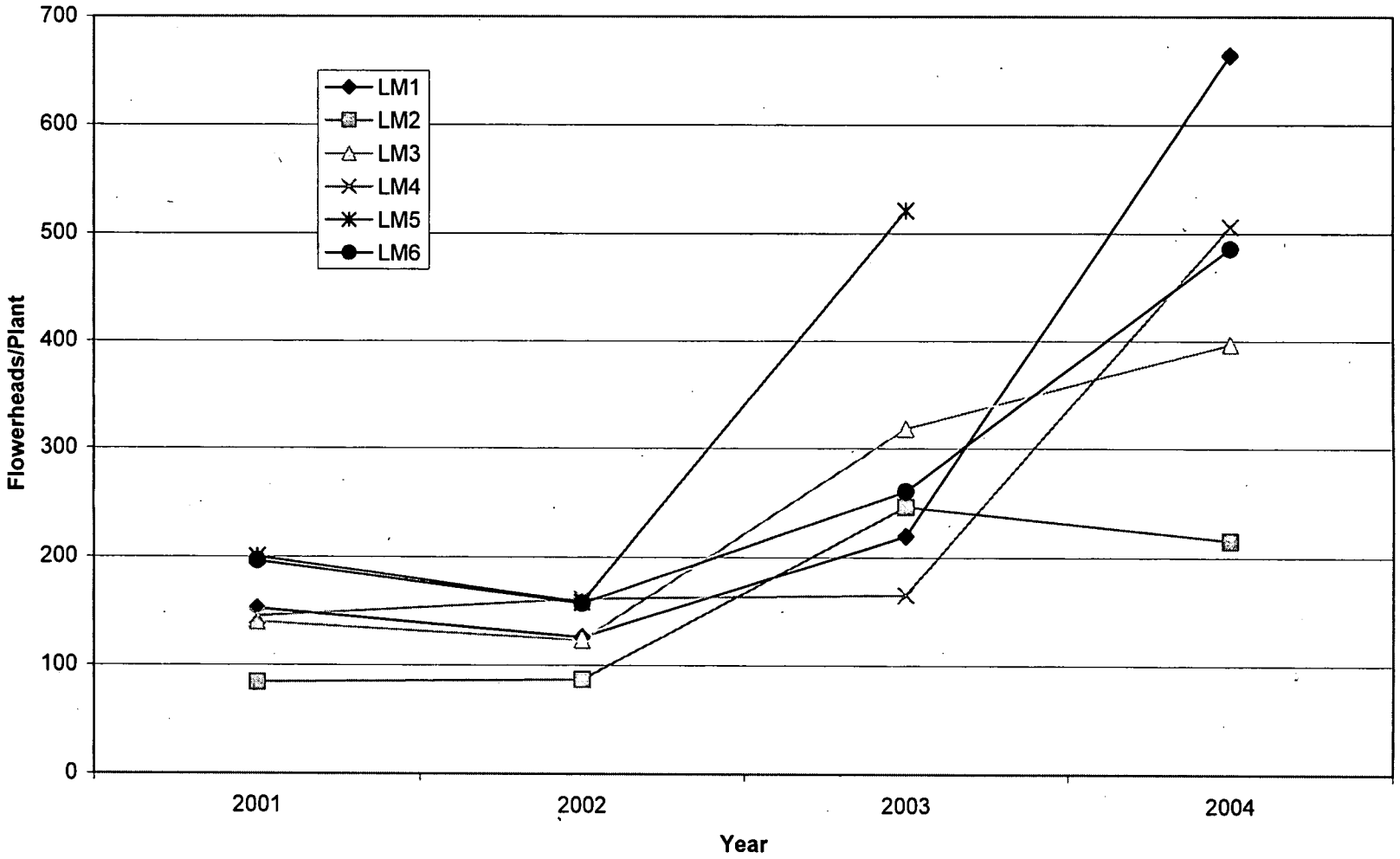


Figure 2-10. Average number of seeds per flowerhead for six biological release locations from 2002 to 2004.

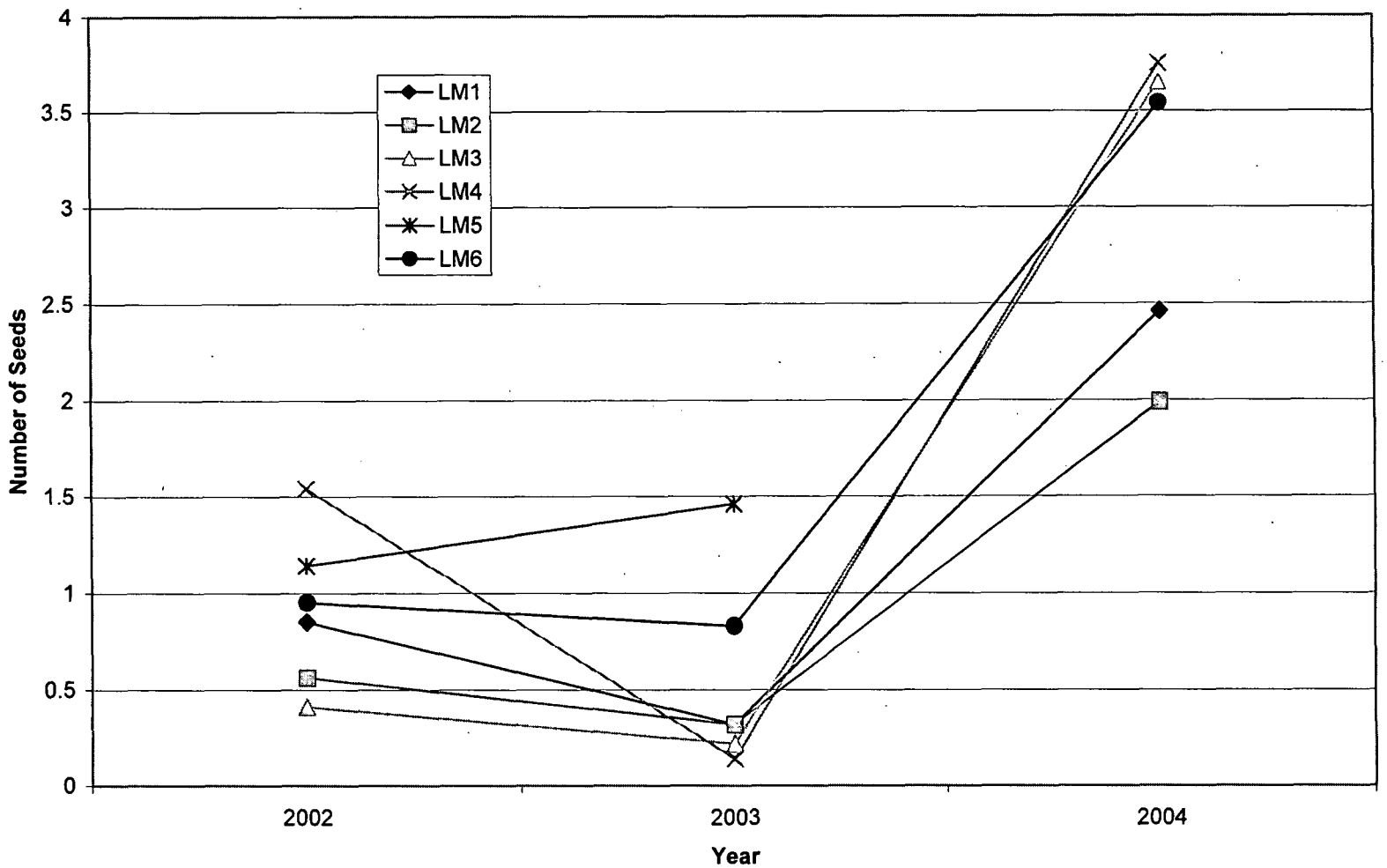


Figure 2-11. Number of flowerheads with evidence of four types of insect damage

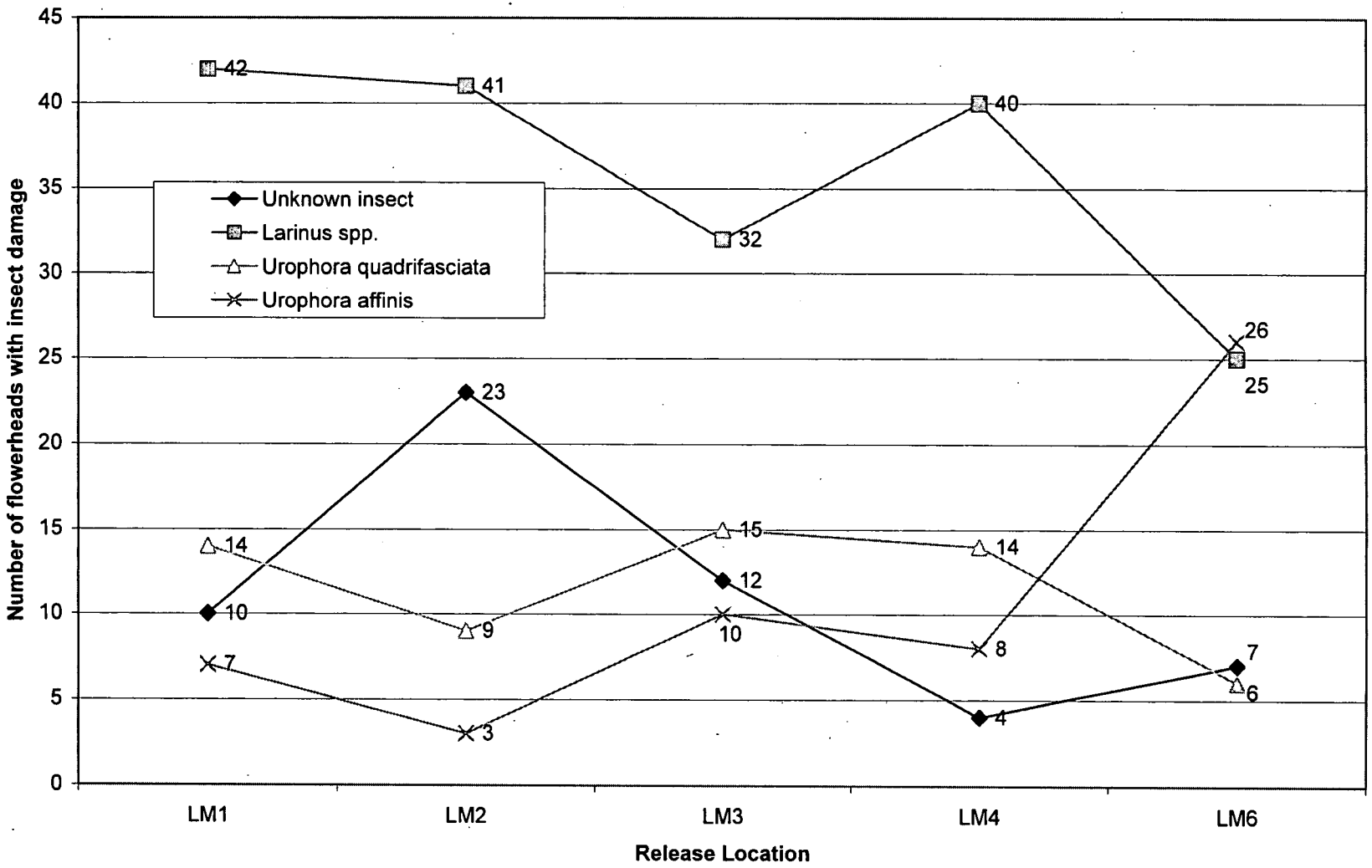


Figure 2-12. Average number of seeds per flowerheads at five biocotnrol release locations

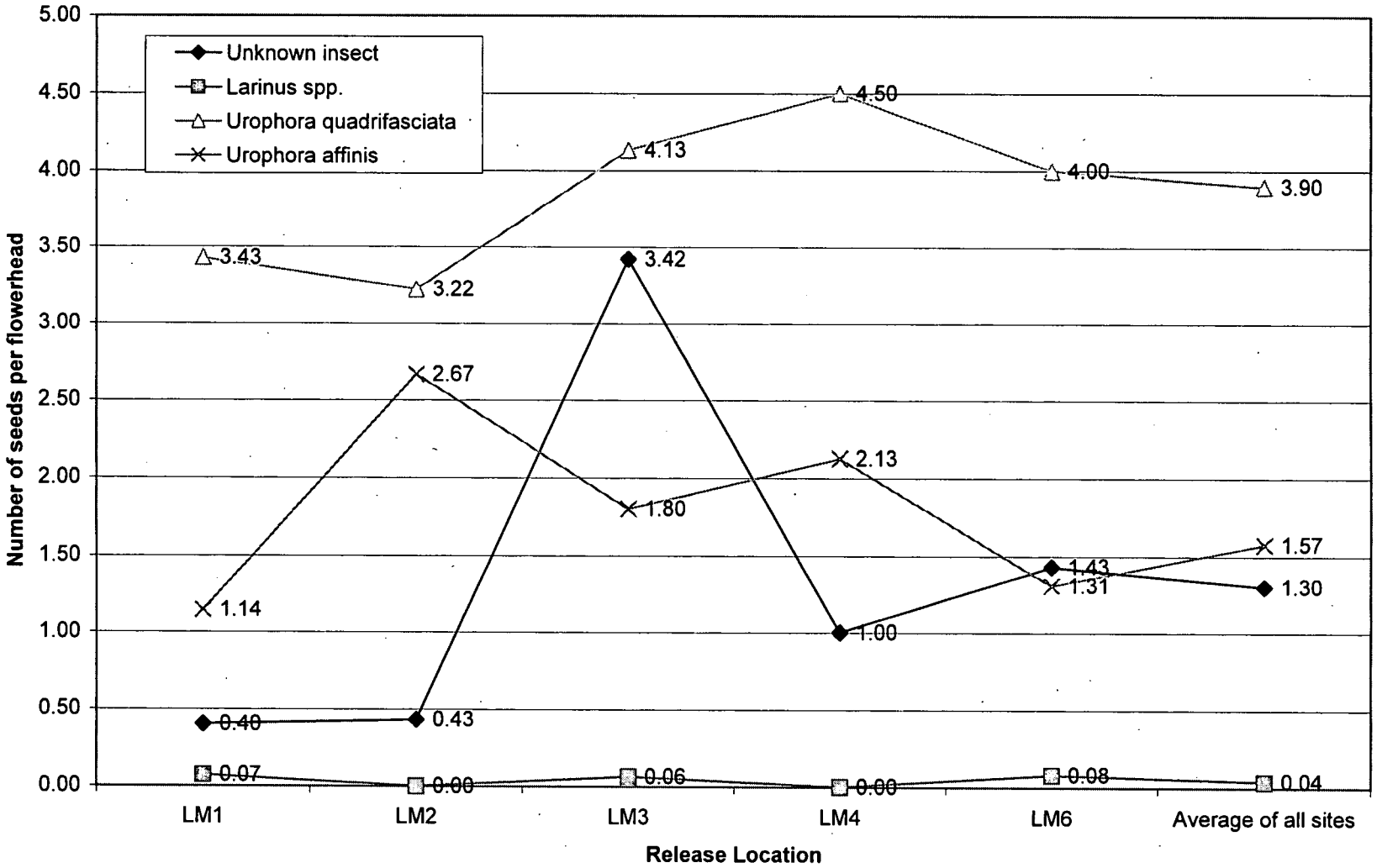
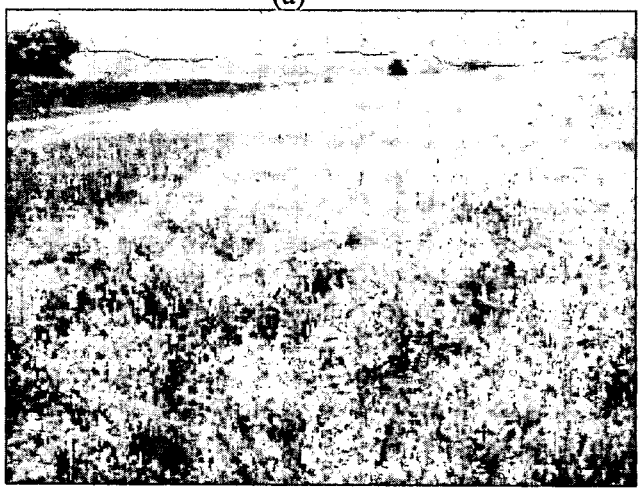
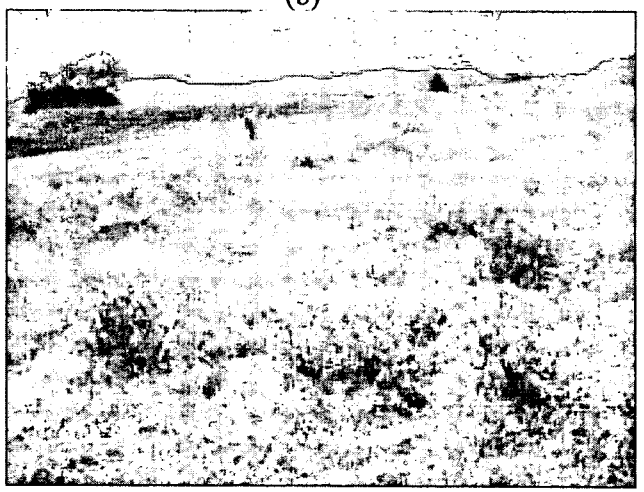


Figure 2-13. Visual documentation of diffuse knapweed at biocontrol insect release location LM1 from 2001(photo a) to 2004 (photo d). In 2001 diffuse knapweed covered almost the entire hillside. The cover decreased in 2002 and 2003 to where only a few plants can be seen in photo c (sage green colored plants). In the 2004 photo, the cover of diffuse knapweed has increased again, but is not as thick as in 2001.

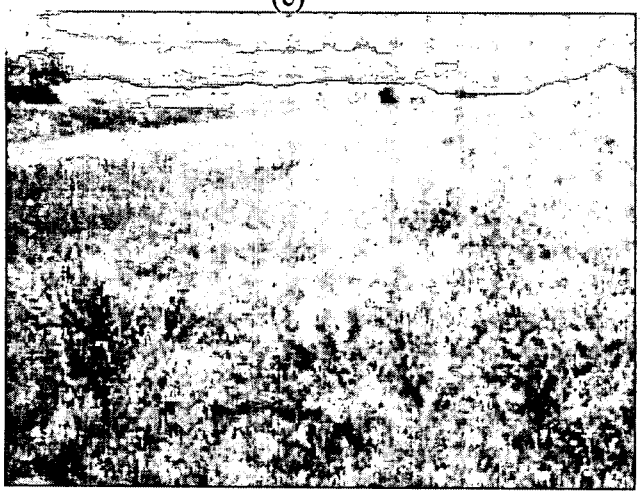
(a)



(b)



(c)



(d)

3. Sitewide Wildlife Survey

3.1 Introduction

Site ecologists monitor for the presence of significant wildlife species through the use of sitewide wildlife surveys. Sitewide wildlife surveys are conducted monthly along established roads in the Buffer Zone (BZ). This monitoring provides information on what significant species of animals use the site, the relative abundance of each of those species, and locational information on the species. Significant species are of special interest because of their status as high-visibility species, indicator organisms, sensitive species, federal and state protected species, or game species. The questions under investigation included:

- What wildlife species use the Buffer Zone at the Site?
- What is the relative abundance of these species?
- At what locations are certain species most commonly found?

3.2 Methods

During 2004, sitewide wildlife surveys were performed monthly along all passable, established BZ roads (Figure 3-1). Road selection was made on the basis of all-season accessibility. Areas surveyed were limited to areas that were visible from the roads. Preference was given to fair weather to optimize observation availability and driving conditions. During these surveys all visible individuals of significant species observed during a short time-span (3 to 4 hours) over the entire property were recorded. Data recorded include species, location (using the BZ gridlines, Figure 3-1), activities, habitat, number of individuals, and age and sex classifications.

Significant species groups include waterfowl, big game mammals, game birds, carnivores, raptors (birds of prey), small game mammals, furbearers, herpetiles, and selected other species. The species observed on Site during the sitewide survey in 2004 were assigned to one of the above-mentioned groups (excluding most songbirds). For data analyses, all mammals (taxonomic group lagomorph, big game, carnivore, and mammal) were grouped together. Relative abundance was calculated separately for the mammal, raptor and waterfowl group. To enable comparisons between 2004 and previous years' sitewide survey data, the relative abundance was also calculated using all the species observed throughout the year, regardless of taxonomic group.

3.3 Results and Discussion

3.3.1 General Relative Abundance

The relative abundance of all the species observed during 2004 were calculated and are shown in Table 3-1. The table also shows the overall relative abundance of all the species observed in 2001, 2002 and 2003. Mule deer (*Odocoileus hemionus,* RA 43.22 %) had the highest relative abundance for all four years. In 2001, 2002 and 2003 the Mallard duck (*Anas platyrhynchos)* had the second highest relative abundance after the mule deer. However in 2004, it was the American Coot (*Fulica americana,* RA 9.95%) that had the second highest relative abundance. The highest number of observations of the American Coot throughout 2004 was made at the D-2 pond, where a large number of these waterbirds nested and fledged their young. The D series ponds, although

close to Indiana Avenue road traffic, is secluded from on site activities and rarely has human visitors.

Most species that were observed in one year, but not another, had a very low relative abundance. Many of these species, which were observed only a few times during the year, use the Site on their way to other locations or for hunting/feeding. The Osprey (*Pandion haliaetus*), for example, (observed during the August sitewide survey in 2004) has not been documented on Site since in 1997. Both observations occurred in the Southeast BZ.

Other species that occasionally visit the Site include the bald eagle (*Haliaeetus leucocephalus*, one observation per year since 2002) which has never been documented nesting on site; most of the time the activity associated with this species has been "in transit". The golden eagle (*Aquila chrysaetos*, three observations in 2002, one in 2003, and one in 2004) has also never been documented nesting on Site, but it has been documented at various times hunting or feeding.

Another species that was seen in 2004, but not in the three preceding years, is the stripped skunk (*Mephitis mephitis*). This nocturnal species was probably present on Site prior to 2004, but never seen because the majority of the surveys are conducted in the daytime. The skunk documented in May 2004 survey was dead and visible due to the presence of turkey vultures.

3.3.2 Mammals

Mule deer

When relative abundance is calculated for the mammal group (excluding the other taxonomic groups), the mule deer is again the species with the highest relative abundance (RA 90.48%, Table 3-2). Figure 3-2 shows mule deer use areas in 2004. This species of deer is widely distributed on Site, and is frequently seen near human disturbance areas (the Industrial Area is not surveyed during this survey; the map does not reflect mule deer use of that area).

Figure 3-3 presents the winter mule deer counts from 1994 through 2004. The 2004 deer count of 155 individuals is one of the highest counts since 1994. The lowest deer count was in 2003 (79 deer), possibly due to the 2002 drought. Data from the winter sitewide survey is used to estimate the mule deer population on Site. The winter survey (usually the December survey) is chosen for this estimate because there is greater visibility of animals. Because of the lack of foliage and occasional presence of snow groundcover, animals are highly visible. Sex is also easily distinguishable during the winter because the males have not yet shed their antlers. Figure 3-4 shows the deer counts from all monthly sitewide surveys for years 2001 through 2004. The graph shows the monthly fluctuations in deer counts. The winter deer counts are the most reliable deer population counts due to the higher visibility of the deer, but some deer may be missed during the survey. So the actual deer numbers may be higher. The September survey was the night sitewide survey for years 2001 through 2003 (lower deer counts results from low visibility), but in 2004 the September survey was not conducted at night.

Elk

In 2004 the number of elk that visited the site was not as high as in 2003. In 2004, there were two sitewide surveys (March and May) with observations of elk. The highest number of elk observed in 2004 were 8 individuals, while in 2003 as many as 17 individuals were observed. Even though there were fewer elk on Site in 2004, they used different areas of the Site. Four individuals were observed in the South Buffer Zone (Figure 3-5), when in previous years elk were only observed in the North Buffer Zone. In the past, elk were a rare visitor to the Site. The increase in elk use of the Site indicates that either conditions on Site are becoming more habitable to the elk (less disturbance in the Buffer Zone, fewer man-made structures such as fences, etc.) or that the

environment usually used by the elk is becoming less habitable (human encroachment, overcrowding, habitat disturbance etc.). Elk observations on Site are still occurring in areas distant from the IA. Perhaps as buildings in the IA are removed and human activity decreases after closure, the elk will utilize a larger portion of the Site.

White-tailed deer

Another flighty big game species that occurs on Site is the white tailed deer (*Odocoileus virginianus*, RA 0.34%, Table 3-2). In 2001and 2002 several observations of white-tailed deer were made, mostly in the South BZ. In 2003 and 2004, the number of observations were lower. Figure 3-6 shows the areas where white tailed deer were observed in 2004. The white tailed deer are more flighty than the mule deer, and are usually seen fleeing or running and do not seem to tolerate human disturbances as well. The only observations in 2004 of white-tailed deer were of a female, and two fawns that were seen with the female. The fawns were assumed to be white-tailed deer at the beginning of the year, but further fortuitous observations showed that the fawns are actually hybrid deer. The fawns looked like mule deer except they had longer black tails. The white-tailed deer and her fawns were observed with a herd of mule deer. When the observer approached with the car, the white-tailed deer and her fawns responded with a flight response, while the mule deer remained lying down.

Black-Tailed Prairie Dogs

The relative abundance of the black-tailed prairie dog (*Cynomys ludovicianus*) in 2004 was 3.17% (Table 3-2). In 1993, the prairie dog population was devastated by plague, and the species was eliminated from most areas on Site. However, prairie dogs have been observed in certain areas on the Site on a regular basis for several years. These sightings have mostly been in the north BZ, along Highway 128, and the southeast part of the BZ, just south of the east gate. It is not surprising to see prairie dogs in these areas because the areas north of Highway 128 and east of Indiana Street are used as prairie dog relocation and release sites by local cities and counties.

Two new prairie dog colonies were established in the fall of 2002. 2002 was a drought year, and it is assumed that the prairie dogs migrated along a powerline service road from the colony located along the eastern Site boundary. One colony was established north of the C-2 pond, and one south of the C-2 pond. Both colonies were active in 2002 and 2003, however the northern location became inactive at the end of 2003. The southern location remained active through 2004, with four individuals being observed in the spring and summer.

Unlike the other colonies located on the periphery of the Site where there is an interchange of individuals to and from offsite, this southern colony is fairly isolated. It is unlikely that individuals from this colony would migrate from their current location, unless the number of prairie dogs increased and the colony was stressed. It is possible to see the same type of expansion that was seen in 2002 if another drought stresses either the peripheral colonies, or the isolated colony south of the C-2 pond. Because of the burrowing nature of prairie dogs, relocation actions on Site may be necessary if, in the future, the prairie dogs move closer to locations in the Industrial Area where they are undesired.

3.3.3 Raptors

One of the largest groups of predators that utilize the Site is the raptor group. Ecologically, raptors are an important taxonomic group because they require very specific nesting sites (mostly riparian woodland) and help limit the populations of small mammal prey species.

During the 2004 sitewide surveys, there were 112 observations of raptors on Site, which is almost twice as high as the 66 observations in 2003. The most common raptor on Site during 2003 was

the Red Tailed Hawk (*Buteo jamaicensis*) with a relative abundance of 40.18%. The American Kestrel (*Falco sparverius*) followed in second place with a relative abundance of 23.21%. And the great horned owl (*Bubo virginianus*, third most common raptor on Site) had a relative abundance of 11.61% (Table 3-3). These three species are common on Site throughout the whole year, and have either been seen or are believed to be nesting on Site.

The relative abundance of the Swainson's hawk (*Buteo swainsoni*) increased from 3.03 in 2003 to 8.93 in 2004 (fourth highest raptor relative abundance in 2004). A pair of Swainson's hawks nested in North Walnut Creek upstream from the A-1 pond, and successfully raised one offspring. This species of hawk has been observed on Site in the past years, but has not been observed nesting since 1999, when a pair of Swainson's hawks nested upstream from the C-1 pond in Woman Creek. The year prior, in 1998, a pair of Swainson's hawks was observed nesting in North Walnut Creek, in the same area as the pair from 2004. Other species of raptors observed on Site and their relative abundance are shown in Table 3-3.

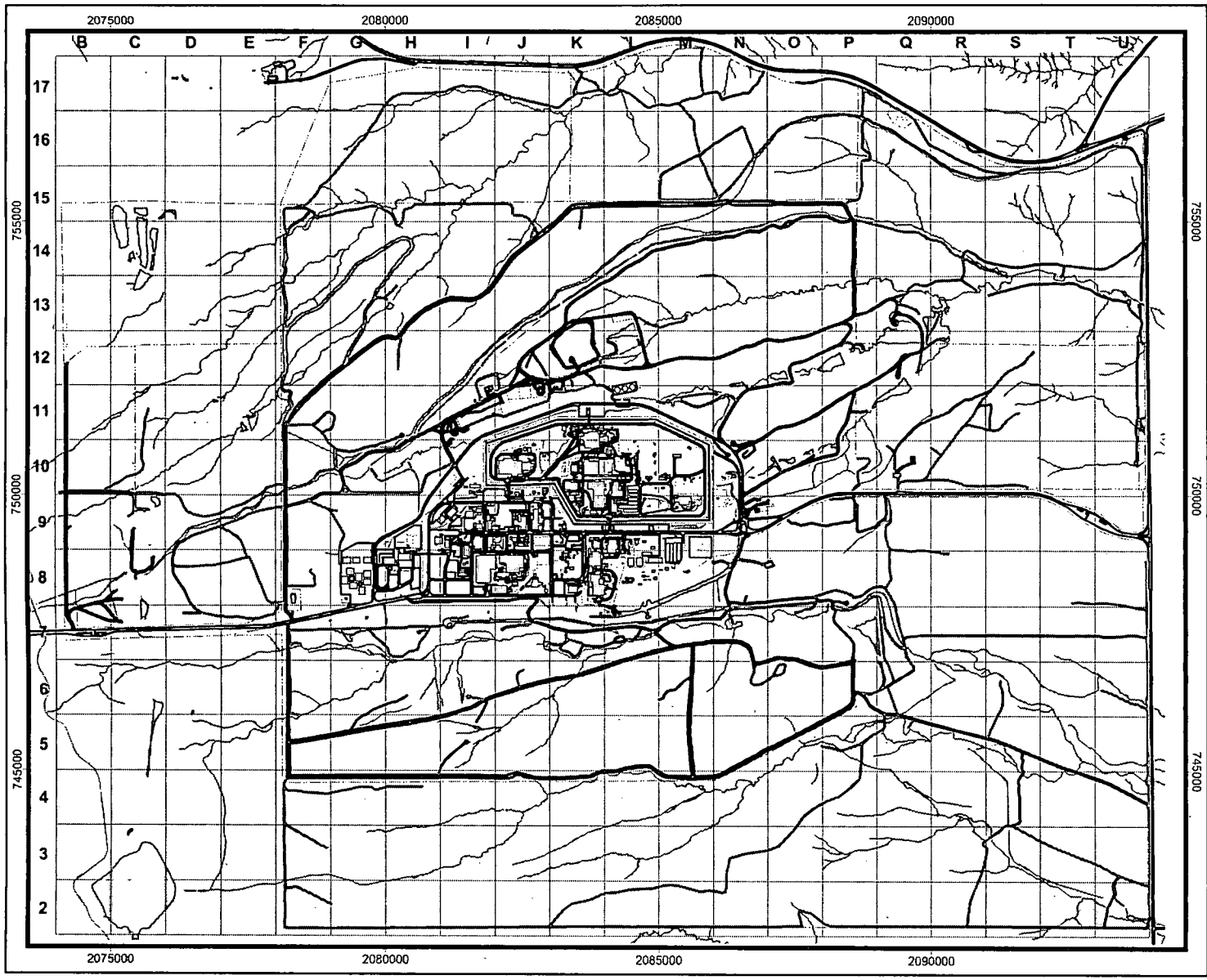
3.3.4 Waterfowl

The relative abundance for the waterfowl taxonomic group was calculated, and the American coot was the species with the highest relative abundance (22.17%, Table 3-4), closely followed by the mallard duck (22.08%). There has been a fairly dramatic increase in the abundance of American coots over the past three years. In 2002 and 2003 the relative abundance of the American coot was 1.71% and 13.33%, respectively. As mentioned previously, the majority of American coot observations in 2004 occurred at the D-2 pond, where there is little human disturbance. The increase in American coot abundance could be a result of natural population fluctuations, or disturbance of coot habitat in off-site locations.

As expected, waterfowl observations were mostly made near water structures such as the man-made ponds in Walnut and Woman Creek (Figure 3-7). Waterfowl observations made in locations not associated with a water structure were usually of birds in transit. There are a lot of remediation and closure-related activities planned in 2005 for ponds in Walnut Creek and Woman Creek. It is expected that there may be a drop in waterfowl abundance during times of project activities. However, since ponds will remain in place post closure, it is expected that waterfowl will continue using the Site's water features in future years.

3.4 Conclusion

The sitewide survey continued to document the presence of many of the significant wildlife species at the Site. Annual variations in relative abundance from 2003 to 2004 were documented, but are expected given this type of survey. The diversity and abundance of wildlife species observed on surveys conducted in 2004 continued to verify the high quality of habitat available in the Buffer Zone at the Site.



Buffer Zone Road Access

LEGEND

- Dirt roads, authorized for general use
- Dirt roads, access by permission* only
- Closed to vehicle use

Standard Features

- Buildings
- Lakes & ponds
- Streams & ditches
- Fences
- Paved roads

* Permission obtained through the Buffer Zone Office.

Updated March, 2001.
Supersedes previous versions.

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95.

Data Source Ecology Features:
Road categories provided by Exponent.
K-H Ecology Group POC; Karan North 303-966-9876.

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent®

For: Kaiser-Hill Company, LLC

RFETS GIS Dept. 303-966-7707

MAP ID: 99-0468

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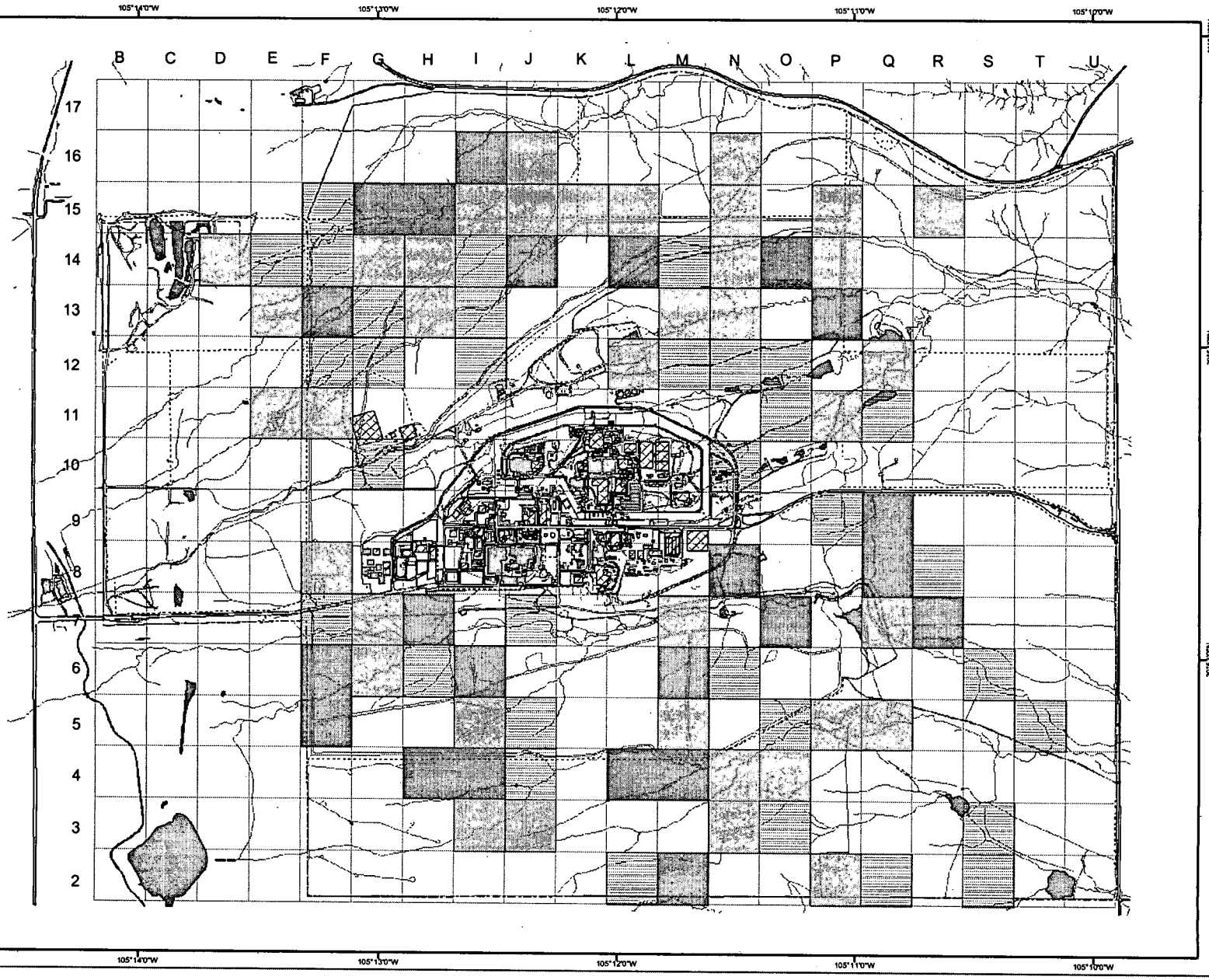

2004 Annual Mule Deer Area Use at Rocky Flats

Figure 3-2

Legend

- Low (1-5 observations)
- Medium (6-15 observations)
- High (16+ observations)

Standard Features

- Buildings
- Demolished Buildings
- Lakes
- Streams
- Boundary Fence
- Fences
- Trails
- Dirt Roads
- Paved Roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95.

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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For: Kaiser-Hill Company, LLC

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303-966-7707

MAP ID:05-0019

March 22, 2005

Figure 3-3. Total Number of Mule Deer in Winter (1994-2004)

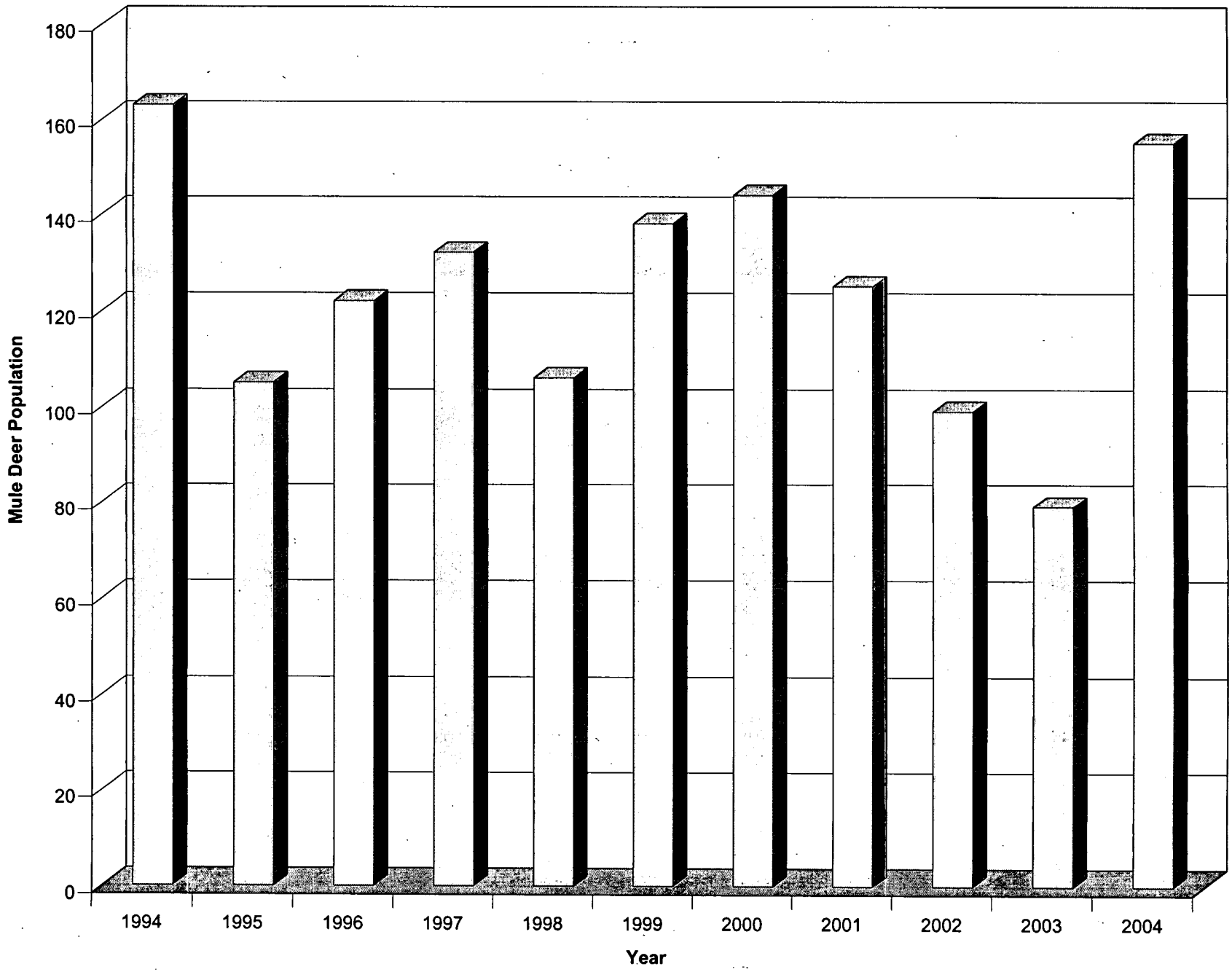
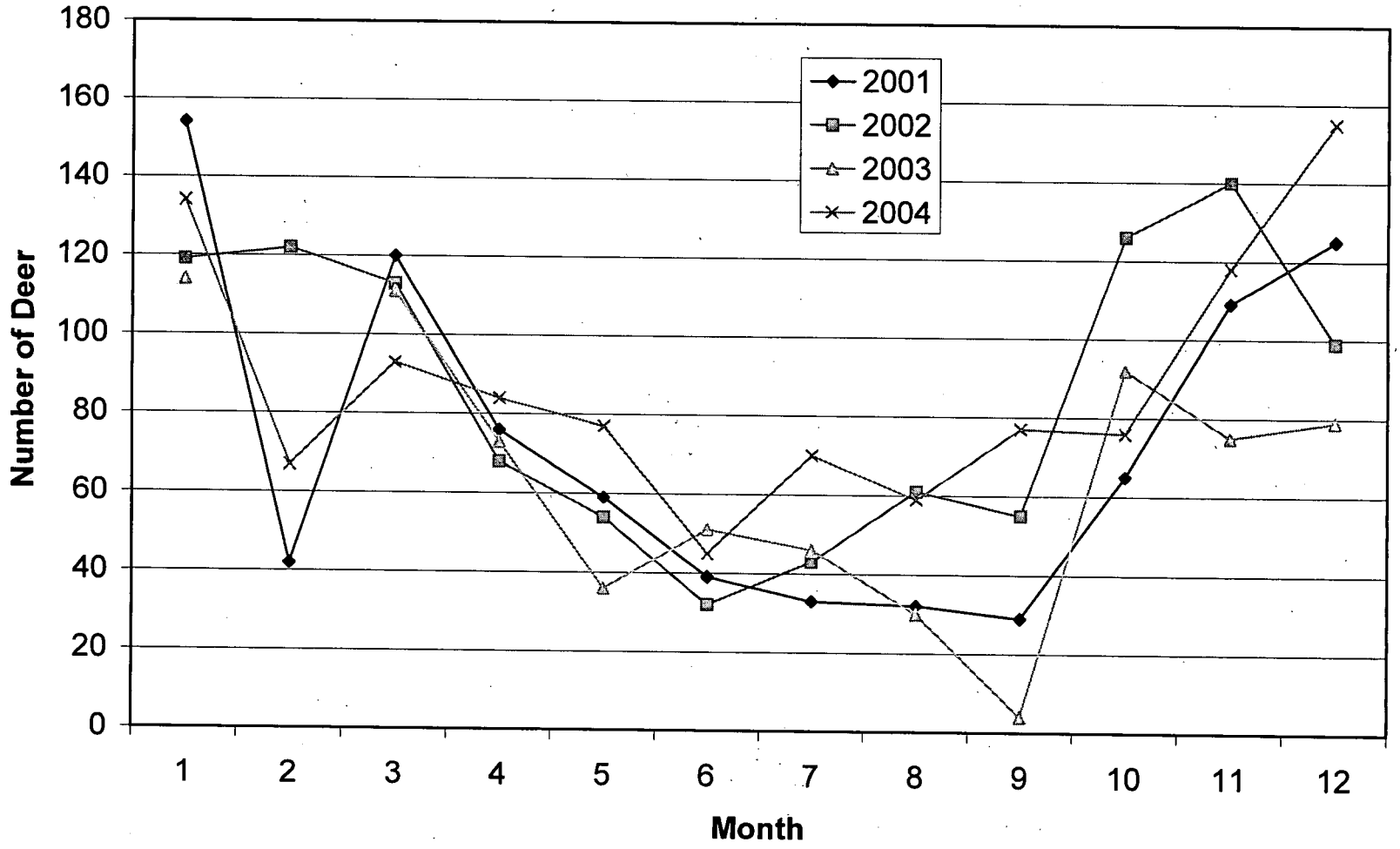
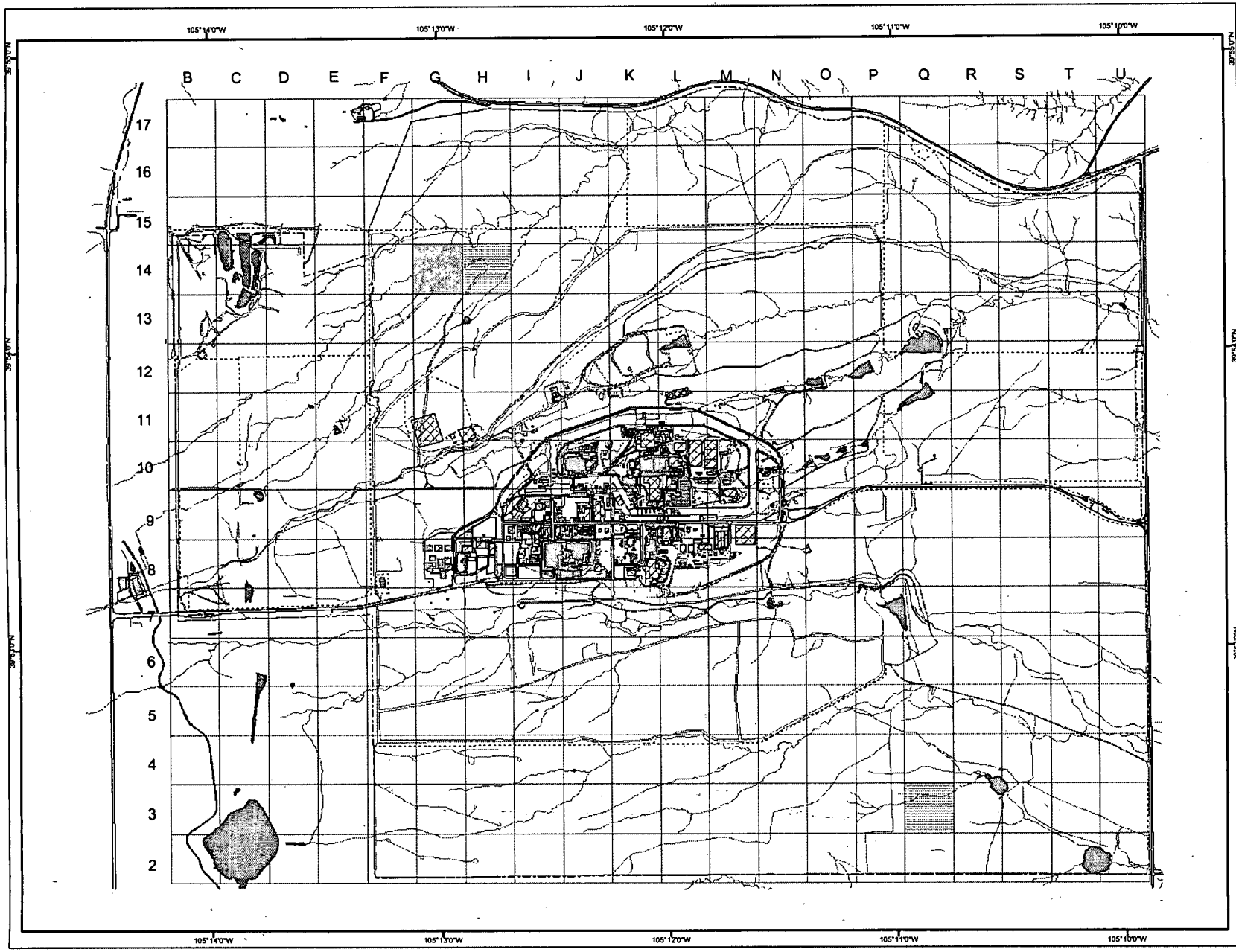


Figure 3-4. Sitewide Survey Mule Deer Observations from 2001 to 2004





2004 Annual Elk Area Use at Rocky Flats

Figure 3-5

Legend

DENSITY

- Low (1-5 observations)
- Medium (6-15 observations)
- High (16+ observations)

Standard Features

- Buildings
- Demolished Buildings
- Lakes
- Streams
- Boundary Fence
- Fences
- Trails
- Dirt Roads
- Paved Roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95.

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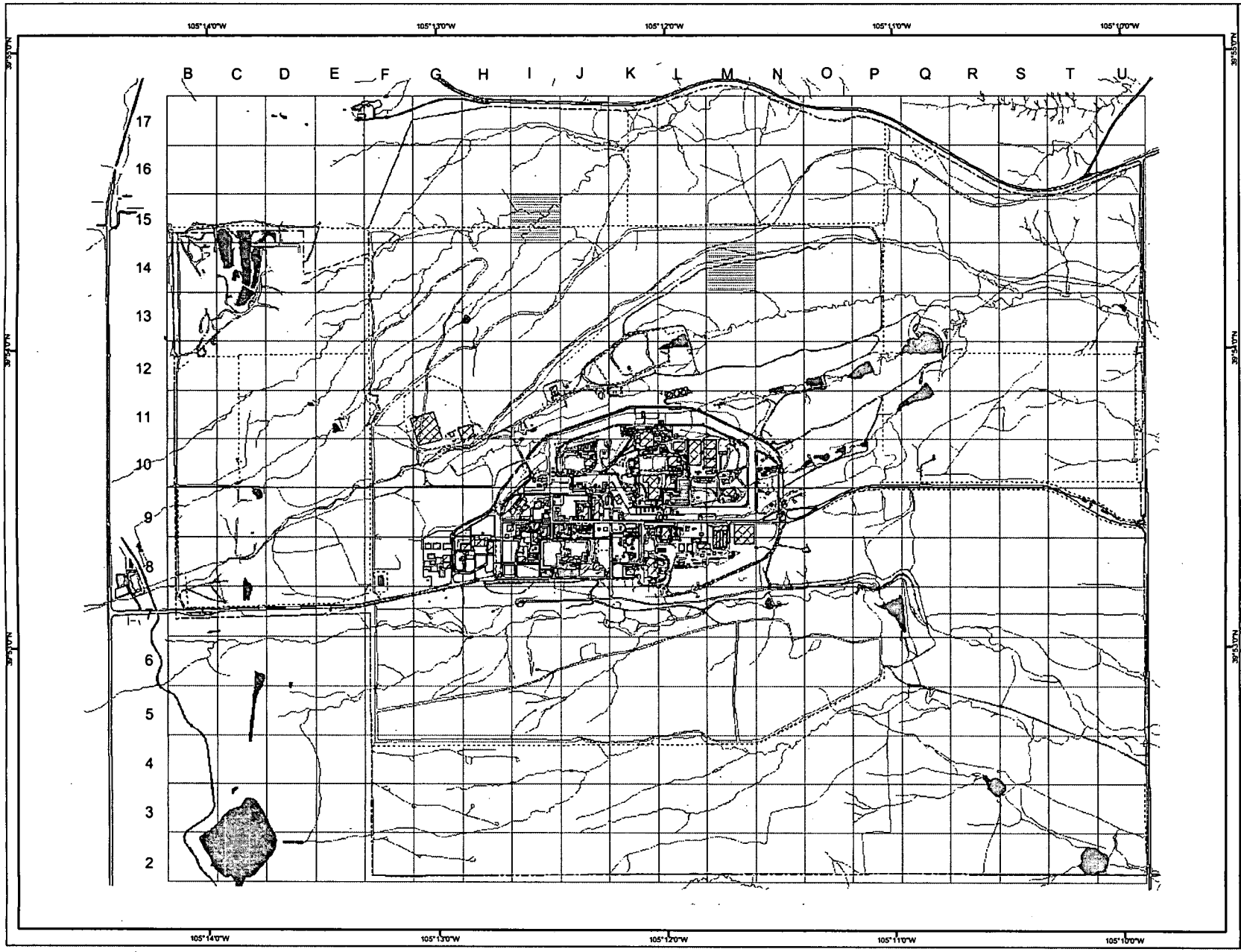

2004 Annual White-Tailed Deer Area Use at Rocky Flats

Figure 3-6

Legend

- Low (1-5 observations)
- Medium (6-15 observations)
- High (16+ observations)

Standard Features

- Buildings
- Demolished Buildings
- Lakes
- Streams
- Boundary Fence
- Fences
- Trails
- Dirt Roads
- Paved Roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
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State Plane Coordinate Projection
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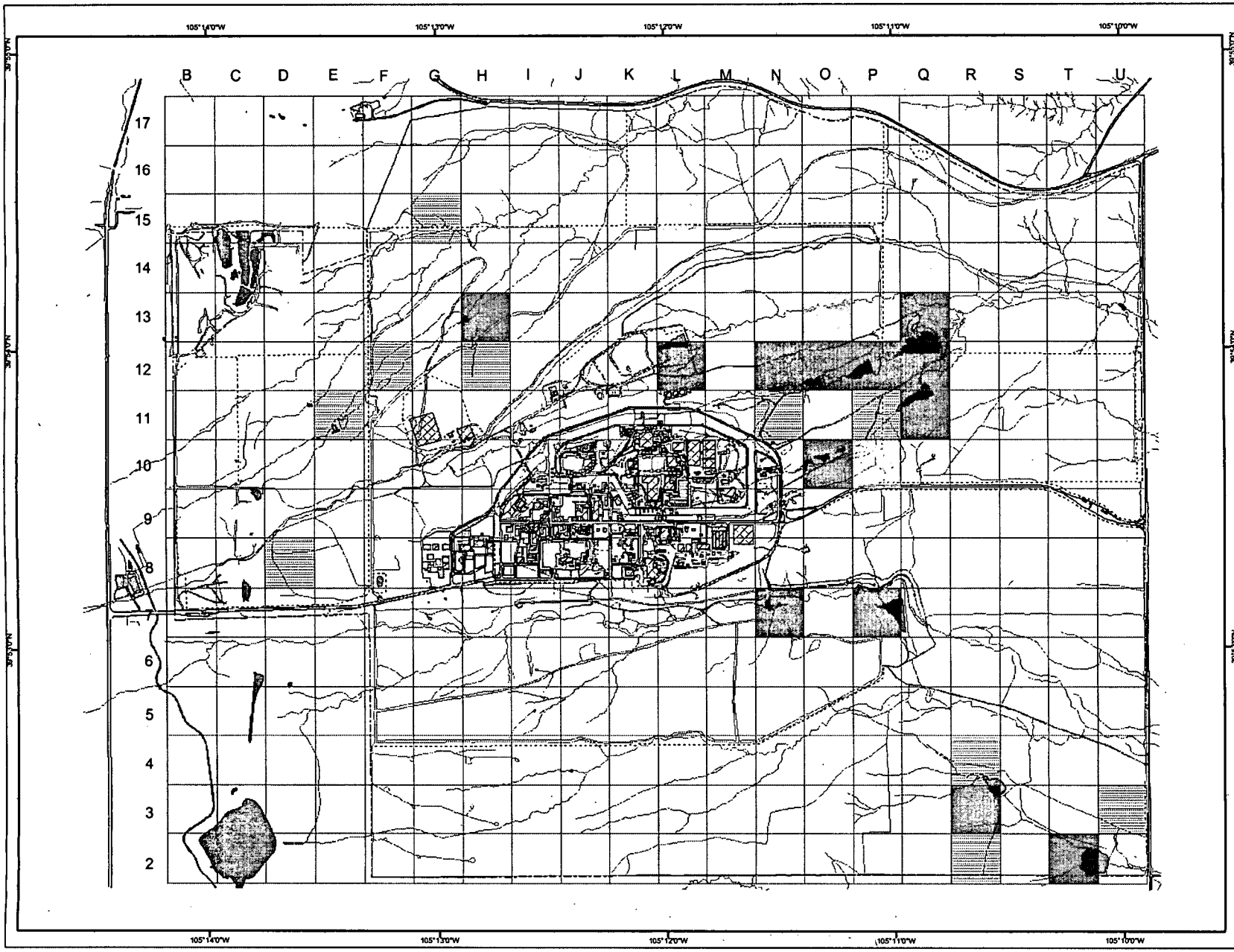
MAP ID:05-0021

March 23, 2005



2004 Annual Waterfowl Area Use at Rocky Flats

Figure 3-7

Legend

- Low (1-5 observations)
- Medium (6-15 observations)
- High (16+ observations)

Standard Features

- Buildings
- Demolished Buildings
- Lakes
- Streams
- Boundary Fence
- Fences
- Trails
- Dirt Roads
- Paved Roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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Rocky Flats Environmental Technology Site

Prepared by: Professional Environmental Group, LLC

For: Kaiser-Hill Company, LLC

RFETS GIS Dept.
303-966-7707

MAP ID:05-0022 March 23, 2005

Table 3-1. Relative abundance (RA) of all species observed during the 2004 Sitewide Survey, as well as the corresponding relative abundance from the 2001, 2002 and 2003 survey. The table is sorted by the 2004 relative abundance (last column).

Common Name	Scientific Name	2001	2002	2003	2004
Mule deer	*Odocoileus hemionus*	44.28	49.26	39.70	**43.22**
American Coot	*Fulica americana*	3.38	0.64	5.70	**9.95**
Mallard	*Anas platyrhynchos*	17.41	12.27	12.73	**9.91**
Ring-necked Duck	*Aythya collaris*	3.22	4.06	2.74	**3.81**
Pied-billed Grebe	*Podilymbus podiceps*	3.17	1.04	2.90	**3.48**
Redhead	*Aythya americana*	1.61	2.08	*	**3.40**
Green-winged Teal	*Anas crecca*	1.72	2.32	0.73	**2.83**
Gadwall	*Anas strepera*	1.09	0.30	4.24	**2.62**
Western Painted Turtle	*Chrysemys picta*	0.78	2.23	4.02	**2.34**
Blue-winged Teal	*Anas discors*	1.66	2.23	1.45	**2.13**
Red-tailed Hawk	*Buteo jamaicensis*	1.14	1.43	1.56	**1.84**
Coyote	*Canis latrans*	2.23	2.52	2.07	**1.64**
Canada Goose	*Branta canadensis*	0.99	2.92	3.69	**1.60**
Black-tailed prairie dog	*Cynomys ludovicianus*	0.42	0.89	3.80	**1.52**
Double-crested Cormorant	*Phalacrocorax auritus*	1.09	1.34	1.45	**1.11**
American Kestrel	*Falco sparverius*	1.20	1.38	0.78	**1.07**
American White Pelican	*Pelecanus erythrorhynchos*	0.26	0.79	0.95	**1.07**
Bufflehead	*Bucephala albeola*	1.87	1.58	2.18	**0.70**
Desert cottontail	*Sylvilagus audubonii*	0.52	0.30	0.45	**0.70**
Great Horned Owl	*Bubo virginianus*	1.04	0.84	0.45	**0.53**
Ruddy Duck	*Oxyura jamaicensis*	*	*	0.17	**0.53**
Common Goldeneye	*Bucephala clangula*	0.68	0.74	0.78	**0.49**
Elk (Wapiti)	*Cervus elaphus*	0.05	*	2.35	**0.49**
Cinnamon Teal	*Anas cyanoptera*	0.31	3.07	0.89	**0.41**
Swainson's Hawk	*Buteo swainsoni*	0.10	0.05	0.11	**0.41**
Boreal Chorus Frog	*Pseudacris triseriatus maculata*	4.05	0.10	0.22	**0.33**
Lesser Scaup	*Aythya affinis*	0.10	*	0.56	**0.20**
Great Blue Heron	*Ardea herodias*	0.78	0.40	0.67	**0.16**
Turkey Vulture	*Cathartes aura*	0.05	0.15	0.28	**0.16**
White-tailed deer	*Odocoileus virginianus*	1.61	1.78	0.11	**0.16**
Common Snipe	*Gallinago gallinago*	*	*	0.22	**0.12**
Short-eared Owl	*Asio flammeus*	*	*	*	**0.12**
Black-crowned Night-heron	*Nycticorax nycticorax*	0.05	0.15	0.11	**0.08**
Cooper's Hawk	*Accipiter cooperii*	*	*	*	**0.08**
Eared grebe	*Podiceps nigricollis*	*	*	*	**0.08**
Northern Harrier	*Circus cyaneus*	0.73	0.40	0.17	**0.08**
Prairie Falcon	*Falco mexicanus*	0.10	0.05	0.17	**0.08**
Spotted Sandpiper	*Actitis macularia*	*	*	*	**0.08**
American Wigeon	*Anas americana*	*	0.10	*	**0.04**
Bald Eagle	*Haliaeetus leucocephalus*	*	0.05	0.06	**0.04**
Eastern Yellowbelly Racer	*Coluber constrictor*	*	*	*	**0.04**
Golden Eagle	*Aquila chrysaetos*	0.62	0.15	0.06	**0.04**
Greater Yellowlegs	*Tringa melanoleuca*	*	0.10	*	**0.04**
Loggerhead Shrike	*Lanius ludovicianus*	*	0.10	0.06	**0.04**
Merlin	*Falco columbarius*	*	*	*	**0.04**
Osprey	*Pandion haliaetus*	*	*	*	**0.04**

Common Name	Scientific Name	2001	2002	2003	2004
Rough-legged Hawk	*Buteo lagopus*	0.78	0.25	0.06	**0.04**
Sora	*Porzana carolina*	*	*	0.17	**0.04**
Striped skunk	*Mephitis mephitis*	*	*	*	**0.04**
Bullfrog	*Rana catesbeiana*	*	0.05	0.34	*
Cattle Egret	*Bubulcus ibis*	*	0.15	*	*
Common Merganser	*Mergus merganser*	0.52	1.14	0.06	*
Common Nighthawk	*Chordeiles minor*	*	*	0.06	*
Common Raven	*Corvus corax*	*	*	0.06	*
Ferruginous Hawk	*Buteo regalis*	0.10	*	*	*
Greater Scaup	*Aythya marila*	*	0.15	*	*
Long-eared Owl	*Asio otus*	*	0.05	*	*
Muskrat	*Ondatra zibethicus*	0.16	0.20	0.28	*
Northern Flicker	*Colaptes auratus*	*	*	0.06	*
Northern Pintail	*Anas acuta*	*	*	0.22	*
Raccoon	*Procyon lotor*	0.05	*	*	*
Rock Dove	*Columba livia*	*	*	0.06	*
Sandhill Crane	*Grus canadensis*	*	0.20	*	*
Snowy Egret	*Egretta thula*	0.05	*	*	*
Thirteen-lined Ground Squirrel	*Spermophilus tridecemlineatus*	*	0.05	*	*
Upland Sandpiper	*Bartramia longicauda*	*	*	0.06	*
White-faced Ibis	*Plegadis chihi*	*	*	0.06	*

* Species was not observed this year during Sitewide Surveys.

Table 3-2. Relative abundance (RA) of the mammal species observed during the 2002, 2003 and 2004 Sitewide Surveys. The table is sorted by the 2004 relative abundance (last column).

Common Name	Scientific Name	2002	2003	2004
Mule deer	*Odocoileus hemionus*	89.65	81.44	**90.48**
Coyote	*Canis latrans*	4.59	4.24	**3.43**
Black-tailed prairie dog	*Cynomys ludovicianus*	1.62	7.79	**3.17**
Desert cottontail	*Sylvilagus audubonii*	0.54	0.92	**1.46**
Elk (Wapiti)	*Cervus elaphus*	*	4.81	**1.03**
White-tailed deer	*Odocoileus virginianus*	3.24	0.23	**0.34**
Striped skunk	*Mephitis mephitis*	*	*	**0.09**
Muskrat	*Ondatra zibethicus*	0.36	0.57	*

* Species was not observed this year during Sitewide Surveys.

Table 3-3. Relative abundance (RA) of the raptor species observed during the 2002, 2003 and 2004 Sitewide Surveys. The table is sorted by the 2004 relative abundance (last column).

Common Name	Scientific Name	2002	2003	2004
Red-tailed Hawk	*Buteo jamaicensis*	30.21	42.42	**40.18**
American Kestrel	*Falco sparverius*	29.17	21.21	**23.21**
Great Horned Owl	*Bubo virginianus*	17.71	12.12	**11.61**
Swainson's Hawk	*Buteo swainsoni*	1.04	3.03	**8.93**
Turkey Vulture	*Cathartes aura*	3.13	7.58	**3.57**
Short-eared Owl	*Asio flammeus*	*	*	**2.68**
Prairie Falcon	*Falco mexicanus*	1.04	4.55	**1.79**
Northern Harrier	*Circus cyaneus*	7.29	4.55	**1.79**
Cooper's Hawk	*Accipiter cooperii*	*	*	**1.79**
Bald Eagle	*Haliaeetus leucocephalus*	1.04	1.52	**0.89**
Rough-legged Hawk	*Buteo lagopus*	5.21	1.52	**0.89**
Golden Eagle	*Aquila chrysaetos*	3.13	1.52	**0.89**
Merlin	*Falco columbarius*	*	*	**0.89**
Osprey	*Pandion haliaetus*	*	*	**0.89**
Long-eared Owl	*Asio otus*	1.04	*	*

*Species was not observed this year during Sitewide Surveys.

Table 3-4. Relative abundance (RA) of the waterfowl species observed during the 2002, 2003 and 2004 Sitewide Surveys. The table is sorted by the 2004 relative abundance (last column).

Common Name	Scientific Name	2002	2003	2004
American Coot	*Fulica americana*	1.71	13.33	**22.17**
Mallard	*Anas platyrhynchos*	32.55	29.80	**22.08**
Ring-necked Duck	*Aythya collaris*	10.76	6.41	**8.49**
Pied-billed Grebe	*Podilymbus podiceps*	2.76	6.80	**7.76**
Redhead	*Aythya americana*	5.51	*	**7.57**
Green-winged Teal	*Anas crecca*	6.17	1.70	**6.30**
Gadwall	*Anas strepera*	0.79	9.93	**5.84**
Blue-winged Teal	*Anas discors*	5.77	3.40	**4.74**
Canada Goose	*Branta canadensis*	7.74	8.63	**3.56**
Double-crested Cormorant	*Phalacrocorax auritus*	3.54	3.40	**2.46**
American White Pelican	*Pelecanus erythrorhynchos*	2.1	2.22	**2.37**
Bufflehead	*Bucephala albeola*	4.2	5.10	**1.55**
Ruddy Duck	*Oxyura jamaicensis*	*	0.39	**1.19**
Common Goldeneye	*Bucephala clangula*	1.97	1.83	**1.09**
Cinnamon Teal	*Anas cyanoptera*	8.14	2.09	**0.91**
Lesser Scaup	*Aythya affinis*	*	1.31	**0.46**
Great Blue Heron	*Ardea herodias*	1.05	1.57	**0.36**
Common Snipe	*Gallinago gallinago*	*	0.52	**0.27**
Spotted Sandpiper	*Actitis macularia*	*	*	**0.18**
Black-crowned Night-heron	*Nycticorax nycticorax*	0.39	0.26	**0.18**
Eared grebe	*Podiceps nigricollis*	*	*	**0.18**
American Wigeon	*Anas americana*	0.26	*	**0.09**
Sora	*Porzana carolina*	*	0.39	**0.09**

Greater Yellowlegs	*Tringa melanoleuca*	0.26	*	**0.09**
Northern Pintail	*Anas acuta*	*	0.52	*
Greater Scaup	*Aythya marila*	0.39	*	*
Upland Sandpiper	*Bartramia longicauda*	*	0.13	*
Sandhill Crane	*Grus canadensis*	0.52	*	*
Common Merganser	*Mergus merganser*	3.02	0.13	*
White-faced Ibis	*Plegadis chihi*	*	0.13	*

*Species was not observed this year during Sitewide Surveys.

4. 2004 High-Value Vegetation Surveys

4.1 Introduction

The Rocky Flats Environmental Technology Site (the Site) is located along the Front Range of Colorado in an ecotonal position between the Great Plains and Rocky Mountains. As a result it contains plant species common to both physiographic regions. Several plant communities have been identified by the Colorado Natural Heritage Program (CNHP) as containing significant or rare ecological resources at both the local and regional scale (CNHP 1994, 1995). These high-value plant communities, as they are called at the Site (xeric tallgrass prairie, tall upland shrubland, selected wetlands, and Great Plains riparian woodland), have been selected for special qualitative monitoring to assess their status, quality, and condition. These qualitative surveys evaluate conditions at a community-wide scale across the Site as a whole. This qualitative information, coupled with other quantitative monitoring data gathered at specific locations within the plant communities, provides important information at appropriate scales for resource management.

Objectives of the high-value vegetation monitoring are to qualitatively:

- Identify any rare plant populations, and document the locations and continued presence of any rare plant populations
- Identify and document any infestations of noxious weeds
- Document the effectiveness of weed-control efforts
- Assess the impacts of disturbance on the plant communities
- Provide a general assessment of the overall status and quality of the plant communities.

4.2 Methods

4.2.1 Weed Mapping

Sitewide weed mapping continued for selected species as a means of identifying high-priority treatment areas, monitoring the distribution of specific noxious weed species, discovering new weed species (if any), and tracking the effectiveness of weed control. Weed mapping in 2004 was conducted both on foot and from a vehicle using binoculars at the Site. Species were mapped during their respective flowering periods and/or when they were most visible. The species mapped in 2004 included diffuse knapweed (*Centaurea diffusa*) and dalmatian toadflax (*Linaria dalmatica*).

Infestation areas were classified into general density categories of high, medium, low, and scattered, based on a subjective interpretation of the extent, visual density, need for control, and aggressive nature of the species. In general, a high-density category indicated that an area that was dominated by a nearly solid infestation and/or very high cover of the species. A medium-density category was used where the infestation provided less cover and was less homogeneous in the distribution of the species. The low-density category was used where individuals of the species were present in fewer numbers and were not visually dominating the landscape, but were

beginning to establish a foothold in the community and were in need of control. The scattered-density category indicated a sporadic occurrence of the species.

The noxious weed populations and distributions were drawn in the field on 44- × 34-inch sitewide base maps. With regard to the resulting maps, it should be noted that the boundaries shown on the maps are only approximate and are based on professional judgement. They should not be interpreted as a precise outline of the distribution of these species, because no surveying or global positioning system (GPS) equipment was used to locate boundary edges, nor do the maps necessarily represent every location of the species on the Site. Attempts were made to visit the entire Site, but some infestations may still have been missed.

4.2.2 Photographic Documentation

Photographs were taken at all the permanent photo points in the Buffer Zone (BZ) and Industrial Area (IA) during the summer of 2004 to document and evaluate any changes resulting from climatic changes or natural resource management actions. Photographs were taken from established photo points in the same compass directions as past photographs. Photographs were then compared to those taken previously. Time-series photographs can be viewed in Appendix C, D, and E on the CD-ROM.

Further details on the high-value vegetation monitoring methods are found in the document High-Value Vegetation Survey Plan for the Rocky Flats Environmental Technology Site (K-H 1997a), the Environmental Management Department Operating Procedures Manual (DOE 1995), and 2004 Ecological Field Sampling Plans for the Rocky Flats Environmental Technology Site (K-H 2004a).

4.3 Results and Discussion

4.3.1 Site Flora

As a result of the 2004 fieldwork, a total of 3 new records of vascular plant species are reported. Plant nomenclature follows that of GPFA (1986), Weber (1976), and Weber (1990), in that order of determination. The new plant species reports as occurring at the Site include:

Family	Scientific Name	Speccode
Papaveraceae	*Eschscholzia californica* Chamisso	ESCA1
Verbenaceae	*Verbena bipinnatifida* Nutt.	VEBI1
Malvaceae	*Sphaeralcea parvifolia* A. Nelson	SPPA1

The complete list of plant species known to occur at Rocky Flats as of the end of 2004 is found in Appendix F on the CD-ROM. Voucher specimens of these species will be deposited at the University of Colorado Herbarium in Boulder, Colorado (COLO).

4.3.2 Rare-Plant Monitoring

Four plant species that occur at the Site are listed as rare and imperiled in Colorado by the Colorado Natural Heritage Program (CNHP 1999). The presence of these species underscores the significance of the ecological resources found at the Site and its value in the regional landscape. Although none of them have any legal protection under state or federal law, they are monitored at the Site and projects are modified to minimize potential impacts, as feasible. On-Site populations

of mountain-loving sedge (*Carex oreocharis*), forktip three-awn (*Aristida basiramea*), carrionflower greenbriar (*Smilax herbacea* ssp. *lasioneuron*), and dwarf wild indigo (*Amorpha nana*) were revisited during 2004. Populations of all four species were visited during 2004 and appeared in good condition.

An evaluation was continued on efforts to establish new populations of forktip three-awn in the Buffer Zone (BZ; see K-H, 2002, 2003, 2004b for details). In fall 2001, seed collected from the only known location of forktip three-awn was sown by broadcasting into two – 1 meter square plots (approximately 100 seeds per plot: Figure 4-1). In fall 2002, monitoring was conducted to determine whether any of the seeds germinated, developed into adult plants, and produced any fruit. One plot had a total of 25 plants present and while the other plot had a total of 28 individuals. Only a few of the plants in the plots had produced flowers and gone to seed.

During 2002, additional seed (approximately 400 seeds) was collected at large population discovered along North Walnut Creek, west of the IA in 2001. This seed was then planted in four 1-meter square plots near where the seeding trials had been conducted in 2001 (Figure 4-1). Approximately 100 seeds were placed in each plot in fall 2002. In fall 2003, all the seeded plots were rechecked and the number of individual plants counted. During 2003, in the original 2001 plots, 15 and 28 plants were counted. In the 2002 plots, the plots contained 15, 20, 27, and 85 individuals. Many of these had flowered. During fall 2004, additional counts were made in each of the plots. In and near the 2001 plots, 7 and 54 individuals were counted. In the 2002 plots, a total of 13, 21, 34, and 136 individuals were observed in the vicinity of the plots. The fact that the forktip three-awn germinated and grew so easily, even in drought conditions, would suggest it is not too difficult to establish new populations under suitable environmental conditions. The 2004 observations indicated the plants have begun to spread outside the original plots (largely downwind). The native, iron oxidized, reddish gravel typical of borrow areas and other disturbed areas where the topsoil has been scraped off at the Site seems very suited to the species. It might be feasible to increase the populations of forktip three-awn further at the Site by reseeding the species into closed BZ roads on the top of the pediment, on some of the areas where mine reclamation will eventually take place, or at some revegetation sites in the Industrial Area (IA). Figure 4-1 shows the known locations of forktip three-awn at the Site.

4.3.3 Plant Community Disturbance in 2004

During 2004, several projects disturbed areas of the Buffer Zone near the IA (Figure 4-2). The incinerator project removed some large concrete flows and a buried incinerator from the southwest BZ (see Revegetation Section of this annual report for more information). Approximately 3.5 acres was disturbed and has been revegetated to return the previous concrete flows back to native prairie. East and south of the 903 pad area approximately 39 acres were disturbed and revegetated during remediation activities. The Centennial Mine, north of the west access road, expanded eastward near the raw water pond in the western BZ, disturbing approximately 36.5 acres of xeric tallgrass prairie at the Site.

4.3.4 Weed Mapping and Weed Control

Resource management is an important concern, with a goal to protect and sustain the native ecological resources that make the Site so unique along the Front Range. One of the big challenges at the Site is to manage the ecological resources with a limited set of methods available as management tools. Currently most efforts have focused on the control or eradication of the weed species themselves with little emphasis on trying to improve conditions for the desired native species. Two of the key tools for grassland management, fire and grazing, are not currently allowed or planned for use at the Site through closure. As a result, management of the ecological resources is largely limited to controlling the noxious weeds themselves. The

Comprehensive Conservation Plan (CCP; USFWS 2005) developed by the U.S. Fish and Wildlife Service for management of the Rocky Flats National Wildlife Refuge after closure, has identified the full range of Integrated Pest Management (IPM) tools for use at the refuge for controlling weeds. This includes administrative, cultural, biological, mechanical, chemical, prescribed fire, and grazing as viable tools for controlling noxious weeds and ecosystem management.

The 2004 weed distribution maps for diffuse knapweed and dalmatian toadflax are shown in Figures 4-3 and 4-4, respectively. Weed distribution maps for various mapped species at the Site from 1997 through 2004 can be found in Appendix G on the CD-ROM. After being entered into the Site Geographic Information System (GIS), the overall extent of these species across the Site was estimated by species and by infestation level. Table 4-1 contains the estimated total acreage and acreage-by-density category for each species, based on the 2004 maps. Dalmatian toadflax covered approximately 2,858 acres, while diffuse knapweed was present on 2,259 acres at various levels of infestation. The total acreage of the Site is approximately 6,500 acres (K-H 1997b). It should be noted that the acreage values are only approximate and should not be interpreted as exact areas. These values are also only representative of known locations for these species. It is possible that unmapped infestations are present as well.

Table 4-2 shows the annual total infested acreages for diffuse knapweed, dalmatian toadflax, musk thistle (*Carduus nutans*), and common mullein (*Verbascum thapsus*) from 1997 to 2004. [NOTE: Most of the large increases in infestation acreages from 1997 to 1998 were a result of the time of year in which mapping was conducted. Mapping in 1997 was conducted in August for each of the species. Beginning in 1998, weed mapping was conducted for each species when that species was in flower and/or most visible. Therefore, the higher visibility of the species at the time of mapping allowed more accurate estimates of their infestation levels from 1998 through 2004.]

Considerable annual variation in the number of infested acres for each species listed in Table 4-2 exists due to annual climatic differences and herbicide applications. Most of the reductions for each species from 1998 or 1999 through 2002 were due to the large-scale aerial herbicide applications. In 2002, some of the decreases seen for each species were also a result of the drought that year. This caused many species, native species and noxious weeds alike, to either remain dormant or to not germinate from seed. However, in 2003 there was a large increase in the number of infested acres due to the above average snowfall received in March 2003 that caused a large germination seed from the seedbank and growth of dormant perennial plants. This caused a two to four fold increase in the number of infested acres for the different noxious weed species compared to 2002. Increased precipitation in 2004 also probably accounts for the continued high number of infested acres in 2004. Diffuse knapweed levels dropped in 2004 for the high and medium categories. Increases were noted in the low and scattered categories. Also due to increased mining activities and expansion of the Centennial Mine on the west side of the Site no mapping was conducted in this area in 2004 because of difficulty of access. This accounted for approximately 113 acres and may account for part of the overall reduction in total acreage for diffuse knapweed in 2004. For dalmatian toadflax, the only category with an increase in acreage in 2004 was the medium category. The high, low, and scattered categories all showed declines in overall acreage in 2004.

During 2004, a total of approximately 330 acres were treated with herbicides using ground applications: Transline® (14 acres), Plateau® (16 acres), Roundup® (11 acres), and Tordon22K® (227 acres @ 1 pint/acre and 62 acres @ 1 quart/acre) (Figure 4-5). The species these herbicides were used for are discussed below. Additional herbicide treatment locations from earlier years (1997 – 2004) can be found in Appendix G on the CD-ROM.

The abundance of diffuse knapweed has been decreased considerably on the pediment tops at the Site through the past herbicide applications made with a helicopter (1999-2002). Both Transline® and Tordon22K® have been used. Tordon22K® has given approximately 4 years of control at many locations. However, studies at the Site have shown there are also impacts to the native forb species with Tordon22K® (see K-H 2004b for more details). The native forb community takes approximately seven years to return to pre-treatment levels after an application of Tordon22K® (application rate = one pint/acre). In the drainages, however, treatment of diffuse knapweed with large scale herbicide applications are no longer possible because these areas are located in Preble's mouse habitat (a federally listed threatened species) and permission from the USFWS has not been obtained that will allow weed control of any significance in the mouse habitat. So instead, several releases of diffuse knapweed biocontrol insects have been made at locations where herbicide applications are not possible. Large numbers of biocontrol insects have been released since 2001 and some reduction in seed production of diffuse knapweed plants has been observed at the release locations during some years (see biocontrol section of this annual report for details of 2004 biocontrol monitoring). The goal is to allow the insects to continue to expand across the Site and achieve levels of control similar to what has been seen on Boulder County Open Space to the north of the Site. As a result, continued large-scale herbicide applications for diffuse knapweed are not planned in order to give the insects the opportunity to continue to build their populations. Some small-scale herbicide applications at selected locations may be made where biocontrols do not seem to be establishing. Interior fencing that previously captured many diffuse knapweed plants that were blowing across the Site was removed during the winter of 2003/2004 as part of BZ cleanup activities and so is no longer available for helping control the spread of the species at the Site.

Past herbicide applications of Tordon22K® (one pint/acre) have had some reduction effect on the flowering and abundance of dalmatian toadflax at some locations. This was observed at some high-density locations of dalmatian toadflax after the helicopter spraying in 2000. At some locations densities still remain reduced, while at other locations the densities have returned or never really changed from pre-treatment levels. Higher applications rates of Tordon22K® have been suggested as potentially having a greater effect at controlling dalmatian toadflax. Of course with higher rates there will be greater impacts to the native forb community also. So it is a balancing act between trying to control the noxious weed species while retaining the biodiversity of the grasslands that make Rocky Flats such a unique area ecologically. The challenge with the dalmatian toadflax is compounded by the fact that it seems to now be slowly increasing in the locations where diffuse knapweed has previously been very abundant. However, if we want to increase the effectiveness of the biocontrol insects on diffuse knapweed, we cannot continue to spray these areas to get rid of the dalmatian toadflax, because it just decreases the effectiveness of the diffuse knapweed biocontrols. So the control efforts of the two species seem almost in opposition to each other. Two different biocontrols released for dalmatian toadflax at the Site have been unsuccessful at establishing and have had essentially no effect on the toadflax. So dalmatian toadflax control on the scale of the infestation levels present at the Site continue to remain a challenge.

Musk thistle and common mullein have been targeted as additional species for control where spraying has been done for diffuse knapweed or dalmatian toadflax. The herbicides used for the latter species usually control the musk thistle and common mullein as well. A mowing effort was also conducted in 2003 to knock down the mullein stems that had created a virtual "forest" at one location at the Site. In 2004, it was observed that the mullein came back as strong as ever, so the mowing was not much of a success, other than providing some initial aesthetic relief.

Biocontrol insects released for Canada thistle (*Cirsium arvense*) have shown little success at the Site and because the species is common in wetland areas, control with herbicides is impractical.

A mowing and spraying effort was begun on Canada thistle in 2003 at an upland area to determine the effectiveness of this treatment. Observations in 2004 showed some reduction in Canada thistle abundance and the area looked much better. Additional mowing was not conducted because the large mower needed to mow the area was unavailable.

Russian knapweed (*Centaurea repens*) occurs at one small location at the Site and has been kept from expanding by controlling it with herbicides the past few years. Applications of Telar®, Tordon22K®, and Roundup® over the past four years have contained the population and reduced the population, but it still holds on. Roundup® has been the most effective treatment on the species. Roundup® was broadcast in the Russian knapweed patch in 2004 and effectively killed everything in the area (which was predominantly smooth brome). Eradication is the long-term goal for this species at the Site and reseeding of the area with native species has been done to try to return the area to a native grassland. Russian knapweed seed has a seed bank lifespan of two to eight years, so continued monitoring of this area should be conducted to prevent any seed set, which would effectively reset the clock on this species at this location.

Annual rye (*Secale cereale*), although not a state listed noxious weed, is of concern at the Site because it has gotten established at several locations along roadsides in the BZ and has begun to invade the surrounding native prairie. Mowing has been conducted for the past few years to try and prevent seed set, but because of problems in getting the mowing crews to the locations at the proper time and because the mower height must be set so high due to the rocky nature of the roadsides, little success has been made. Because the species is an annual plant, preventing seed set is a key factor to its control. Studies have shown that after 14 months, less than one percent of the seed remains viable (Stump and Westra 1993). In 2004, Roundup® was applied along the roadsides in the early spring prior to flowering of the annual rye. This was followed by reseeding of the roadsides with native species. At one location where annual rye has invaded the native grassland, Plateau® was applied in an attempt to prevent seed set. Observations along the roadside where Roundup® was applied showed a good "kill" of the annual rye. By late summer, several annual weeds (green foxtail [*Seteria viridis*], filaree [*Erodium cicutarium*], and barnyard grass [*Echinochloa crusgallii*]) were common along the roadside, but annual rye was not present. However, at the location where Plateau® was applied, the annual rye was only stunted and seed set was not prevented. It is unclear whether an earlier application of Plateau® would have been more effective or not, however, while the Plateau® initially seemed to top kill the plants, the plants eventually recovered and set seed at a shorter height. Whether this observed effect was influenced by higher than normal precipitation is unclear. A beneficial effect of the Plateau® application was the reduction and apparent die back of Canada bluegrass (*Poa compressa*), a non-native grass species that is common on the xeric tallgrass prairie at the Site. Continued observations on the Canada bluegrass will be made to determine the long-term effects and whether Plateau® could be used effectively to decrease the abundance of this undesired cool-season species and promote the warm season natives that are common in the area.

Along one road in the south BZ, jointed goatgrass (*Aegilops cylindrica*) was sprayed with Roundup® along the roadside edge to kill it and prevent it from going to seed. The treatment was effective and killed all the jointed goatgrass. The treated area was later seeded with native grass species to try and establish native vegetation along the roadside edge.

Control of several small populations of Scotch thistle (*Onopordum acanthium*) was continued and while some success has been seen at specific locations, the species continues to be found at new locations across the Site. Containment of the species at some locations has been made using hand control and spot herbicide applications of Roundup®. These locations are expected to be monitored and control applied as necessary.

Over the past several years numerous releases of various biocontrol insects have been made at the Site to help control different weed species. Most of the insects have been obtained through the Colorado Department of Agriculture Insectary at Palisade, Colorado. Figure 4-6 shows the release locations of the different species released by the Ecology Group at the Site. Table 4-3 provides additional information on release dates and numbers of insects released. Other releases that were made prior to the early 1990's or made by the USFWS and Texas A&M University are not included in the map or table.

4.4 Conclusions

The rare and imperiled plant species populations (as listed by the CNHP) at the Site appear to be healthy; all four rare species were observed during 2004. Attempts to transplant the forktip three-awn grass in new suitable habitat have proven to be successful at new locations at the Site. As a whole, the ecological resources of the Site remain of high quality and comprise a significant component of the larger surrounding regional ecosystem, however, several management concerns remain.

The threat from noxious weeds continues to be a high management priority. Several noxious weed species are problematic and are a threat to the long-term quality and sustainability of the plant communities at the Site. Diffuse knapweed, dalmatian toadflax, musk thistle, common mullein, and Canada thistle are the most significant noxious weed problems. Control efforts for some of these species have reduced the abundance of these species over the past several years, shifting the abundance levels from high and medium infestation levels to the low and scattered levels. Given the scale of these infestations, however, continued integrated control efforts will be necessary for the foreseeable future. Other smaller infestations of newly discovered or recently invaded species like bouncing bet, scotch thistle, Russian thistle, and others continue to be controlled by hand or spot chemical control with the goal of eradication. In addition to herbicide applications in 2004, several biocontrol insects were released at the Site to help control several different noxious weed species.

Efforts continue to preserve and improve the quality of the ecological resources at the Site. As the Site becomes a National Wildlife Refuge after cleanup and closure, efforts to integrate more of a comprehensive, ecosystem approach to resource management must be continued to restore natural processes if long-term sustainability of the native communities is to be achieved. Recent efforts have focused substantively on the noxious weeds themselves, without addressing the underlying conditions that have lead to the stressed condition of the native communities and contributed to the large-scale weed invasions. Specifically, prescribed fire and grazing are both crucial processes necessary for grassland health and management. As long-term management plans are developed for the National Wildlife Refuge, the use of these and other resource management tools should be included to provide the best chance for long-term sustainability of the ecosystems at the Site.

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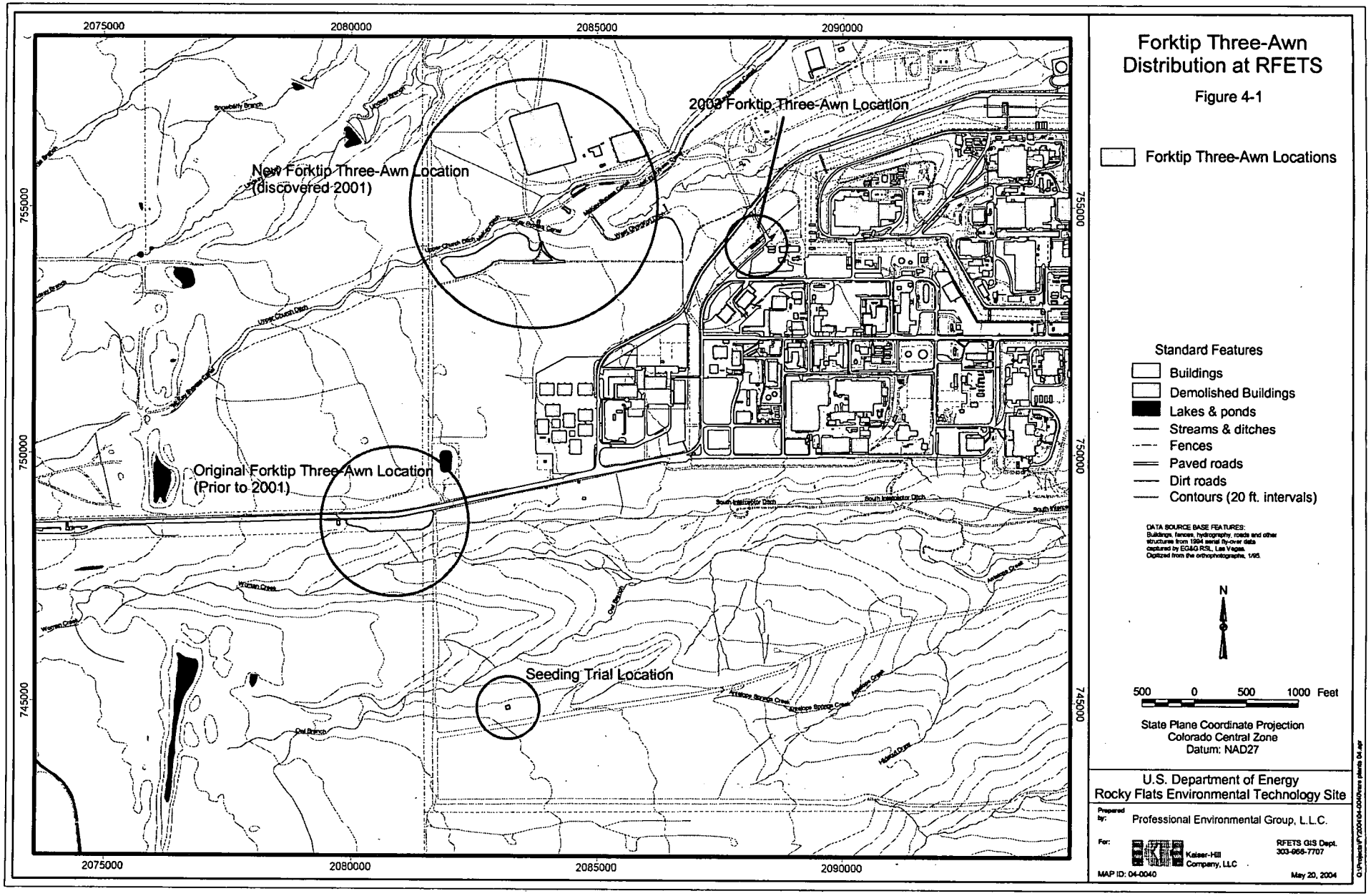
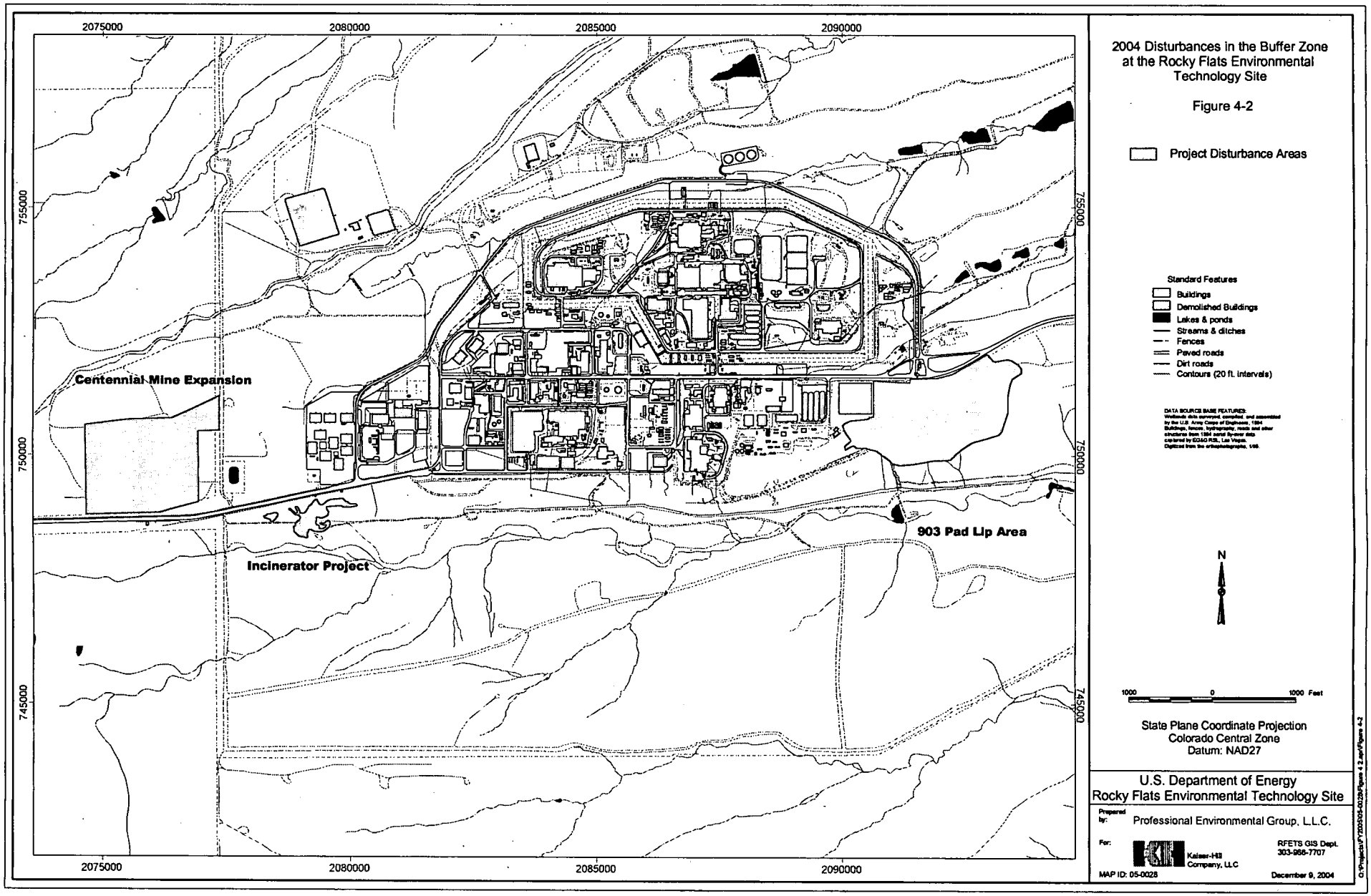
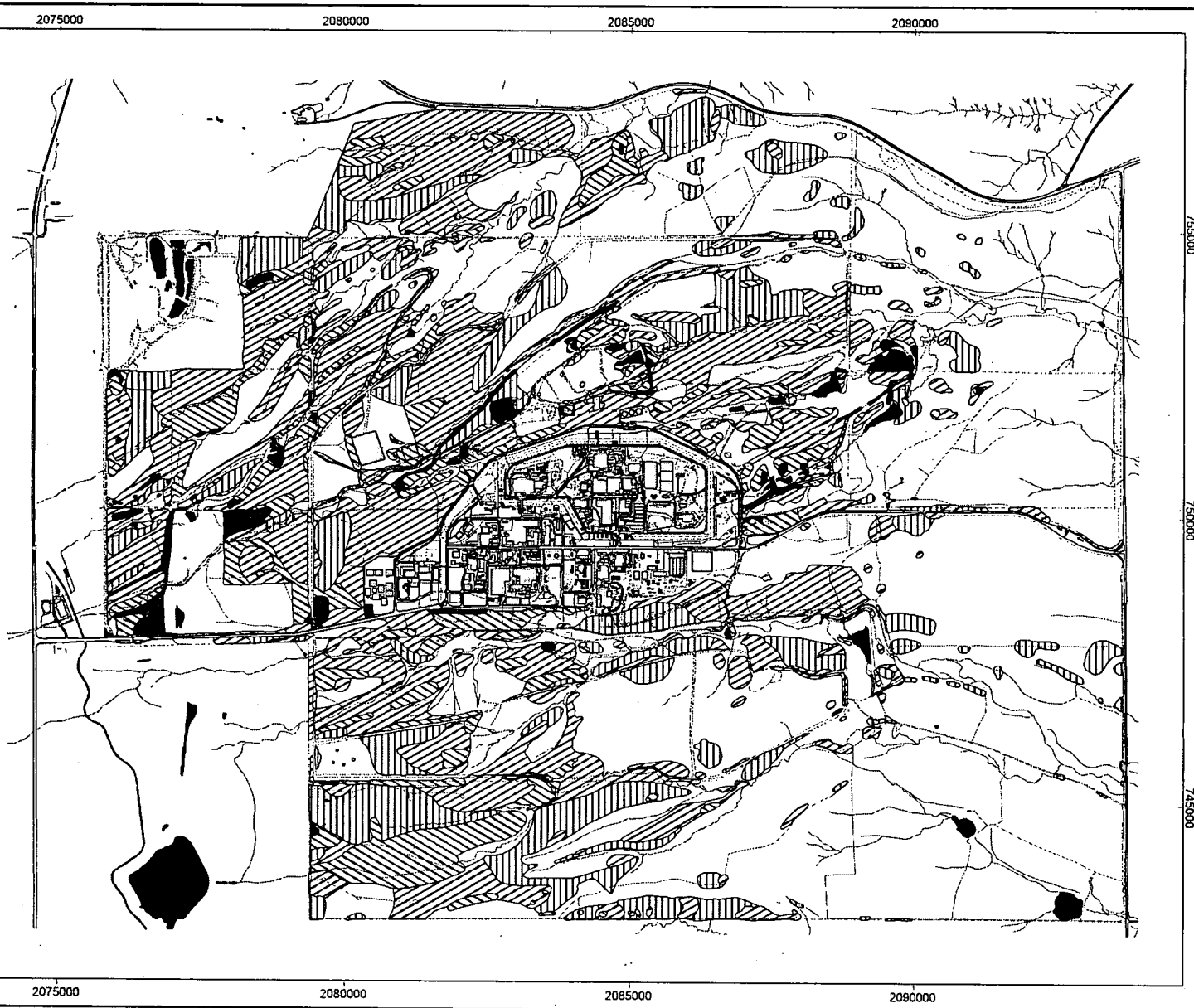


Forktip Three-Awn Distribution at RFETS

Figure 4-1


2075000
2080000
2085000
2090000
755000
750000
745000
Centennial Mine Expansion
Incinerator Project
903 Pad Lip Area
2004 Disturbances in the Buffer Zone at the Rocky Flats Environmental Technology Site
Figure 4-2
Project Disturbance Areas
Standard Features
Buildings
Demolished Buildings
Lakes & ponds
Streams & ditches
Fences
Paved roads
Dirt roads
Contours (20 ft. intervals)
N
1000 0 1000 Feet
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27
U.S. Department of Energy
Rocky Flats Environmental Technology Site
Prepared by:
Professional Environmental Group, L.L.C.
For:
Kaiser-Hill Company, LLC
RFETS GIS Dept.
303-966-7707
MAP ID: 05-0028
December 9, 2004



2004 Diffuse Knapweed (Centaurea diffusa) Distribution at the Rocky Flats Environmental Technology Site

Figure 4-3

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

Standard Features

- Buildings
- Demolished Buildings
- Lakes & ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft. intervals)

DATA SOURCE BASE FEATURES:
Wetlands data surveyed, compiled, and assembled by the U.S. Army Corps of Engineers, 1994.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas
Digitized from the orthophotographs, 1/85

N

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Professional Environmental Group, L.L.C.

For: Kaiser-Hill Company, LLC

RFETS GIS Dept.
303-966-7707

MAP ID: 05-0025

May 11, 2005

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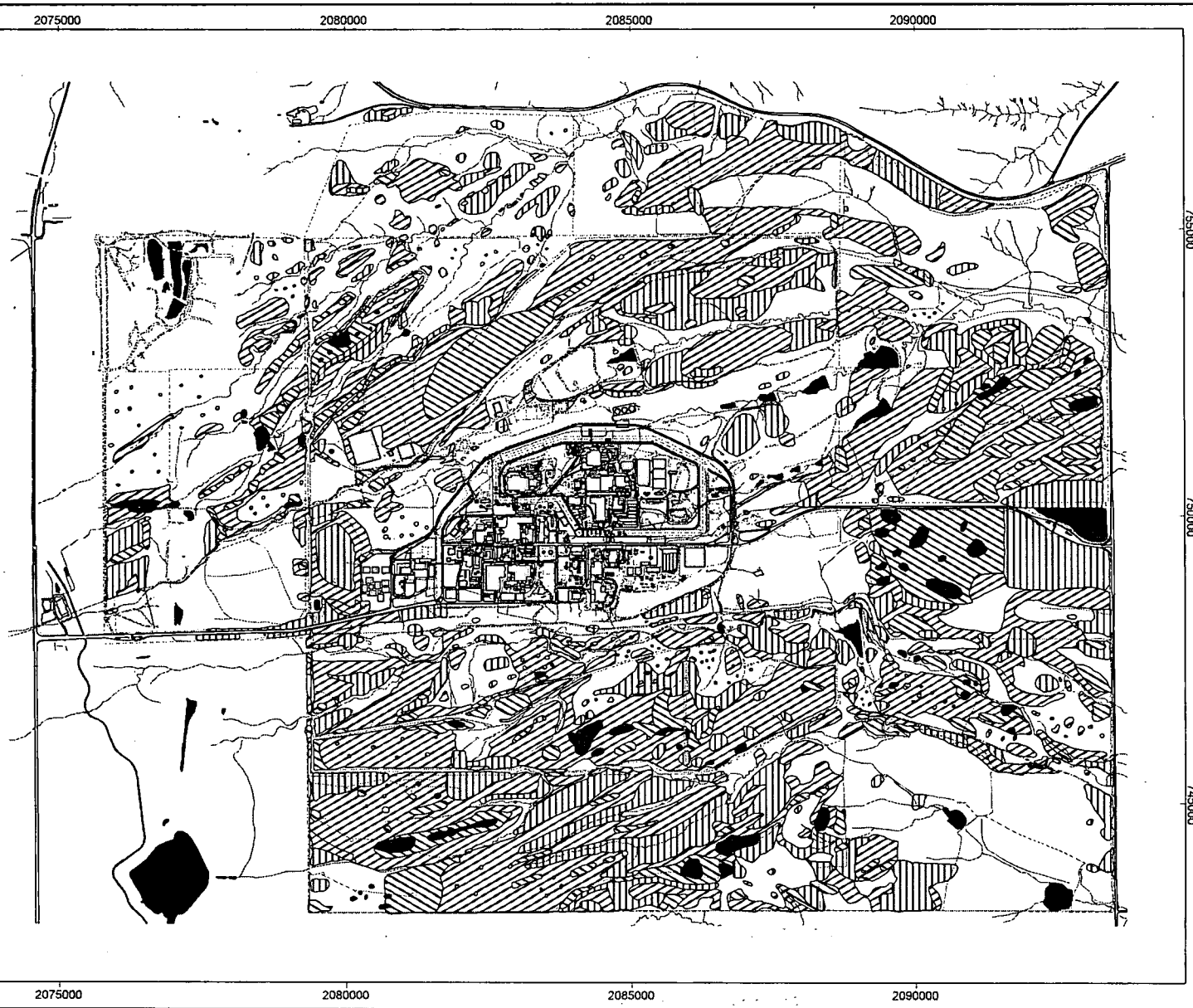

2004 Dalmatian Toadflax
(Linaria dalmatica) Distribution
at the Rocky Flats Environmental
Technology Site

Figure 4-4

High Density Areas
Medium Density Areas
Low Density Areas
Scattered Density Areas

Standard Features
Buildings
Demolished Buildings
Lakes & ponds
Streams & ditches
Fences
Paved roads
Dirt roads
Contours (20 ft. intervals)

DATA SOURCE BASE FEATURES:
Wetlands data surveyed, compiled, and assembled by the U.S. Army Corps of Engineers, 1994.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95.

N

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Professional Environmental Group, L.L.C.

For: Kaiser-Hill Company, LLC

RFETS GIS Dept.
303-966-7707

MAP ID: 05-0026

May 11, 2005

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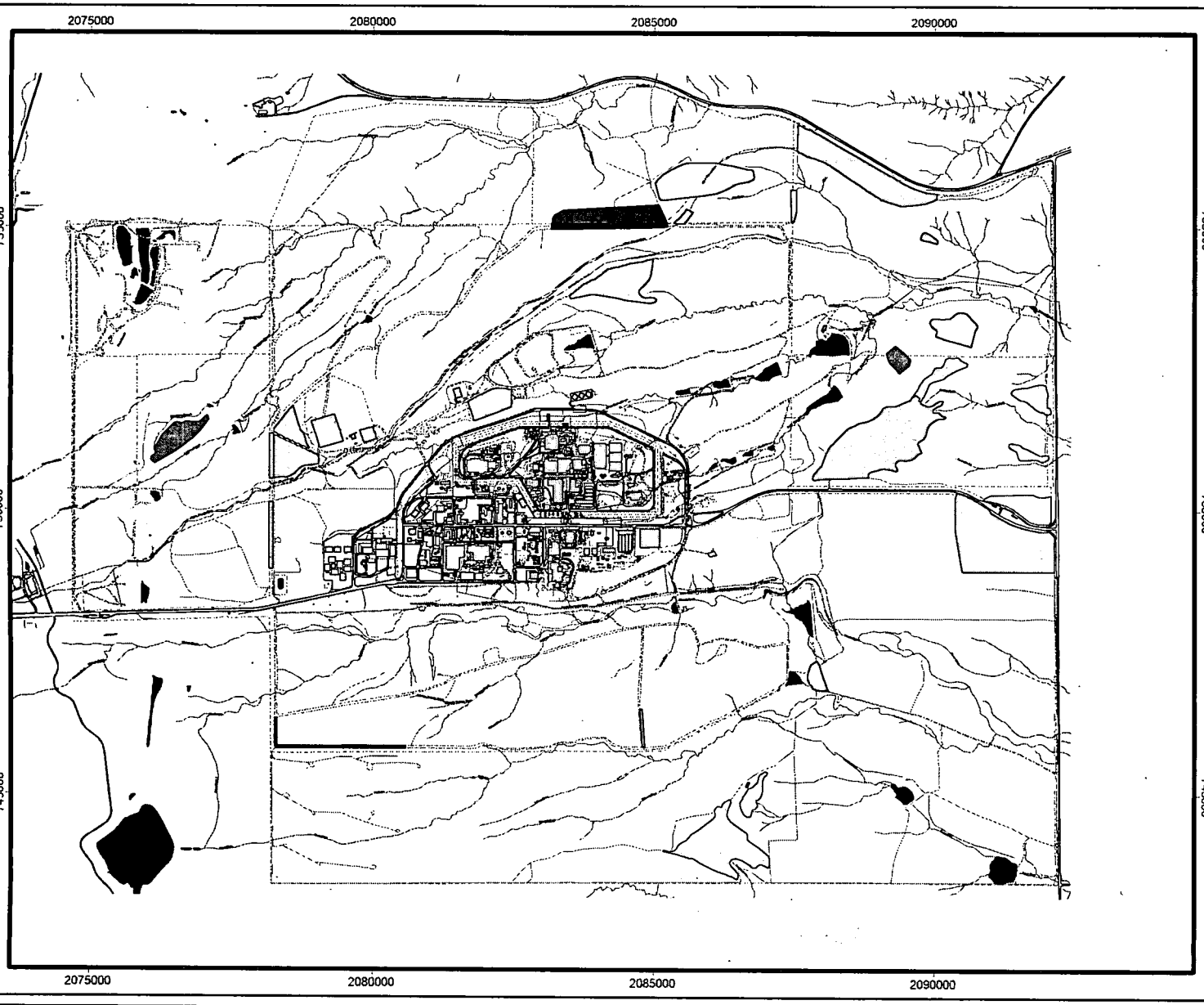

2004 Broadcast Herbicide Application Locations

Figure 4-5

Legend

- Roundup
- Plateau
- Transline
- Tordon 22K 1pt/acre
- Tordon 22K 1 qt/acre

Standard Features

- Buildings
- Demolished Buildings
- Lakes & ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft. intervals)

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95.

N

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Professional Environmental Group, L.L.C.

For: Kaiser-Hill Company, LLC

RFETS GIS Dept.
303-966-7707

MAP ID: 04-0021

May 11, 2005

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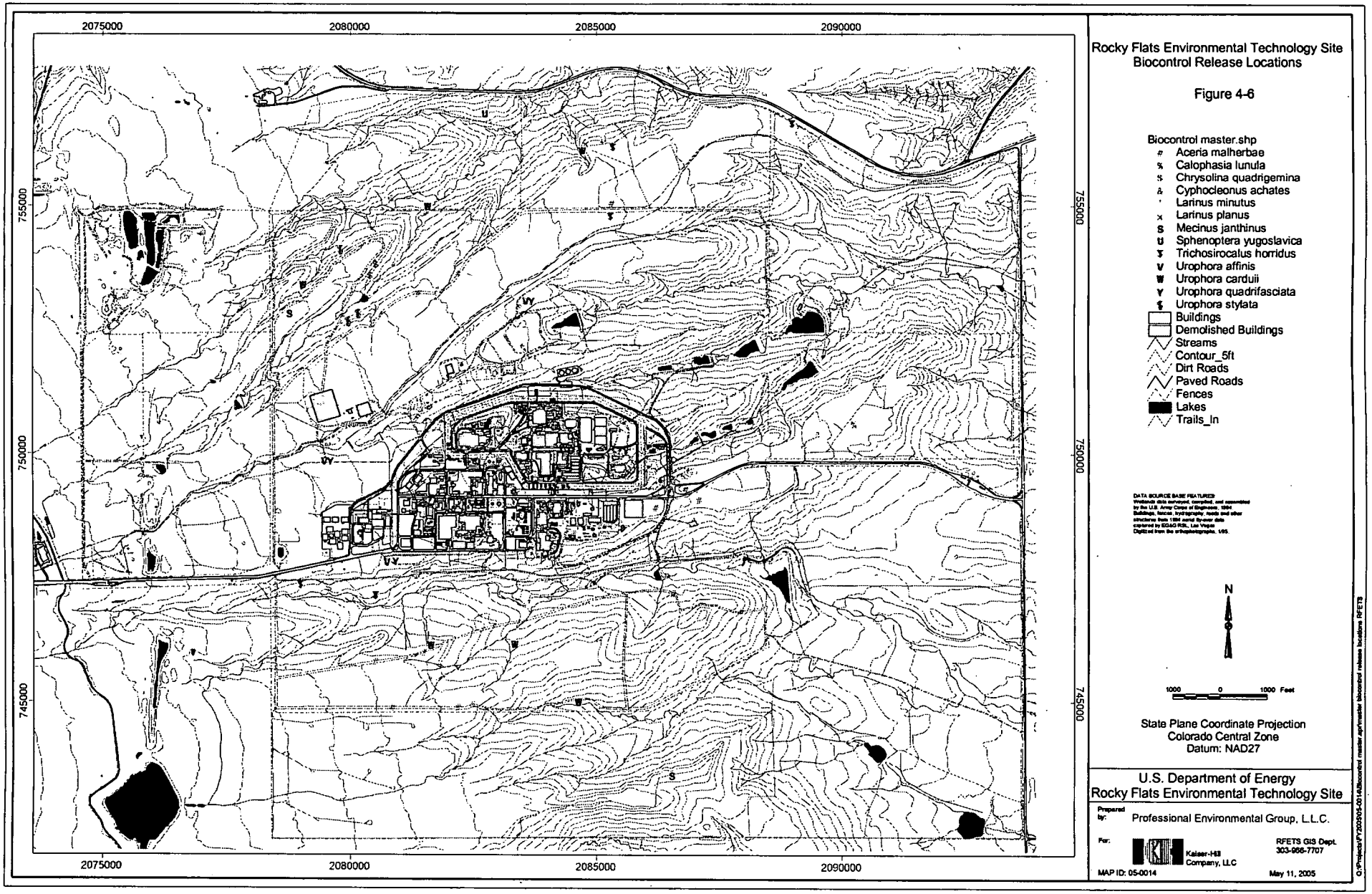


Rocky Flats Environmental Technology Site
Biocontrol Release Locations

Figure 4-6

Table 4-1. 2004 Estimated Weed Infestation Acreage Summary for the Rocky Flats Environmental Technology Site

	2004 Acreage				
		Density Level			
Common Name	Site Total	High	Medium	Low	Scattered
Diffuse Knapweed	2259	77	390	1187	605
Dalmatian Toadflax	2858	77	450	1559	772

All values are approximate acreages.

See text for density level descriptions.

Table 4-2. Comparison of 1997-2004 Weed Infestation Extents at the Rocky Flats Environmental Technology Site

			Density Level			
Weed Species	Year	Site Total	High	Medium	Low	Scattered
Diffuse Knapweed	1997	2678	696	893	658	431
	1998	2913	761	778	987	388
	1999	2295	466	613	873	343
	2000	2223	510	531	771	412
	2001	1957	381	525	674	377
	2002	1093	165	344	368	215
	2003	2127	182	512	857	576
	2004*	2259	77	390	1187	605
Dalmatian Toadflax	1997	422	135	205	82	0
	1998	1934	313	273	989	359
	1999	2507	341	389	1240	537
	2002	1264	5	69	281	909
	2003	2897	109	388	1563	837
	2004	2858	77	450	1559	772
Musk Thistle	1997	474	2	270	202	0
	1998	1685	32	515	1035	102
	1999	1353	1	311	684	357
	2000	792	0	55	242	494
	2001	869	9	84	430	346
	2002	468	27	99	169	173
	2003	2068	61	415	1157	435
Mullein	1997	575	117	238	203	17
	1998	867	168	225	460	13
	1999	1068	130	204	450	284
	2000	1010	69	184	451	307
	2001	1357	47	183	627	500
	2002	965	20	98	182	665
	2003	1840	53	409	982	396

All values are approximate acreages.

See text for density level descriptions.

* 2004 Diffuse knapweed values does not include Centennial Mine area as it has in past years. It was not mapped in 2004 due to the expansion of the mine and lack of access and visibility of the mine area.

Table 4-3. RFETS Biological Control Insect Releases

Release Date	Releasing Group	Insect	# Released	Target Species	Release Locations
7/15/1991	RFETS Ecology	Trichosirocalus horridus	500	Musk Thistle	Walnut Creek, south of raw water pond.
1994	RFETS Ecology	Cyphocleonus achates	?	Diffuse Knapweed	Walnut Creek (W of IA)
1994	RFETS Ecology	Urophora affinis	?	Diffuse Knapweed	Walnut Creek, Woman Creek
1994	RFETS Ecology	Urophora quadrifasciata	?	Diffuse Knapweed	Walnut Creek, Woman Creek
1994	RFETS Ecology	Urophora carduii	?	Canada Thistle	Rock Creek
1994	RFETS Ecology	Larinus planus	?	Canada Thistle	Rock Creek
1994	RFETS Ecology	Trichosirocalus horridus	?	Musk Thistle	Woman Creek
7/14/1997	RFETS Ecology	Sphenoptera jugoslavica	167 adults	Diffuse Knapweed	Rock Creek
8/21/1997	RFETS Ecology	Calophasia lunula	50 larvae	Dalmatian Toadflax	Walnut Creek
6/22/2000	RFETS Ecology	Urophora carduii	200 adults	Canada Thistle	Rock Creek
6/27/2001	RFETS Ecology	Larinus minutus	250 adults	Diffuse Knapweed	Rock Creek (LM1)
7/18/2001	RFETS Ecology	Trichosirocalus horridus	100 adults	Musk Thistle	Walnut Creek
7/23/2001	RFETS Ecology	Larinus minutus	85 adults	Diffuse Knapweed	Woman Creek (LM4)
7/31/2001	RFETS Ecology	Larinus minutus	100 adults	Diffuse Knapweed	Walnut Creek (LM3)
8/2/2001	RFETS Ecology	Larinus minutus	125 adults	Diffuse Knapweed	Walnut Creek (LM2)
8/2/2001	RFETS Ecology	Larinus minutus	125 adults	Diffuse Knapweed	Woman Creek (LM5)
6/21/2001	RFETS Ecology	Chrysolina quadrigemina	121	St. John's-Wort	relocation on site, released near Lindsey Ranch
5/16/2002	RFETS Ecology	Urophora carduii	200 adults	Canada Thistle	Woman Creek
6/13/2002	RFETS Ecology	Larinus minutus	200 adults	Diffuse Knapweed	Rock Creek (LM6)
6/25/2002	RFETS Ecology	Mecinus janthinus	400 adults	Dalmatian Toadflax	Smart Ditch
9/20/2002	RFETS Ecology	Aceria malherbae	1000 galls	Bindweed	Rock Creek
5/21/2003	RFETS Ecology	Urophora carduii	100 adults	Canada Thistle	Smart Ditch
6/12/2003	RFETS Ecology	Mecinus janthinus	200 adults	Dalmatian Toadflax	Rock Creek
6/17/2003	RFETS Ecology	Larinus minutus	200 adults	Diffuse Knapweed	Smart Ditch
6/17/2003	RFETS Ecology	Aceria malherbae	~200 galls	Bindweed	Rock Creek
6/23/2003	RFETS Ecology	Aceria malherbae	1000 galls	Bindweed	Woman Creek
7/17/2003	RFETS Ecology	Urophora stylata	258 adults	Bull Thistle	Rock Creek
7/12/2003	RFETS Ecology	Chrysolina quadrigemina	100	St. John's-Wort	relocation on site, released near Lindsey Ranch
5/14/2004	RFETS Ecology	Urophora carduii	100 adults	Canada Thistle	Woman Creek
5/28/2004	RFETS Ecology	Larinus minutus	200 adults	Diffuse Knapweed	Smart Ditch
6/10/2004	RFETS Ecology	Larinus minutus	200 adults	Diffuse Knapweed	Walnut Creek
6/30/2004	RFETS Ecology	Trichosirocalus horridus	100 adults	Musk Thistle	Woman Creek
8/19/2004	RFETS Ecology	Aceria malherbae	1000 galls	Bindweed	Rock Creek, Woman Creek, and Smart Ditch
8/26/2004	RFETS Ecology	Calophasia lunula	300 larvae	Dalmatian Toadflax	Walnut Creek
9/2/2004	RFETS Ecology	Aceria malherbae	1000 galls	Bindweed	Woman Creek

Note: This table does not reflect all the biocontrol releases made at RFETS. Additional releases made earlier than 1990 or by other agencies such as the here as that information was not available.

5. 2004 Dalmatian Toadflax Monitoring

5.1 Introduction

Dalmatian toadflax (*Linaria dalmatica*) is a noxious weed that has invaded hundreds of acres across the Site and is a problem throughout much of the Front Range of Colorado. The species is an escaped ornamental plant from Europe. The species is well adapted to arid environments and has a deep, extensive root system. The deep root system, waxy leaves, and high seed production make the species difficult to control. The species is a significant problem for ecological resource management because of its ability to replace native plant species and degrade the quality of the land for wildlife or grazing.

A two-phase study was conducted to evaluate the effectiveness of Tordon 22K® (applied at two different application rates [one pint/acre and one quart/acre]) on dalmatian toadflax.

5.2 Monitoring

5.2.1 Purpose

The purpose of this monitoring effort was to: document the effect of two different application rates of Tordon 22K® on dalmatian toadflax density.

5.3 Methods

5.3.1 Phase 1

During June 2003, several dense infestations of dalmatian toadflax in the Buffer Zone (BZ) were sprayed with Tordon 22K® (one pint/acre) to evaluate the effectiveness of this herbicide in reducing the density of toadflax populations. The locations selected for monitoring were established in the south BZ at the Site (Figure 5-1). A control plot and treatment plot were established for comparative purposes. Two fifty-meter transects were established in each plot and five one-square meter (square shaped) quadrats were randomly located along each transect. Within each quadrat the density of dalmatian toadflax stems were counted. Each live stem, regardless of height, that was rooted within the quadrat was counted and the total number recorded on field data sheets. The average number of stems per quadrat (n = 10) was calculated from the data for the control plot and treatment plot. This data established the baseline for Phase 1 of the study. In 2004, the transects in both the control and treatment plots were monitored to determine the effectiveness the spraying (one pint/acre) had on reducing dalmatian toadflax densities.

Phase 2

A second phase was added to the project in 2004 when an application of Tordon 22K® (one quart/acre) was applied to a large infestation of dalmatian toadflax adjacent to the control plot transects (Figure 5-1). Pre-treatment monitoring of toadflax density in this area was conducted along two fifty-meter transects established using the same methodology described above. The control plots used for the first phase of the study were used as control plots for this phase as well. This data established the baseline for Phase 2 of the study. Monitoring in 2005 will determine

how effective an application of Tordon 22K® at one quart/acre is on reducing dalmatian toadflax as compared to one pint/acre.

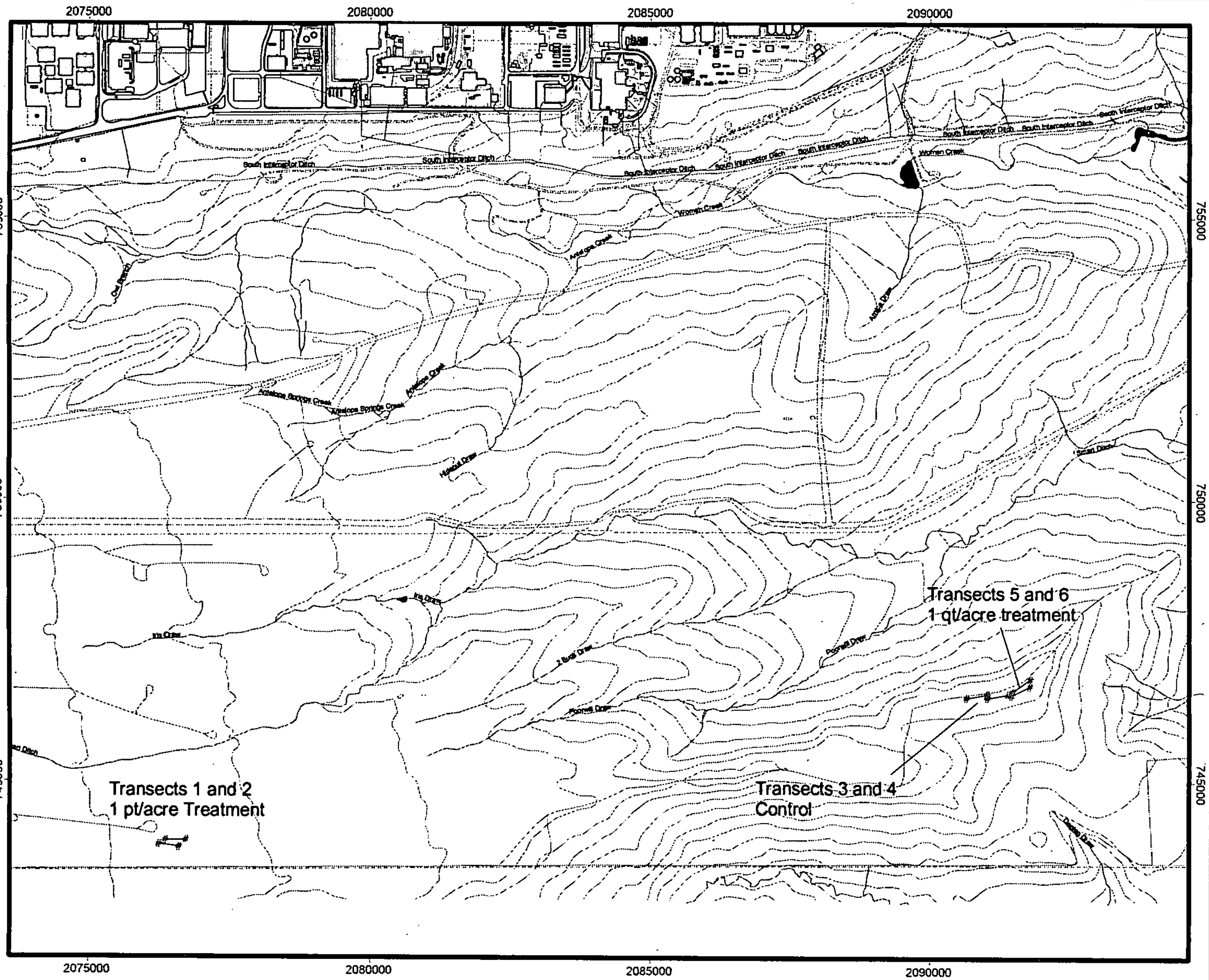
5.4 Results and Discussion

In 2003, dalmatian toadflax density in the control plot was 75.2 stems/m^2 and the treatment plot was 72.0 stems/m^2 (Figure 5-2). In 2004, at the one pint/acre treatment plot, dalmatian toadflax density dropped to 37 stems/m^2, while in the control plot dalmatian toadflax density rose to 95 stems/m^2 (Figure 5-2). The increase in stem density in the control plot is likely a result of the increased precipitation received during 2004 as compared to 2003 (5 inches additional precipitation from January to August 2004, compared to 2003). Thus the herbicide application did have a substantial impact on dalmatian toadflax density, reducing stem densities in the treatment plot to just above one-third what they were in the control plot. These results are similar to data previously evaluated at the Site where fortuitous monitoring of dalmatian toadflax density at a different set of ten quadrats in the BZ was conducted for a period of several years after Tordon 22K® was applied at a rate of one pint/acre. No control area, however, was available for comparison purposes at this study since the study was originally designed for another purpose. However, those data shown in Figure 5-3, showed substantial declines in dalmatian toadflax density at that location after the herbicide application. Densities dropped from about 100 stems/m^2 to 8 stems/m^2 after the herbicide application. The current evaluation will try to replicate these results. Monitoring in 2005 will determine how effective the residual Tordon 22K® is at controlling dalmatian toadflax in extended years.

Monitoring at the newly established one quart/acre spray plot in 2004 showed that dalmatian toadflax had a density of 64.8 stems/m^2 pre-treatment (Figure 5-2). Continuation of the monitoring in 2005 will determine the effectiveness of this treatment compared to the one pint/acre application.

5.5 Conclusions

A study was set up in the south BZ at the Site to evaluate the impact of Tordon 22K® applied at application rates of one pint/acre or one quart/acre on dalmatian toadflax density. After the first growing season, dalmatian toadflax density in the treatment plot was reduced to slightly more than one third of that in the control plot. A second phase of the study was initiated in 2004 where dalmatian toadflax infestations were treated with Tordon 22K® applied at application rate of one quart/acre. Future evaluations will determine the effectiveness of the treatments.



Dalmatian Toadflax Herbicide Monitoring Transects

Figure 5-1

\# Transect Endpoints

Standard Features

- Buildings
- Demolished Buildings
- Lakes & ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft. intervals)

DATA SOURCE BASE FEATURES
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95.

N

500 0 500 1000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Professional Environmental Group

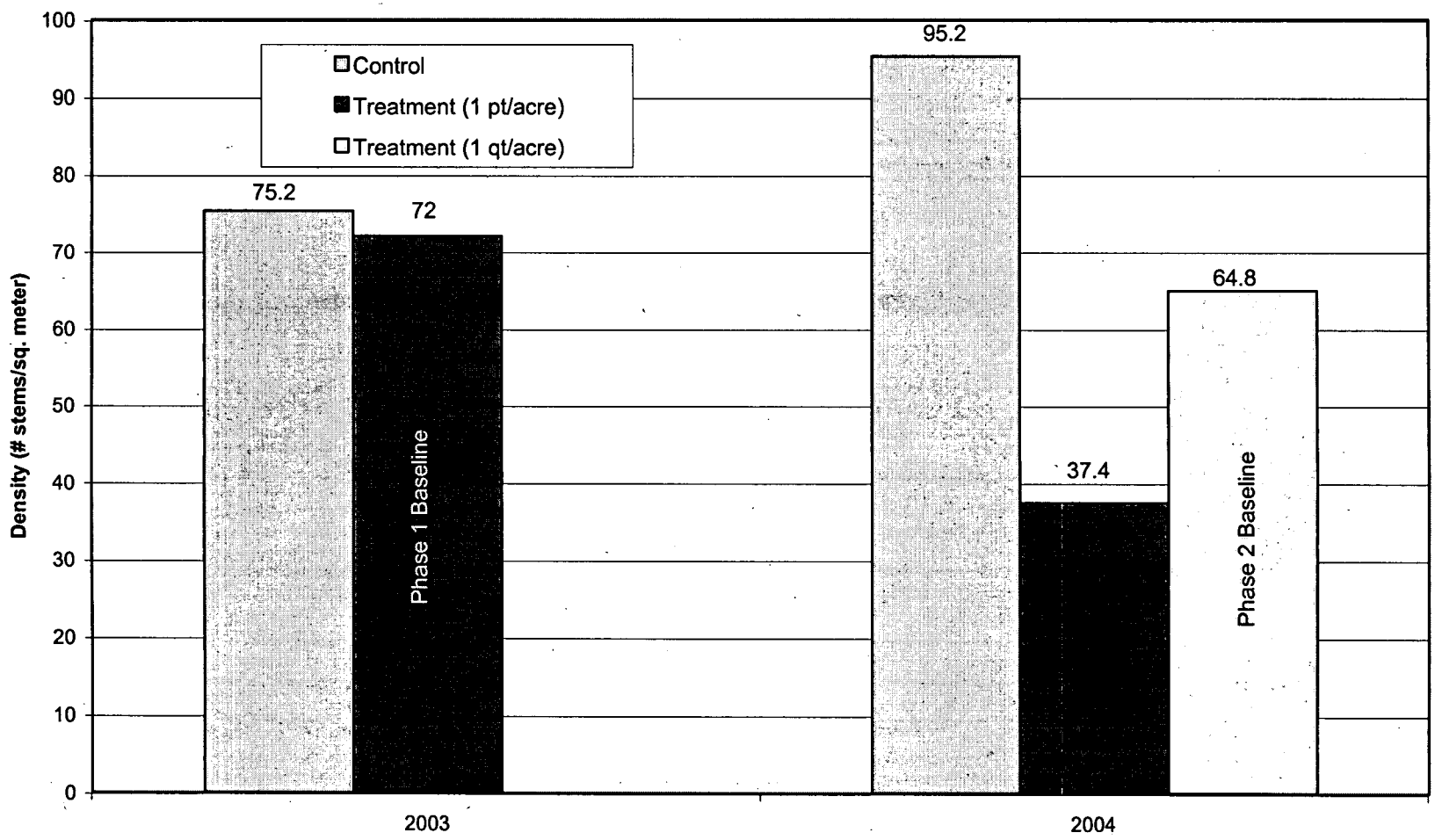
For: Kaiser-Hill Company, LLC

RFETS GIS Dept.
303-966-7707

MAP ID: 03-0024

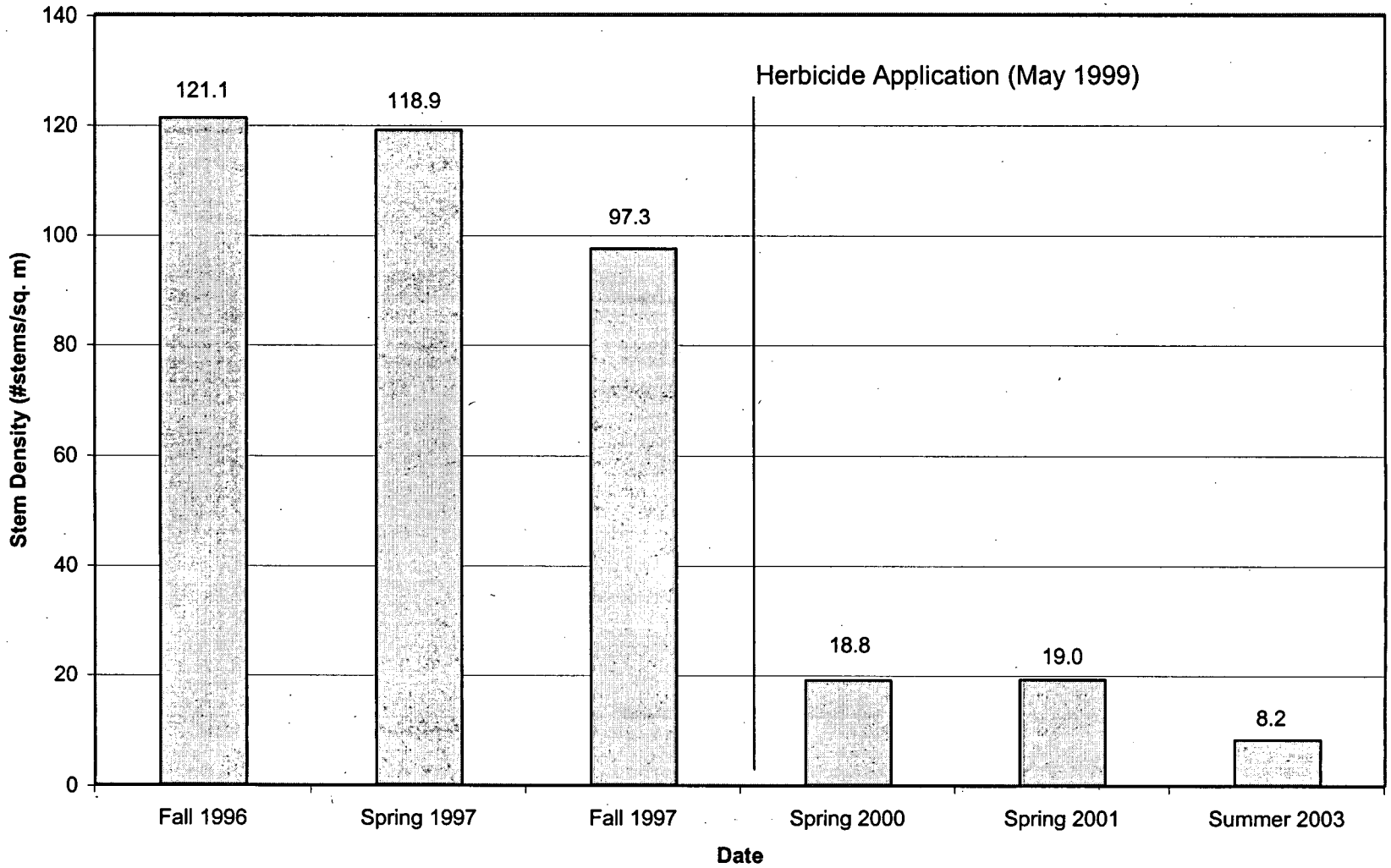
March 3, 2005

Figure 5-2. 2003/2004 *Linaria dalmatica* (Dalmatian Toadflax) Density Herbicide Response



Note: The treatment (1 qt/acre) was begun in 2004.

Figure 5-3. *Linaria dalmatica* (Dalmatian Toadflax) Density in Response to Tordon22K (1 pint/acre)



6. 2004 Revegetation Monitoring

6.1 Introduction

The Rocky Flats Environmental Technology Site (Site), a U.S. Department of Energy facility, is located near Golden, Colorado. For nearly 40 years during the Cold War, the Site was an integral part of the United States nuclear weapons program, producing nuclear weapons components. Since the early 1990's however the Site has been shut down and is currently undergoing cleanup and closure under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The Industrial Area (IA), located in the center of the Site, occupies an area of about 385 acres and contains buildings, roads, and other infrastructure equivalent to that of a small town. As cleanup and removal of the buildings and other structures in the IA takes place, revegetation of these areas is necessary to prevent erosion and sedimentation of the Site streams and to meet water quality standards. Re-establishment of native plant species is desirable to benefit wildlife and the future of the Site as a National Wildlife Refuge. As part of the revegetation process, monitoring is conducted to determine whether success criteria, as stated in the Revegetation Plan (K-H 2004a) are being met as well as to determine whether management of these resources are needed. The Revegetation Plan provides success criteria to be used to determine when a revegetated area as has become re-established, typically 3 to 5 years after seeding, and as a management tool to determine if addition actions are required for the area. This section of the annual report summarizes the revegetation monitoring results for data collected during 2004.

Objectives of the revegetation monitoring in 2004 were to:

- Provide a photographic baseline for new revegetation projects,
- Continue to document photographically changes in past revegetation efforts,
- Qualitatively assess the conditions present at each revegetation project and make any recommendations for management of these areas,
- Quantitatively assess the revegetation efforts at selected locations.

6.2 Methods

Revegetation monitoring is conducted with a two-fold approach at the Site using both qualitative and quantitative methods. Qualitative monitoring is used to monitor revegetation locations less than one acre in size. Qualitative monitoring consists of the use of permanent photopoints and field notes. A minimum of two photopoints is used to document each revegetation location. Photopoints are visited at least annually during the summer. Additional photographs may be taken at other times as appropriate. Field notes are also taken to complement the photographs. Photo monitoring has been used at the Site for the past several years to qualitatively document revegetation efforts at the Site. The locations and photographs of these disturbances have been presented in past annual reports for the Rocky Flats Environmental Technology Site (K-H 2000, 2001, 2002, 2003a, 2004b). Photographs were taken in 2004 from the same locations for comparison to previous photographs. These can be found in Appendix C on the CD-ROM. Qualitative monitoring was conducted in August 2004.

Quantitative monitoring was used during 2004 to monitor revegetation locations larger than one acre in size. A total of twenty 50-m transects were randomly located at six revegetation

locations: the Solar Ponds, Incinerator, New Landfill, MST area, Building 116, and Building 886 (Figure 6-1). Three of these locations, the Solar Ponds, New Landfill, and MST area, were monitored in 2003 also. At the Incinerator area, three transects were located in the revegetation area and three control or reference transects were located in adjacent native grassland areas for comparison. This was done because this area was located in Preble's mouse habitat and the monitoring for the Preble's mouse mitigation areas requires a control area for comparison purposes. In 2004, monitoring was conducted from August 10 to August 23. Both species richness and species cover was measured along each transect. Species richness was determined in a 2-m-wide belt centered along the length of each 50-m transect. Every plant species rooted within the 100-m^2 area was recorded. In addition, the numbers of any woody plant stems and cactus stems were counted and recorded for the 100-m^2 area.

Basal cover and foliar cover were estimated using a point-intercept method along each 50-m transect (Bonham 1989). A 2-m-long, 6-mm-diameter rod was dropped vertically at 50-cm intervals along the transect to record a total of 100 intercept points. Two categories of hits were recorded: basal and foliar. Basal cover hits were recorded based on what material was hit by the rod at the ground surface. Hits could be vegetation (live plants), litter (fallen dead material), rock (pebbles and cobbles greater than the rod diameter), bare ground, or water, in that order of priority based on the protection from erosion provided by each type of cover. Basal vegetation hits were recorded by species only if the rod is touching the stem or crown of the plant where the plant enters the ground. Foliar vegetation hits (defined as a portion of a plant touching the rod) were recorded by species in three categories as defined by height and growth form. The topmost hit of each growth form was recorded. The growth forms measured included herbaceous, woody <2 m in height, and woody >2 m in height (where present).

Data were analyzed and summarized for each transect and cumulatively for each revegetation location. Species richness data were summarized by generating species lists and tallying the number of overall species and percent of native species. Foliar cover data are reported as absolute cover and relative cover for each species encountered. Absolute foliar cover is defined as the percentage of the number of hits on a species out of the total number of hits possible for each location. This value is the actual cover of a species. Relative foliar cover is defined as the number of hits a species had relative to the total number of vegetative hits recorded per location (i.e., the percent of total vegetative cover [100 percent] represented by the species).

6.3 Results and Discussion

Photo monitoring results for the quantitative monitoring locations are presented in Appendix E on the CD-ROM. Table 6-1 lists revegetation information for these locations. No qualitative monitoring results are presented since by late 2004, most of the smaller revegetation locations had been destroyed or re-disturbed by continuing cleanup and closure activities. Therefore only the quantitative monitoring results are presented.

The 2003 results from the New Landfill, MST tank area, Solar Ponds, and the B442/452 area that were sampled in 2003 are shown in Tables 6-2, 6-3, and 6-4. The B442/452 area was re-disturbed in 2004 and was not sampled during 2004. The monitoring results for the locations sampled in 2004 are shown in Tables 6-5, 6-6, and 6-7.

Overall species richness in 2004 at the revegetation locations varied from 34 species at the MST to 71 species at the incinerator (Tables 6-2 and 6-5). The percentage of native species in 2004 ranged from 34% at the MST to 53% at the incinerator revegetation area. The control area at the incinerator had a richness of 71 species with 69% of these being native species. Species richness increased at each of the locations (MST, new landfill, and solar ponds) re-monitored in 2004 (Tables 6-2 and 6-5). The largest increase in the number of species occurred at the New Landfill (4 species in 2003 to 41 species in 2004), while the Solar Ponds and MST areas increased by 17

and 9 species respectively. The percentage of native species increased at the New Landfill while decreasing at the Solar Ponds and MST areas (Table 6-2 and 6-5). Total species richness at the three new locations monitored in 2004 (B116, B866, and the incinerator [control and revegetation areas]) was higher than at the other locations monitored in 2004 (Tables 6-2 and 6-5).

Slightly different seed mixes were used at the different locations. Of the native plant species seeded, in 2004, four species were present at the B886 and MST areas, six species were present at B116, the Incinerator, and Solar Pond areas, and seven species were present at the New Landfill. One of the success criterion in the Revegetation Plan (K-H 2004a) states that at least 50% of the seeded species must be present in the area to be considered successful. The total number of species seeded at these locations was 14 species at the New Landfill, Solar Ponds, and B886, 10 species at the MST tank area, and 11 species at B116 and the Incinerator. So at the end of 2004, B116, the Incinerator, and the New Landfill, have meet this criterion for the percentage of seeded species present.

Ground cover protection from rock, litter, and current year live vegetation varied from 66% to 94% at the revegetation locations in 2004 (Tables 6-3 and 6-6). Another success criterion outlined in the Revegetation Plan for the Site (K-H 2004a), states a minimum of 70% total ground cover comprised of litter cover, current year live vegetation basal cover, and rock cover is to be present to help prevent erosion. Based on the 2004 data, only the MST area did not meet this criterion.

Foliar vegetation cover and species composition differs between the revegetation locations and has changed from 2003 to 2004 (Tables 6-4 and 6-7). In 2003, both the New Landfill and Solar Ponds were dominated by winter wheat (*Triticum aestivum*) which germinated from seed heads present in the crimped straw mulch. No winter wheat was encountered along the point-intercept transects at these two locations in 2004, although it was recorded on the species richness belt transects. It was uncommon during the summer of 2004. During 2004, the New Landfill was dominated by slender wheatgrass (*Agropyron caninum* = *Agropyron trachycaulum*), wild lettuce (*Lactuca serriola*), and Russian thistle (*Salsola iberica*). Total vegetation cover at the New Landfill dropped from 36% in 2003 to 12% in 2004, largely due to the loss of the winter wheat. Qualitative observations of the New Landfill revegetation is that it is progressing very slowly. At the Solar Ponds in 2004, the area was dominated by yellow sweet clover (*Melilotus officinalis*) and slender wheatgrass and the total vegetation cover increased from 42% in 2003 to 59% in 2004. A third success criterion outlined in the Revegetation Plan for the Site (K-H 2004a), states that a minimum of 30% of desired species must be present and a forth criterion states that no single species comprise more than 45% of the total relative cover. Total relative vegetation cover of desired species at the New Landfill and Solar Ponds was 49% and 28%, respectively. So the New Landfill met this forth criterion in 2004. However, slender wheatgrass comprised 47% of the relative cover at the New Landfill, while yellow sweet clover represented 50% of the relative cover at the Solar Ponds in 2004. So neither location met the third criterion in 2004, since both were largely dominated by a single species. The difference in the success of the revegetation at the New Landfill and Solar Ponds is interesting considering they were both seeded at the same time, in the same way, and with the same species. Differences in the soil characteristics may account for some of this since the New Landfill has more clay in the soil than does the Solar Ponds area.

At the MST area, the vegetation was dominated by kochia (*Kochia scoparia*; 53%) and slender wheatgrass in 2004 (16%; Tables 6-4 and 6-7). Total vegetation cover did not change from 2003 (89%) to 2004 (90%). The total relative cover of desired species at the MST area in 2004 was 31%. Thus the total relative cover of desired species meets the success criterion, while the overall dominance by the single species, kochia, is above the 45% threshold.

At B116, B886, and the Incinerator (revegetation location), the total vegetation cover in 2004 was 31%, 86%, and 44%, respectively (Tables 6-4 and 6-7). The total relative cover of desired species at these locations was 17%, 38%, and 23%, respectively. Only B886 met the success criterion of a minimum of 30% relative cover of desired species in 2004. No single species comprised greater than 45% relative cover at any of these locations in 2004.

Table 6-8 presents a summary of the pass/fail criteria and how each revegetation location monitored in 2004 measured up. None of the revegetation locations passed all the criteria in 2004. However, this is not unexpected, as it is only the first or second growing season for each of the locations. The first few years are often weedy as the native perennial species get established. If often takes 3-5 years to establish a good stand of vegetation. Additionally, some of the revegetation locations may require some reseeding and weed control. Proactive management of revegetation plots is critical to success. These data provide useful information for making management decisions and provide documentation of the successional changes at the revegetation locations that can then be used to help improve revegetation techniques at the Site.

6.4 Conclusions

Qualitative and quantitative monitoring was conducted at a number of revegetation locations at the Site during 2004. Photo monitoring and qualitative assessments were conducted at several revegetation locations. Many of the locations were redisturbed or destroyed however, as cleanup and closure activities continued at the Site during the winter of 2004. Quantitative monitoring was conducted at six locations. Results indicate that the vegetation is establishing, however, success criteria in the Revegetation Plan have not been met as of 2004 at any of the locations monitored. This is not unexpected since for each of these locations it was only the first or second growing season since they had been seeded. In general, however, vegetation has begun to establish and is protecting the soil from erosion. Over the next few years the seeded species should become more established. Therefore, there are no recommended changes to the management of these areas at this time.

6.5 References

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K-H. 2001. 2000 Annual vegetation report for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, LLC, Rocky Flats Environmental Technology Site, Golden, CO.

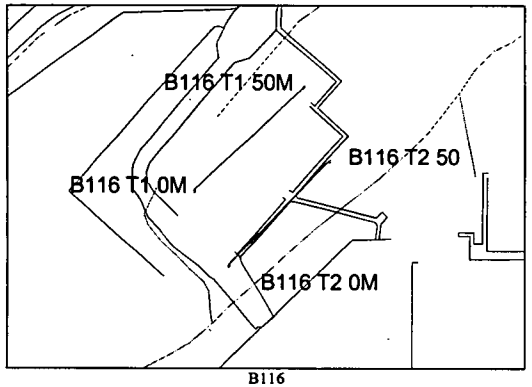
K-H. 2002. 2001 Annual vegetation report for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, LLC, Rocky Flats Environmental Technology Site, Golden, CO.

K-H. 2003a. 2002 Annual vegetation report for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, LLC, Rocky Flats Environmental Technology Site, Golden, CO.

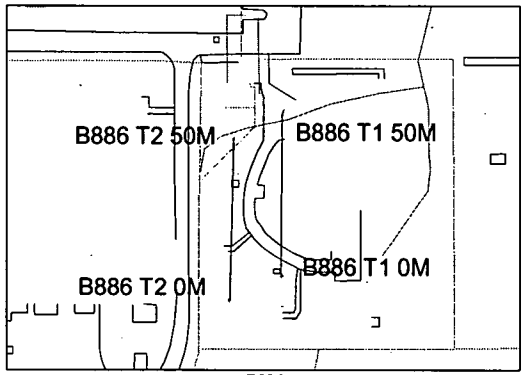
K-H. 2004a. Rocky Flats Environmental Technology Site Industrial Area Revegetation Plan. Rev. 2. Kaiser-Hill Company, LLC, Rocky Flats Environmental Technology Site, Golden, CO. January 2004.

K-H. 2004b. 2003 Annual vegetation report for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, LLC, Rocky Flats Environmental Technology Site, Golden, CO.

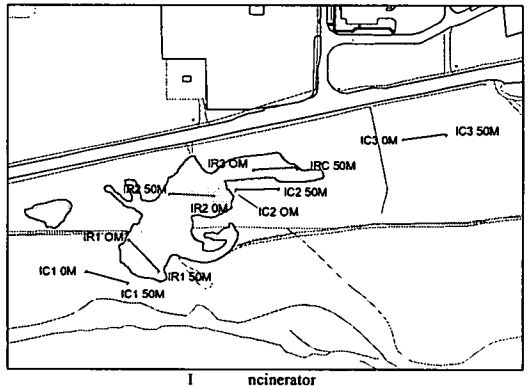
Figure 6-1. 2004 Revegetation Monitoring Transect Locations



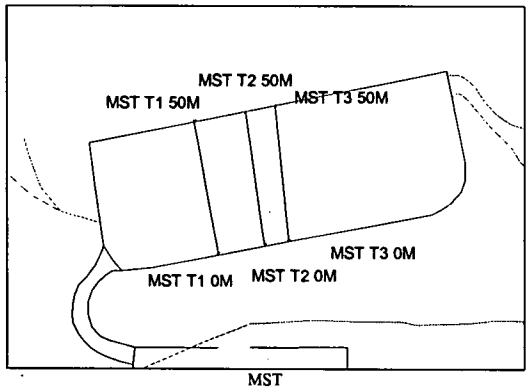
B116



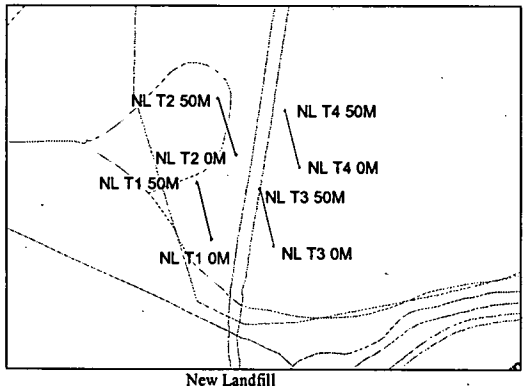
B886



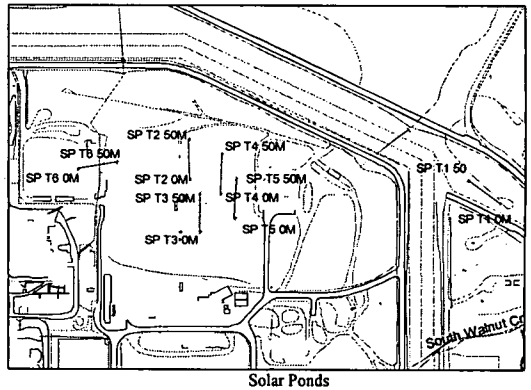
I ncinerator



MST



New Landfill



Solar Ponds

Table 6-1. Rocky Flats Environmental Technology Site Project Revegetation Specifications

Project	Mitigation/ Agency	Reveg Date	Imported Topsoil Depth	Topsoil Origin Location	Fertilizer Type/Amount	Mulch	Irrigation Amount/Frequency	Weed Control Type	Seed Mix	Reseeded	Comments	Project
Building 116/T117A		March-04	None	NA	None	Hydromulch	None	None	Flat Areas Seed Mix Hillside Slope Areas Seed Mix (Reveg Plan Rev. 2)	Portions Yes, some areas were ripped and reseeded in July 2004	Summer 2004 parts of west area and all of east area ripped and reseeded.	Building 116/T117A
Building 888		August-02	5"	Parker, CO area	None	Hydromulch	None	None	Xeric A	Yes, Flat Areas Seed Mix, Reveg Plan Rev. 1		Building 888
Incinerator Project	Yes/USFWS	March-04	None	NA	None	Hydromulch/ Erosion mats/ Wattles	None	None	Flat Areas Seed Mix Bottomland Seed Mix (Reveg Plan)	Yes - Flat Areas Seed Mix Hillside Slope Areas Seed Mix (Reveg Plan Rev. 2)	Reseeded 10/04.	Incinerator Project
MST Tanks		January-03	5"	?	None	Hydromulch	None	None	IA Mesic Worksheet Mix	Yes - used Hillside Slope Areas Seed Mix (Reveg Plan Rev. 2)	Reseeded 10/04.	MST Tanks
New Landfill		May-03	None	NA	None	Crimped Hay	None	None	Flat Areas Seed Mix (Reveg Plan Rev.1)	Yes - Flat Areas Seed Mix (IA Reveg Plan Rev. 2). Also added some PAVI1, ARLO1, and RACO1.	Reseeded 10/04.	New Landfill
Solar Ponds		May-03	None	NA	None	Crimped Hay	None	None	Flat Areas Seed Mix Hillside Slope Areas Seed Mix (Reveg Plan Rev. 1)	Yes - Flat Areas Seed Mix (IA Reveg Plan Rev. 2).	Reseeded 10/04.	Solar Ponds

Table 6-2. 2003 Revegetation Monitoring Species Richness Summary

				New Landfill		MST Tanks		Solar Ponds				B442/B452 Area	
				Transect Number									
Family	Scientific Name	Speccode	Native	1	2	3	4	5	6	7	8	9	10
		UNKN					X						
AMARANTHACEAE	Amaranthus retroflexus L.	AMRE1	Y				X						
ASTERACEAE	Ambrosia psilostachya DC.	AMPS1	Y						X			X	X
ASTERACEAE	Centaurea diffusa Lam.	CEDI1	N				X	X	X		X	X	X
ASTERACEAE	Cirsium arvense (L.) Scop.	CIAR1	N						X		X		
ASTERACEAE	Grindelia squarrosa (Pursh.) Dun.	GRSQ1	Y			X			X		X	X	X
ASTERACEAE	Helianthus annuus L.	HEAN1	Y			X			X				X
ASTERACEAE	Lactuca serriola L.	LASE1	N			X							
ASTERACEAE	Onopordum acanthium L.	ONAC1	N										X
ASTERACEAE	Taraxacum officinale Weber	TAOF1	N									X	
BRASSICACEAE	Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley	ALMI1	N									X	X
BRASSICACEAE	Camelina microcarpa Andrz. ex DC.	CAMI1	N			X	X					X	X
BRASSICACEAE	Descurainia pinnata (Walt.) Britt.	DEPI1	Y			X	X						
BRASSICACEAE	Sisymbrium altissimum L.	SIAL1	N			X	X	X		X			X
BRASSICACEAE	Thlaspi arvense L.	THAR1	N			X	X						
CHENOPODIACEAE	Chenopodium album L.	CHAL1	N			X	X		X			X	X
CHENOPODIACEAE	Kochia scoparia (L.) Schrad.	KOSC1	N			X	X	X	X	X	X	X	X
CHENOPODIACEAE	Salsola iberica Senn. & Pau.	SAIB1	N		X	X	X			X	X		
CONVOLVULACEAE	Convolvulus arvensis L.	COAR1	N						X				
FABACEAE	Medicago lupulina L.	MELU1	N					X				X	X
FABACEAE	Melilotus officinalis (L.) Pall.	MEOF1	N	X				X	X			X	
GERANIACEAE	Erodium cicutarium (L.) L'Her.	ERCI1	N									X	X
PLANTAGINACE	Plantago lanceolata L.	PLLA1	N										X
POACEAE	Aegilops cylindrica Host	AECY1	N										X
POACEAE	Agropyron caninum (L.) Beauv. ssp. majus (Vasey) C. L. Hitchc.	AGCA1	Y	X		X	X		X			X	X
POACEAE	Agropyron cristatum (L.) Gaertn.	AGCR1	N				X					X	
POACEAE	Agropyron smithii Rydb.	AGSM1	Y			X					X		
POACEAE	Avena fatua var. sativa (L.) Hausskn.	AVFA1	N				X						
POACEAE	Bouteloua curtipendula (Michx.) Torr.	BOCU1	Y								X		
POACEAE	Bouteloua gracilis (H. B. K.) Lag ex Griffiths	BOGR1	Y								X		
POACEAE	Bromus japonicus Thunb. ex Murr.	BRJA1	N								X	X	X
POACEAE	Bromus tectorum L.	BRTE1	N			X	X		X			X	X
POACEAE	Buchloe dactyloides (Nutt.) Engelm.	BUDA1	Y			X			X		X		
POACEAE	Eragrostis pilosa (L.) Beauv.	ERPI1	N										X
POACEAE	Panicum capillare L.	PACA1	Y									X	X
POACEAE	Poa compressa L.	POCO1	N			X	X						
POACEAE	Secale cereale L.	SECE1	N									X	X
POACEAE	Setaria viridis (L.) Beauv.	SEVI1	N									X	
POACEAE	Triticum aestivum L.	TRAE1	N	X	X	X	X	X	X	X	X		
POLYGONACEAE	Polygonum arenastrum Jord. ex Bor.	POAR1	N			X	X	X	X			X	X
POLYGONACEAE	Polygonum ramosissimum Michx.	PORA1	Y			X	X					X	X
SCROPHULARIACEAE	Verbascum blattaria L.	VEBL1	N				X						
SCROPHULARIACEAE	Veronica peregrina L. var. xalapensis (H. B. K.) St. John & Warren	VEPE1	Y				X						
VERBENACEAE	Verbena bracteata Lag. & Rodr.	VEBR1	Y					X	X			X	X
	Total Number of Species by Transect			3	2	18	20	8	15	4	11	21	23
	Percent Native Species by Transect			33	0	39	25	13	40	0	45	29	30
	Number of Species by Revegetation Location			4		25		22				27	
	Percent Native Species by Revegetation Location			25		38		41				26	

Table 6-3. 2003 Revegetation Monitoring Ground Cover Summary

	New Landfill			MST Tanks			Solar Ponds					B442/B452 Area		
Transect	**1**	**2**	**1/2**	**3**	**4**	**3/4**	**5**	**6**	**7**	**8**	**5-8**	**9**	**10**	**9/10**
Ground Cover (%)														
Bare Ground (%)	10.0	18.0	14.0	42.0	42.0	42.0	23.0	27.0	22.0	39.0	27.8	80.0	71.0	75.5
Litter (%)	72.0	66.0	69.0	52.0	53.0	52.5	68.0	58.0	62.0	44.0	58.0	7.0	18.0	12.5
Rock (%)	18.0	16.0	17.0	1.0	0.0	0.5	8.0	12.0	11.0	14.0	11.3	11.0	9.0	10.0
Vegetation (%)	0.0	0.0	0.0	5.0	5.0	5.0	1.0	3.0	5.0	3.0	3.0	2.0	2.0	2.0
Total Rock, Litter, Vegetation (%)	90.0	82.0	86.0	58.0	58.0	58.0	77.0	73.0	78.0	61.0	72.3	20.0	29.0	24.5
Total Cover (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 6-4. 2003 Revegetation Monitoring Foliar Cover Summary

				Location	New Landfill						MST Tanks						Solar Ponds										B442/B452 Area					
				Transect	1	1	2	2	1/2	1/2	3	3	4	4	3/4	3/4	5	5	6	6	7	7	8	8	5-8	5-8	9	9	10	10	9/10	9/10
Scientific Name	Speccode	Growth Form	Native	Cool/ Warm Season	Absolute Cover (%)	Relative Cover (%)	Absolute Cover (%)	Relative Cover (%)	Absolute Cover (%) Mean	Relative Cover (%) Mean	Absolute Cover (%)	Relative Cover (%)	Absolute Cover (%)	Relative Cover (%)	Absolute Cover (%) Mean	Relative Cover (%) Mean	Absolute Cover (%)	Relative Cover (%)	Absolute Cover (%)	Relative Cover (%)	Absolute Cover (%)	Relative Cover (%)	Absolute Cover (%)	Relative Cover (%)	Absolute Cover (%) Mean	Relative Cover (%) Mean	Absolute Cover (%)	Relative Cover (%)	Absolute Cover (%)	Relative Cover (%)	Absolute Cover (%) Mean	Relative Cover (%) Mean
Centaurea diffusa Lam.	CEDI1	F	N																										1.0	1.7	0.5	0.8
Chenopodium album L.	CHAL1	F	N								24.0	26.7	13.0	14.8	18.5	20.7											1.0	2.9			0.5	1.5
Kochia scoparia (L.) Schrad.	KOSC1	F	N								18.0	20.0	19.0	21.6	18.5	20.8					1.0	2.4			0.3	0.6	12.0	35.3	23.0	38.3	17.5	36.8
Salsola iberica Senn. & Pau.	SAIB1	F	N								8.0	8.9	1.0	1.1	4.5	5.0					1.0	2.4			0.3	0.6					0.0	
Melilotus officinalis (L.) Pall.	MEOF1	F	N																2.0	5.1					0.5						0.0	
Polygonum arenastrum Jord. ex Bor.	POAR1	F	N								12.0	13.3	27.0	30.7	19.5	22.0			1.0	2.6					0.3	0.6	2.0	5.9	4.0	6.7	3.0	8.3
Ambrosia psilostachya DC.	AMPS1	F	Y																								1.0	2.9			0.5	1.5
Polygonum ramosissimum Michx.	PORA1	F	Y										1.0	1.1	0.5	0.6															0.0	
Verbena bracteata Lag. & Rodr.	VEBR1	F	Y																1.0	2.6					0.3	0.6					0.0	
Bromus japonicus Thunb. ex Murr.	BRJA1	G	N	C																									1.0	1.7	0.5	0.8
Bromus tectorum L.	BRTE1	G	N	C									2.0	2.3	1.0	1.1											2.0	5.9	5.0	8.3	3.5	7.1
Poa compressa L.	POCO1	G	N	C									1.0	1.1	0.5	0.6															0.0	
Triticum aestivum L.	TRAE1	G	N	C	34.0	100.0	38.0	100.0	38.0	100.0							58.0	100.0	35.0	89.7	40.0	95.2	27.0	93.1	40.0	94.5					0.0	
Eragrostis pilosa (L.) Beauv.	ERPI1	G	N	W																									1.0	1.7	0.5	0.8
Agropyron caninum (L.) Beauv. ssp. majus (Vasey) C. L. Hitchc.	AGCA1	G	Y	C							26.0	28.9	24.0	27.3	25.0	28.1											16.0	47.1	25.0	41.7	20.5	44.4
Agropyron smithii Rydb.	AGSM1	G	Y	C							2.0	2.2			1.0																0.0	
Bouteloua curtipendula (Michx.) Torr.	BOCU1	G	Y	W																			1.0	3.4	0.3	0.9					0.0	
Buchloe dactyloides (Nutt.) Engelm.	BUDA1	G	Y	W																			1.0	3.4	0.3	0.9					0.0	
Total Foliar Cover*					34.0	100.0	38.0	100.0	38.0	100.0	90.0	100.0	88.0	100.0	89.0	98.9	58.0	100.0	39.0	100.0	42.0	100.0	29.0	100.0	42.0	98.7	34.0	100.0	60.0	100.0	47.0	100.0
Total Forb Cover					0.0	0.0	0.0	0.0	0.0	0.0	62.0	68.9	61.0	69.3	61.5	69.1	0.0	0.0	4.0	10.3	2.0	4.8	0.0	0.0	1.5	2.5	16.0	47.1	28.0	46.7	22.0	46.9
Total Non-Native Forb Cover					0.0	0.0	0.0	0.0	0.0	0.0	62.0	68.9	60.0	68.2	61.0	68.5	0.0	0.0	3.0	7.7	2.0	4.8	0.0	0.0	1.3	1.8	15.0	44.1	28.0	46.7	21.5	45.4
Total Native Forb Cover					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.1	0.5	0.6	0.0	0.0	1.0	2.6	0.0	0.0	0.0	0.0	0.3	0.6	1.0	2.9	0.0	0.0	0.5	1.5
Total Graminoid Cover					34.0	100.0	38.0	100.0	38.0	100.0	28.0	31.1	27.0	30.7	27.5	29.8	58.0	100.0	35.0	89.7	40.0	95.2	29.0	100.0	40.5	96.2	18.0	52.9	32.0	53.3	25.0	53.1
Total Non-Native Graminoid Cover					34.0	100.0	38.0	100.0	38.0	100.0	0.0	0.0	3.0	3.4	1.5	1.7	58.0	100.0	35.0	89.7	40.0	95.2	27.0	93.1	40.0	94.5	2.0	5.9	7.0	11.7	4.5	8.8
Total Native Graminoid Cover					0.0	0.0	0.0	0.0	0.0	0.0	28.0	31.1	24.0	27.3	26.0	28.1	0.0	0.0	0.0	0.0	0.0	0.0	2.0	6.9	0.5	1.7	16.0	47.1	25.0	41.7	20.5	44.4
Total Native Cover					0.0	0.0	0.0	0.0	0.0	0.0	28.0	31.1	25.0	28.4	26.5	28.6	0.0	0.0	1.0	2.6	0.0	0.0	2.0	6.9	0.8	2.4	17.0	50.0	25.0	41.7	21.0	45.8
Total Non-Native Cover					34.0	100.0	38.0	100.0	38.0	100.0	62.0	68.9	63.0	71.6	62.5	70.2	58.0	100.0	38.0	97.4	42.0	100.0	27.0	93.1	41.3	96.4	17.0	50.0	35.0	58.3	26.0	54.2
Total Warm-Season Graminoid Cover					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	6.9	0.5	1.7	0.0	0.0	1.0	1.7	0.5	0.8
Total Cool-Season Graminoid Cover					34.0	100.0	38.0	100.0	36.0	100.0	28.0	31.1	27.0	30.7	27.5	29.8	58.0	100.0	35.0	89.7	40.0	95.2	27.0	93.1	40.0	94.5	18.0	52.9	31.0	51.7	24.5	52.3

Absolute Cover = The percentage of the number of hits on a species out of the total number of hits possible.
Relative Cover = The percentage of the number of hits on a species out of the total number of vegetation hits.
Native Categories: Y = Native, N = Non-Native
Growth Form Categories: F = Forb, G = Graminoid
Cool/Warm Season Categories: C = Cool-Season Graminoid, W = Warm-Season Graminoid
* = Total Foliar Cover Means for a Site do not always add up to 100% because of small rounding errors resulting from the averaging.

Table 6-5. 2004 Revegetation Monitoring Species Richness Summary

Family	Scientific Name	Speccode	Native	B116	B886	Incinerator-Control	Incinerator-Reveg	MST	New Landfill	Solar Ponds
AMARANTHACEAE	Amaranthus albus L.	AMAL2	N				X			
AMARANTHACEAE	Amaranthus retroflexus L.	AMRE1	Y				X			
ASCLEPIADACEAE	Asclepias viridiflora Raf.	ASVI1	Y			X				
ASTERACEAE	Achillea millefolium L. ssp. lanulosa (Nutt.) Piper	ACMI1	Y			X	X			
ASTERACEAE	Ambrosia psilostachya DC.	AMPS1	Y	X	X	X	X	X	X	X
ASTERACEAE	Artemisia campestris L. ssp. caudata (Michx.) Hall & Clem.	ARCA1	Y		X	X				
ASTERACEAE	Artemisia frigida Willd.	ARFR1	Y		X					
ASTERACEAE	Artemisia ludoviciana Nutt. var. ludoviciana	ARLU1	Y			X	X			
ASTERACEAE	Aster falcatus Lindl.	ASFA1	Y			X				
ASTERACEAE	Aster porteri Gray	ASPO1	Y	X		X	X		X	
ASTERACEAE	Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi	CANU1	N		X	X		X	X	X
ASTERACEAE	Centaurea diffusa Lam.	CEDI1	N	X	X	X	X	X	X	X
ASTERACEAE	Chrysopsis fulcrata Greene	CHFU1	Y						X	
ASTERACEAE	Chrysopsis villosa Pursh.	CHVI1	Y						X	
ASTERACEAE	Cirsium arvense (L.) Scop.	CIAR1	N	X	X	X	X		X	X
ASTERACEAE	Conyza canadensis (L.) Cronq.	COCA1	Y			X	X		X	X
ASTERACEAE	Dyssodia papposa (Vent) Hitchc.	DYPA1	N	X			X		X	X
ASTERACEAE	Erigeron divergens T. & G.	ERDI1	Y		X	X				
ASTERACEAE	Erigeron flagellaris A. Gray	ERFL1	Y		X	X				
ASTERACEAE	Grindelia squarrosa (Pursh.) Dun.	GRSQ1	Y	X	X	X	X	X	X	X
ASTERACEAE	Helianthus annuus L.	HEAN1	Y	X	X	X	X	X	X	X
ASTERACEAE	Kuhnia eupatorioides L.	KUEU1	Y			X				
ASTERACEAE	Lactuca serriola L.	LASE1	N	X	X	X	X	X	X	X
ASTERACEAE	Liatris punctata Hook.	LIPU1	Y			X	X		X	
ASTERACEAE	Onopordum acanthium L.	ONAC1	N					X		
ASTERACEAE	Ratibida columnifera (Nutt.) Woot. & Standl.	RACO1	Y	X	X		X			
ASTERACEAE	Scorzonera laciniata L.	SCLA1	N	X			X			
ASTERACEAE	Senecio spartioides T. & G.	SESP1	Y		X	X	X			
ASTERACEAE	Sonchus arvensis L. ssp. arvensis L.	SOAR1	N	X			X		X	
ASTERACEAE	Taraxacum officinale Weber	TAOF1	N	X		X	X		X	X
ASTERACEAE	Tragopogon dubius Scop.	TRDU1	N	X		X	X		X	X
BORAGINACEAE	Cynoglossum officinale L.	CYOF1	N	X			X			
BORAGINACEAE	Lithospermum incisum Lehm.	LIIN1	Y			X	X			
BRASSICACEAE	Alyssum alyssoides (L.) L.	ALAL1	N	X						
BRASSICACEAE	Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley	ALMI1	N	X	X	X	X	X		
BRASSICACEAE	Arabis hirsuta (L.) Scop. var. pynocarpa (Hopkins) Rollins	ARHI1	Y			X				
BRASSICACEAE	Camelina microcarpa Andrz. ex DC.	CAMI1	N		X	X		X		
BRASSICACEAE	Descurainia pinnata (Walt.) Britt.	DEPI1	Y							X
BRASSICACEAE	Descurainia richardsonii (Sweet) Schultz	DERI1	Y		X			X		
BRASSICACEAE	Lepidium campestre (L.) R. Br.	LECA1	N	X					X	
BRASSICACEAE	Lesquerella montana (A. Gray) Wats.	LEMO1	Y			X				
BRASSICACEAE	Sisymbrium altissimum L.	SIAL1	N		X	X	X	X	X	X
BRASSICACEAE	Thlaspi arvense L.	THAR1	N	X						
CACTACEAE	Echinocereus viridiflorus Engelm.	ECVI1	Y			X				
CACTACEAE	Opuntia macrorhiza Engelm.	OPMA1	Y			X	X			
CARYOPHYLLACEAE	Arenaria fendleri A. Gray	ARFE2	Y			X				
CARYOPHYLLACEAE	Silene antirrhina L.	SIAN1	Y	X		X				
CHENOPODIACEAE	Chenopodium album L.	CHAL1	N	X	X	X	X	X		X
CHENOPODIACEAE	Chenopodium botrys L.	CHBO1	N				X		X	
CHENOPODIACEAE	Chenopodium leptophyllum Nutt. ex Moq.	CHLE2	Y	X	X		X		X	
CHENOPODIACEAE	Kochia scoparia (L.) Schrad.	KOSC1	N	X	X		X	X	X	X
CHENOPODIACEAE	Salsola iberica Senn. & Pau.	SAIB1	N	X	X		X	X	X	X
CLUSIACEAE	Hypericum perforatum L.	HYPE1	N		X	X	X			
CONVOLVULACEAE	Convolvulus arvensis L.	COAR1	N	X	X	X				X
CYPERACEAE	Carex heliophila Mack.	CAHE1	Y			X				
CYPERACEAE	Carex praegracilis W. Boott.	CAPR1	Y			X				
EUPHORBIACEAE	Euphorbia dentata Michx.	EUDE1	Y	X		X	X			
EUPHORBIACEAE	Euphorbia marginata Pursh.	EUMA1	Y	X						
EUPHORBIACEAE	Euphorbia serpyllifolia Pers.	EUSE1	Y						X	
FABACEAE	Dalea purpurea Vent	DAPU1	Y			X	X			
FABACEAE	Glycyrrhiza lepidota Pursh.	GLLE1	Y			X				

Table 6-5. cont.

Family	Scientific Name	Speccode	Native	B116	B886	Incinerator-Control	Incinerator-Reveg	MST	New Landfill	Solar Ponds
FABACEAE	Medicago lupulina L.	MELU1	N	X	X					X
FABACEAE	Medicago sativa L. ssp. sativa	MESA1	N				X	X		X
FABACEAE	Melilotus alba Medic.	MEAL1	N		X			X		X
FABACEAE	Melilotus officinalis (L.) Pall.	MEOF1	N	X	X	X	X	X	X	X
FABACEAE	Psoralea tenuiflora Pursh.	PSTE1	Y			X	X			
FABACEAE	Trifolium pratense L.	TRPR1	N	X						
GERANIACEAE	Erodium cicutarium (L.) L'Her.	ERCI1	N	X	X	X	X	X		X
LAMIACEAE	Lycopus americanus Muhl. ex Barton	LYAM1	Y			X				
LAMIACEAE	Marrubium vulgare L.	MAVU1	N			X	X			
LAMIACEAE	Nepeta cataria L.	NECA1	N		X					
LAMIACEAE	Salvia reflexa Hornem.	SARE1	Y						X	
LILIACEAE	Allium textile A. Nels. & Macbr.	ALTE1	Y			X				
LINACEAE	Linum perenne L. var. lewisii (Pursh.) Eat. & Wright	LIPE1	Y		X		X			
MALVACEAE	Malva neglecta Wallr.	MANE1	N		X					
NYCTAGINACEAE	Mirabilis linearis (Pursh.) Heimerl	MILI1	Y			X	X			
NYCTAGINACEAE	Mirabilis nyctaginea (Michx.) MacM.	MINY1	Y	X						
ONAGRACEAE	Oenothera villosa Thunb. ssp. strigosa (Rydb.) Dietrich & Raven	OEVI1	Y	X						
PAPAVERACEAE	Argemone polyanthemos (Fedde) G. Ownbey	ARPO1	Y				X			
PLANTAGINACE	Plantago lanceolata L.	PLLA1	N	X	X		X			
PLANTAGINACE	Plantago patagonica Jacq.	PLPA1	Y	X						X
POACEAE	Aegilops cylindrica Host	AECY1	N				X			
POACEAE	Agropyron caninum (L.) Beauv. ssp. majus (Vasey) C. L. Hitchc.	AGCA1	Y	X	X		X	X	X	X
POACEAE	Agropyron cristatum (L.) Gaertn.	AGCR1	N		X			X		
POACEAE	Agropyron intermedium (Host) Beauv.	AGIN1	N			X		X		
POACEAE	Agropyron smithii Rydb.	AGSM1	Y	X	X	X	X	X	X	X
POACEAE	Andropogon gerardii Vitman	ANGE1	Y			X	X		X	X
POACEAE	Andropogon scoparius Michx.	ANSC1	Y			X	X		X	
POACEAE	Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr	ARLO1	Y	X		X	X			
POACEAE	Avena fatua var. sativa (L.) Hausskn.	AVFA1	N	X			X			
POACEAE	Bouteloua curtipendula (Michx.) Torr.	BOCU1	Y	X		X			X	X
POACEAE	Bouteloua gracilis (H. B. K.) Lag ex Griffiths	BOGR1	Y	X		X	X			
POACEAE	Bouteloua hirsuta Lag	BOHI1	Y			X				
POACEAE	Bromus inermis Leyss. ssp. inermis	BRIN1	N		X	X		X		X
POACEAE	Bromus japonicus Thunb. ex Murr.	BRJA1	N	X	X	X	X		X	
POACEAE	Bromus tectorum L.	BRTE1	N	X	X	X	X	X	X	X
POACEAE	Buchloe dactyloides (Nutt.) Engelm.	BUDA1	Y	X	X	X	X	X	X	X
POACEAE	Echinochloa crusgallii (L.) Beauv.	ECCR1	N	X			X			
POACEAE	Elymus canadensis L.	ELCA1	Y	X						
POACEAE	Festuca ovina L. var. rydbergii St. Yves	FEOV1	Y			X				
POACEAE	Festuca pratensis Huds.	FEPR1	Y	X			X			
POACEAE	Hordeum jubatum L.	HOJU1	Y	X	X		X			X
POACEAE	Koeleria pyramidata (Lam.) Beauv.	KOPY1	Y			X				
POACEAE	Lolium perenne L. var. perenne	LOPE2	N	X						
POACEAE	Muhlenbergia montana (Nutt.) Hitchc.	MUMO1	Y			X	X			
POACEAE	Panicum capillare L.	PACA1	Y	X			X		X	X
POACEAE	Panicum dichotomiflorum Michx.	PADI1	N	X						
POACEAE	Phleum pratense L.	PHPR1	N	X						
POACEAE	Poa compressa L.	POCO1	N	X		X	X	X	X	
POACEAE	Poa pratensis L.	POPR1	N			X		X		
POACEAE	Secale cereale L.	SECE1	N						X	X
POACEAE	Setaria viridis (L.) Beauv.	SEVI1	N	X			X		X	X
POACEAE	Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc.	SIHY1	Y		X	X				
POACEAE	Sporobolus asper (Michx.) Kunth	SPAS1	Y			X	X			
POACEAE	Sporobolus cryptandrus (Torr.) A. Gray	SPCR1	Y					X		
POACEAE	Sporobolus neglectus Nash	SPNE1	Y	X						
POACEAE	Stipa comata Trin. & Rupr.	STCO1	Y			X				
POACEAE	Stipa viridula Trin.	STVI1	Y	X				X		X
POACEAE	Triticum aestivum L.	TRAE1	N						X	X
POLYGONACEAE	Polygonum arenastrum Jord. ex Bor.	POAR1	N	X	X		X	X	X	X
POLYGONACEAE	Polygonum convolvulus L.	POCO2	N	X			X			
POLYGONACEAE	Polygonum ramosissimum Michx.	PORA1	Y	X			X	X		

Table 6-5. cont.

Family	Scientific Name	Speccode	Native	B116	B886	Incinerator-Control	Incinerator-Reveg	MST	New Landfill	Solar Ponds
POLYGONACEAE	Rumex acetosella L.	RUAC1	N					X		
POLYGONACEAE	Rumex crispus L.	RUCR1	N	X	X					
PORTULACACEAE	Talinum parviflorum Nutt.	TAPA1	Y			X				
ROSACEAE	Potentilla gracilis Dougl. ex Hook. var. glabrata (Lehm.) C. L. Hitchc.	POGR1	Y			X				
SCROPHULARIACEAE	Castilleja sessiliflora Pursh.	CASE3	Y			X				
SCROPHULARIACEAE	Linaria dalmatica (L.) Mill.	LIDA1	N				X			
SCROPHULARIACEAE	Verbascum blattaria L.	VEBL1	N		X			X		
SCROPHULARIACEAE	Verbascum thapsus L.	VETH1	N	X	X	X	X			X
SOLANACEAE	Physalis heterophylla Nees	PHHE2	Y				X			
SOLANACEAE	Solanum rostratum Dun.	SORO1	Y	X			X			
VERBENACEAE	Lippia cuneifolia (Torr.) Steud.	LICU1	Y			X	X			
VERBENACEAE	Verbena bracteata Lag. & Rodr.	VEBR1	Y	X	X		X	X	X	X
	Unknown species	UNKN					X		X	
		Total # Species		62	45	71	71	34	41	39
		Percent Native Species		44	40	69	53	32	48	38
		# Seeded Species Present		5	2	-	5	4	5	5

Table 6-6. 2004 Revegetation Monitoring Ground Cover (Basal Cover) Summary

Ground Cover Type	B116	B866	Incinerator-Control	Incinerator-Reveg	MST	New Landfill	Solar Ponds
Bare Ground (%)	16.0	27.5	6.3	10.7	34.0	17.3	28.5
Litter (%)	51.0	61.0	72.3	61.3	50.7	50.0	61.3
Rock (%)	31.0	5.5	17.7	25.7	4.0	31.8	8.7
Basal Vegetation Cover (%)	2.0	6.0	3.7	2.3	11.3	1.0	1.5
Total Rock, Litter, and Vegetation (%)	84.0	72.5	93.7	89.3	66.0	82.8	71.5
Total Cover (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 6-7. 2004 Revegetation Monitoring Foliar Cover Summary

				Location	B116		B866		Incinerator-Control		Incinerator-Reveg		MST		New Landfill		Solar Ponds	
Scientific Name	Speccode	Growth Form	Native	Cool/ Warm Season	Absolute Cover	Relative Cover	Absolute Cover	Relative Cover	Absolute Cover	Relative Cover	Absolute Cover	Relative Cover	Absolute Cover	Relative Cover	Absolute Cover	Relative Cover	Absolute Cover	Relative Cover
Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley	ALMI1	F	N				2.0	2.3	2.7	3.4	0.3	0.8						
Centaurea diffusa Lam.	CEDI1	F	N				26.5	30.8	0.3	0.4	4.0	9.2	2.0	2.2	0.5	4.3	4.2	7.1
Chenopodium album L.	CHAL1	F	N										4.3	4.8				
Cirsium arvense (L.) Scop.	CIAR1	F	N		0.5	1.6			2.0	2.6							0.3	0.6
Convolvulus arvensis L.	COAR1	F	N						8.3	10.8								
Erodium cicutarium (L.) L'Her.	ERCI1	F	N		0.5	1.6	0.5	0.6	0.3	0.4	0.3	0.8						
Hypericum perforatum L.	HYPE1	F	N						0.3	0.4								
Kochia scoparia (L.) Schrad.	KOSC1	F	N		1.0	3.2	2.5	2.9			0.3	0.8	47.7	53.0			3.7	6.3
Lactuca serriola L.	LASE1	F	N				0.5	0.6	0.7	0.9	1.7	3.8			1.3	10.6	1.7	2.8
Medicago lupulina L.	MELU1	F	N		0.5	1.6												
Melilotus alba Medic.	MEAL1	F	N														2.3	4.0
Melilotus officinalis (L.) Pall.	MEOF1	F	N		2.5	8.1	1.5	1.7	0.7	0.9	8.0	18.3	1.3	1.5	1.0	8.5	29.3	50.0
Polygonum arenastrum Jord. ex Bor.	POAR1	F	N		4.0	12.9							2.3	2.6	1.0	8.5	0.2	0.3
Salsola iberica Senn. & Pau.	SAIB1	F	N								0.3	0.8	3.7	4.1	1.3	10.6		
Scorzonera laciniata L.	SCLA1	F	N		0.5	1.6					0.3	0.8						
Sisymbrium altissimum L.	SIAL1	F	N						0.3	0.4	0.3	0.8						
Tragopogon dubius Scop.	TRDU1	F	N								0.3	0.8			0.8	6.4		
Triticum aestivum L.	TRAE1	F	N												0.3	2.1		
Verbascum thapsus L.	VETH1	F	N						0.3	0.4								
Achillea millefolium L. ssp. lanulosa (Nutt.) Piper	ACMI1	F	Y								0.3	0.8						
Ambrosia psilostachya DC.	AMPS1	F	Y				4.0	4.7	0.7	0.9	3.0	6.9	1.3	1.5				
Artemisia frigida Willd.	ARFR1	F	Y				0.5	0.6										
Aster porteri Gray	ASPO1	F	Y						3.7	4.7								
Descurainia richardsonii (Sweet) Schultz	DERI1	F	Y										1.7	1.9				
Erigeron flagellaris A. Gray	ERFL1	F	Y				0.5	0.6	3.7	4.7								
Grindelia squarrosa (Pursh.) Dun.	GRSQ1	F	Y				6.0	7.0					1.0	1.1			0.8	1.4
Helianthus annuus L.	HEAN1	F	Y								1.0	2.3					0.2	0.3
Listris punctata Hook.	LIPU1	F	Y						0.3	0.4								
Linum perenne L. var. lewisii (Pursh.) Eat. & Wright	LIPE1	F	Y				7.0	8.1										
Lippia cuneifolia (Torr.) Steud.	LICU1	F	Y						0.3	0.4								
Lithospermum incisum Lehm.	LIIN1	F	Y						0.3	0.4								
Physalis heterophylla Nees	PHHE2	F	Y								0.3	0.8						
Psoralea tenuiflora Pursh.	PSTE1	F	Y						1.3	1.7	1.0	2.3						
Ratibida columnifera (Nutt.) Woot. & Standl.	RACO1	F	Y								0.3	0.8						
Verbena bracteata Lag. & Rodr.	VEBR1	F	Y		1.5	4.8	1.5	1.7			0.3	0.8					0.2	0.3
Aegilops cylindrica Host	AECY1	G	N	C							0.3	0.8						
Agropyron cristatum (L.) Gaertn.	AGCR1	G	N	C			1.0	1.2										
Agropyron intermedium (Host) Beauv.	AGIN1	G	N	C					0.7	0.9								
Bromus inermis Leyss. ssp. inermis	BRIN1	G	N	C					1.0	1.3								
Bromus japonicus Thunb. ex Murr.	BRJA1	G	N	C			10.5	12.2	3.7	4.7	0.7	1.5						
Bromus tectorum L.	BRTE1	G	N	C	1.5	4.8	3.5	4.1	7.0	9.1	3.3	7.6	0.7	0.7			0.3	0.6
Lolium perenne L. var. perenne	LOPE2	G	N	C	2.0	6.5												
Poa compressa L.	POCO1	G	N	C					7.7	9.9								
Poa pratensis L.	POPR1	G	N	C					2.3	3.0								
Secale cereale L.	SECE1	G	N	C													0.2	0.3
Panicum dichotomiflorum Michx.	PADI1	G	N	W	0.5	1.6												
Setaria viridis (L.) Beauv.	SEVI1	G	N	W	0.5	1.6					0.3	0.8						
Agropyron caninum (L.) Beauv. ssp. majus (Vasey) C. L. Hitchc.	AGCA1	G	Y	C	10.5	33.9	11.5	13.4			5.7	13.0	14.3	15.9	5.5	46.8	12.8	21.9
Agropyron smithii Rydb.	AGSM1	G	Y	C			4.5	5.2	8.7	11.2	1.0	2.3	7.0	7.8	0.3	2.1	2.2	3.7
Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr	ARLO1	G	Y	C					1.7	2.2								
Carex heliophila Mack.	CAHE1	G	Y	C					0.3	0.4								
Festuca pratensis Huds.	FEPR1	G	Y	C	1.5	4.8												
Koeleria pyramidata (Lam.) Beauv.	KOPY1	G	Y	C					0.3	0.4								
Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc.	SIHY1	G	Y	C			2.0	2.3										
Stipa comata Trin. & Rupr.	STCO1	G	Y	C					2.0	2.6								
Stipa viridula Trin.	STVI1	G	Y	C	0.5	1.6							2.3	2.6				
Andropogon gerardii Vitman	ANGE1	G	Y	W					7.3	9.5								
Bouteloua curtipendula (Michx.) Torr.	BOCU1	G	Y	W					0.3	0.4								
Bouteloua gracilis (H. B. K.) Lag ex Griffiths	BOGR1	G	Y	W					0.7	0.9								
Buchloe dactyloides (Nutt.) Engelm.	BUDA1	G	Y	W	1.0	3.2					1.3	3.1	0.3	0.4			0.3	0.6
Muhlenbergia montana (Nutt.) Hitchc.	MUMO1	G	Y	W					7.3	9.5								
Panicum capillare L.	PACA1	G	Y	W	1.5	4.8					8.7	19.8						
Sporobolus neglectus Nash	SPNE1	G	Y	W	0.5	1.6												
Total Foliar Cover					31.0	100.0	86.0	100.0	77.3	100.0	43.7	100.0	90.0	100.0	11.8	100.0	58.7	100.0
Total Native Cover					17.0	54.8	37.5	43.6	39.0	50.4	23.0	52.7	28.0	31.1	5.8	48.9	16.5	28.1
Total Non-Native Cover					14.0	45.2	48.5	56.4	38.3	49.6	20.7	47.3	62.0	68.9	6.0	51.1	42.2	71.9
Total Forb Cover					11.0	35.5	53.0	61.6	26.3	34.1	22.3	51.1	65.3	72.6	6.0	51.1	42.8	73.0
Total Native Forb Cover					1.5	4.8	19.5	22.7	10.3	13.4	6.3	14.5	4.0	4.4	0.0	0.0	1.2	2.0
Total Non-Native Forb Cover					9.5	30.6	33.5	39.0	16.0	20.7	16.0	36.6	61.3	68.1	6.0	51.1	41.7	71.0
Total Graminoid Cover					20.0	64.5	33.0	38.4	51.0	65.9	21.3	48.9	24.7	27.4	5.8	48.9	15.8	27.0
Total Native Graminoid Cover					15.5	50.0	18.0	20.9	28.7	37.1	16.7	38.2	24.0	26.7	5.8	48.9	15.3	26.1
Total Non-Native Graminoid Cover					4.5	14.5	15.0	17.4	22.3	28.9	4.7	10.7	0.7	0.7	0.0	0.0	0.5	0.9
Total Cool-Season Graminoid Cover					16.0	51.6	33.0	38.4	35.3	45.7	11.0	25.2	24.3	27.0	5.8	48.9	15.5	26.4
Total Warm-Season Graminoid Cover					4.0	12.9	0.0	0.0	15.7	20.3	10.3	23.7	0.3	0.4	0.0	0.0	0.3	0.6

Table 6-8. Success Criteria Summary for Revegetation Locations in 2004

Location	30% Relative Cover of Desired Species	70% Ground Cover of Litter, Rock, and Vegetation	Minimum of 50% of Seeded Species Present	No Single Species With >45% Relative Cover	Overall Pass/Fail
B116	Fail	Pass	Pass	Pass	Fail
B886	Pass	Pass	Fail	Pass	Fail
Incinerator (Reveg)	Fail	Pass	Pass	Pass	Fail
MST	Pass	Fail	Fail	Fail	Fail
New Landfill	Pass	Pass	Pass	Fail	Fail
Solar Ponds	Fail	Pass	Fail	Fail	Fail

Success criteria from Revegetation Plan (K-H, 2004b)

7. Boreal Chorus Frog Vocalization Monitoring

7.1 Introduction

As a taxonomic group, the frogs and toads at the Site are only occasionally recorded during normal wildlife monitoring. Until vocalization monitoring was instituted at the Site in 1998, most observations of amphibians had been fortuitous. Although normal wildlife monitoring provided an annual presence/absence record for these species at the Site, the lack of a repeatable monitoring methodology precluded the ability to effectively track population abundance or the distribution of these species on Site. Because such information can provide additional insight and act as an additional tool for detecting changes in the health of the Site aquatic ecosystems, monitoring for these species was instituted. Amphibians are an important group to track because their semi-aquatic nature makes them particularly sensitive to aquatic impacts (Blaustein 1995). The boreal chorus frog (*Pseudacris triseriatus*) was chosen as the best candidate for vocalization monitoring at the Site after the initial year of data collection in 1998. This species can also serve as an indicator species for tracking general amphibian population abundance on Site.

7.2 Methods

The methods used for the amphibian vocalization surveys in 2004 generally followed the guidelines provided in Mossman et al. (1998). Additional information used for the surveys was taken from the Wisconsin Department of Natural Resources (Mossman and Hine 1984, 1985) and the National Biological Survey (NBS 1997). Some modification of these guidelines was necessary to adapt the surveys for use at the Site.

A total of 20 locations were sampled for species presence/absence and population abundance in 2004 (Figure 7-1). This approach followed the modifications of the protocol implemented in 1999 (K-H 2000). The 20 locations were divided almost evenly between the north and south Buffer Zone areas (using the east and west access roads as the dividing line between north and south). Eleven sites were in the north Buffer Zone and nine were in the south Buffer Zone. Monitoring at all locations was conducted in one night, starting at dusk. In 2004, the vocalization surveys for all monitoring locations were conducted on April 26th.

After arriving at each sample location, the vehicle engine was shut off, and the observer exited the vehicle and waited for approximately one minute before beginning the survey. The waiting period provided time of adjustment for the frogs to become accustomed to the observer. After the one-minute period, the observer listened to vocalizations for approximately three minutes. Vocalizations were categorized using one of the following vocalization indices:

0 = No calling heard

1 = Individuals can be counted; calls not overlapping, there is space between calls

2 = Calls of individuals are distinguishable but some calls overlap

3 = Full chorus; numerous frogs can be heard; calls are constant, continuous, and overlapping.

Additional information recorded at each survey location included: air temperature (°C), water temperature (°C, where feasible), wind speed, cloud cover, precipitation, and noise interference.

7.3 Results and Discussion

Boreal chorus frogs were recorded at 16 of the 20 (80%) sample locations surveyed in 2004. Figure 7-2 shows the frequency of the different vocalization indices at all 20 locations sampled in 2004. Twelve (75%) of the locations sampled had full choruses of frogs calling (vocalization index 3). Two (10%) sampling locations had multiple individuals calling with overlaps between the calls (vocalization index 2). Two (10%) had a vocalization index of 1, where individuals could be counted but the calls were not overlapping. The remaining four (20%) had no calling (vocalization index 0).

On the evening when sampling was conducted, the average water and air temperature (°C) was 12.3° and 11.6°, respectively. No precipitation occurred on the day when sampling was conducted and the mean cloud cover was approximately 7%.

To compare data between years, data from only the locations that were sampled during all six years were used. This restricted the number of sites that could be compared to 16 locations (Table 7-1). The average vocalization index in 2004 was higher than the average from all six years (2.0). The 2004 average vocalization index of 2.3 was higher than the average vocalization index from 2003. In 2003, the vocalization index was 1.4, which was the lowest number since this study was initiated in 1998. Compared to individual survey location data collected in 2003, the vocalization index in 2004 was higher at most sites. Out of the sixteen sites, only two sites (15 and 16) in 2004 had a vocalization index that was lower than in 2003.

In 2004 the vocalization index at site 15 (D-1 Pond) was 0. The D-1 pond remained empty and dry for the majority of the year in 2004 because the dam outlet was open. In 2003 however, the pond held water for most of the year and the vocalization index at this site was 3, the highest since the study began. These results suggest that even though there was more precipitation in 2004, water availability due to pond management had a greater effect on frog populations at this location.

The average frog vocalization index seems to closely follow the total annual precipitation at the site (Figure 7-3). The annual peaks in the frog vocalization indices correlate with the peaks in annual total precipitation. Data was not collected in 2002 (drought year) therefore the direct effects from the drought were not documented. However, the low average vocalization index in 2003 indicates that the 2002 drought probably had a lingering negative effect on frog abundance on Site. The 2004 average vocalization index was about the same as the one in 2001, which suggests the frog population has recovered and stabilized from the 2002 drought. In general, the higher than average chorus frog abundance in 2004, suggests the aquatic ecosystem remains healthy at the Site.

7.4 Conclusions

The results of the 2004 frog vocalization survey showed a higher than average abundance of chorus frogs at the Site during 2004. In 2003, the frog abundance was the lowest it has been since the surveys began in 1998. The 2002 drought may have been a factor contributing to the low boreal chorus frog abundance in 2003. The 2004 survey results show that the frog populations survived, and have rebounded from the effects of the 2002 drought. The presence of the boreal chorus frogs at the Site, even after drought years, provides evidence of the resilience of this amphibian species. It is also evidence of a healthy aquatic ecosystem at the Site.

7.5 References

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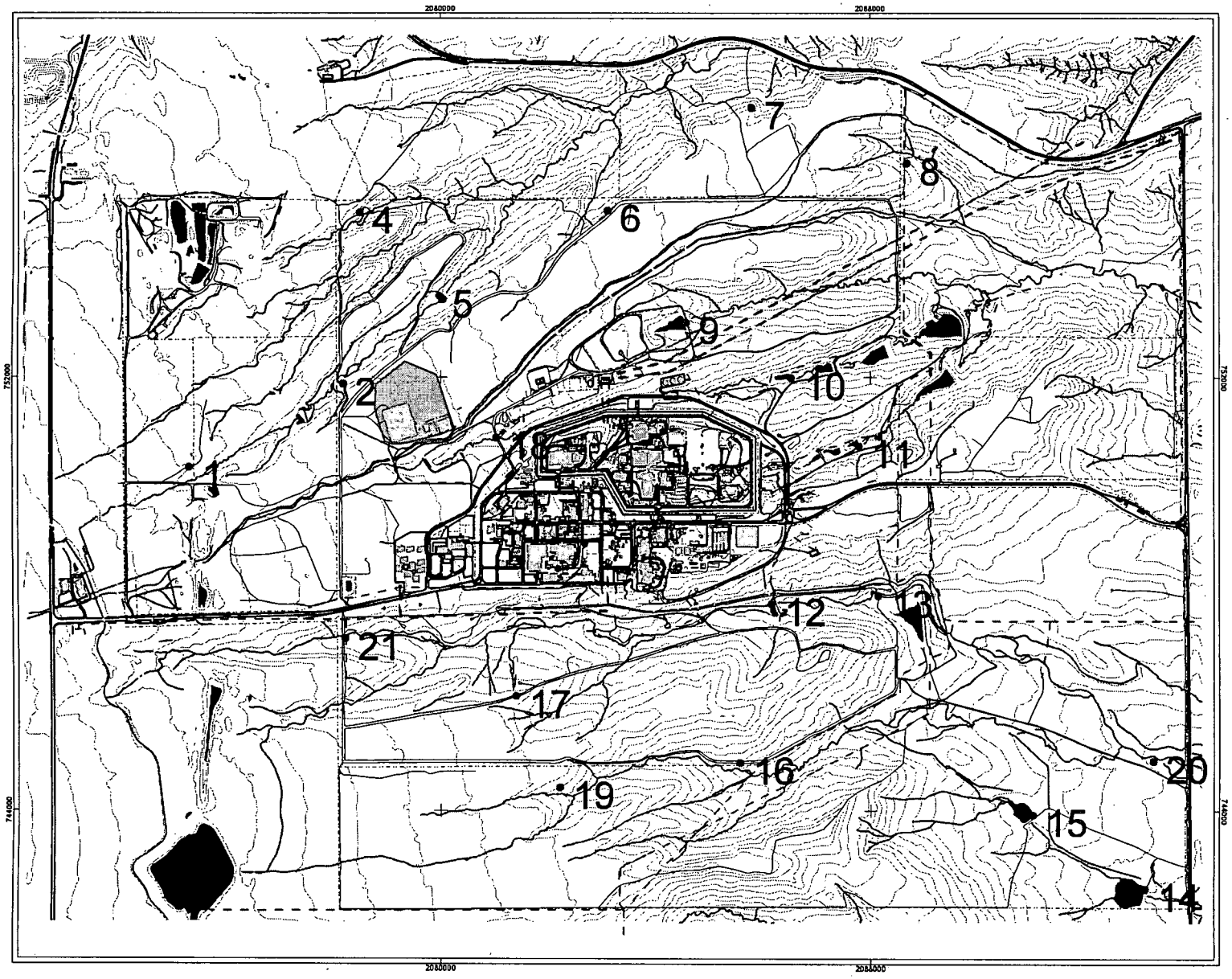


2003 Boreal Chorus Frog Monitoring Locations

Figure 1

LEGEND

● Boreal Chorus Frog Monitoring Locations

Standard Features

- Buildings
- Lakes & ponds
- Landfill
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)
- Power Lines

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

Data Source Ecology Features:
Location data provided by LABAT
Locations are approximate.
K-H Ecology Group POC: Karan North 303-966-9876.

N

1:23675

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: LABAT

For: Kaiser-Hill Company, LLC

RFETS GIS Dept. 303-966-7707

MAP ID: 01-0458

April 4, 2003

Figure 7-2. 2004 Boreal Chorus Frog Vocalization Results. Frequency of vocalization indices from all 20 sites sampled in 2004.

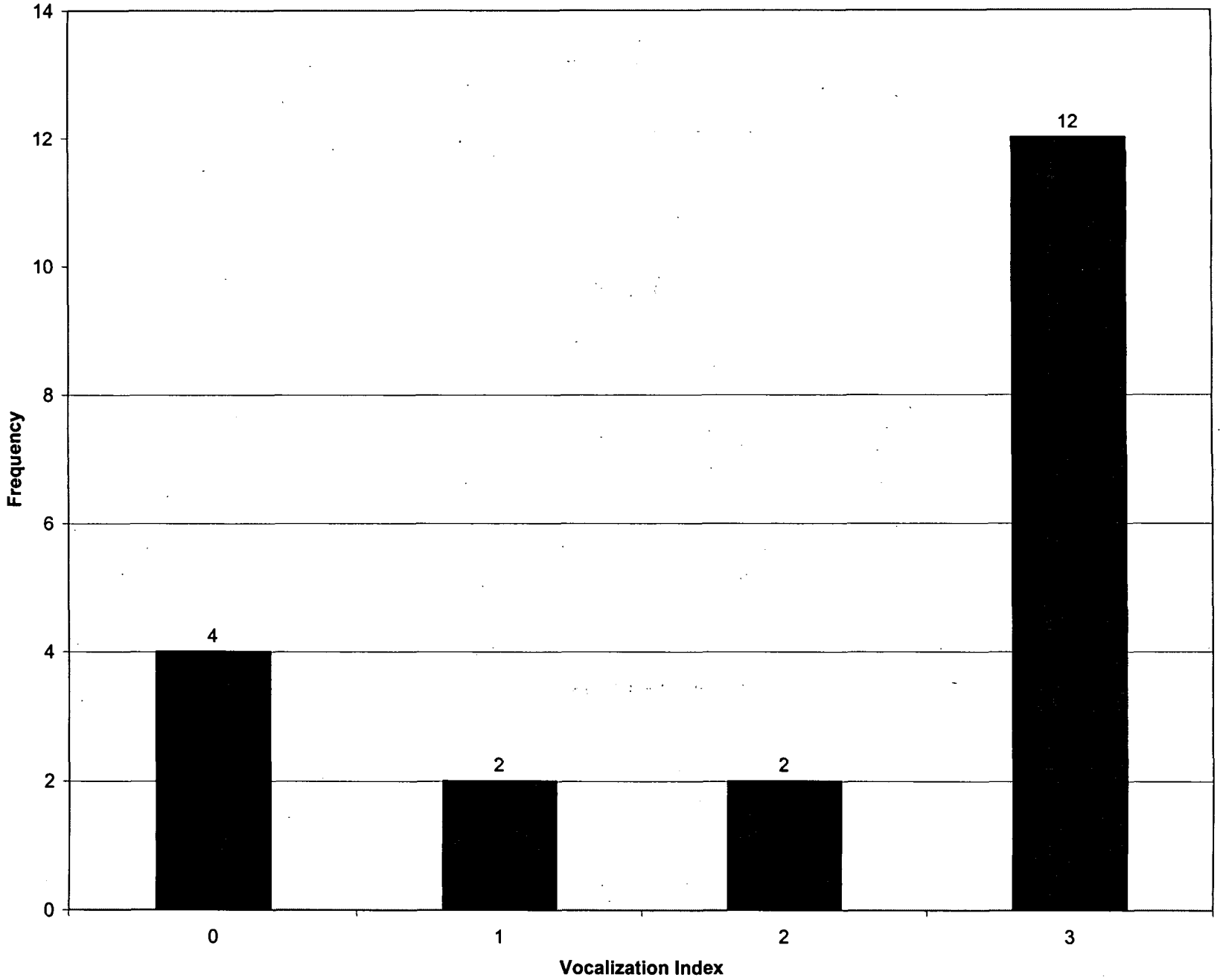


Figure 7-3. Yearly Average Precipitation and Average Frog Vocalization Index from 1998 to 2004.

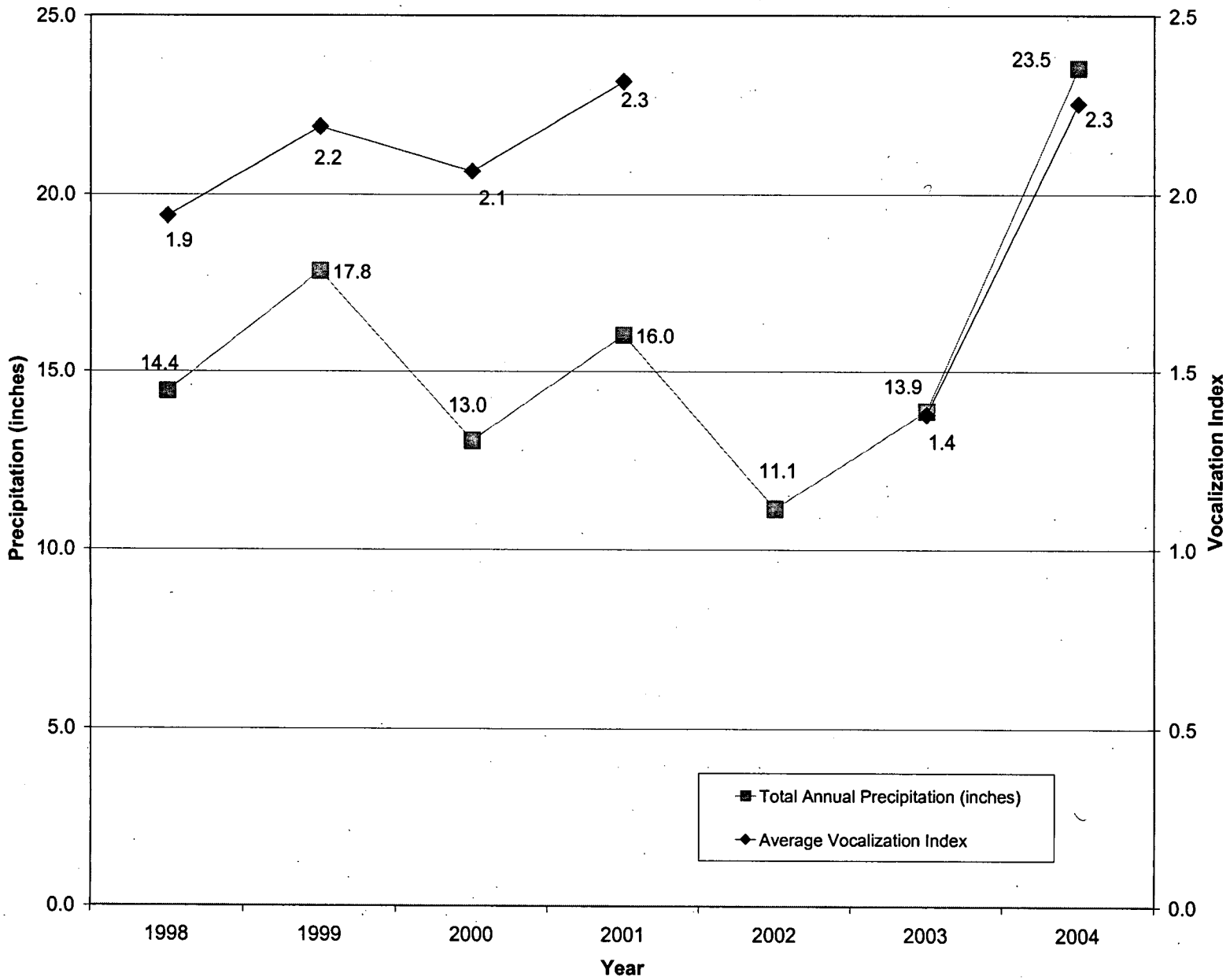


Table 7-1. Boreal Chorus Frog Vocalization Indices Data (1998-2004)

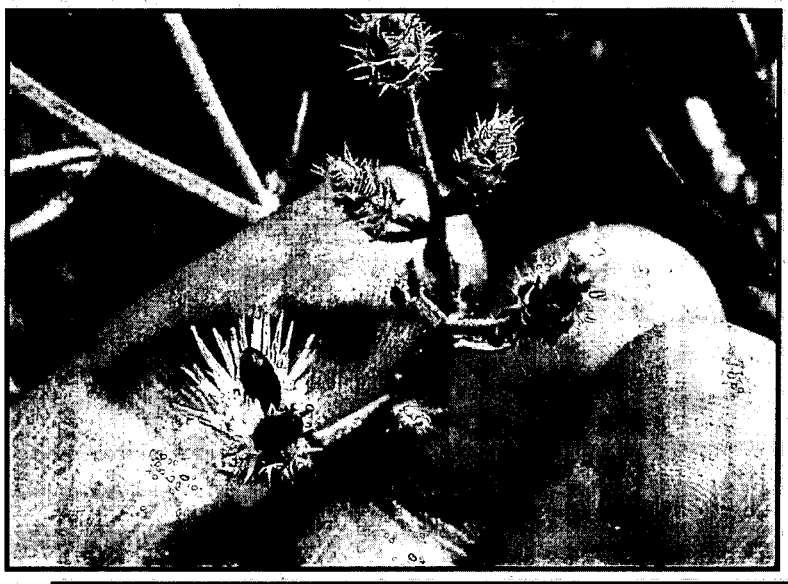
Site	1998	1999	2000	2001	2003	2004	Average
1	3	3	2	1	1	3	2.2
2	3	3	2	3	2	2	2.5
3	3	N/A	N/A	N/A	N/A	N/A	N/A
4	2	3	2	3	0	1	1.8
5	3	3	3	3	0	3	2.5
6	3	3	2	2	2	3	2.5
7	3	3	2	3	0	3	2.3
8	N/A	3	3	2	0	3	N/A
9	1	2	2	2	0	1	1.3
10	3	3	3	3	3	3	3.0
11	3	3	1	3	1	3	2.3
12	0	0	3	1	2	3	1.5
13	3	3	3	3	3	3	3.0
14	2	3	3	3	2	3	2.7
15	0	0	2	2	3	0	1.2
16	0	0	1	3	1	0	0.8
17	1	0	0	1	0	2	0.7
18	1	3	2	1	2	3	2.0
19	N/A	2	3	2	1	0	N/A
20	N/A	2	3	3	0	3	N/A
21	N/A	0	1	1	0	0	N/A
Overall Average	**1.9**	**2.2**	**2.1**	**2.3**	**1.4**	**2.3**	**2.0**

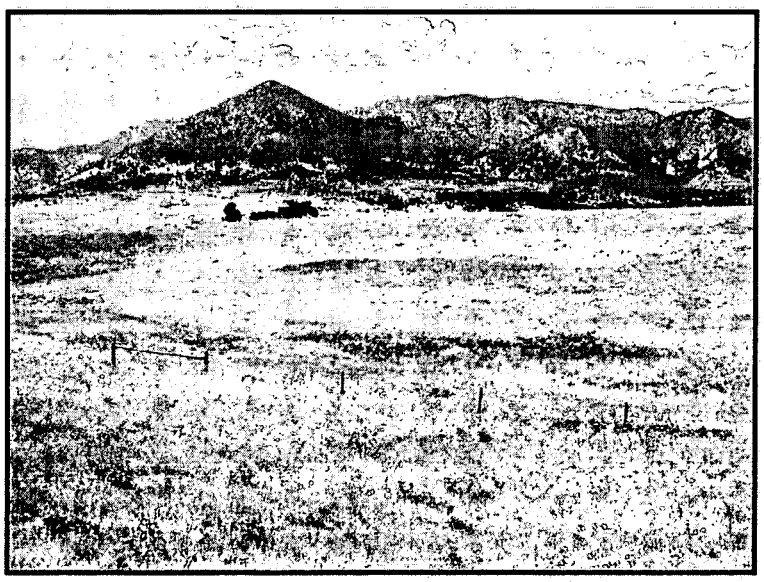
Note: Averages were calculated using data only from locations where data was collected all six years. Site 3, 8, 19, 20, 21 are excluded from the Overall Average calculation.

Appendix B

Diffuse Knapweed Biocontrol Photo Monitoring

In 2001, a photographic monitoring study was designed to evaluate the effectiveness of *Larinus minutus* biocontrol releases on diffuse knapweed infestations at the Rocky Flats Environmental Technology Site. The map below shows the location for each release site at Rocky Flats. By clicking on one of the links below you can see the photographs of the diffuse knapweed infestations at each release location. Comparisons of the time-series photographs show visually how effective the biocontrol insects have been at reducing the overall diffuse knapweed populations at these locations.

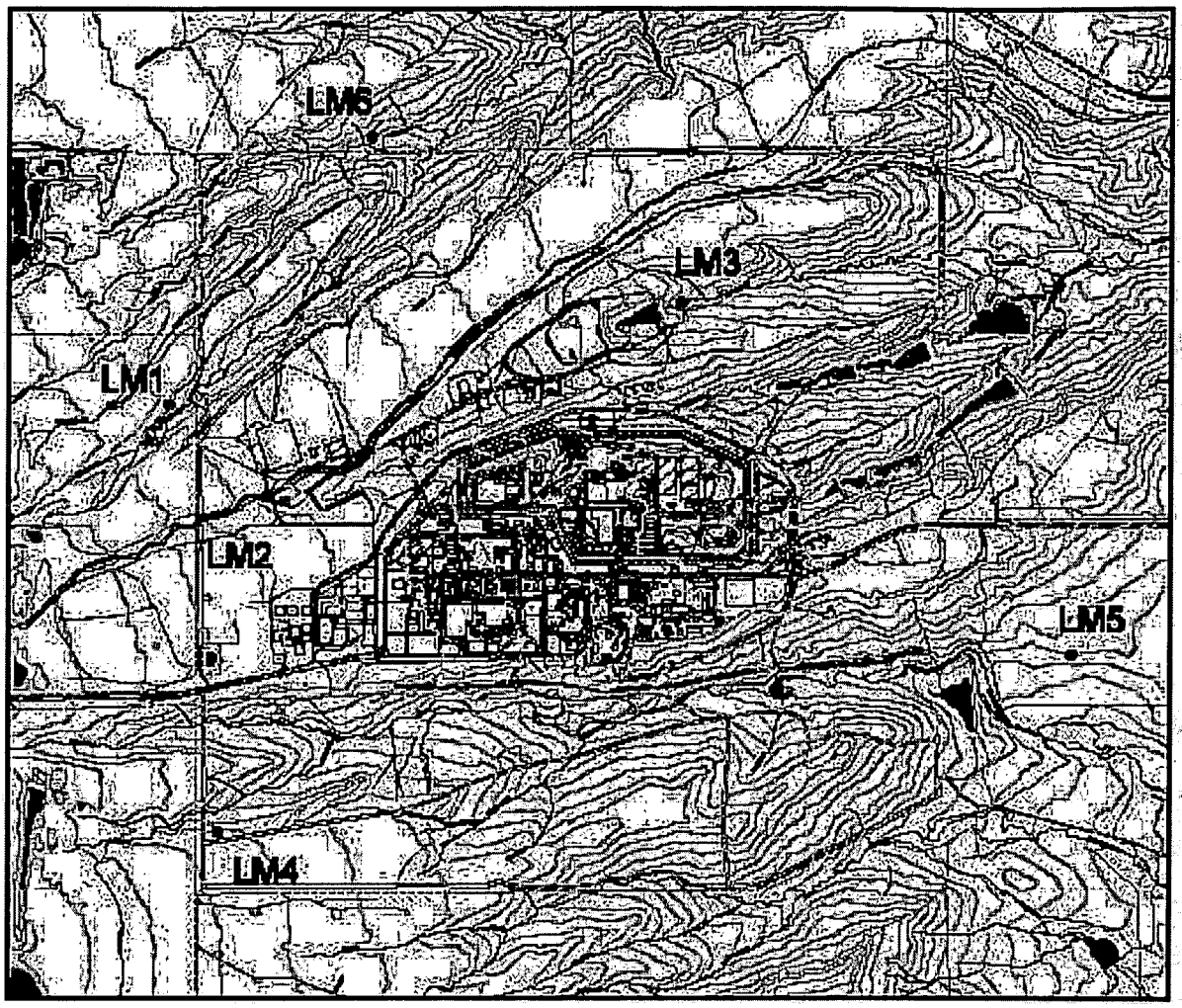




Sites

LM1 **LM2** **LM3** **LM4** **LM5**

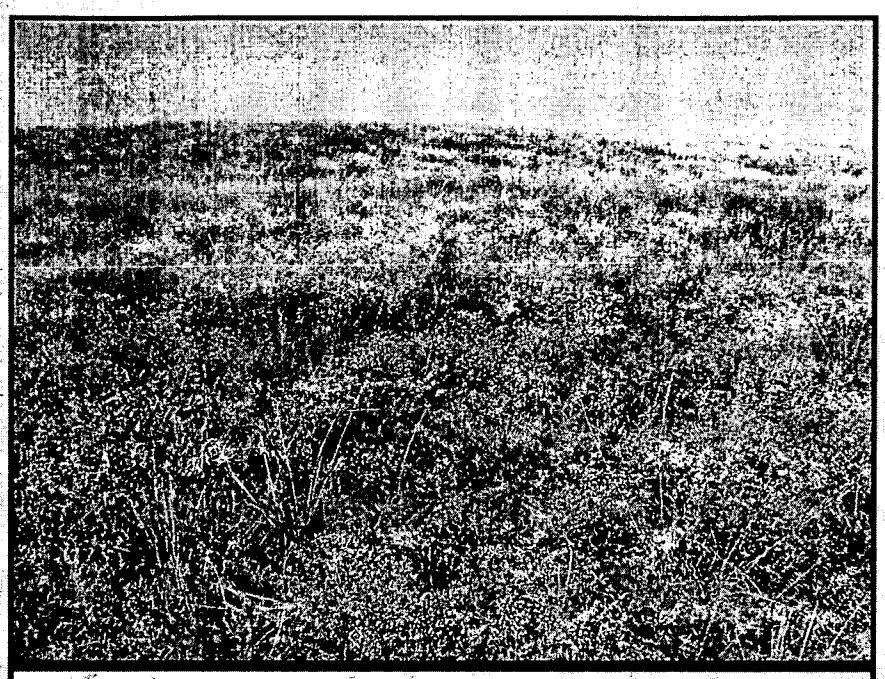
LM6



Site LM1

North

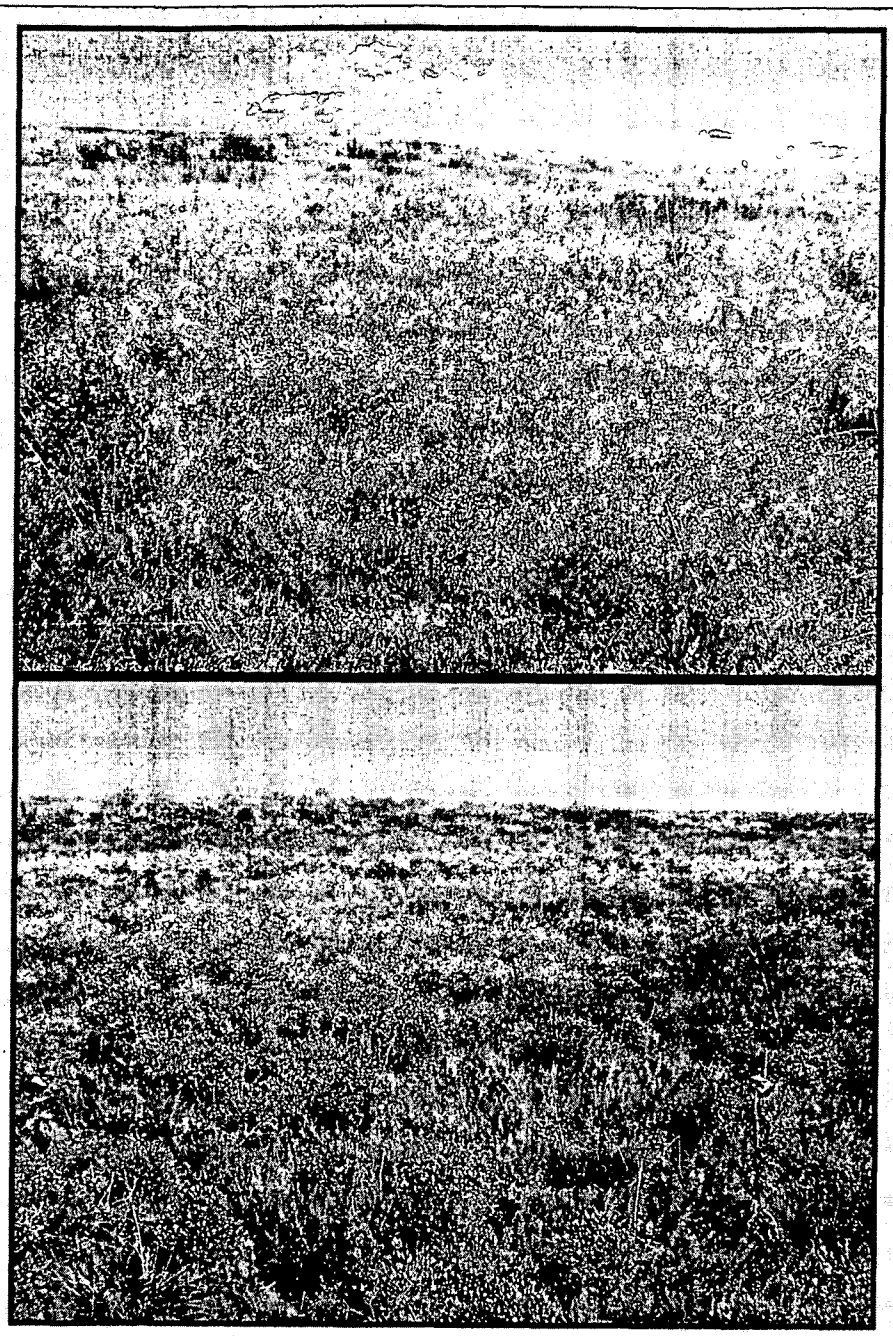
2001



2002

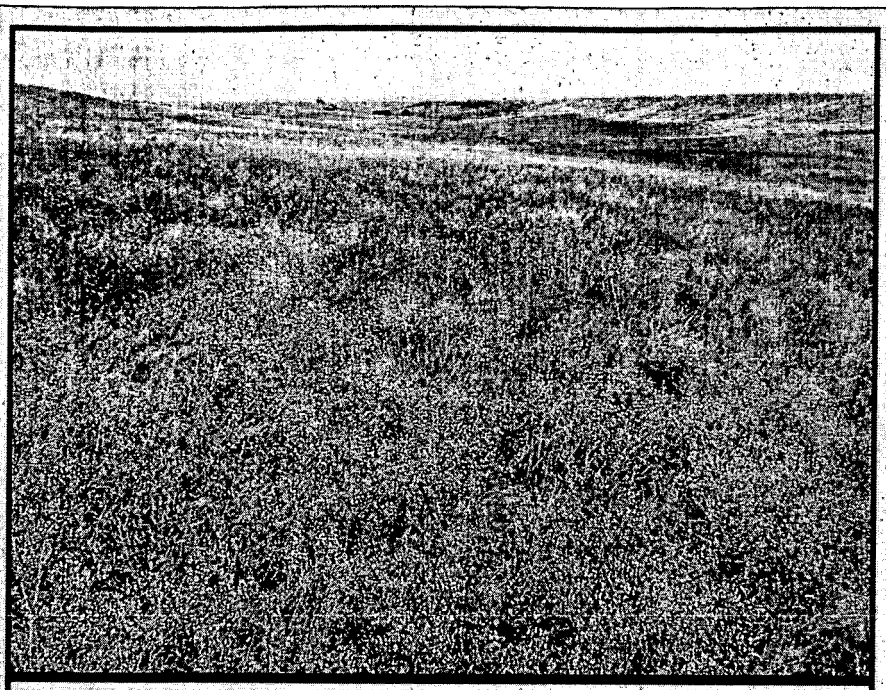
2003

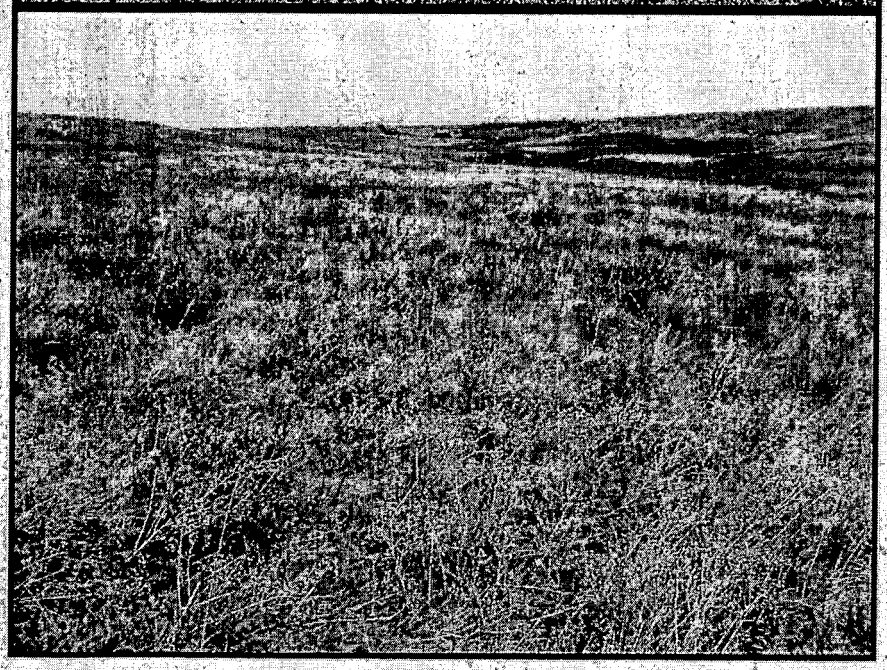
2004



East

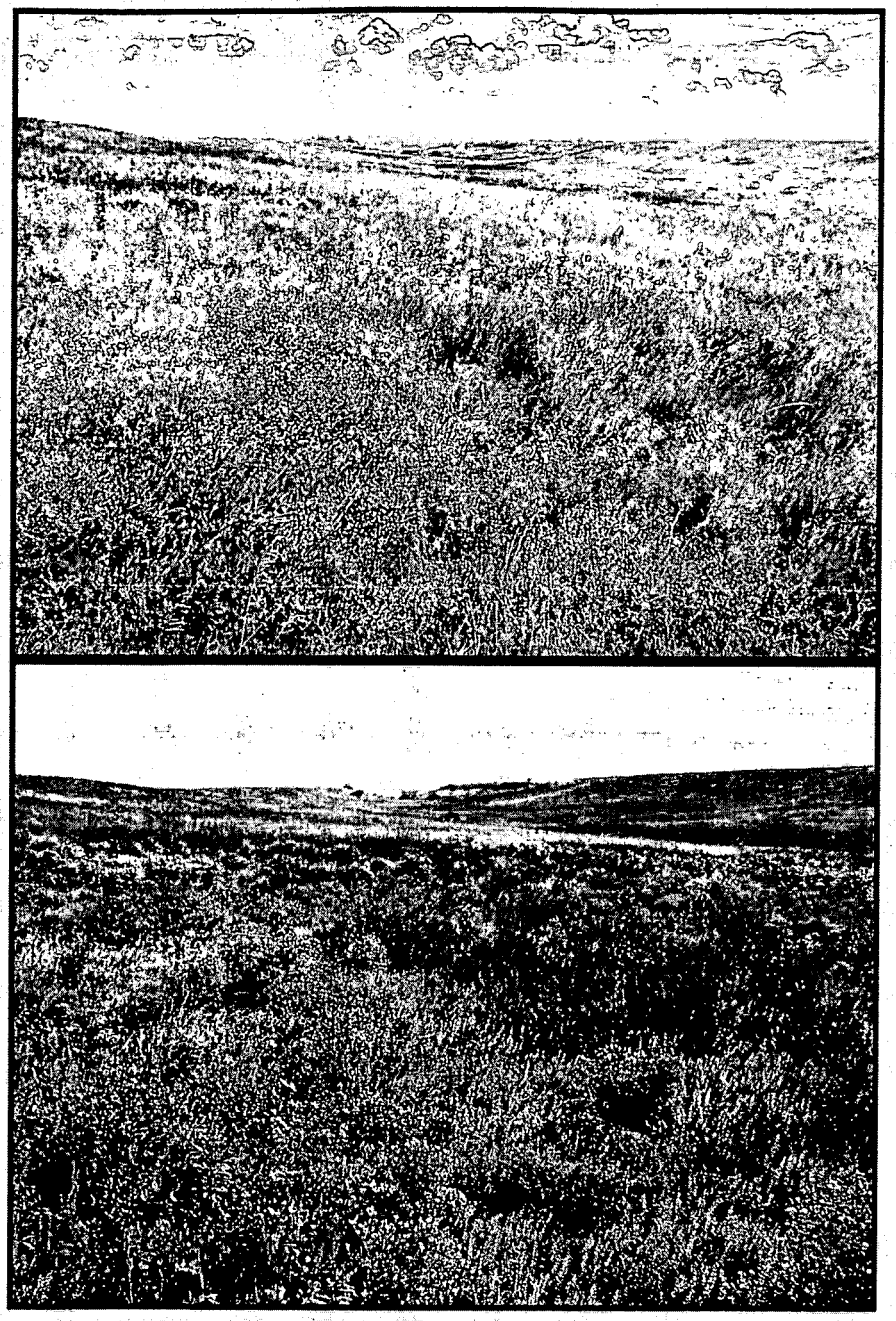
2001 **2002**





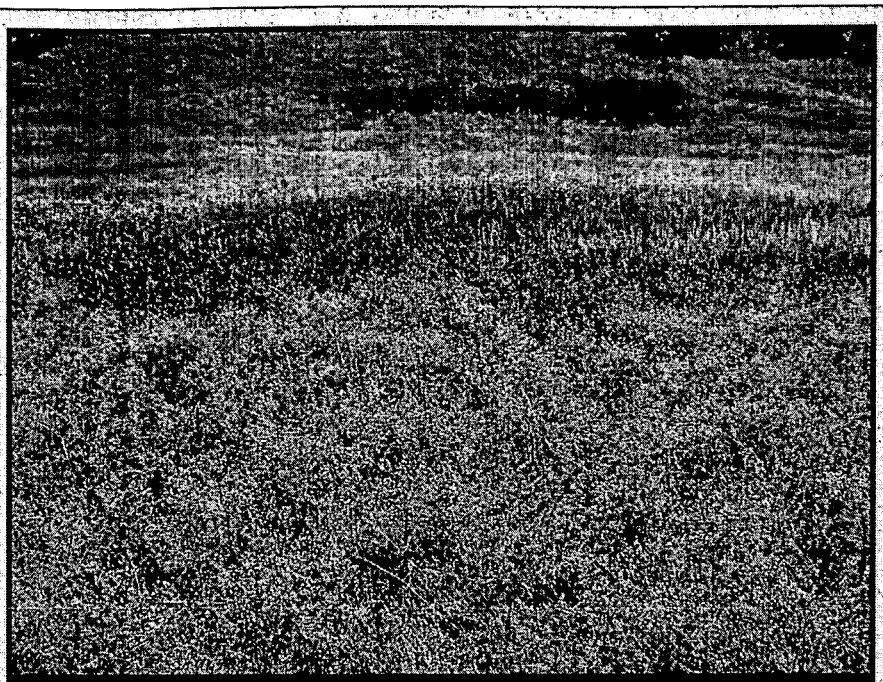
2003

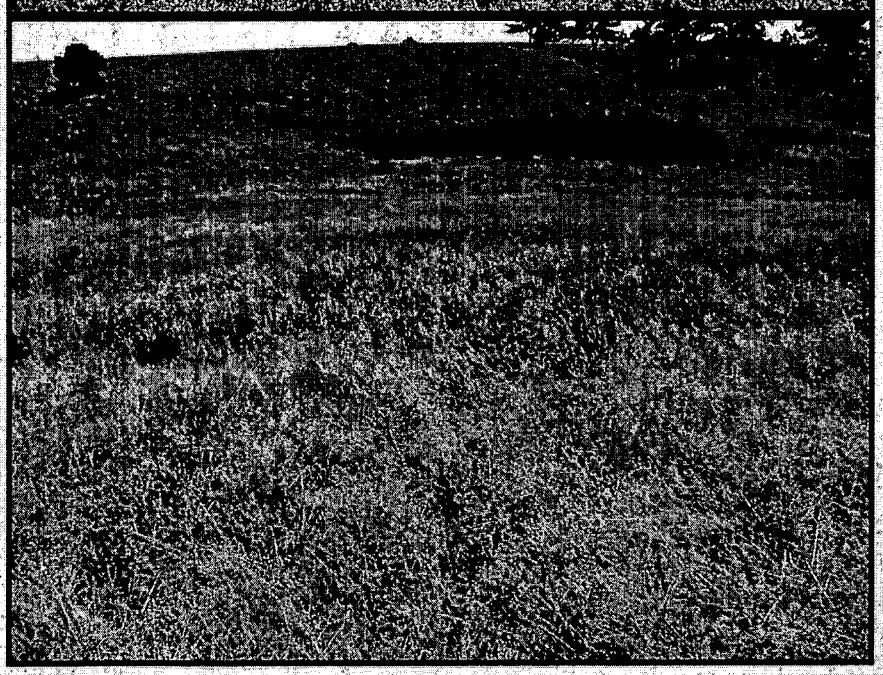
2004



South

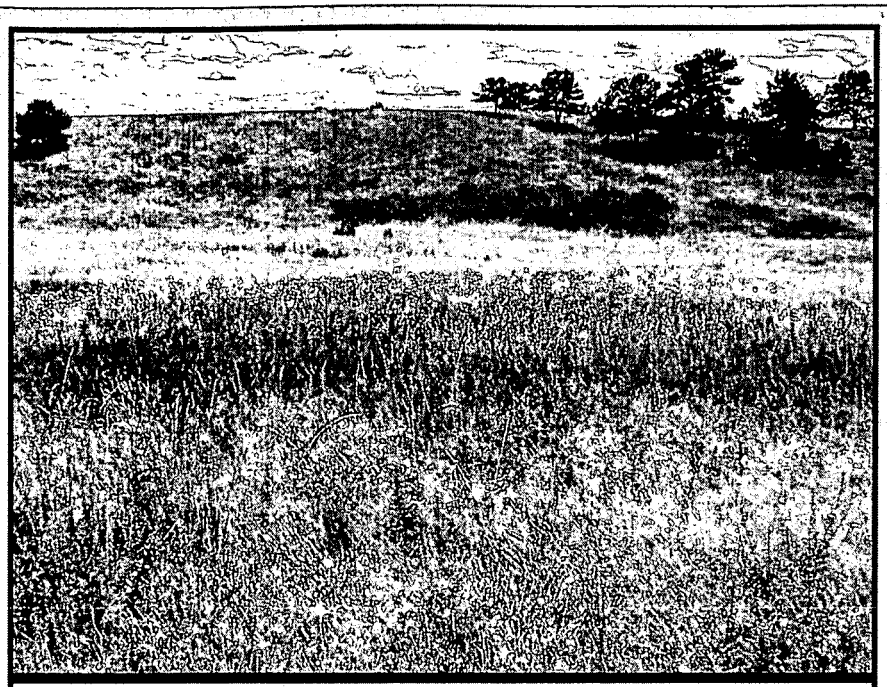
2001 **2002**





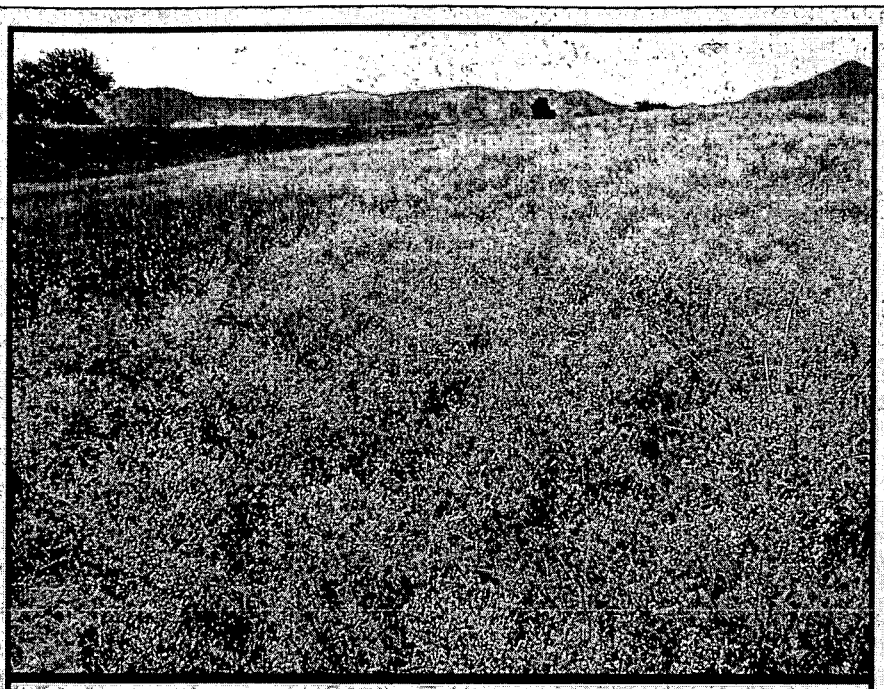
2003

2004



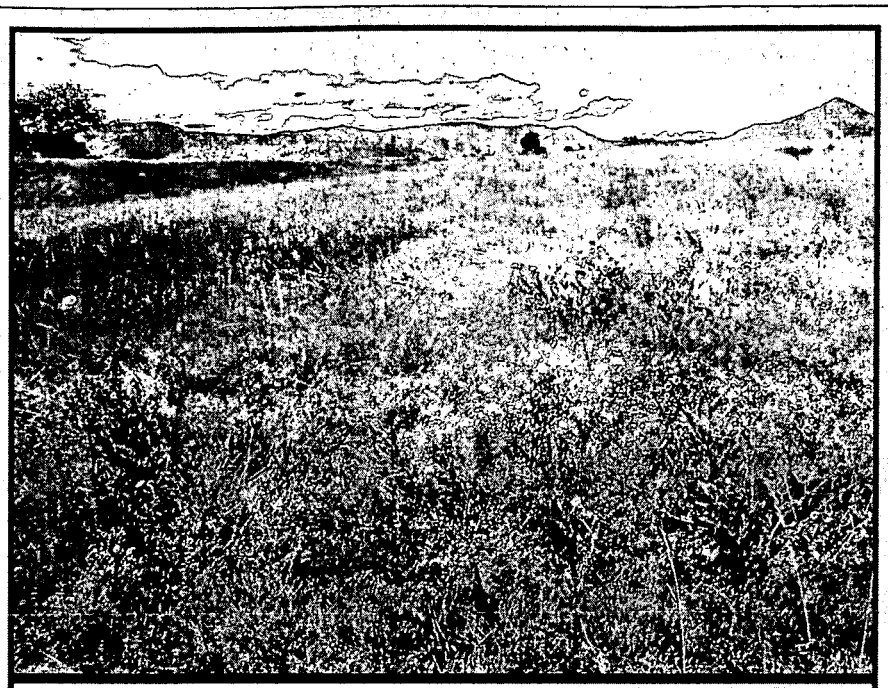
West

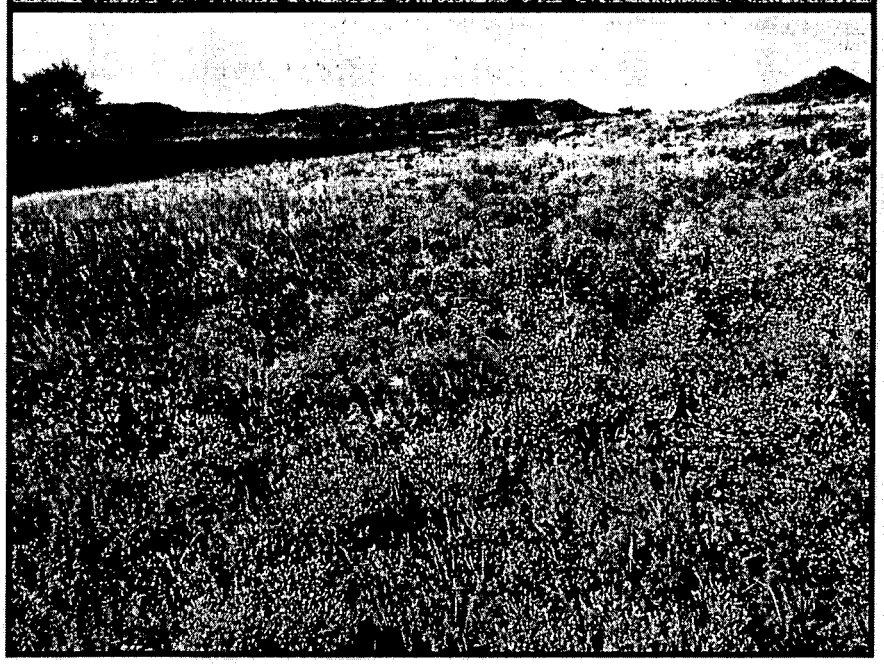
2001 **2002**



2003

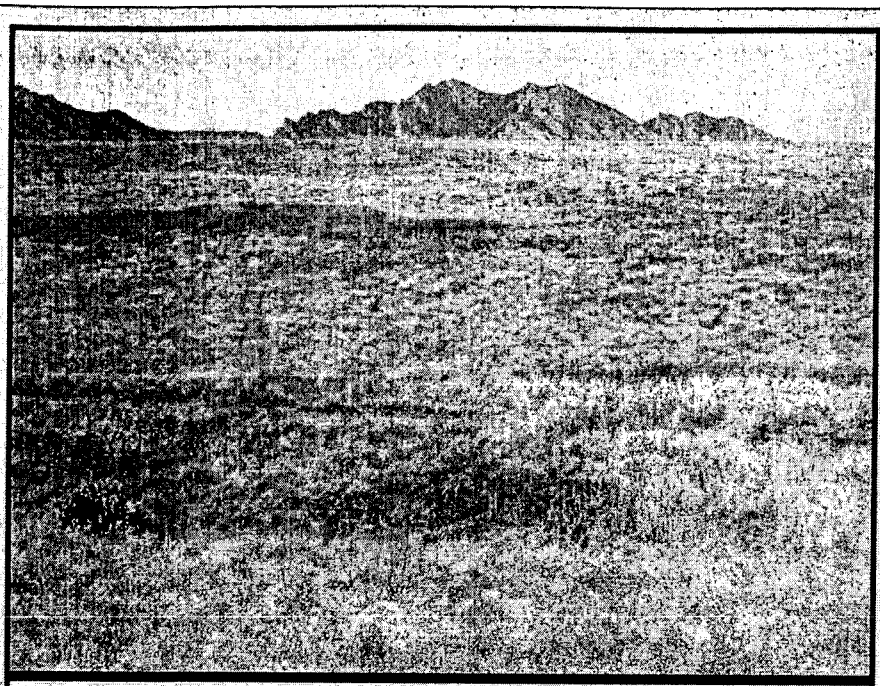
2004

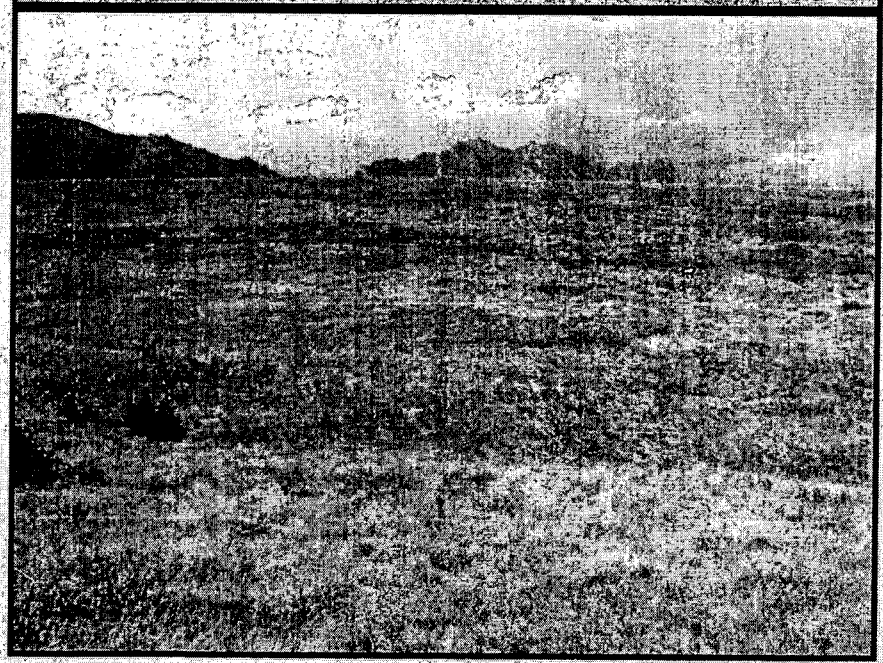




Hillside

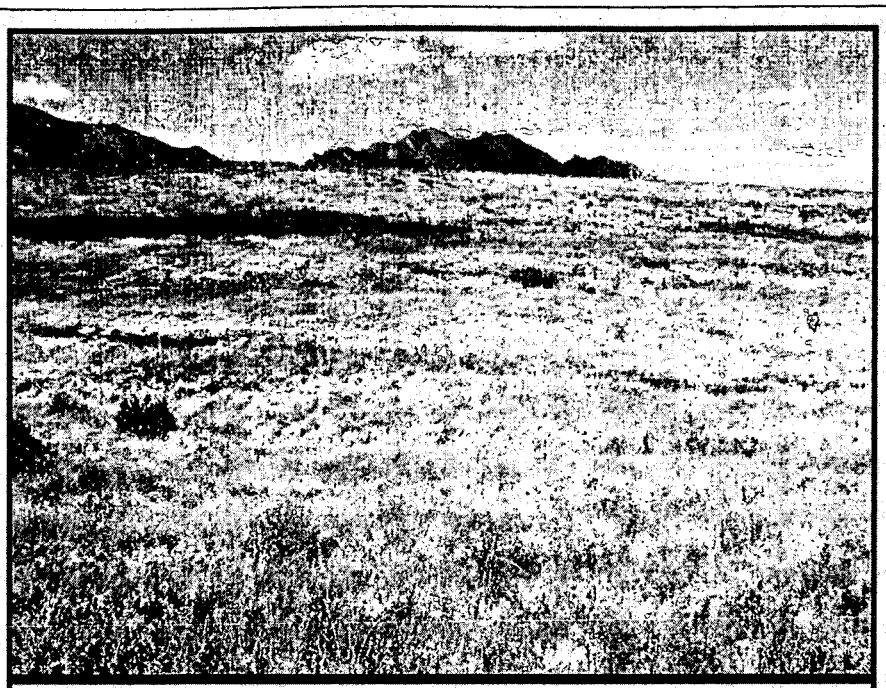
2001 **2002**

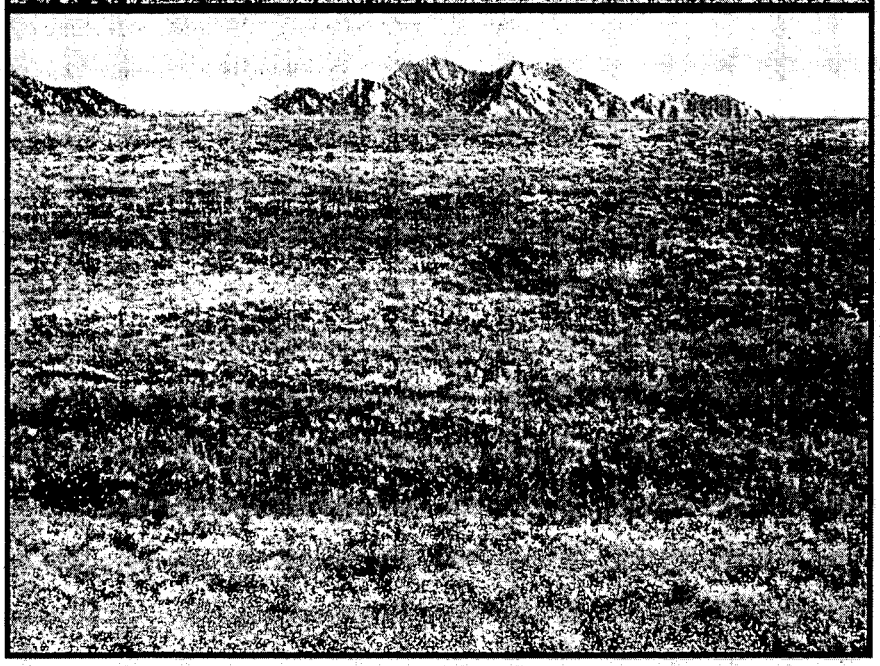




2003

2004





Site LM2

North

2001

2002

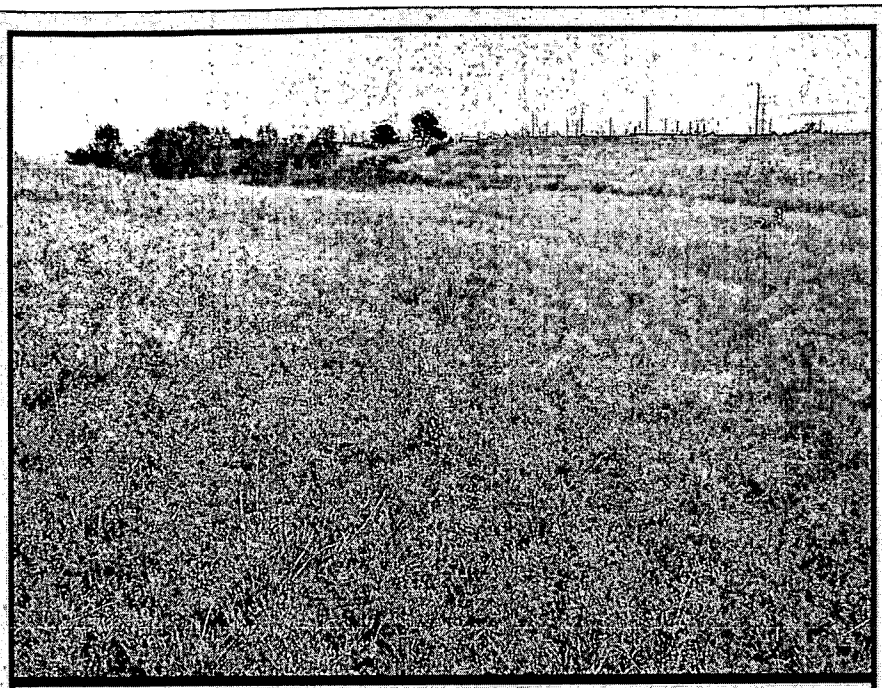
2003

2004

BEST
AVAILABLE
COPY

East

2001 **2002**

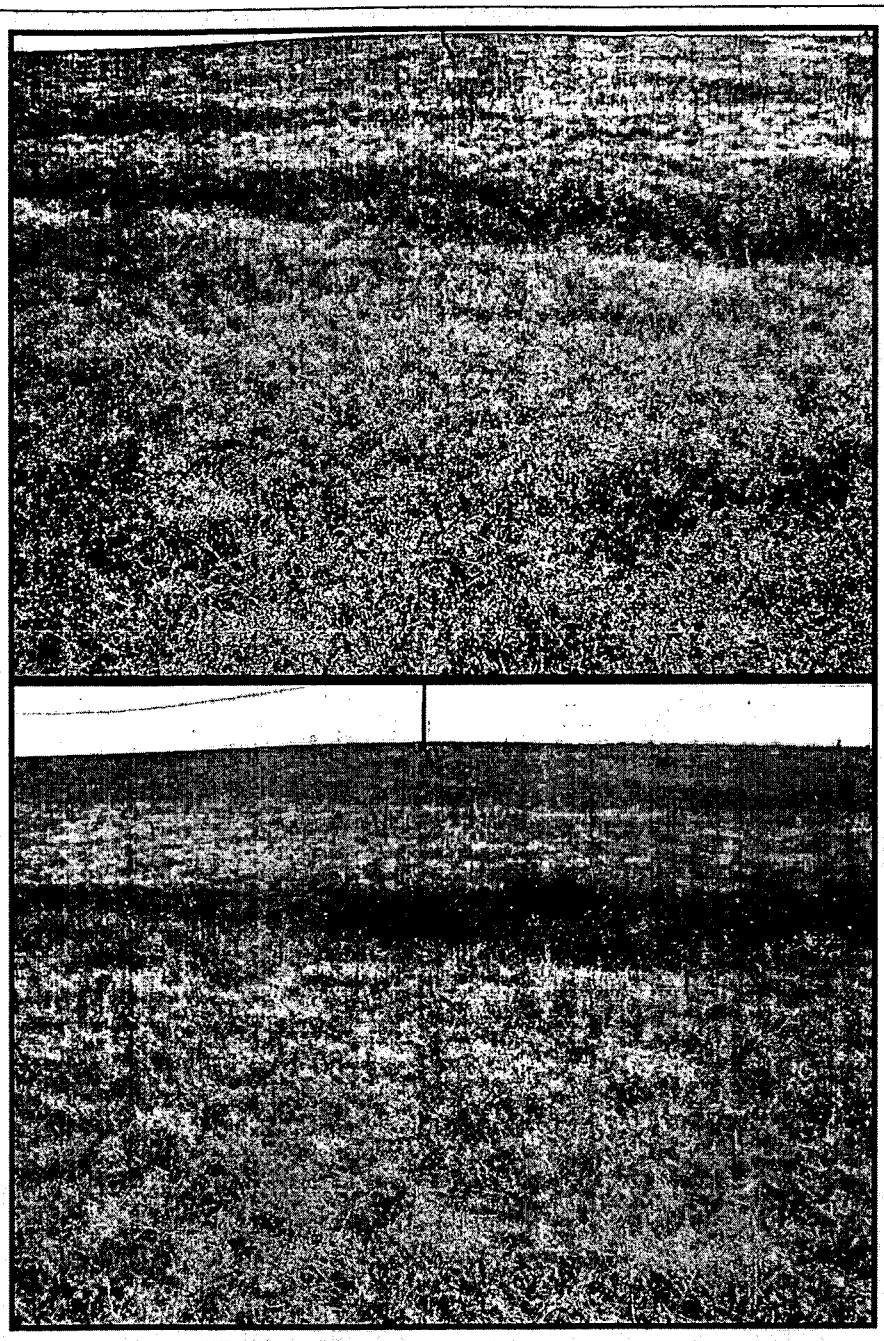


2003

2004

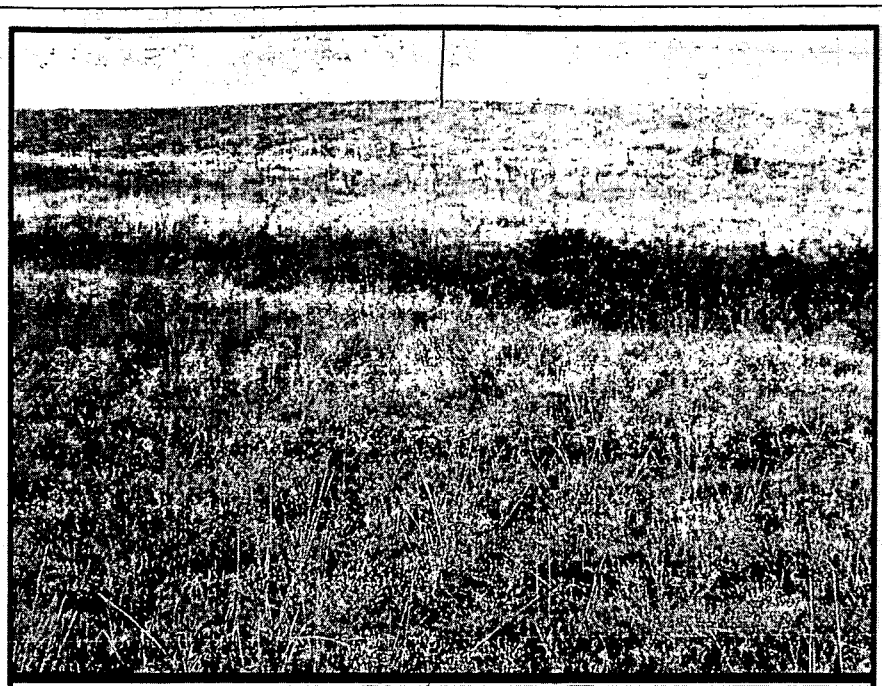
South

2001 **2002**



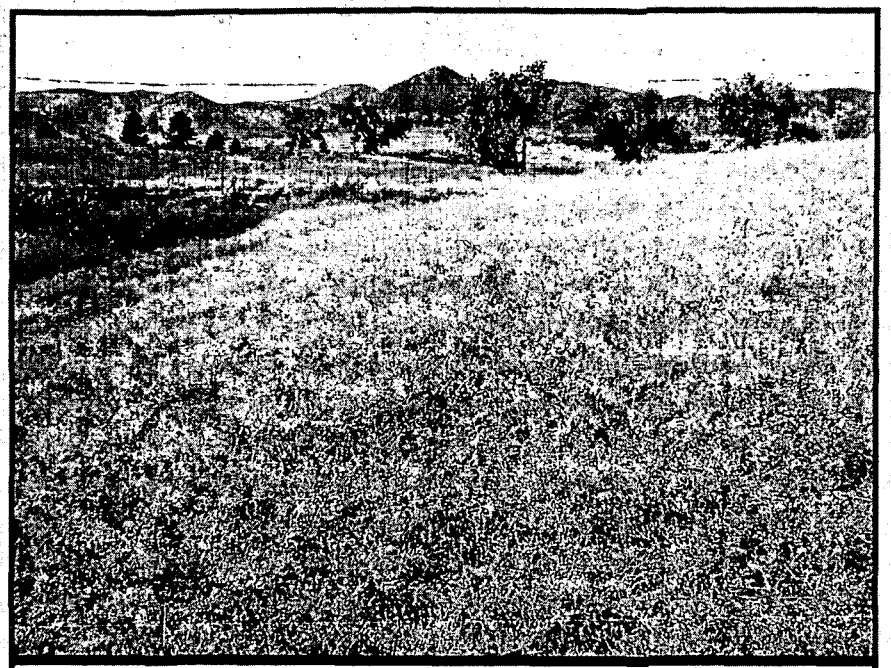
2003

2004



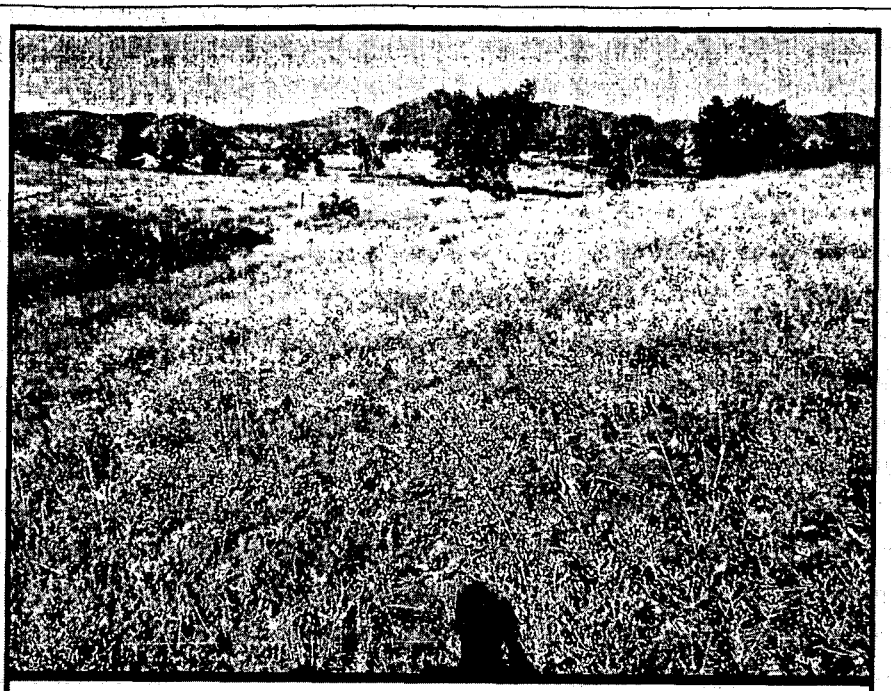
West

2001 **2002**



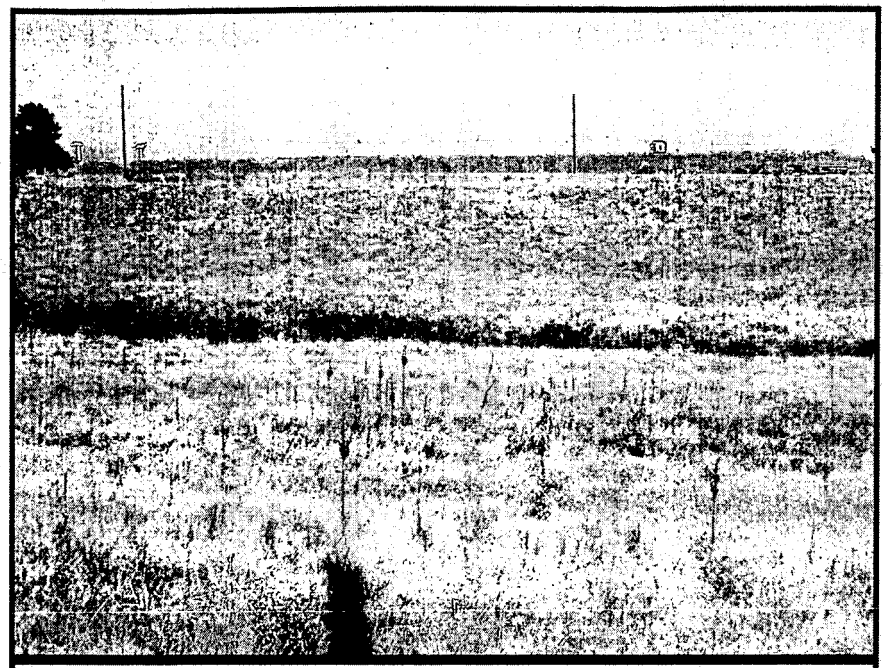
2003

2004

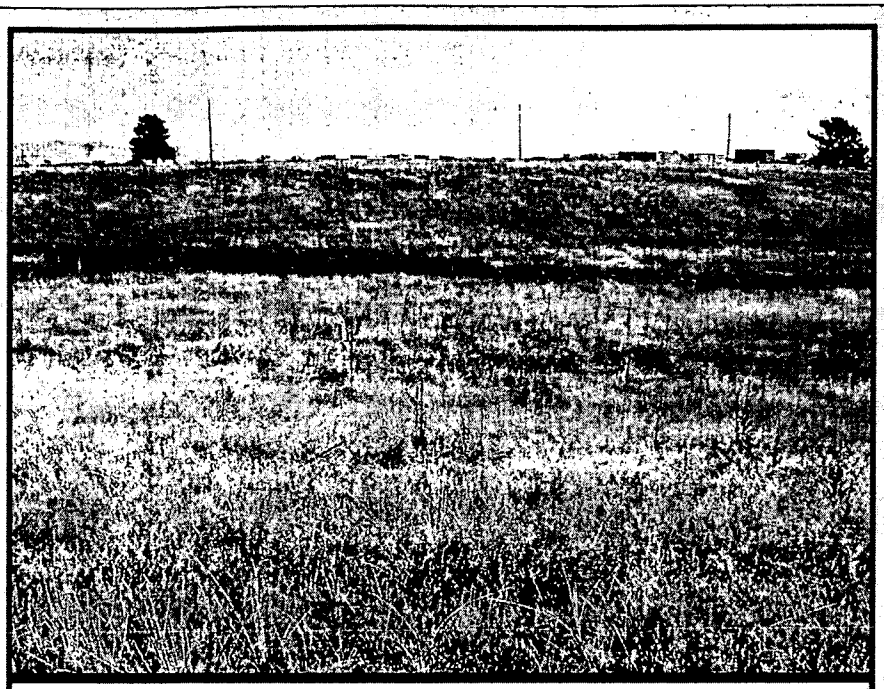


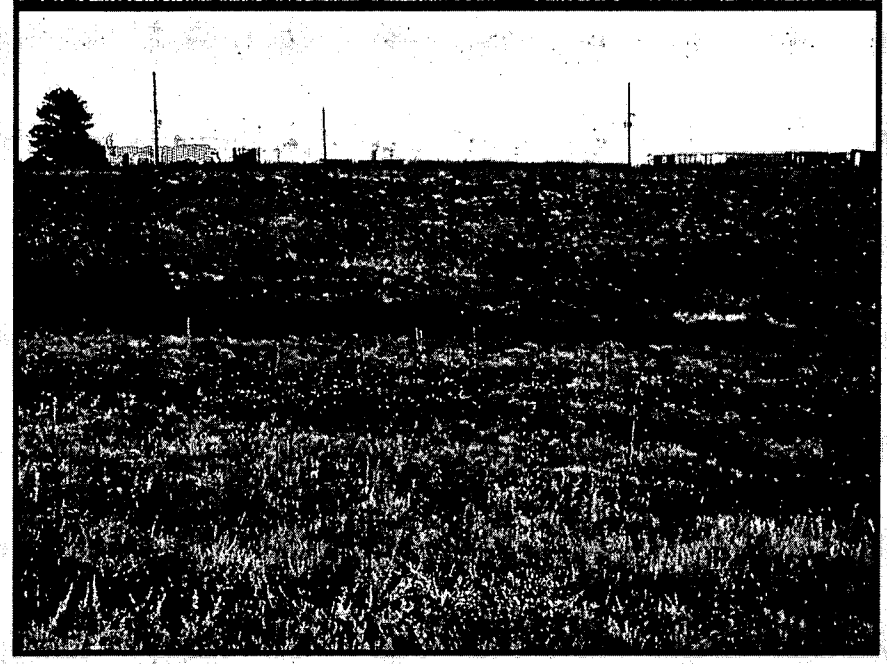
Hillside

2001 **2002**



2003 **2004**

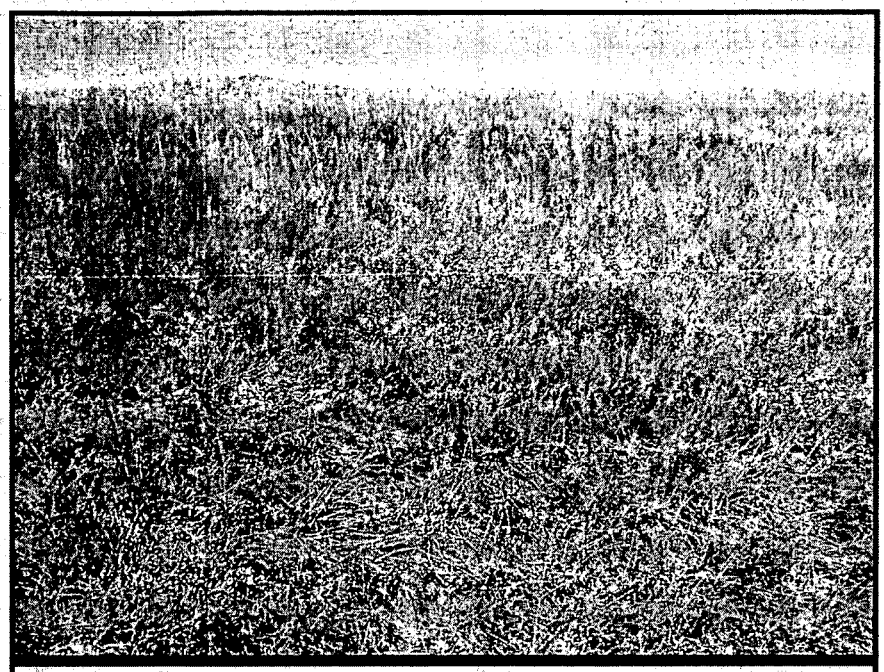




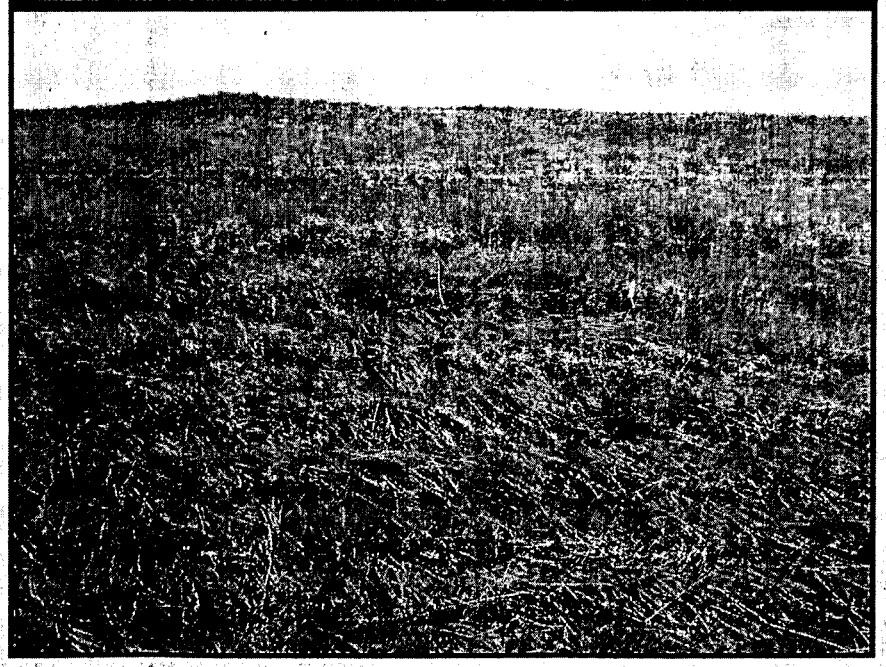
Site LM3

North

2001

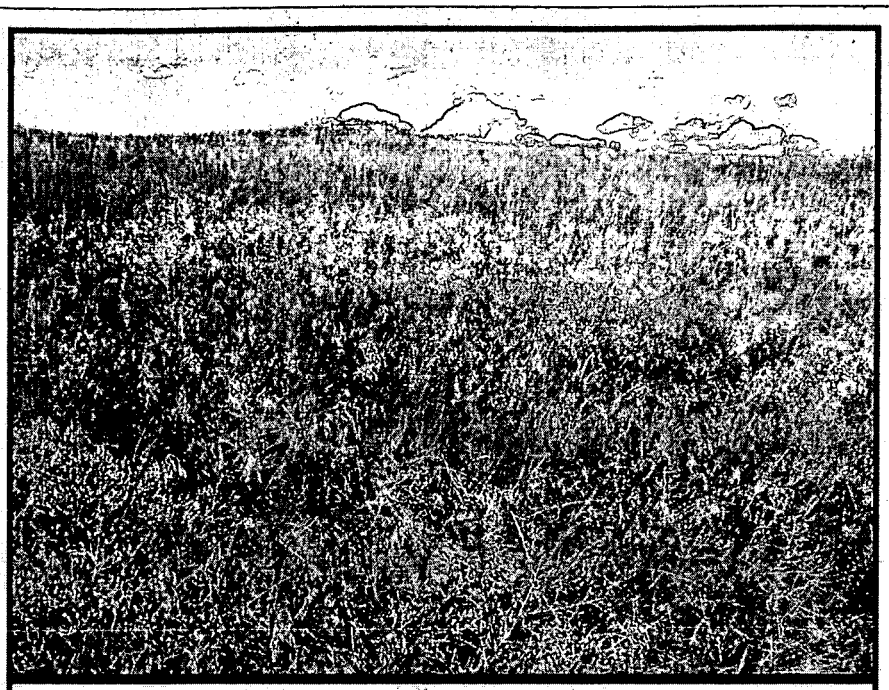


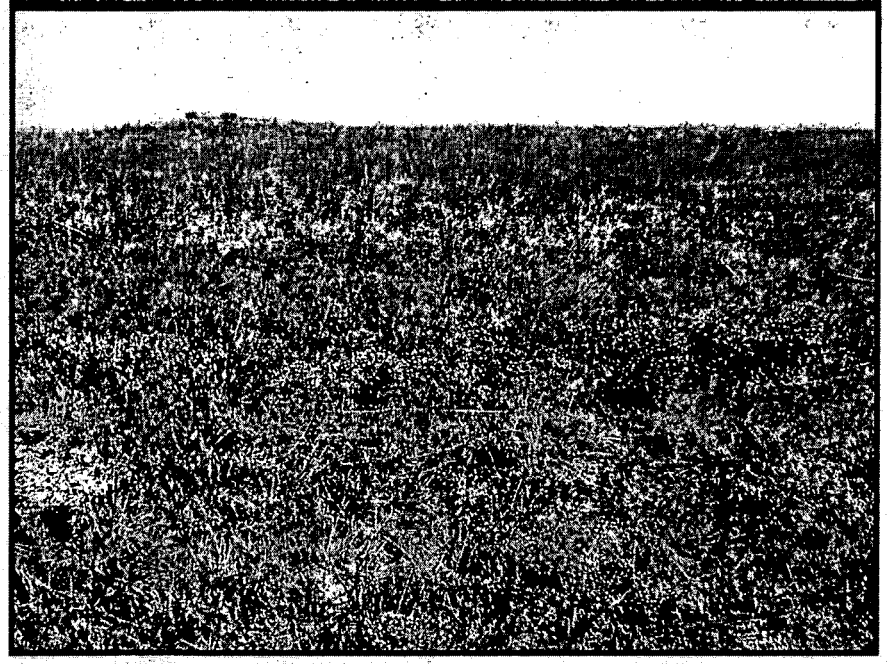
2002



2003

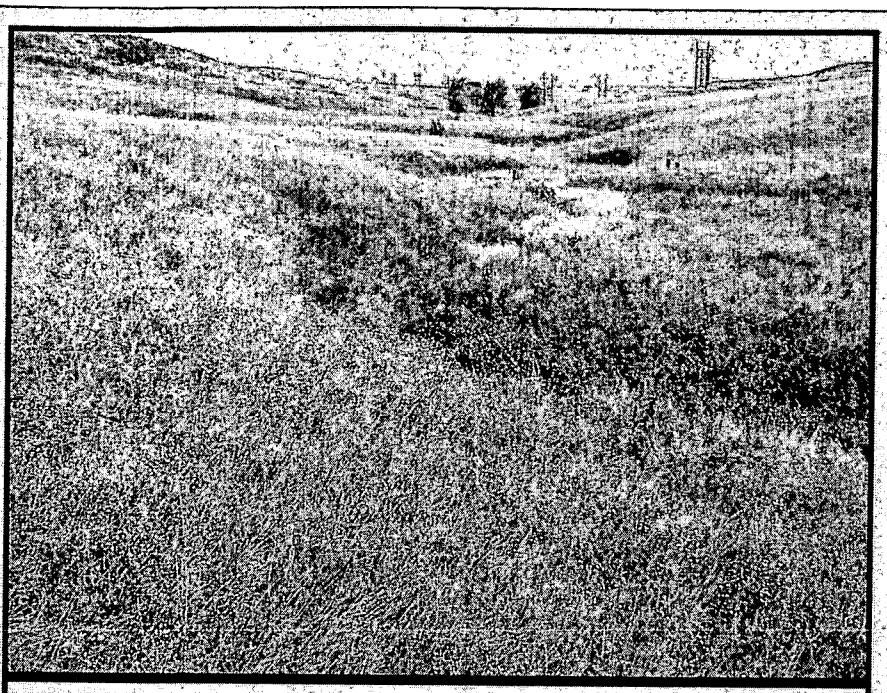
2004





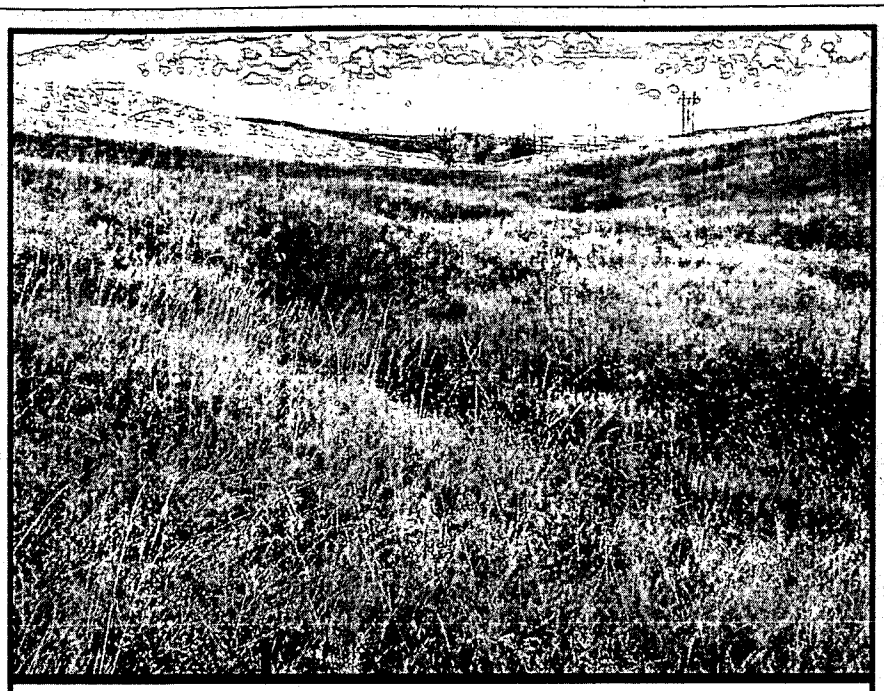
East

2001 **2002**



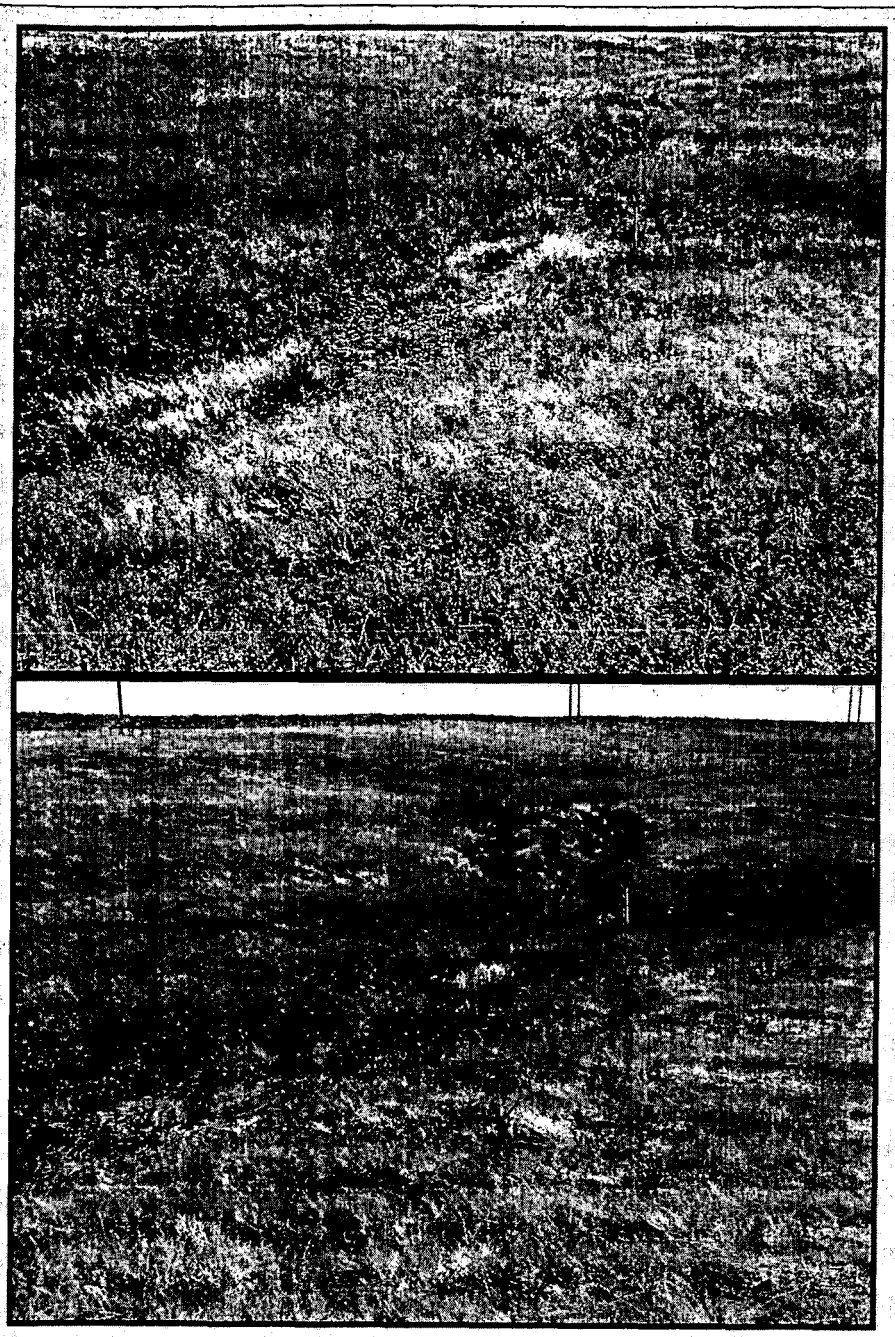
2003

2004



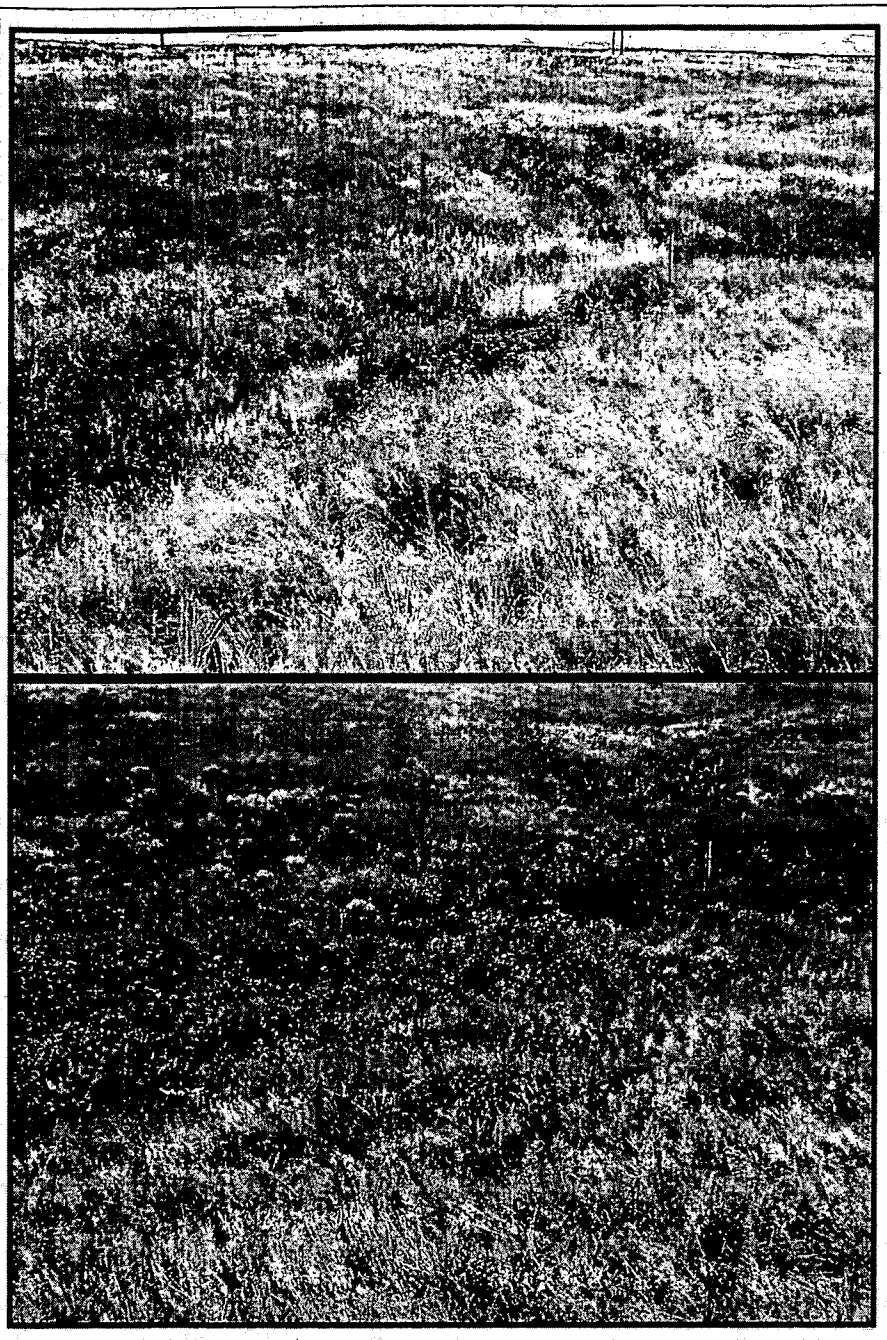
South

2001 **2002**



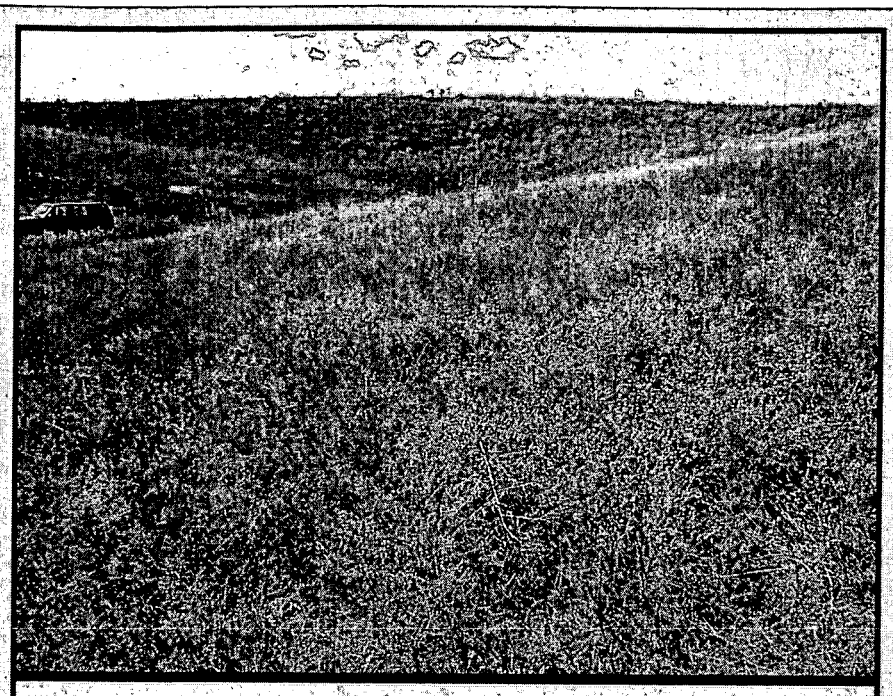
2003

2004



West

2001 **2002**

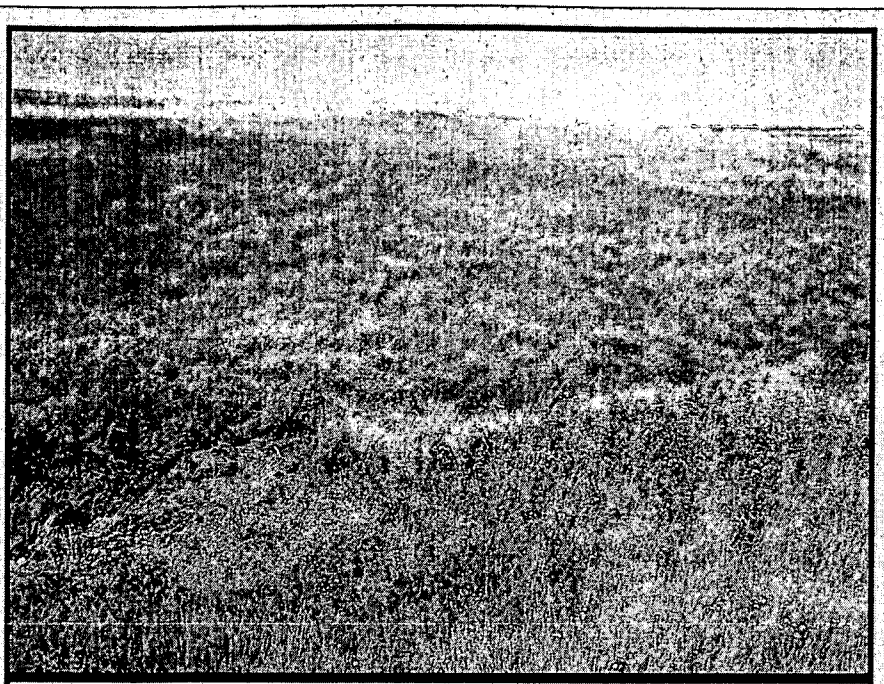


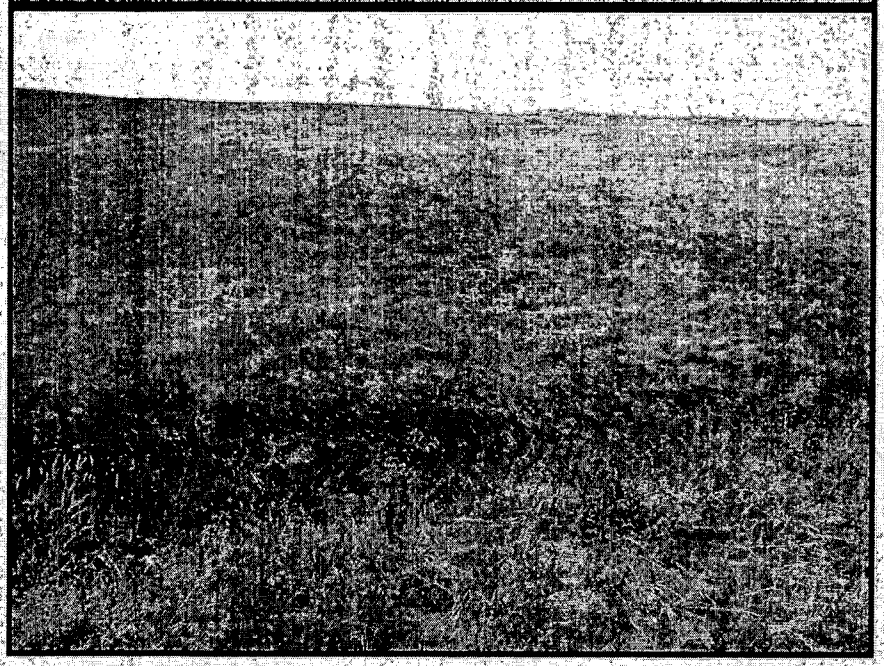
2003

2004

Hillside

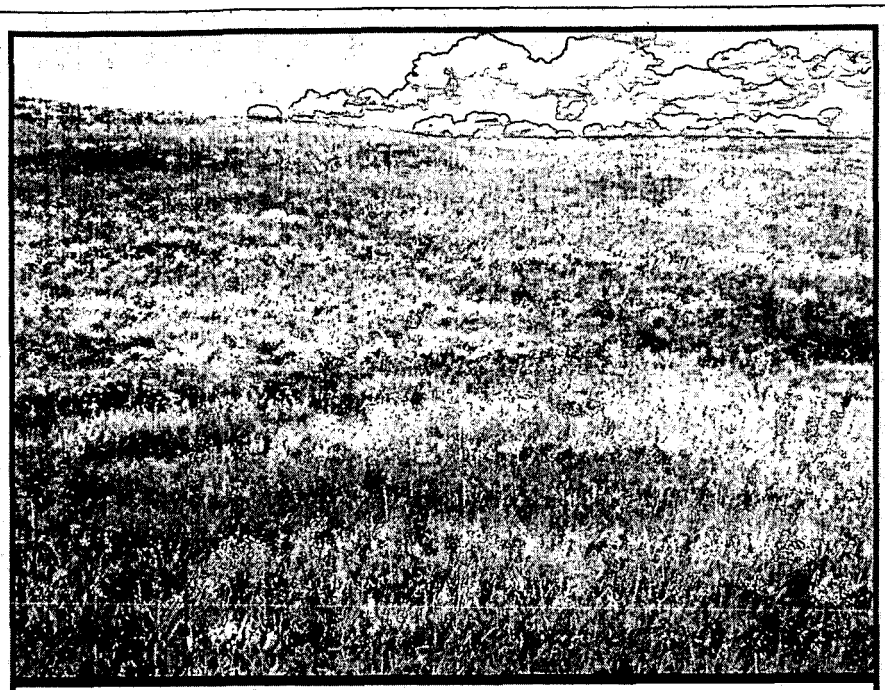
2001 **2002**





2003

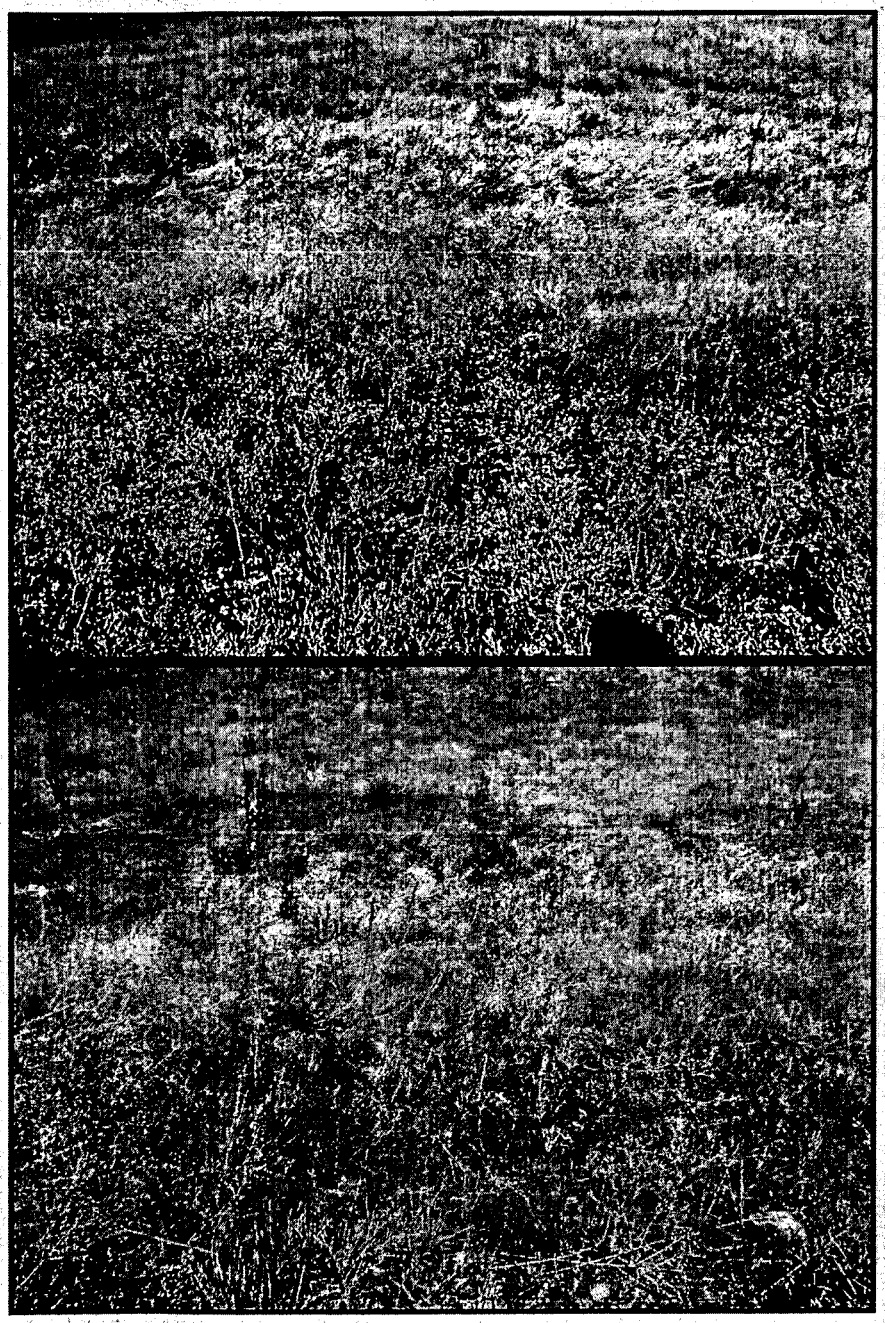
2004



Site LM4

North

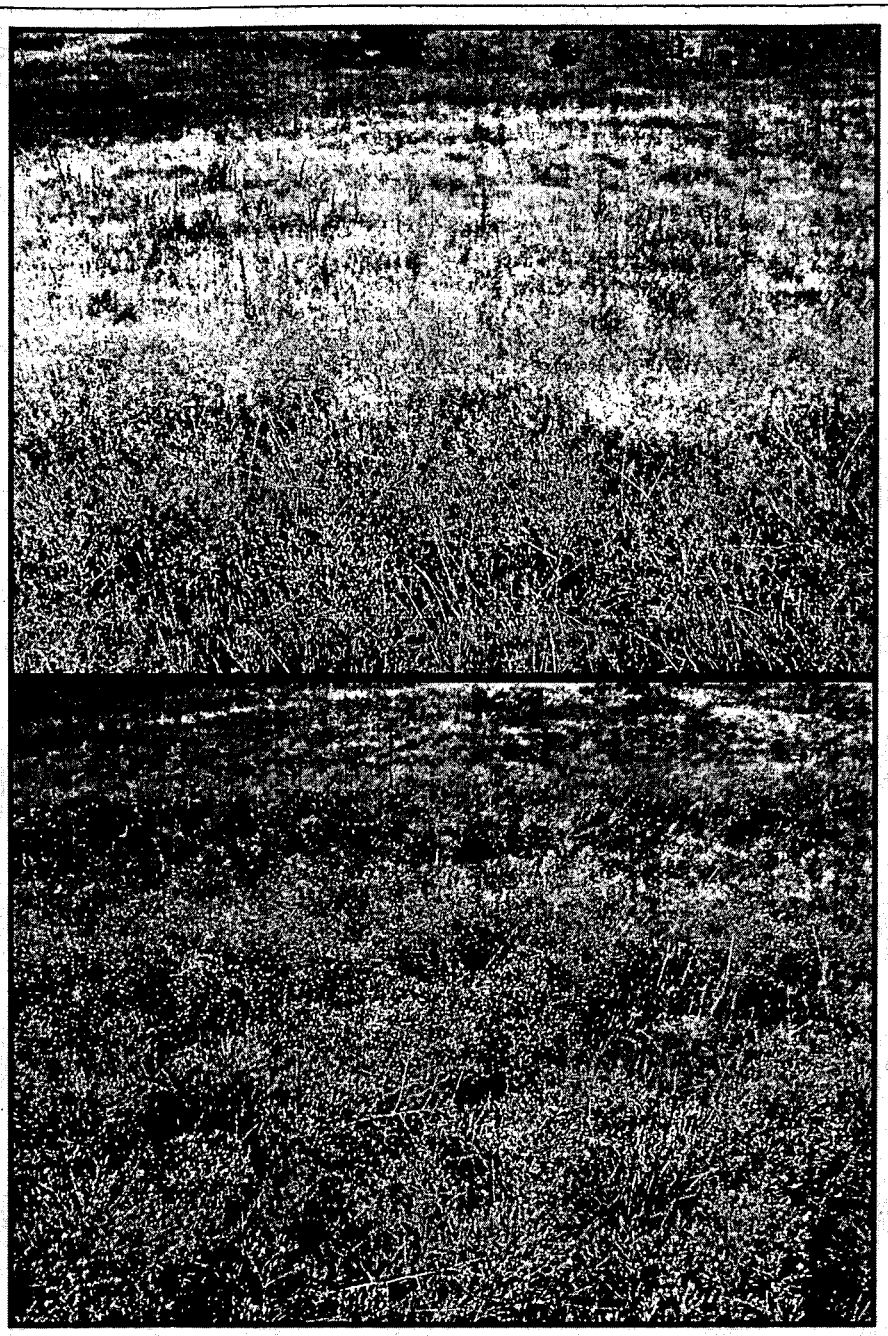
2001



2002

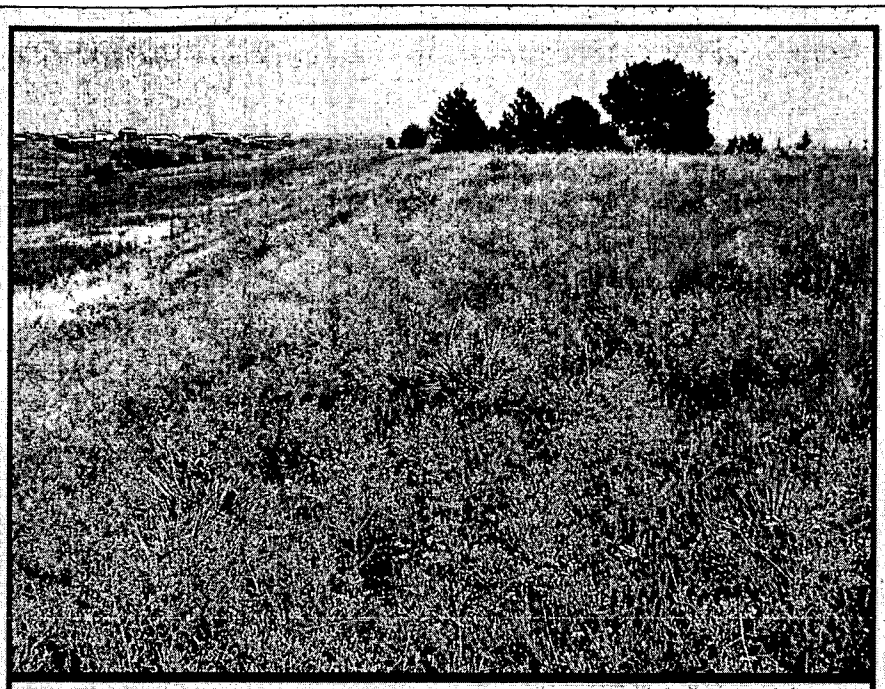
2003

2004



East

2001 **2002**

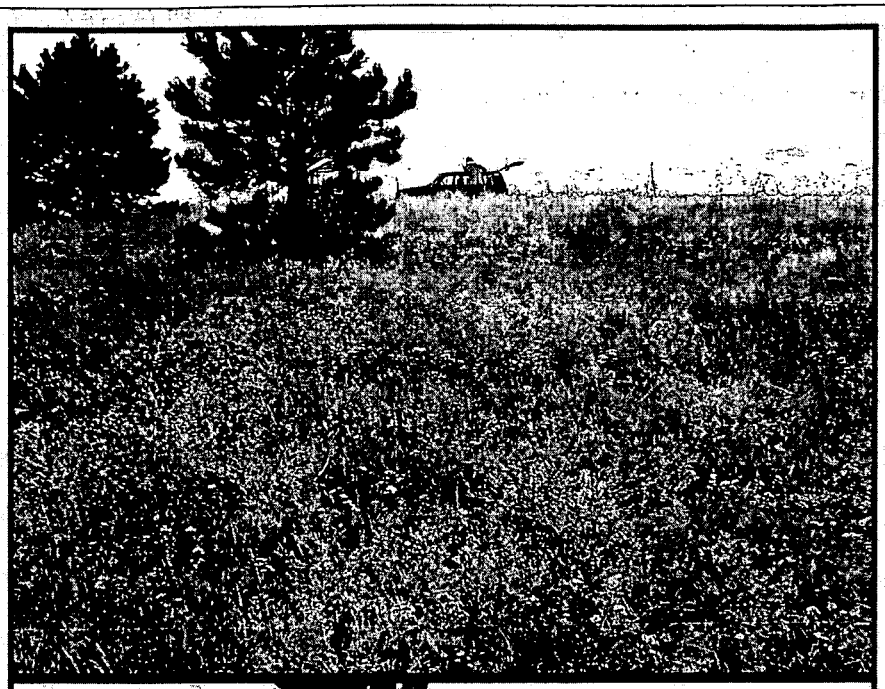


2003

2004

South

2001 **2002**

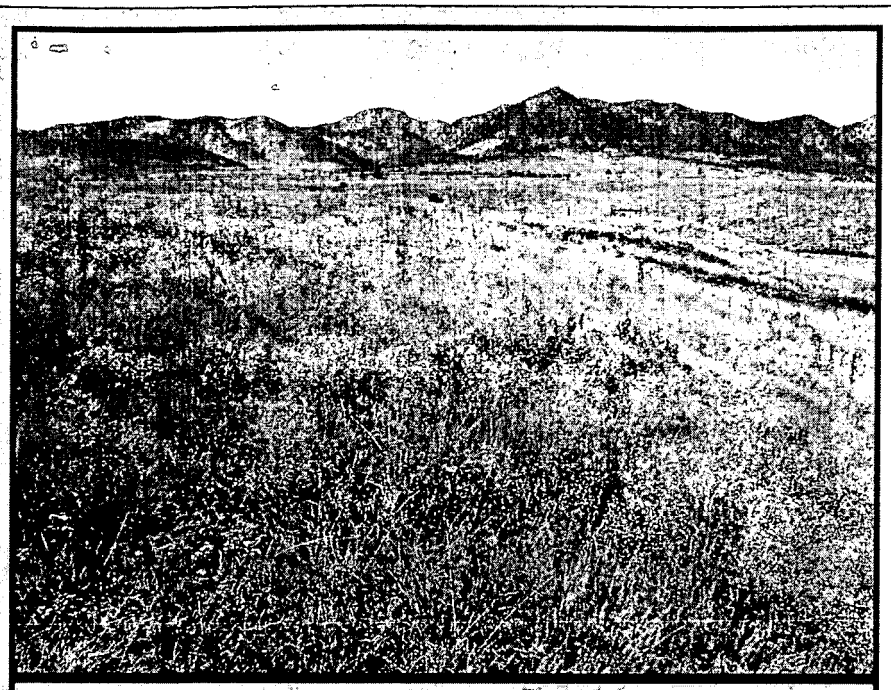


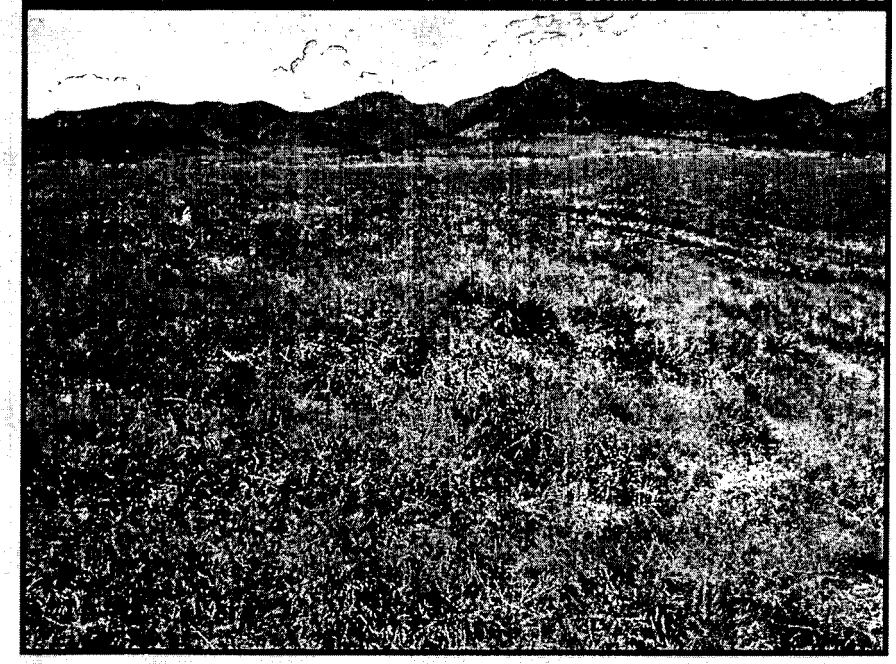
2003

2004

West

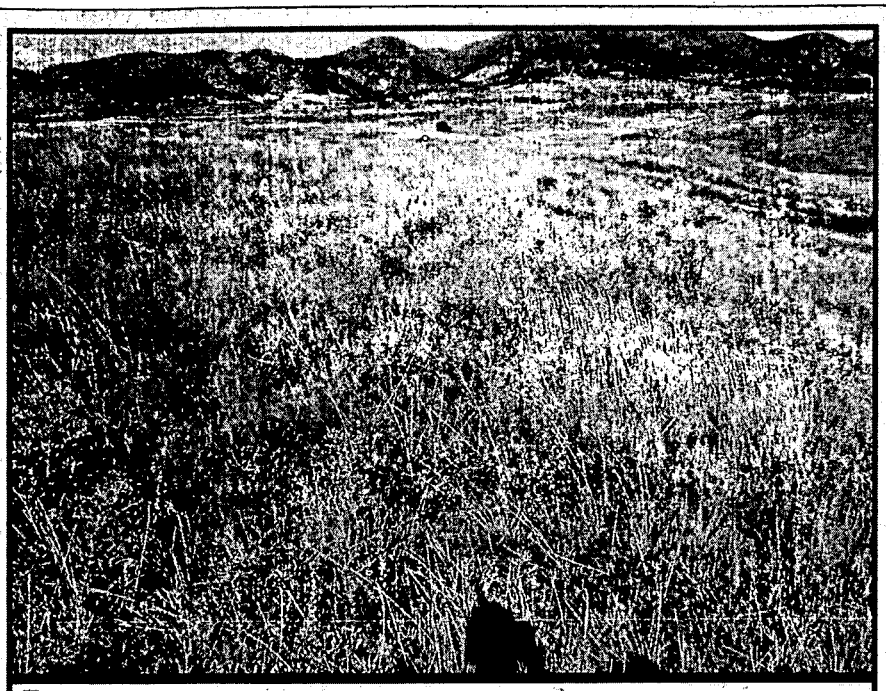
2001 **2002**





2003

2004



Hillside

2001 **2002**

2003

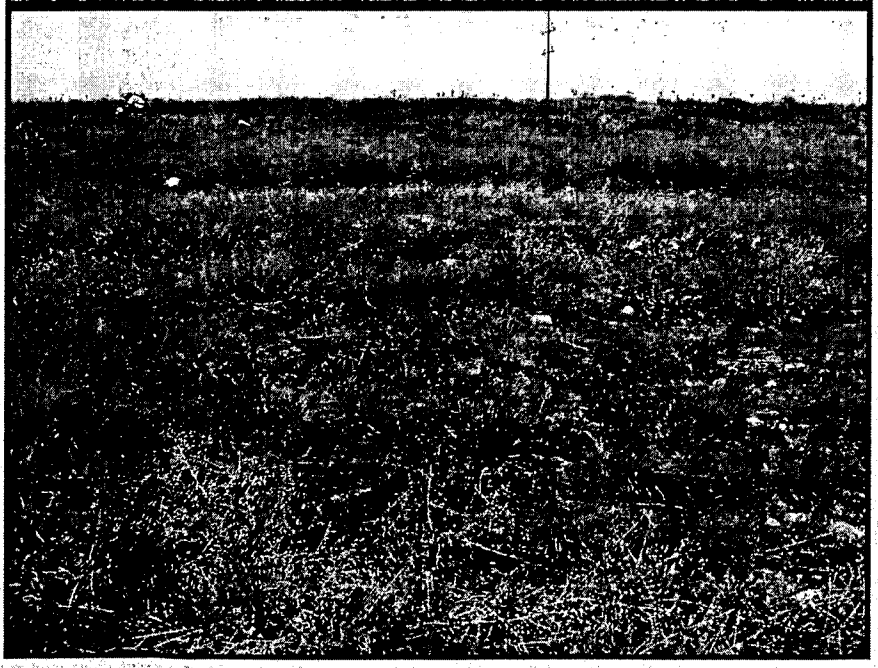
2004

Site LM5

(This location was not monitored in 2004)

North

2001 **2002**

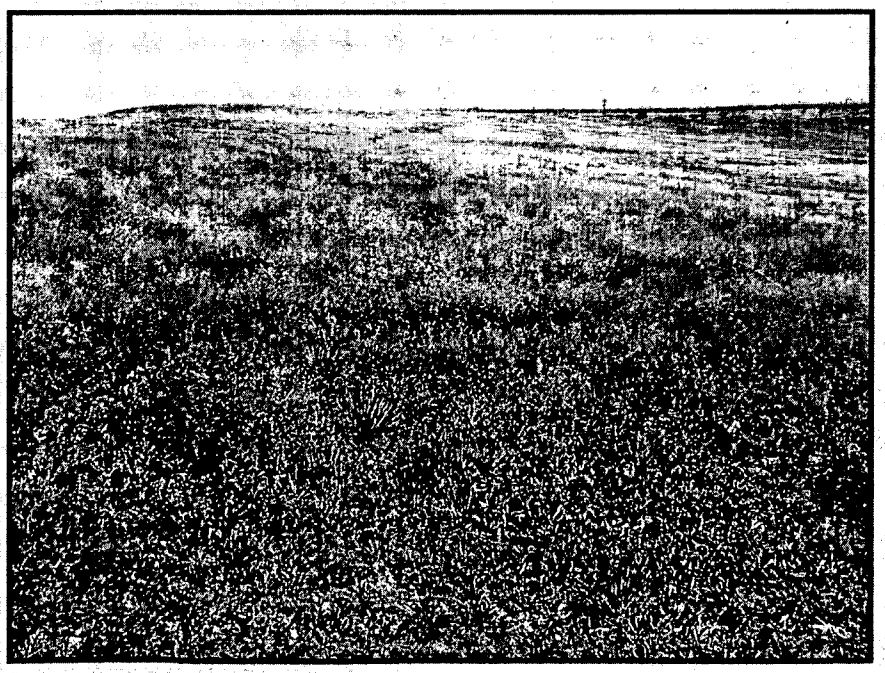


2003

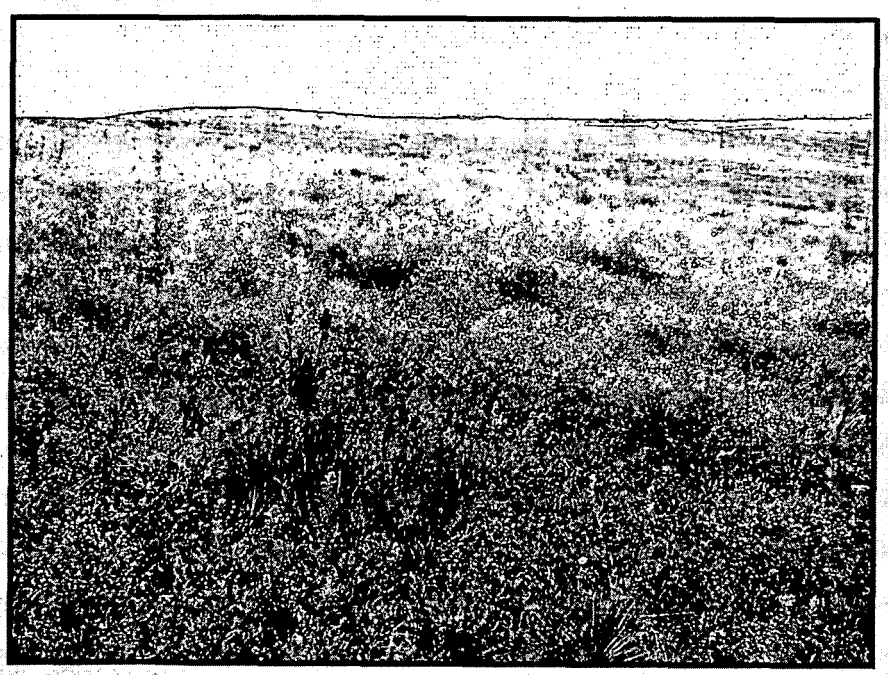
East

2001

2002



2003



South

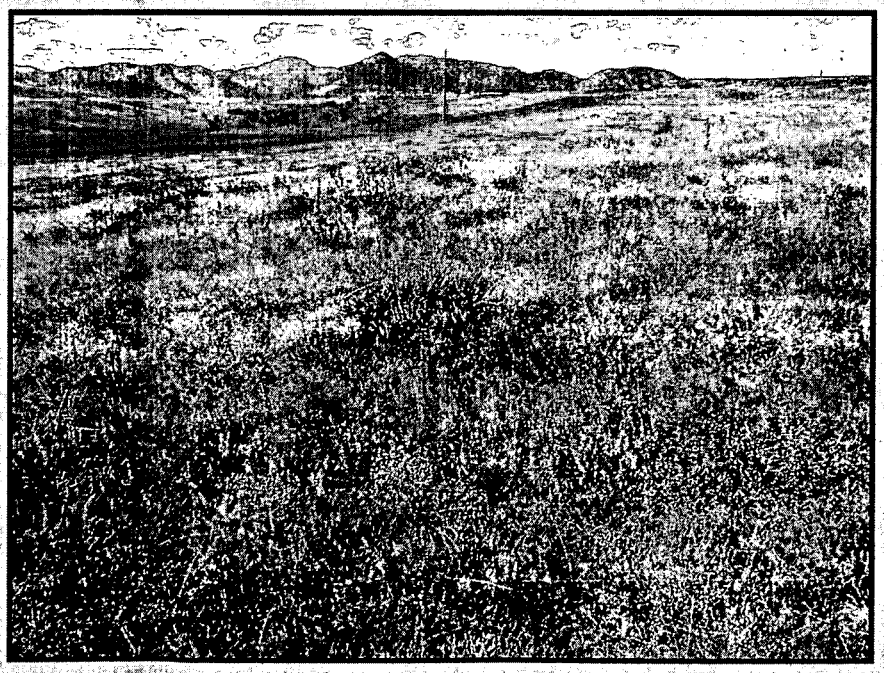
2001

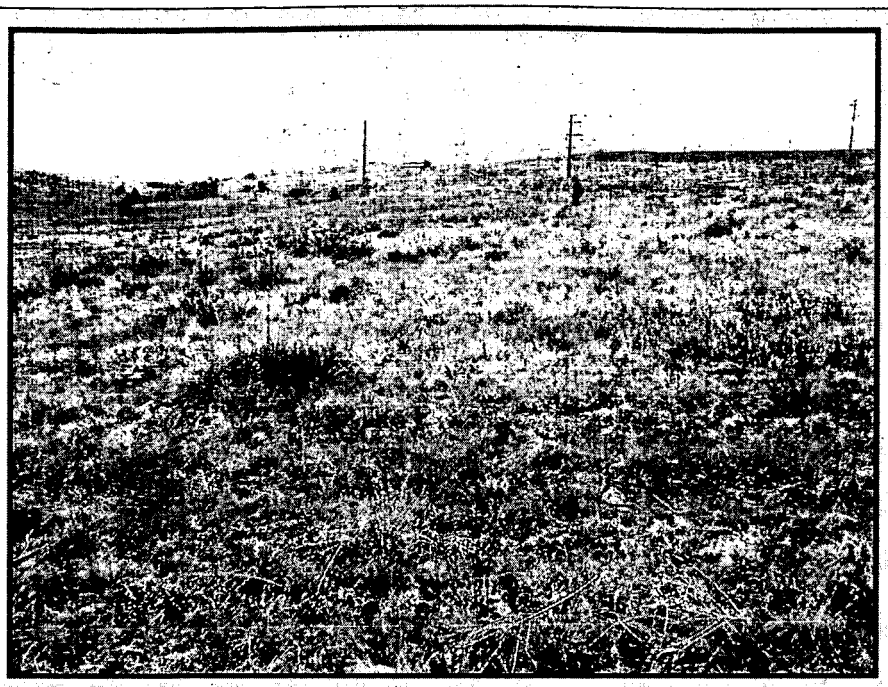
2002

2003

West

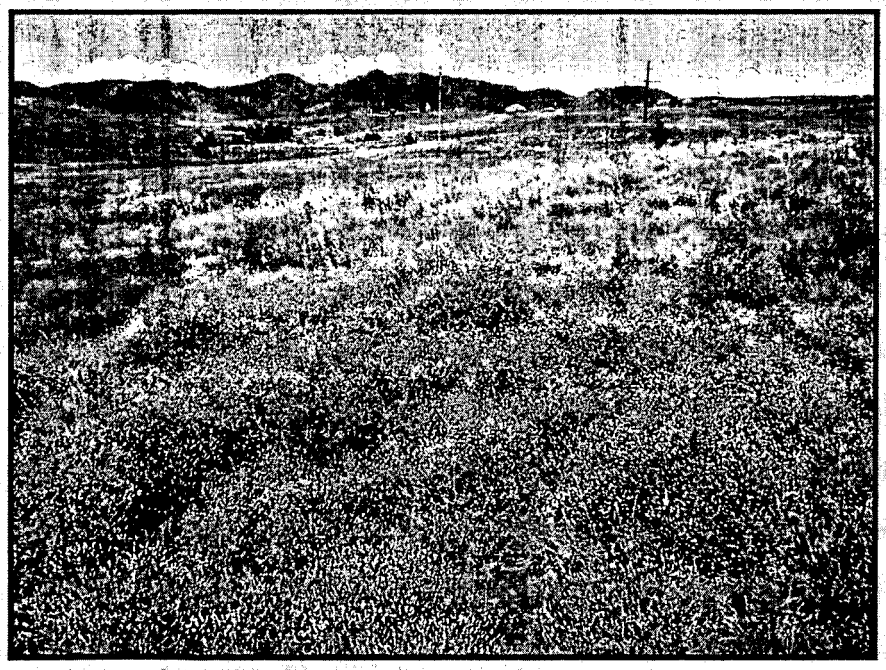
2001 **2002**





2003

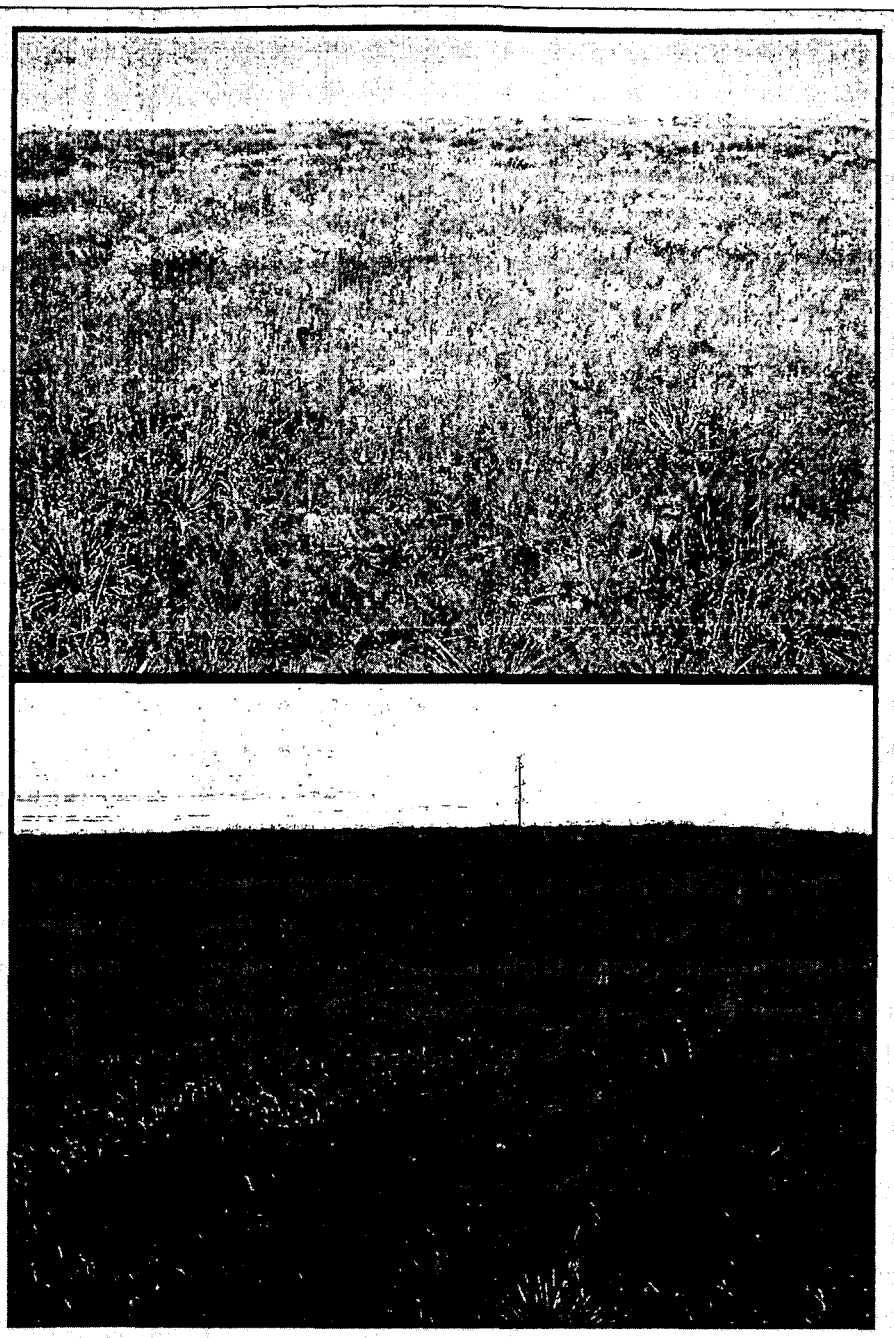
2004



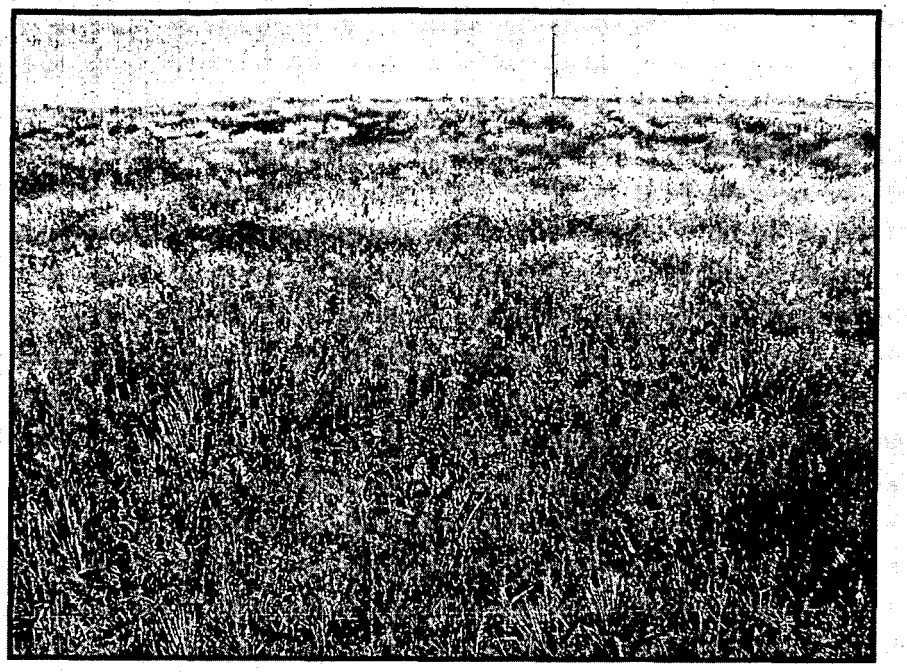
Hillside

2001

2002



2003

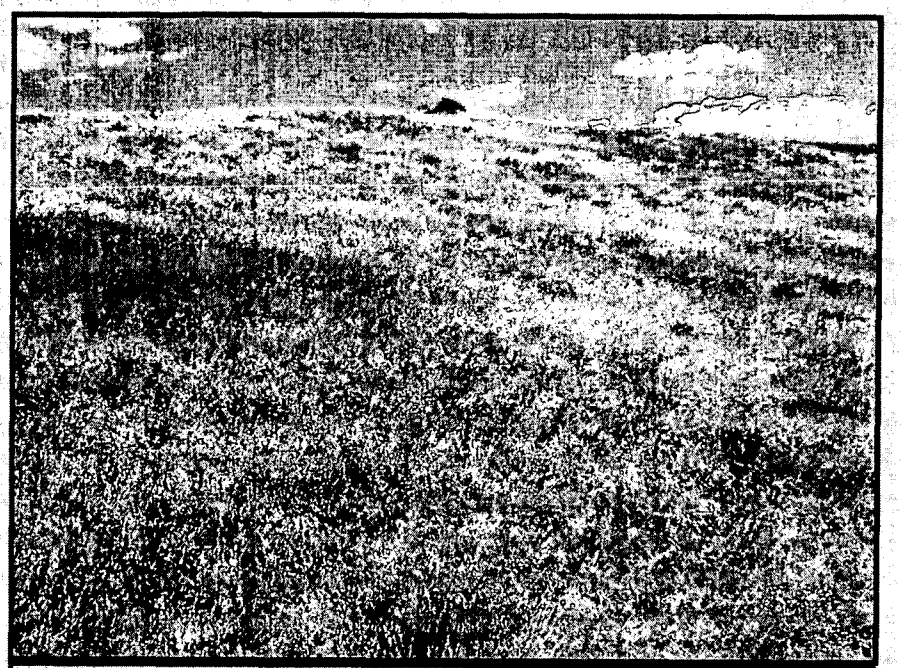


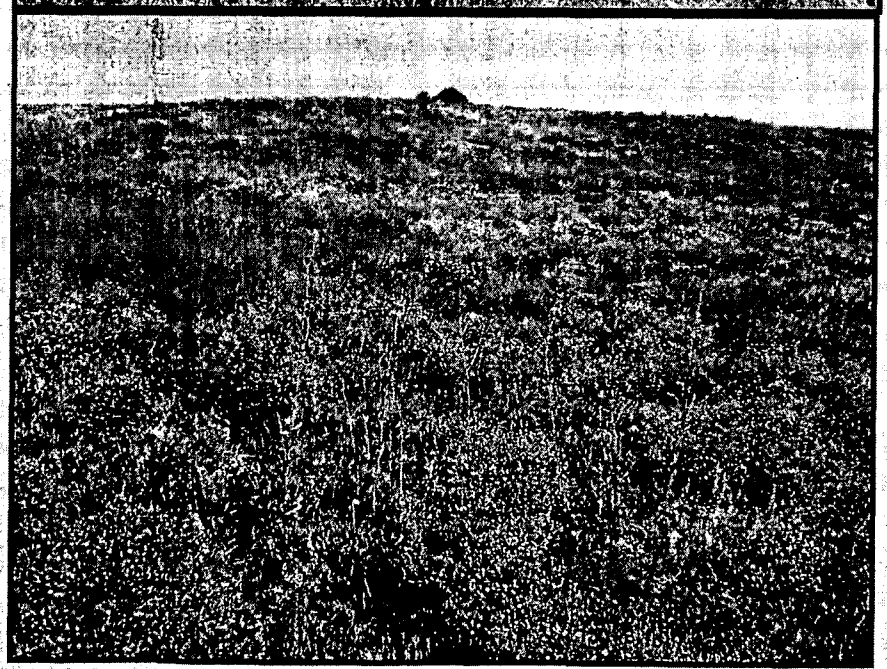
Site LM6

(This release location was established in 2002)

North

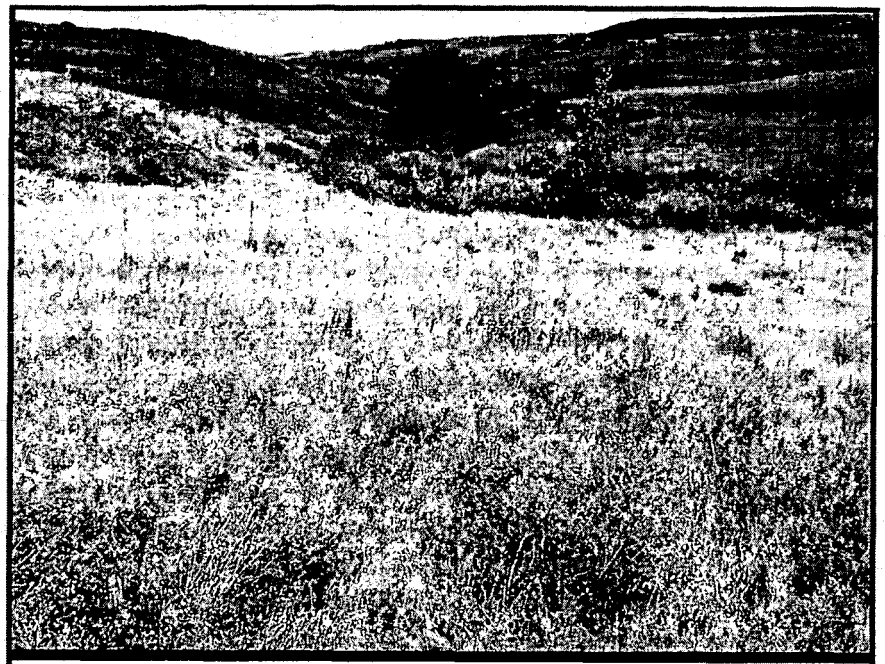
2003 **2004**



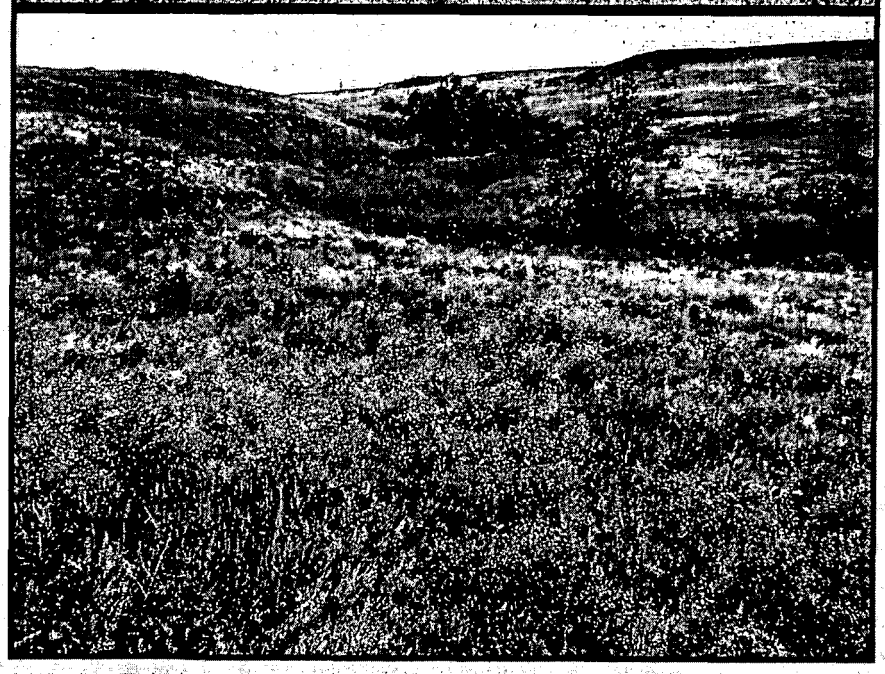


East

2003



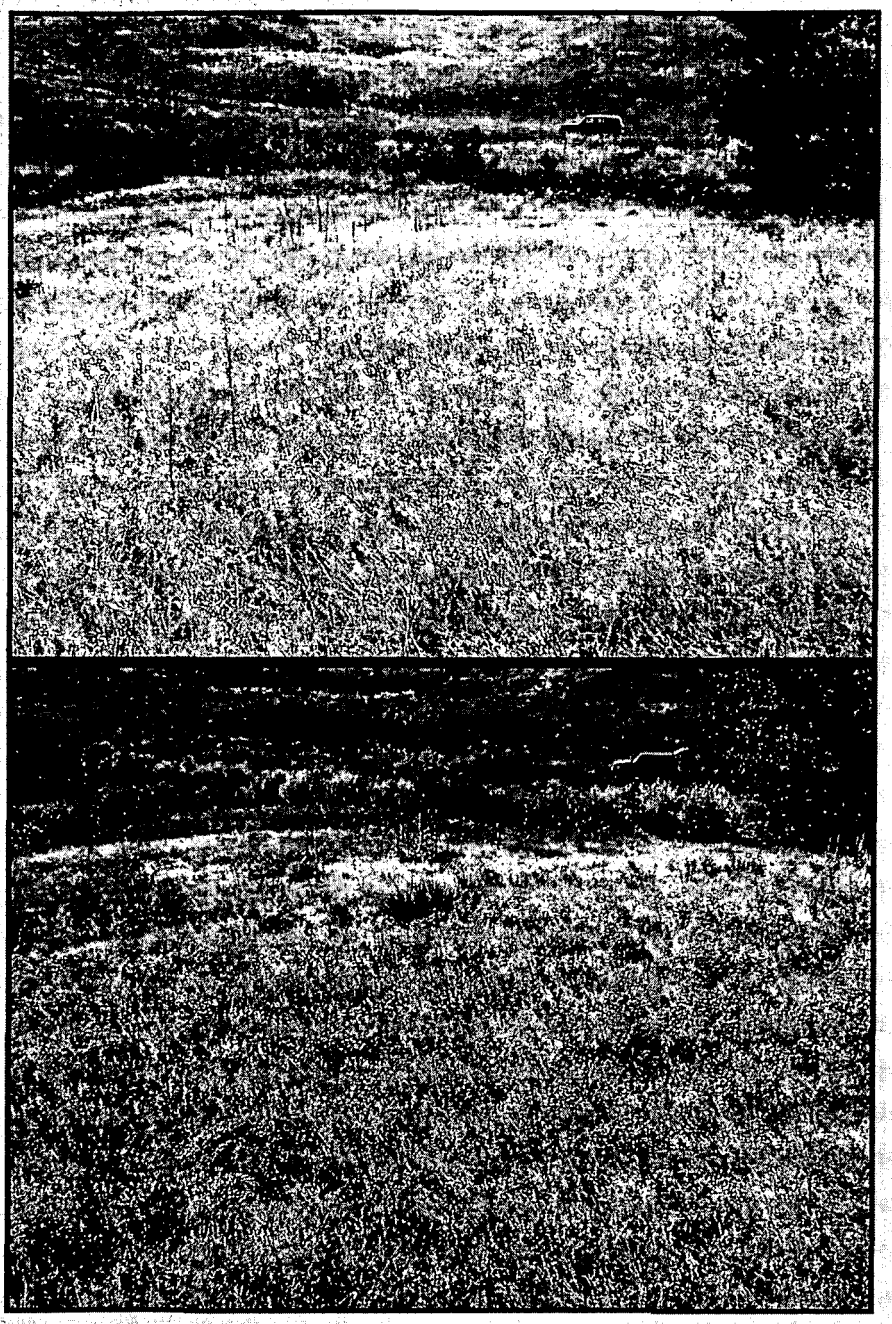
2004



South

2003

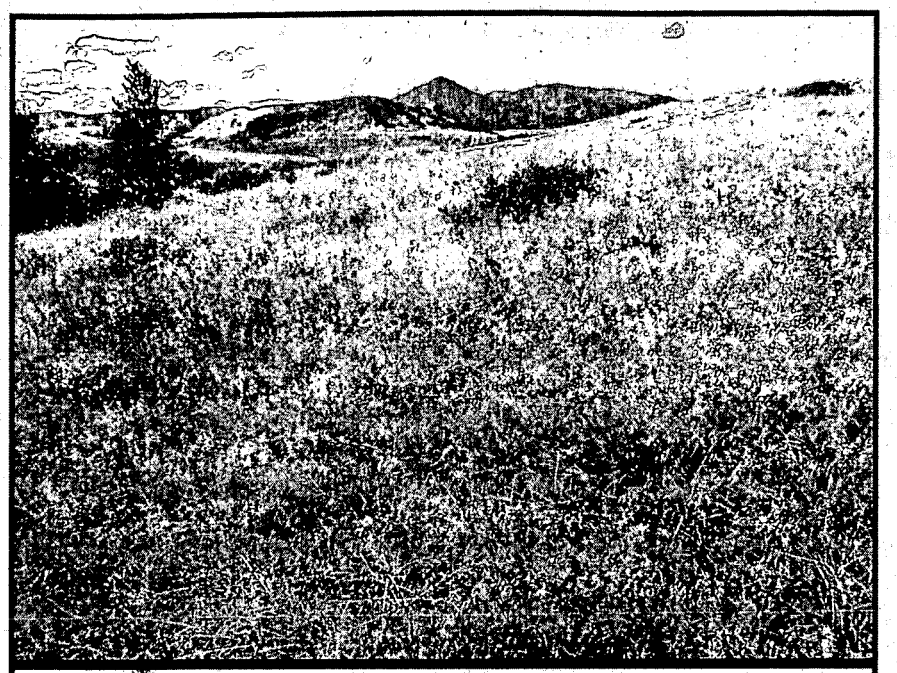
2004

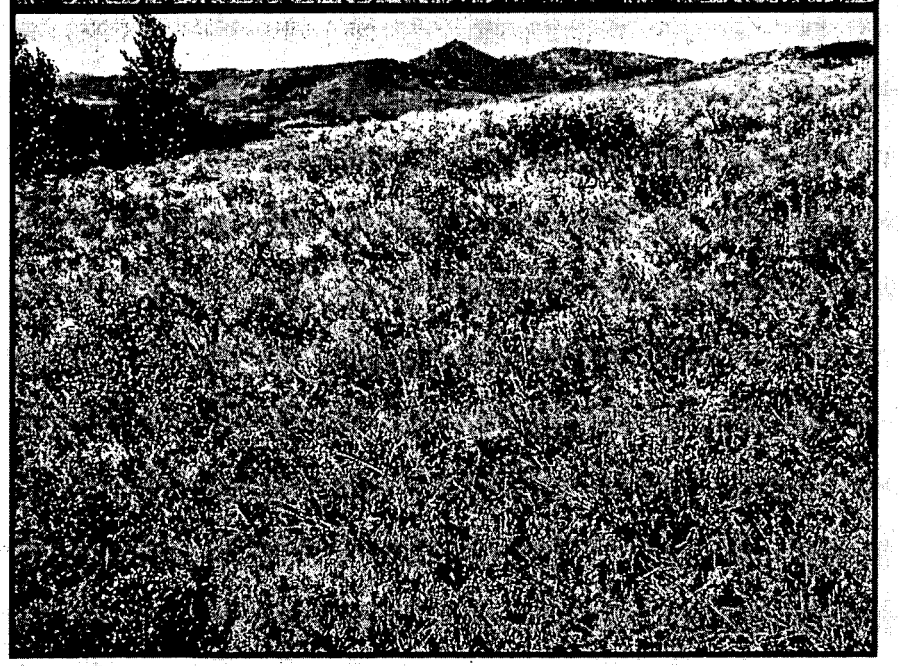


West

2003

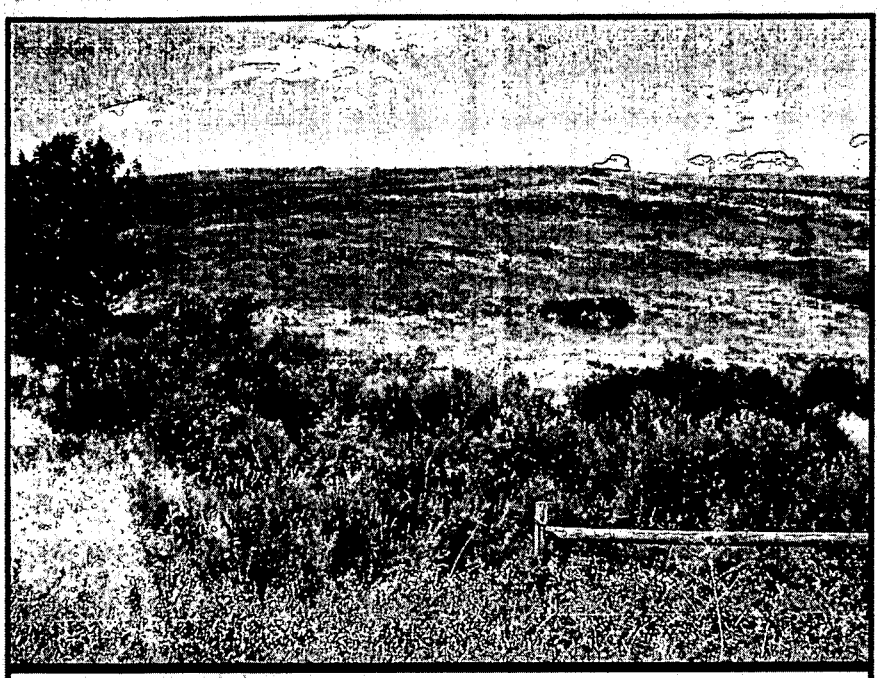
2004





Hillside

2003 **2004**

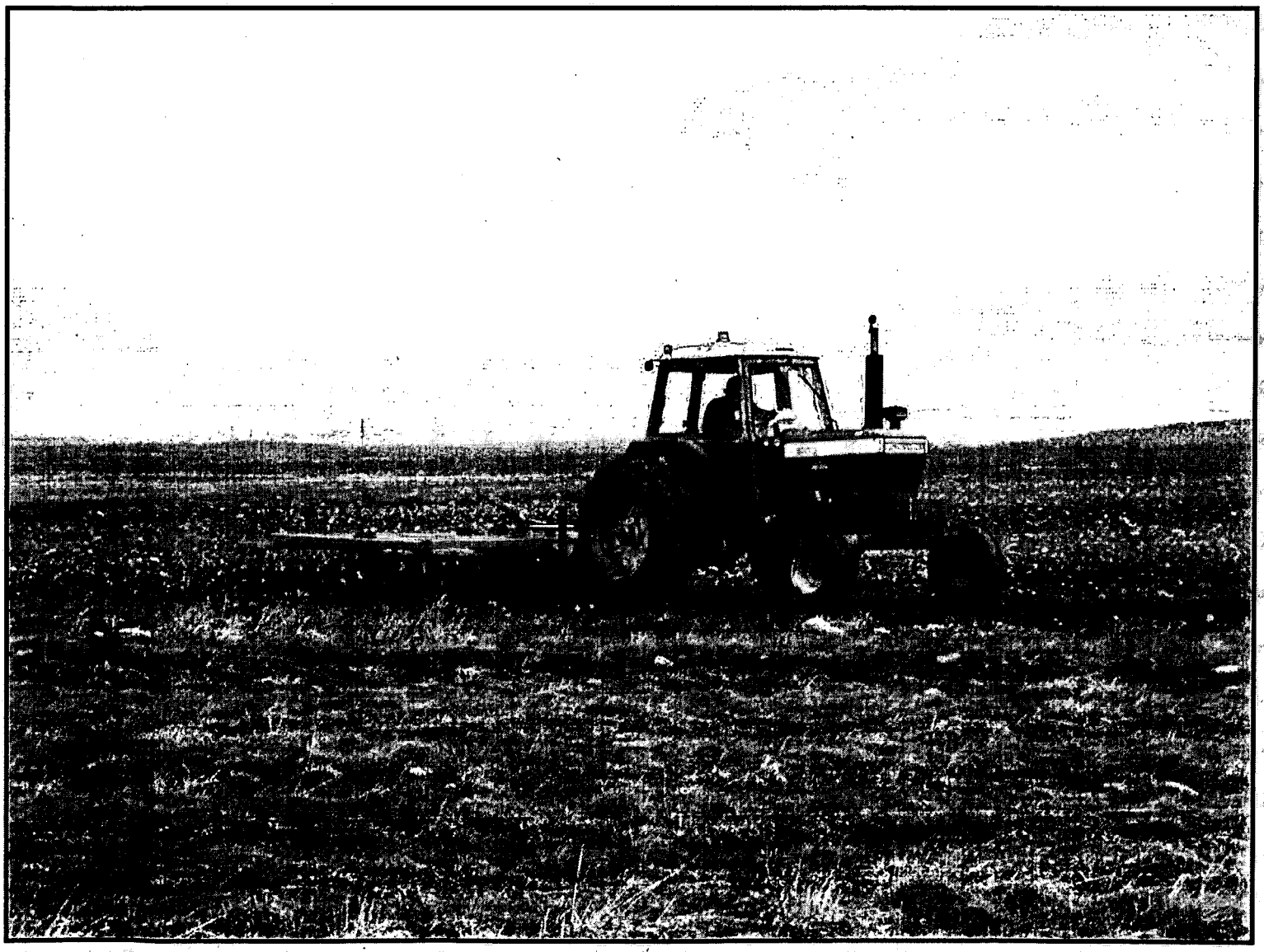


Appendix C

Revegetation Time-Series Photo Monitoring

at the Rocky Flats Environmental Technology Site

Since 1999, a number of locations in the Industrial Area and Buffer Zone at the Rocky Flats Environmental Technology Site have been revegetated at the conclusion of project activities. The links below will take you to maps and time-series photographs showing the locations and extent of the revegetation efforts undertaken to restore these areas with native plant species. Monitoring efforts continue to document the reestablishment of vegetation at these locations. Click on the links below to view the various projects.



Revegetation Areas Map (Linked to projects listed below)

Building 116/117

Building 886

Incinerator/Concrete Removal

MST Tanks

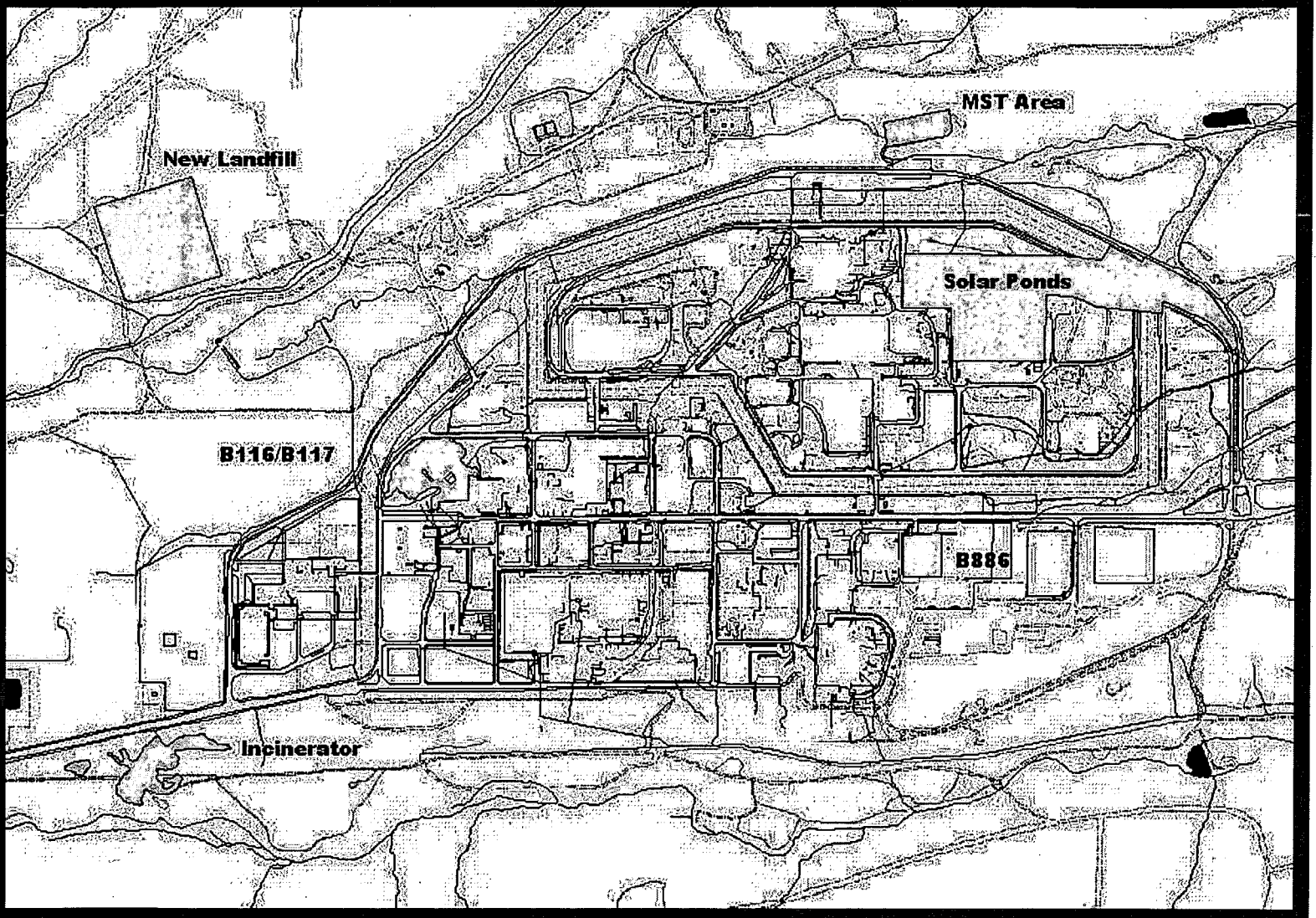
New Landfill

Solar Ponds

Revegetation Location Map

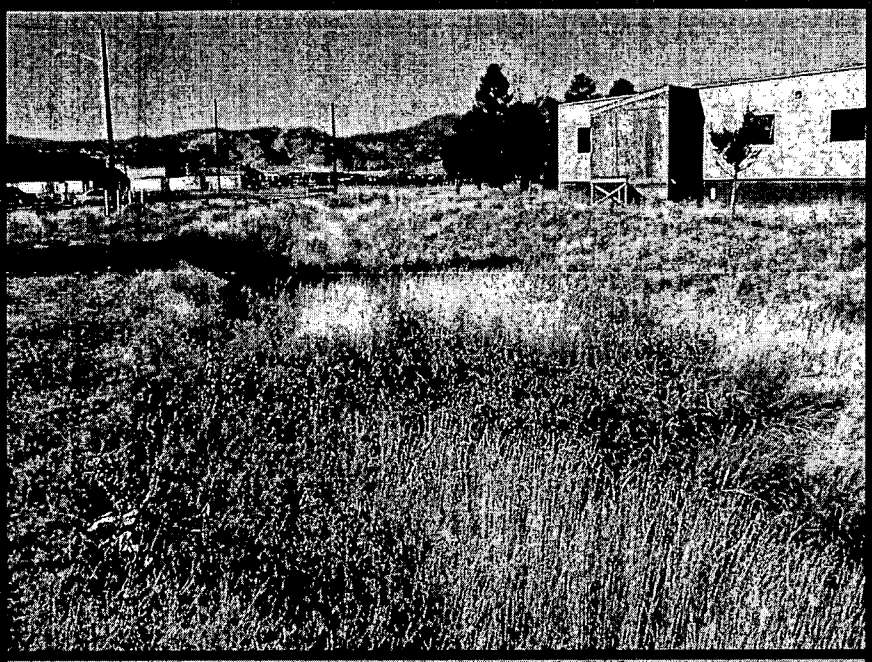
Rocky Flats Environmental Technology Site

As cleanup and closure of Rocky Flats continues, revegetation is being done and revegetation monitoring is being conducted. As part of the qualitative monitoring for revegetation monitoring, photographs of the revegetation locations are taken annually from permanent photo points. By clicking on each of the revegetation labels on the maps below, time-series photographs taken at that location may be viewed.



Building 116/117

October 2003

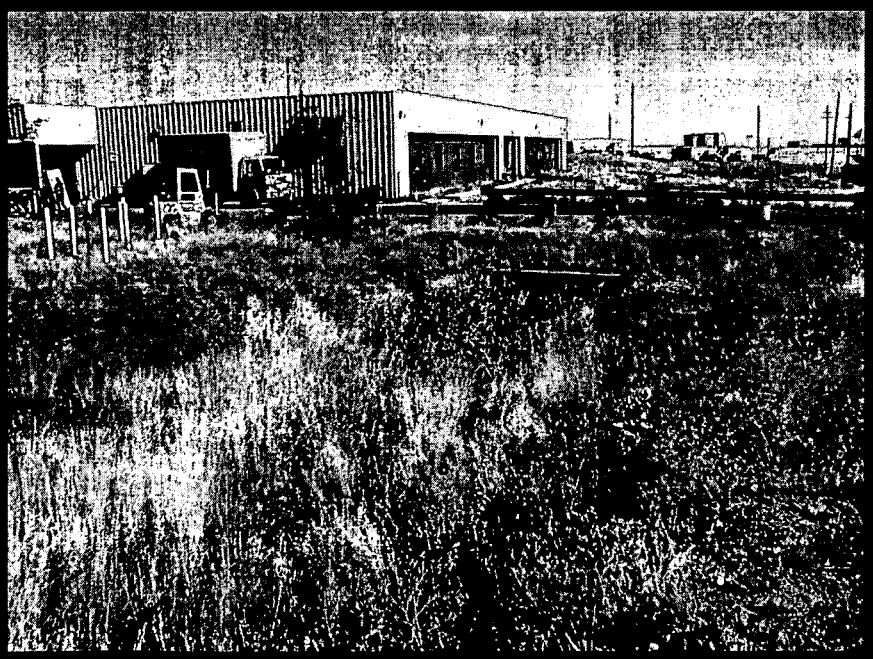


May 2004

August 2004

October 2003

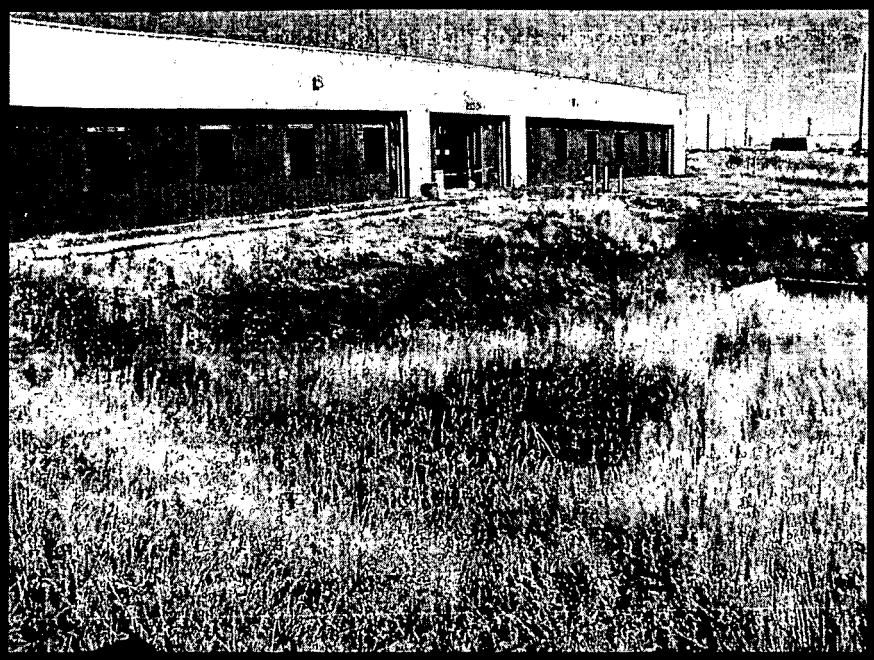
May 2004



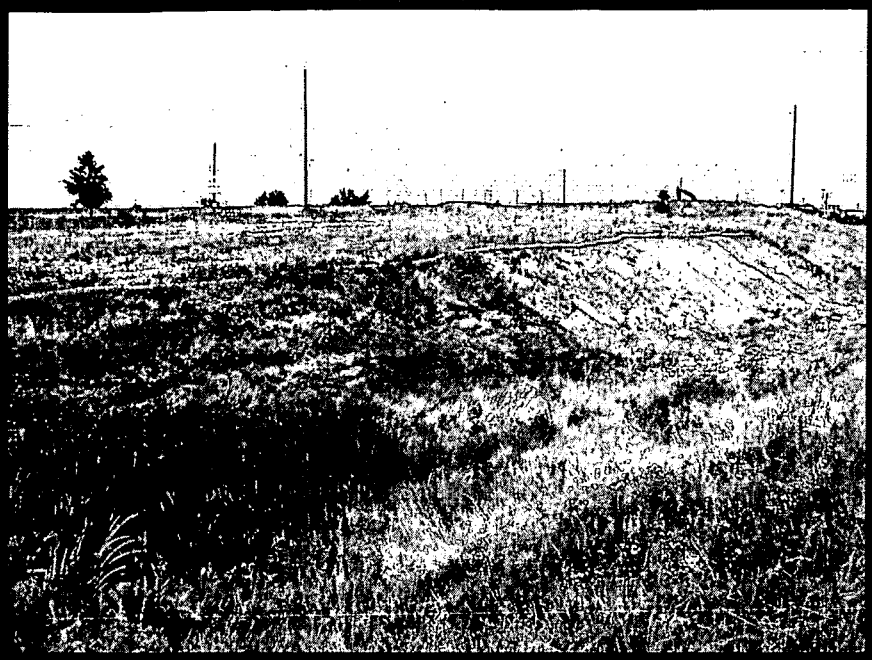
August 2004

October 2003

May 2004

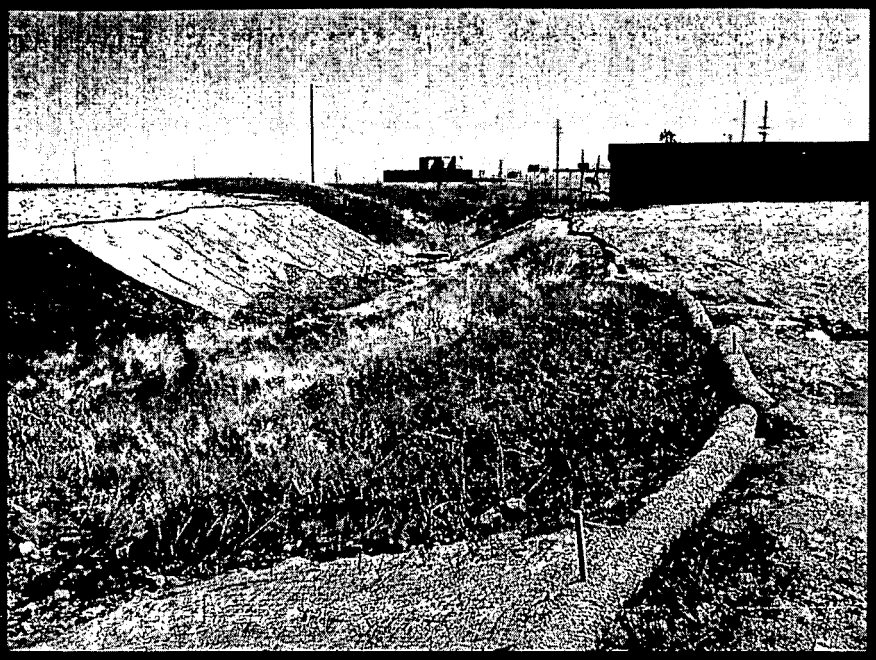


August 2004



October 2003

May 2004



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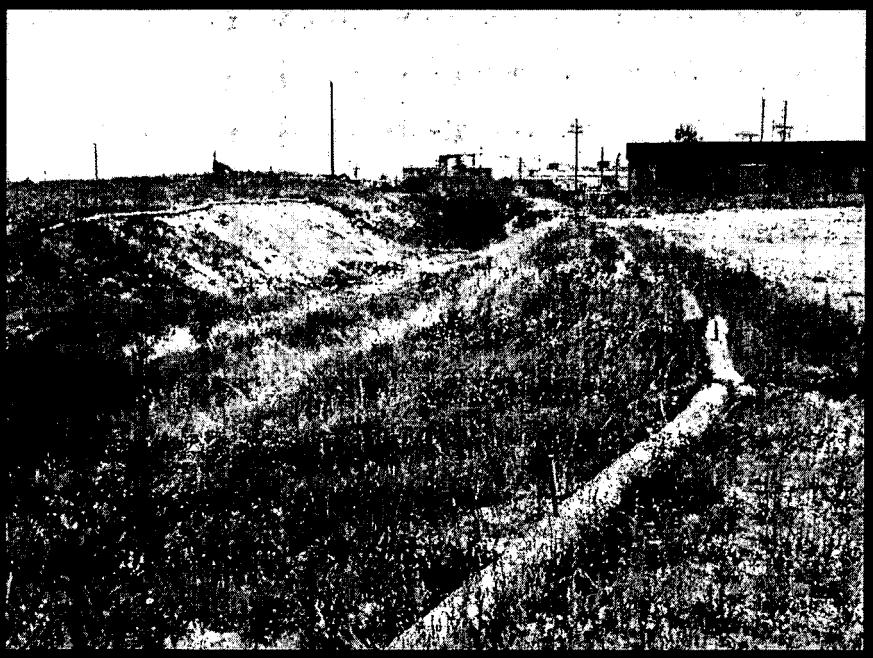
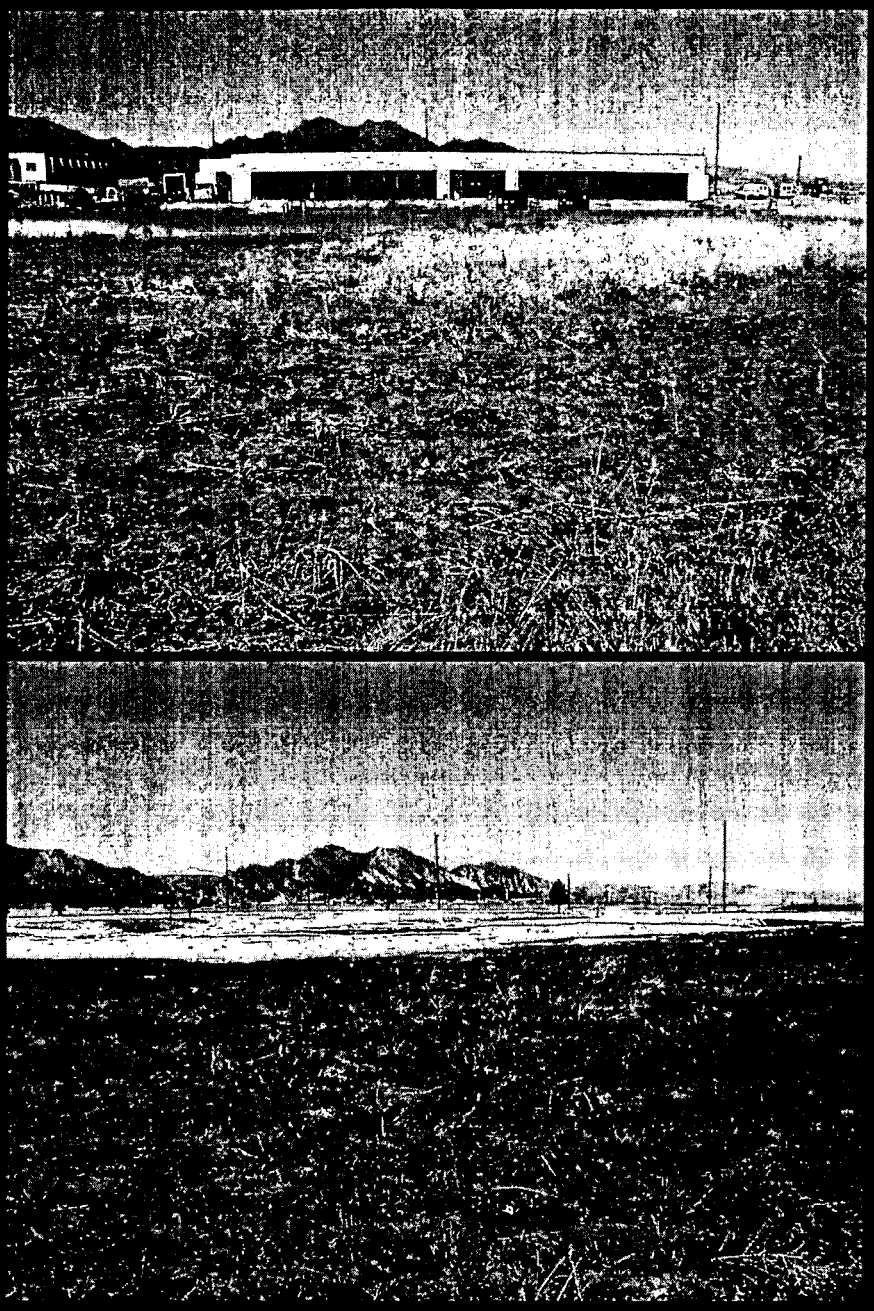
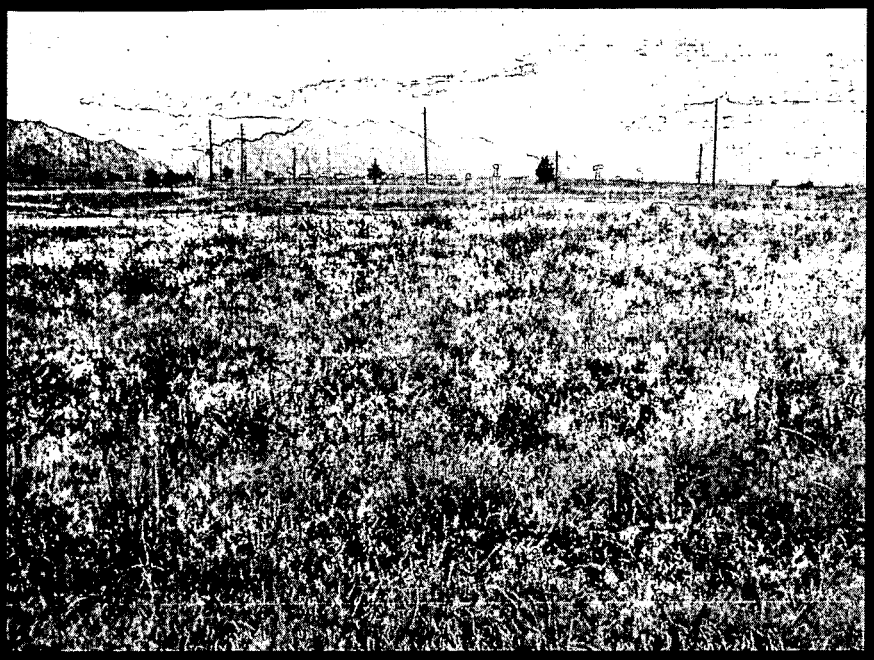


October 2003

May 2004



August 2004



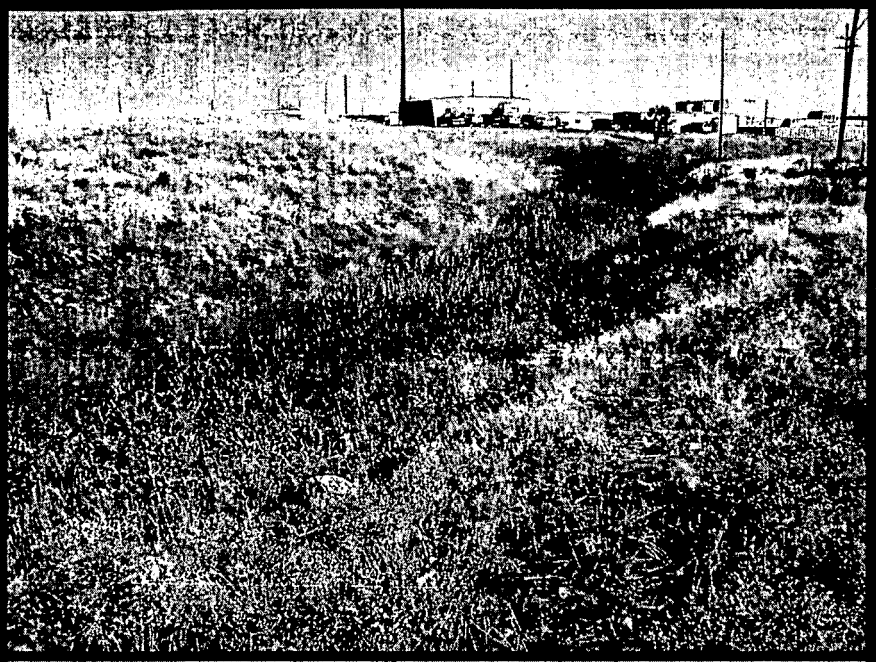
October 2003

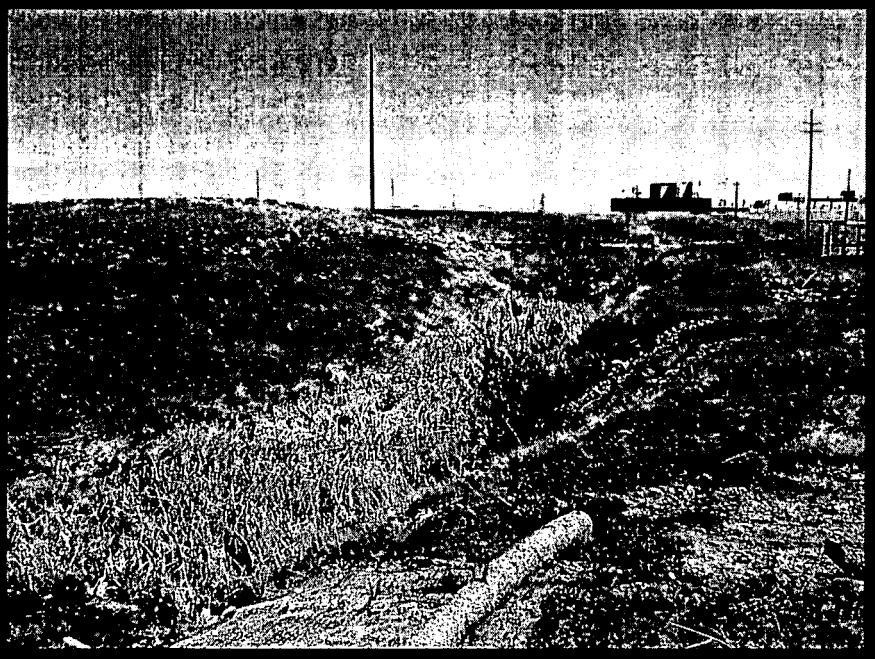
May 2004

August 2004

October 2003

May 2004

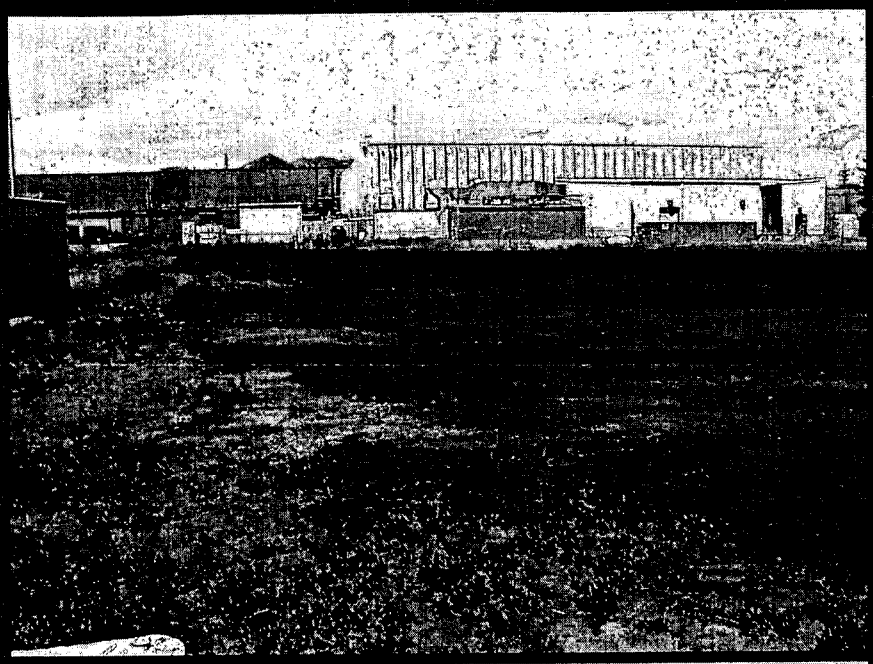




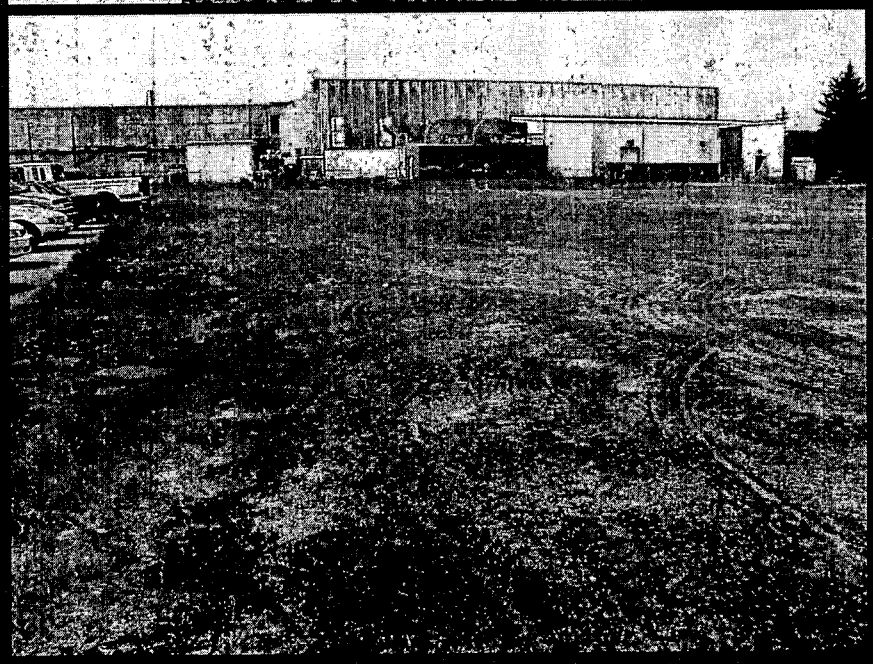
August 2004

Building 886

July 2002

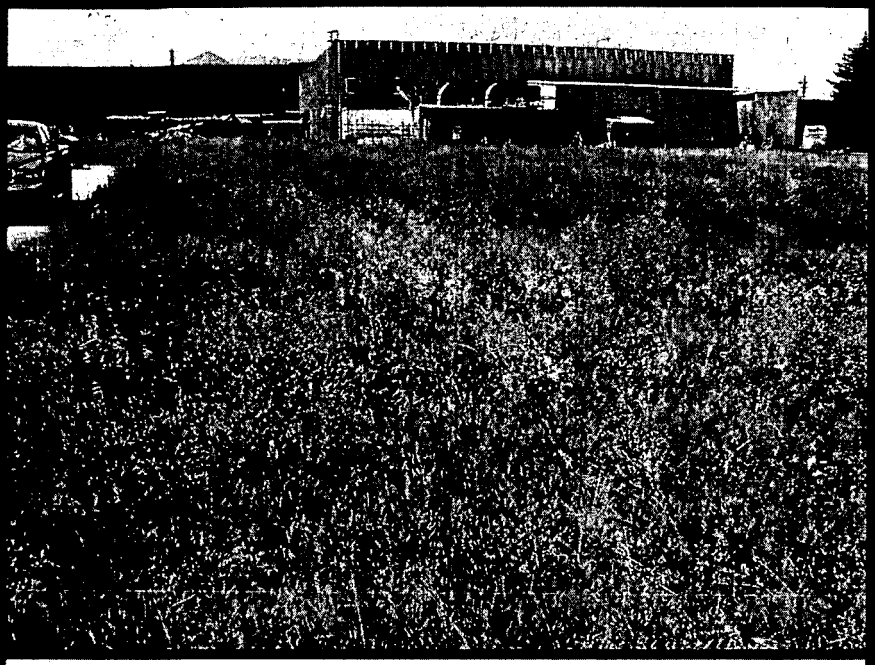


September 2002

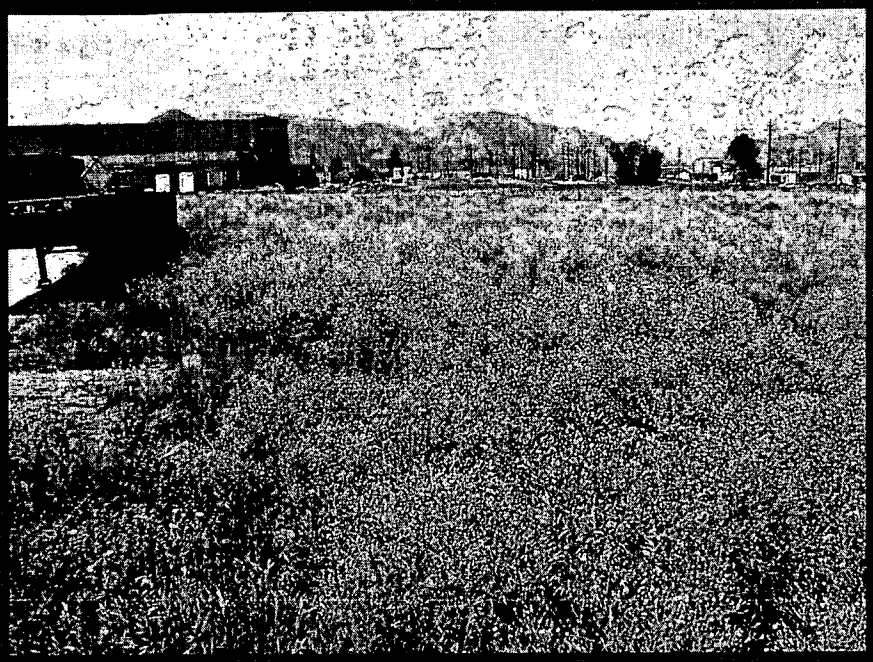


August 2003

May 2004



August 2004

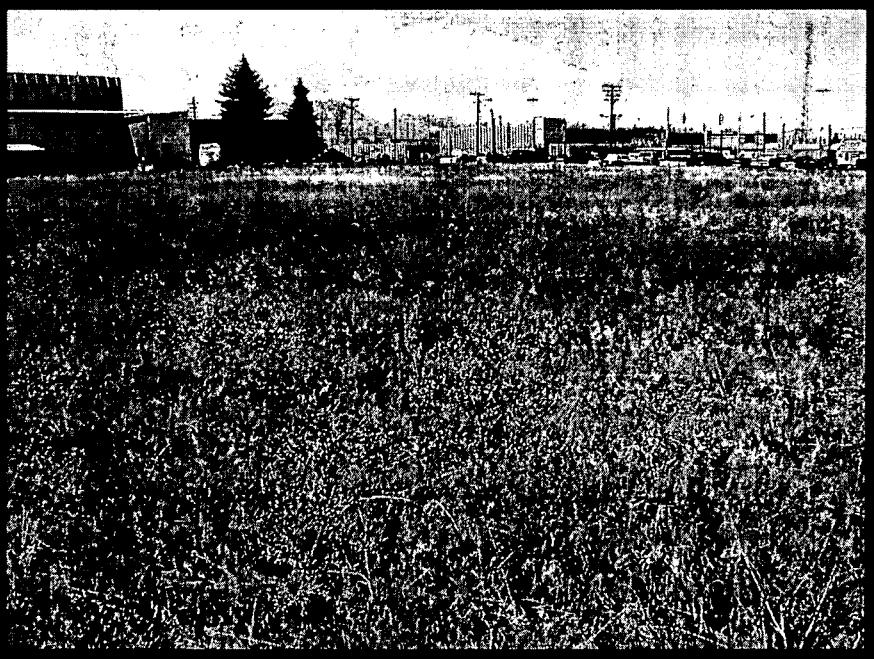


July 2002

September 2002

August 2003

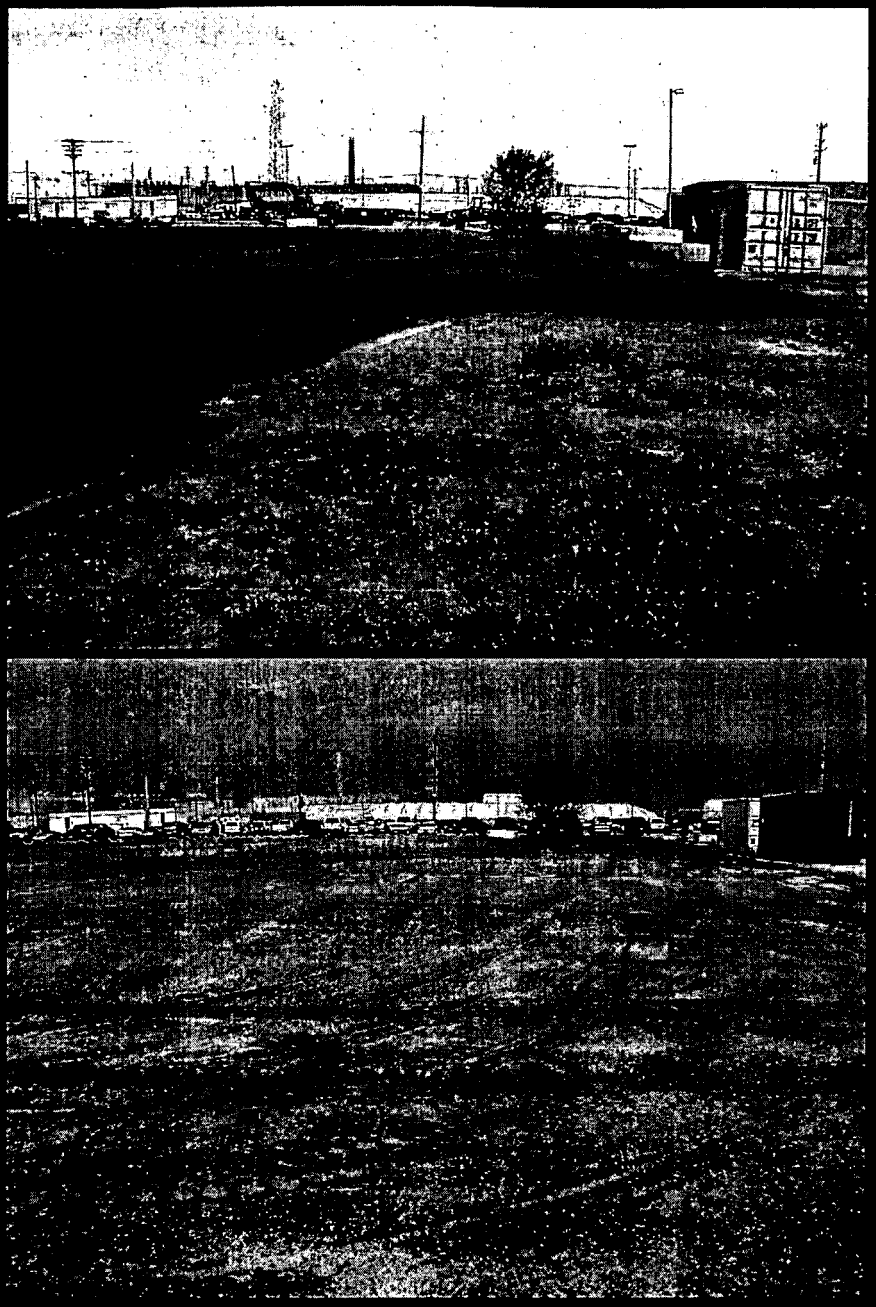
May 2004



August 2004

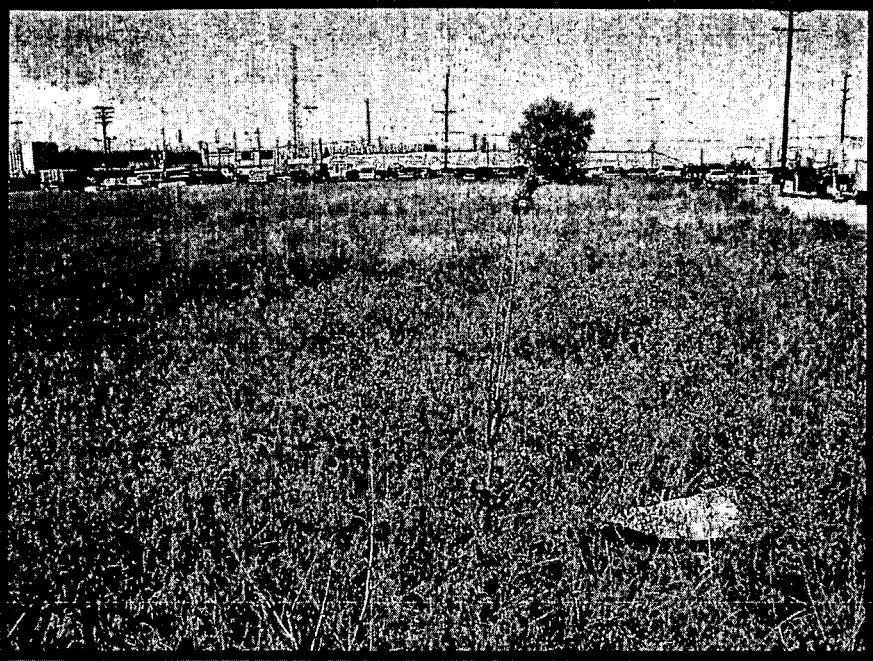
July 2002

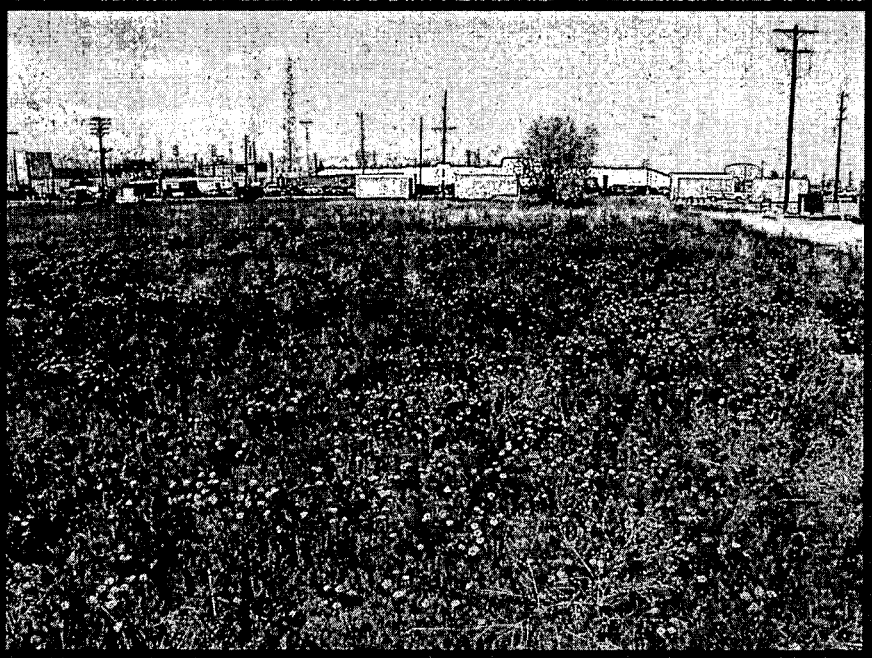
September 2002



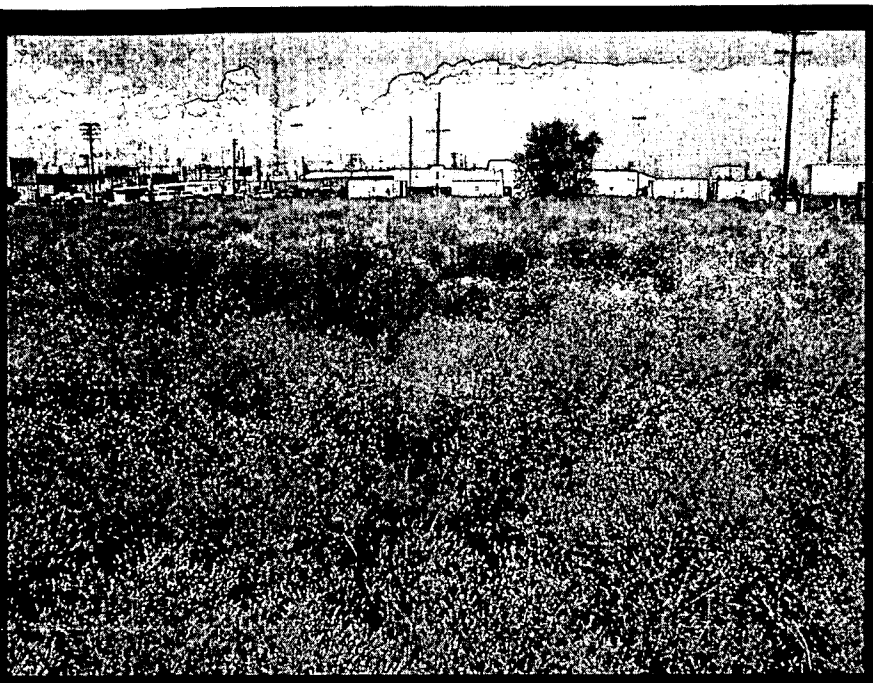
August 2003

May 2004





August 2004



Incinerator

April 2003

(during project work)

March 2004

(after re-seeding)

August 2004

April 2003

March 2004

August 2004

April 2003

March 2004

August 2004

April 2003

March 2004

August 2004

March 2004

August 2004

March 2004

August 2004

March 2004

August 2004

MST TANKS

August 2003

May 2004

August 2004

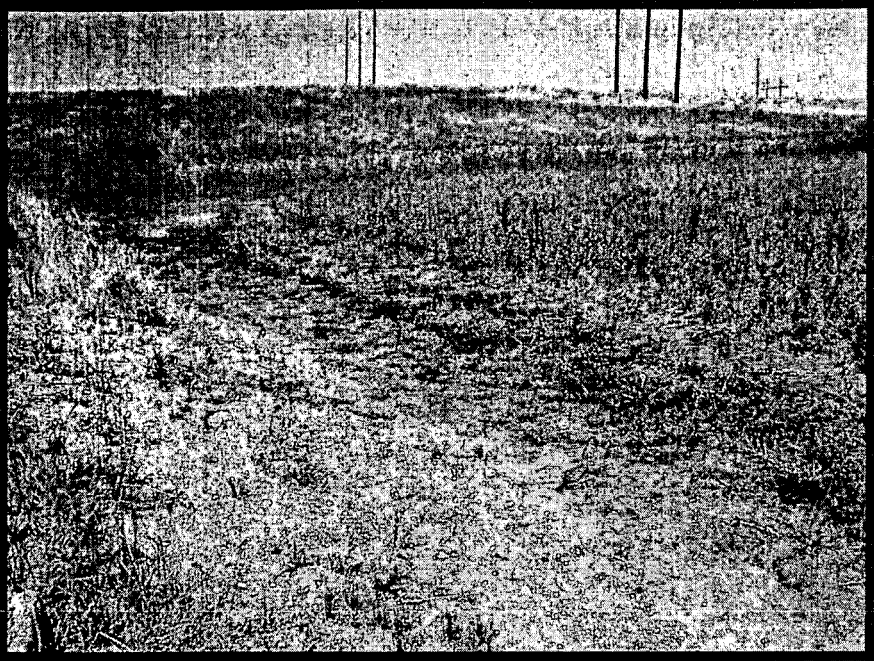
August 2003

May 2004

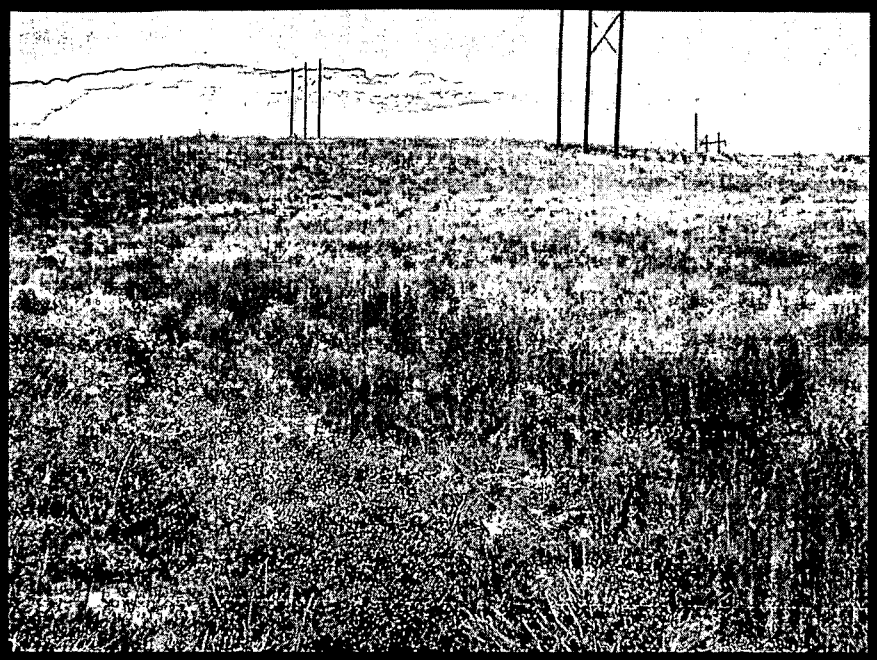
August 2004

August 2003

May 2004

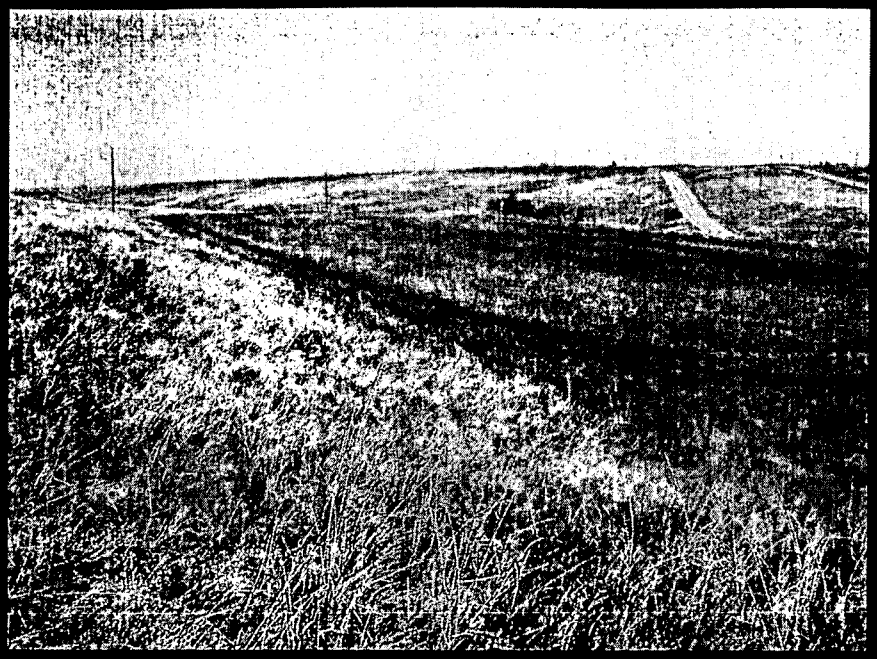


August 2004



August 2003

May 2004



August 2004

New Landfill

May 2003

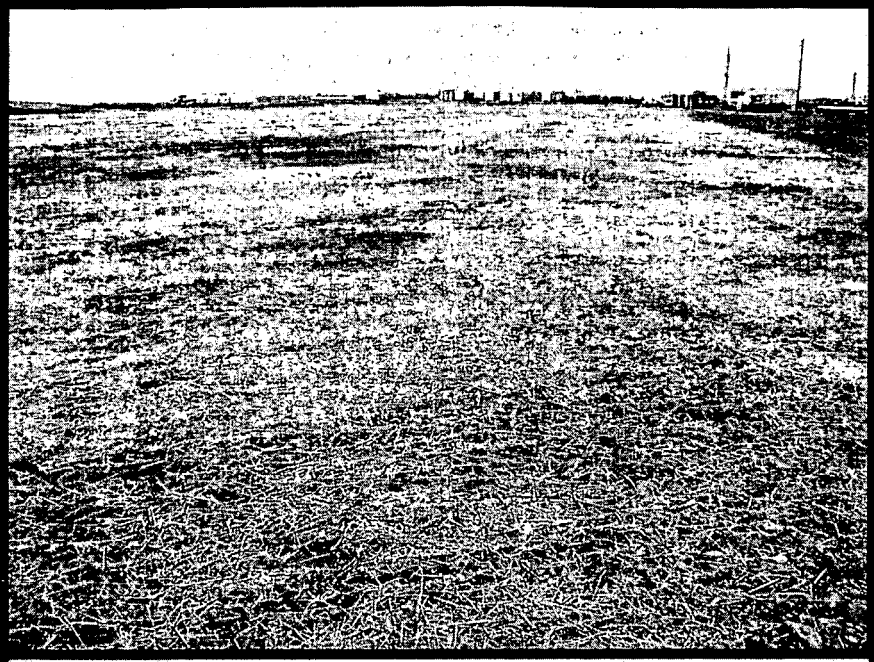
August 2003

May 2004

August 2004

May 2003

August 2003



May 2004

August 2004

May 2003

August 2003

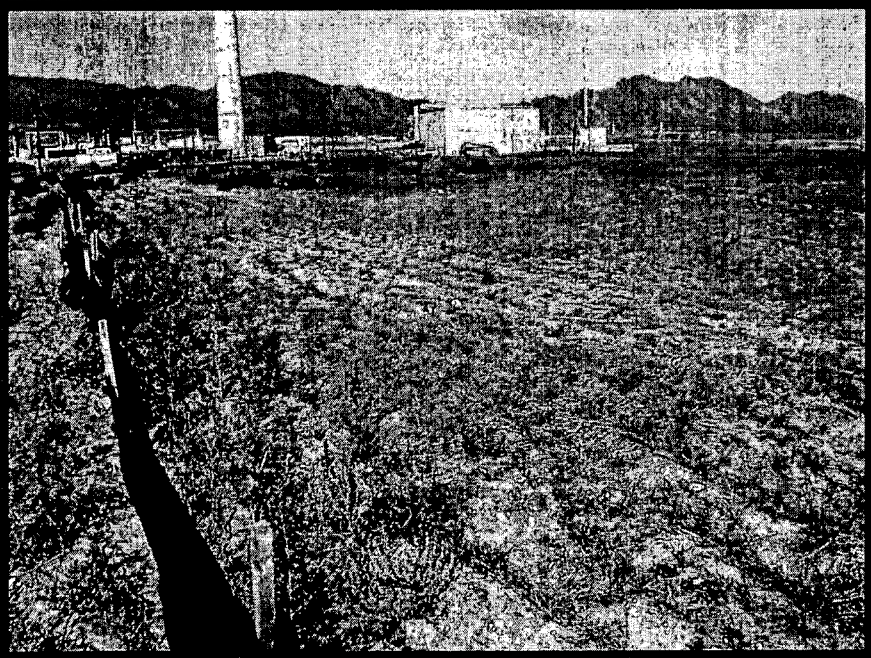
May 2004

August 2004

Solar Ponds

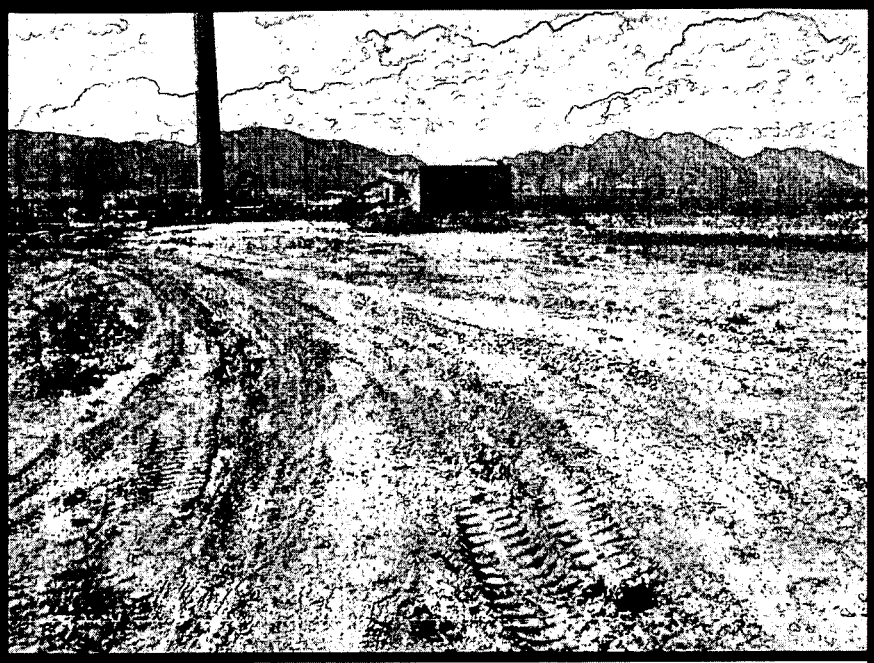
April 2003

August 2003



May 2004

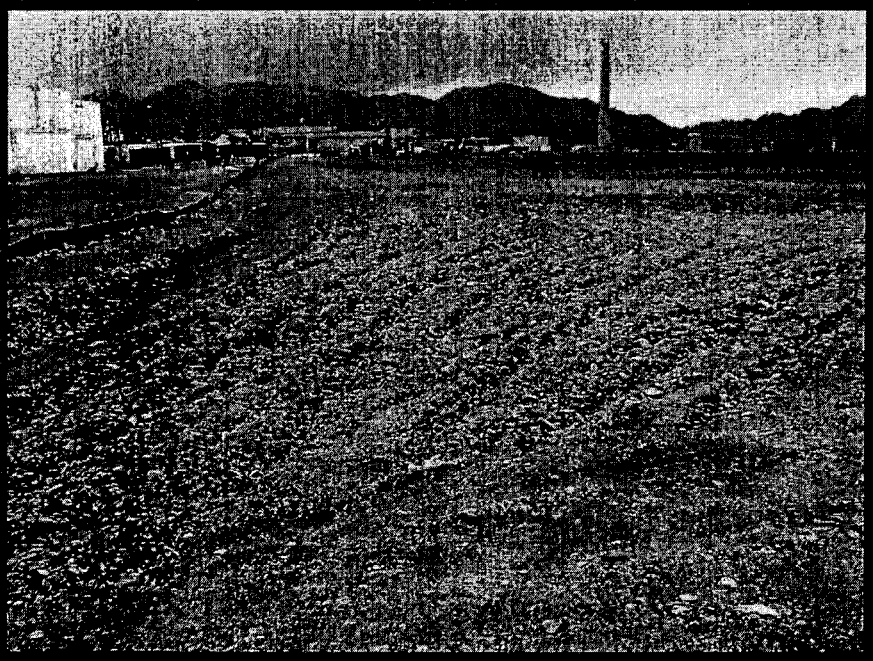
August 2004



September 2004

April 2003

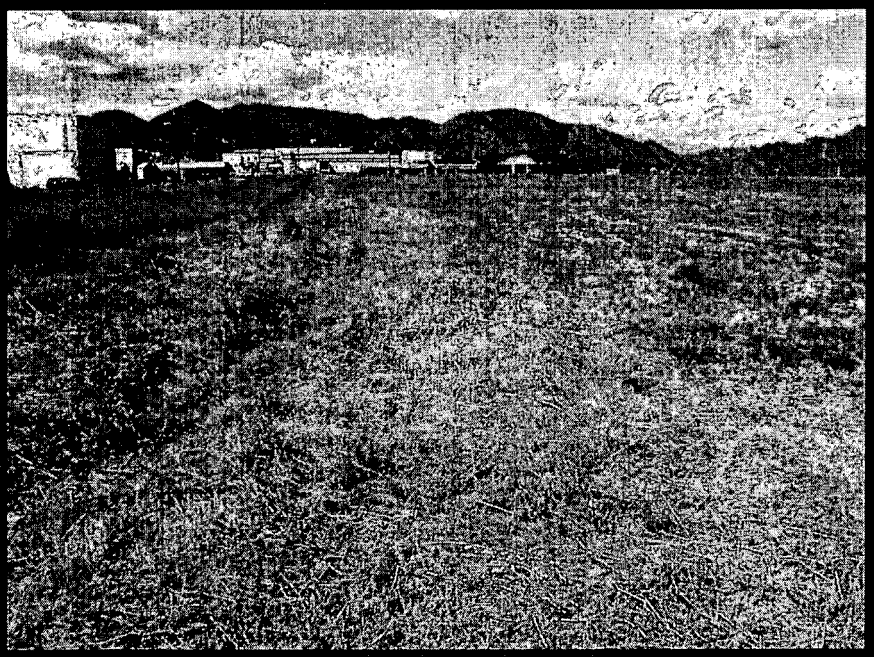
August 2003



May 2004

August 2004

September 2004



April 2003

August 2003

May 2004

August 2004

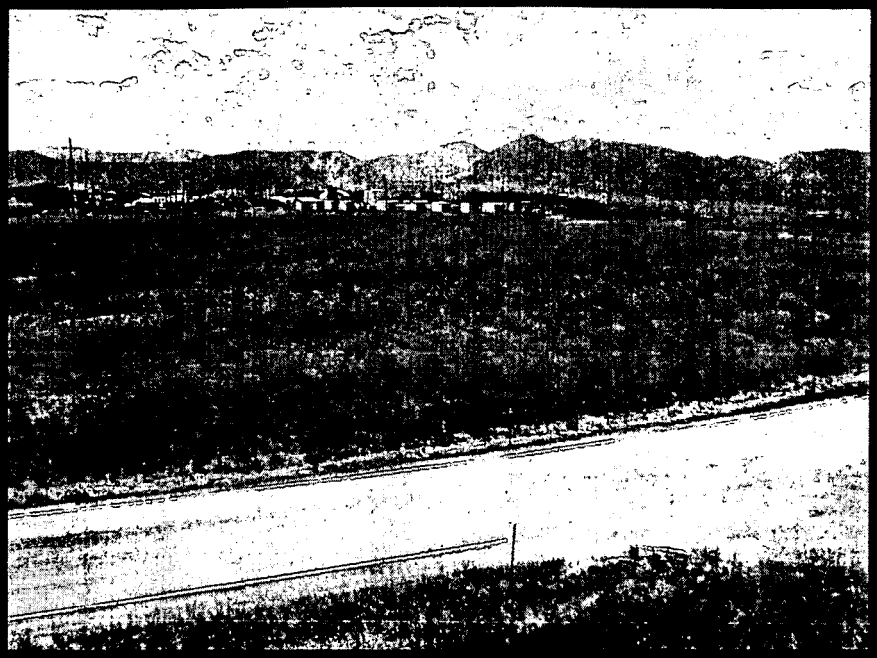
September 2004

April 2003

August 2003

May 2004

August 2004



Appendix D

High Value Vegetation

Photographic Monitoring Results (1997-2004)

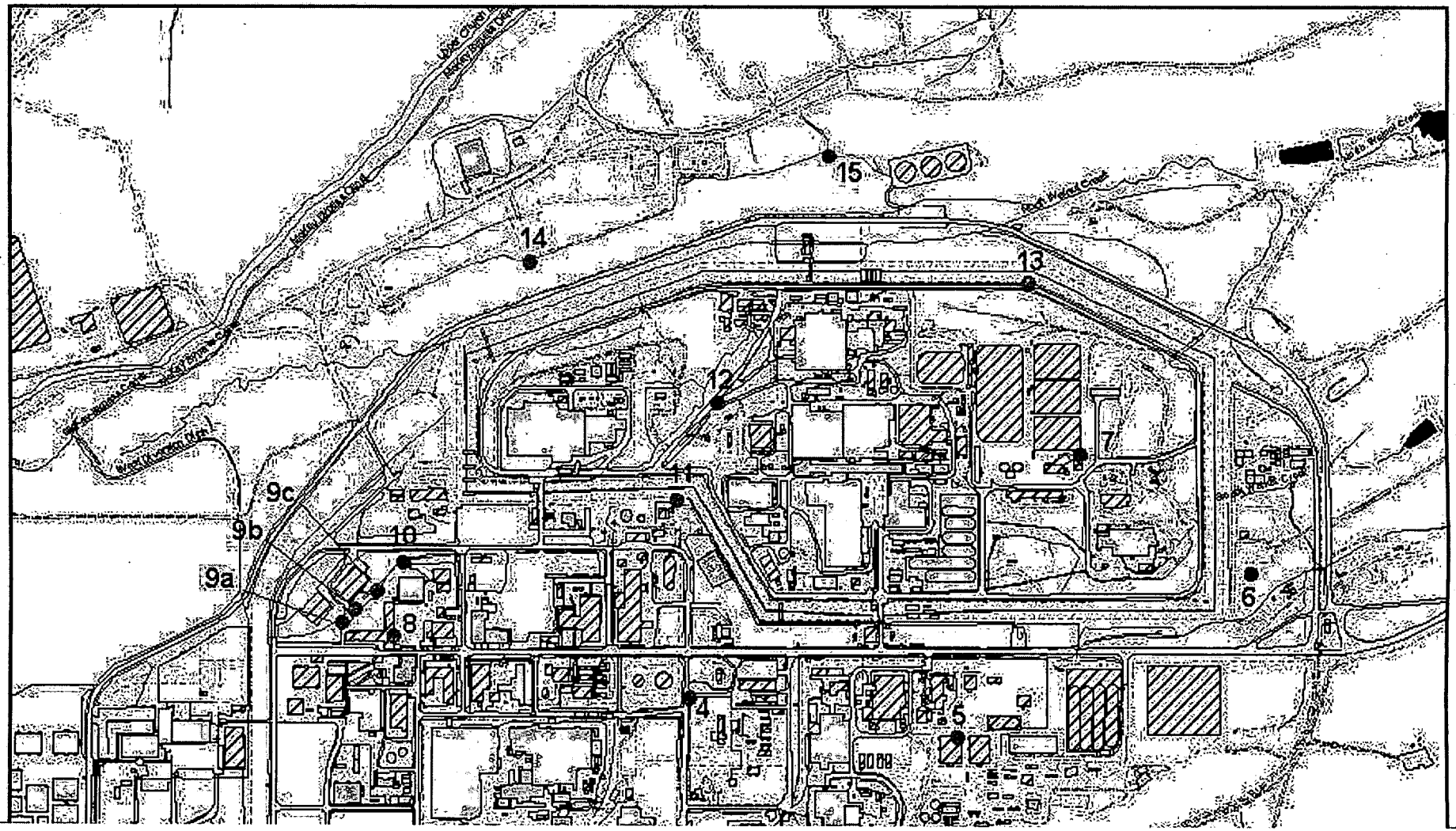
As part of the ongoing ecological monitoring at the Rocky Flats Environmental Technology Site (Site), permanent photo points were set in place in 1997 to provide a visual baseline of the current conditions of the various plant communities at the Site at that time. Starting in 1999 and continuing annually until 2004, photographs were retaken at these locations and examined to evaluate any changes in the plant communities. By clicking on one of the images below you can link to a map that shows the locations of the permanent photo points at the Site. To view side by side comparisons of one of the sets of photographs taken at that location in 1997 and 1999-2004, click on that photo point.

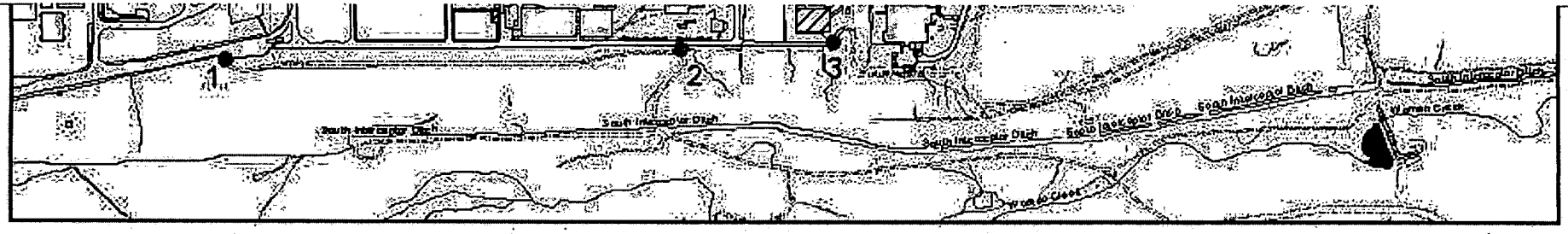
1997 **2004**

Appendix E

RFETS Industrial Area Photo Point Monitoring

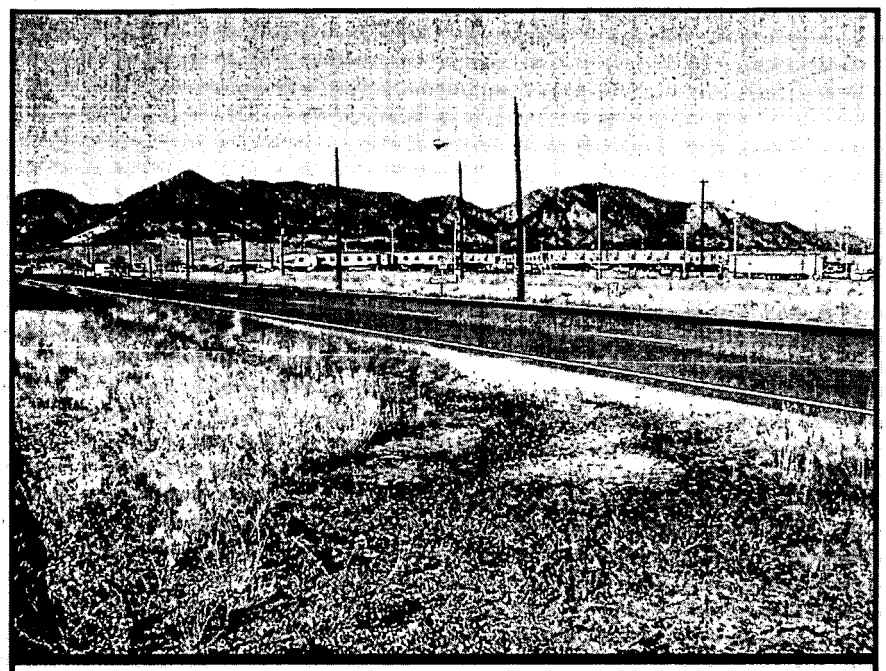
In 2003, a series of permanent photo points were established in the Industrial Area (IA) at the Rocky Flats Environmental Technology Site (RFETS) to monitor landscape changes as the buildings and other structures were removed. As the buildings come down and the area is reseeded to grassland, the photo points will provide a visual documentation of the landscape changes that are transforming the IA from an industrial facility to a National Wildlife Refuge. By clicking on one of the photo points on the map below you can see the photographs taken starting in late 2003 that document the condition of the IA at that time.



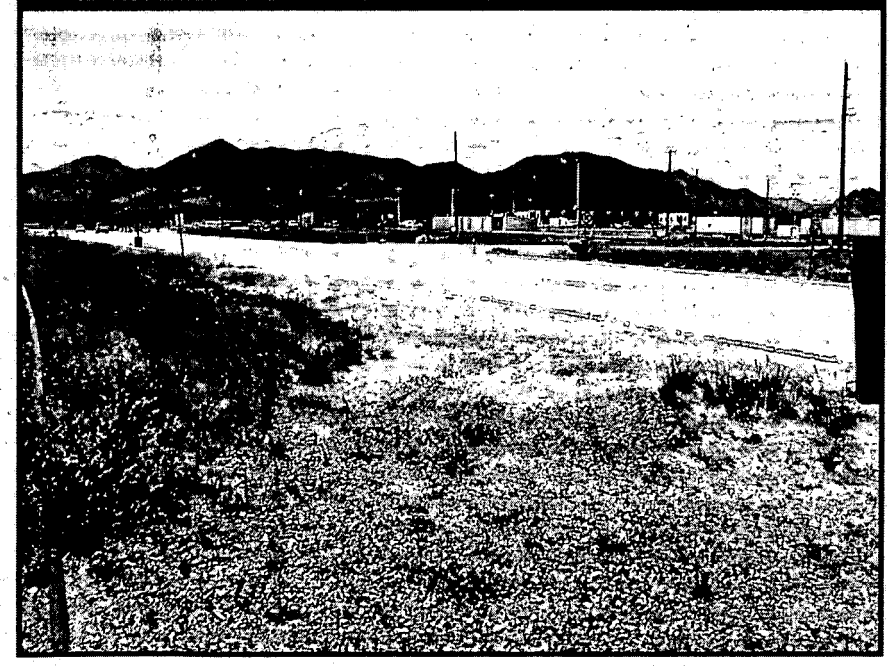

1
2
3
South Interceptor Ditch
South Interceptor Ditch
South Interceptor Ditch
South Interceptor Ditch
South Interceptor Ditch
Woman Creek
Woman Creek

IA Photopoint #1

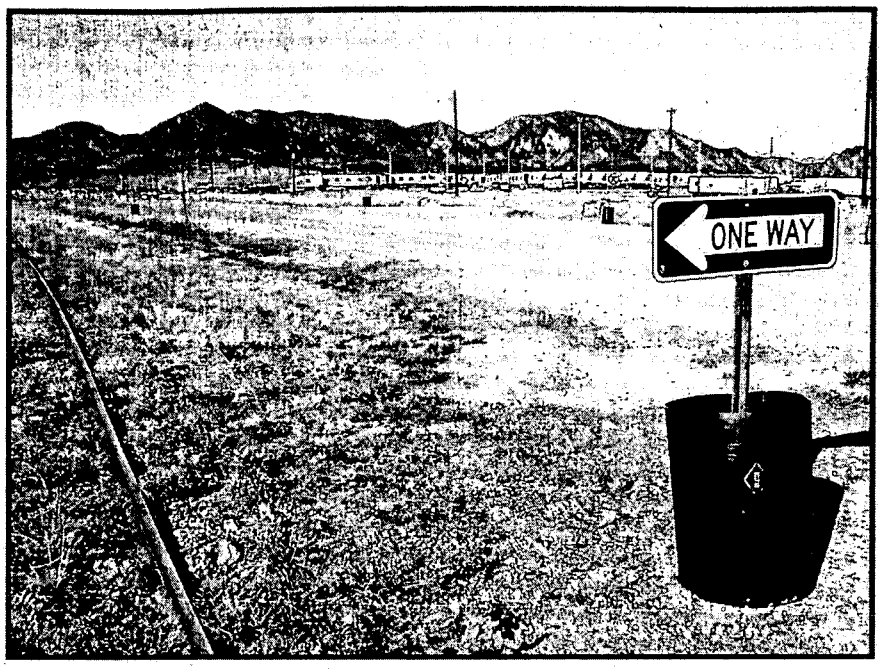
October 2003

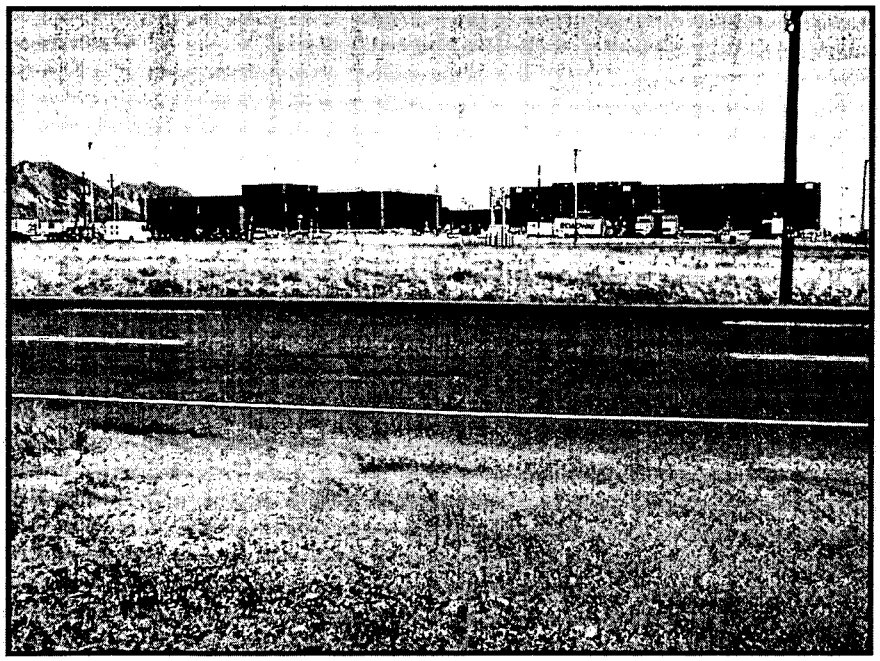


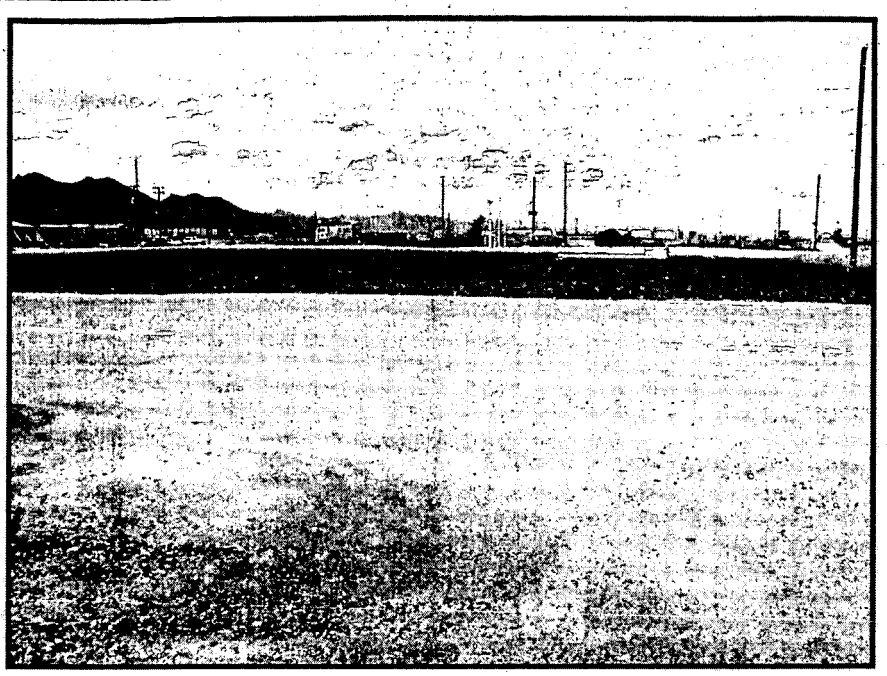
May 2004

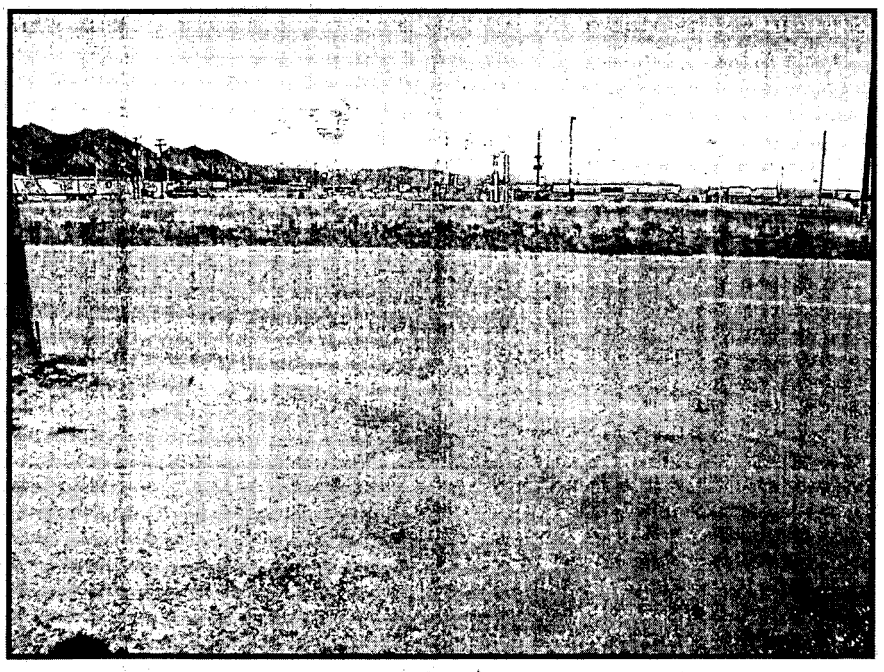


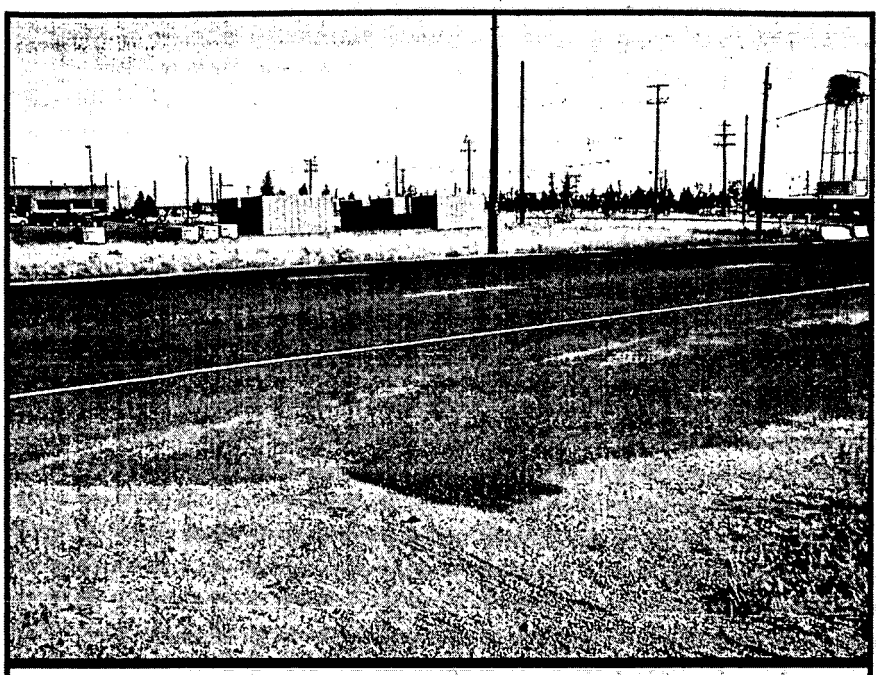
October 2004

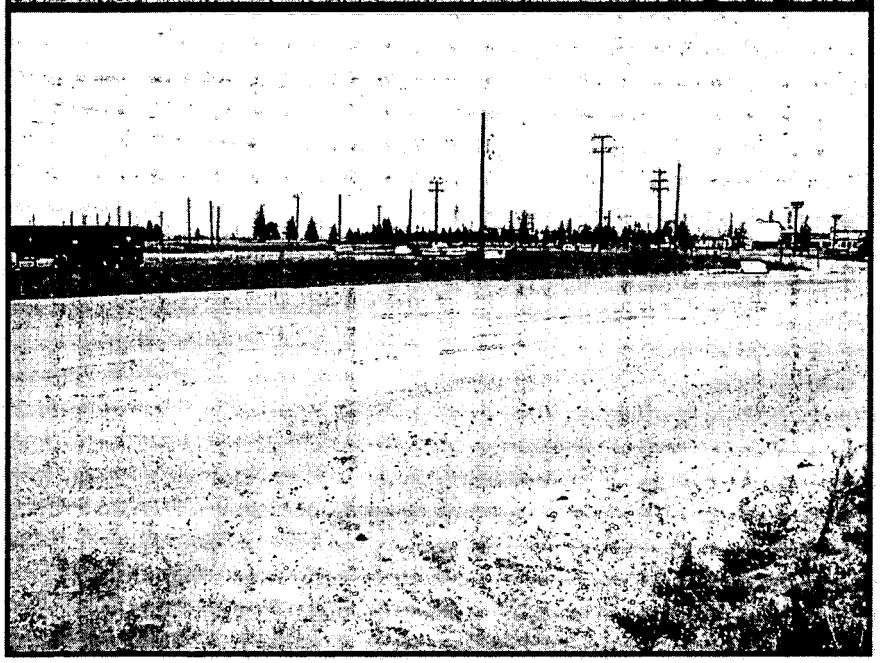

ONE WAY

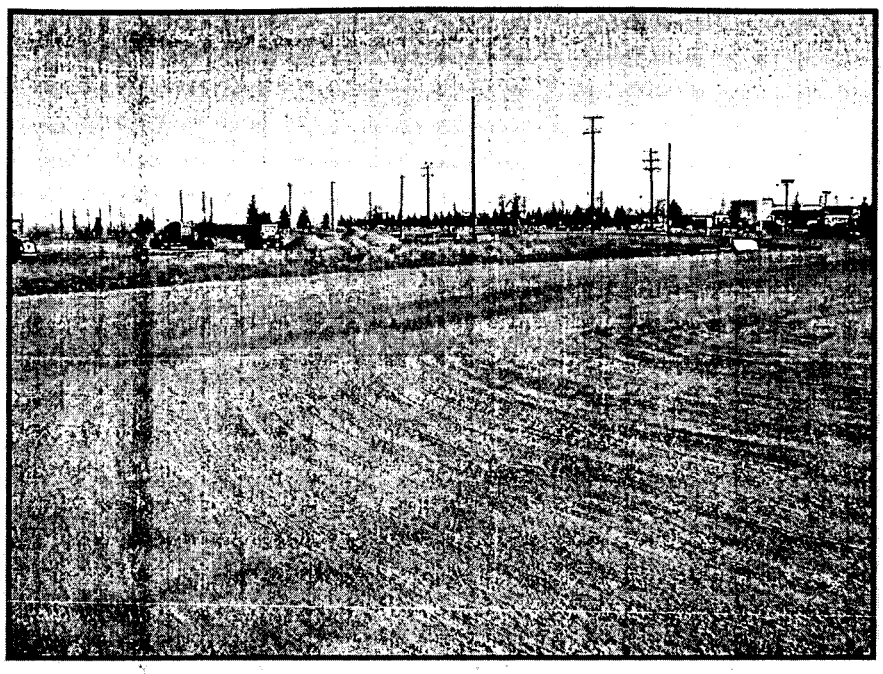


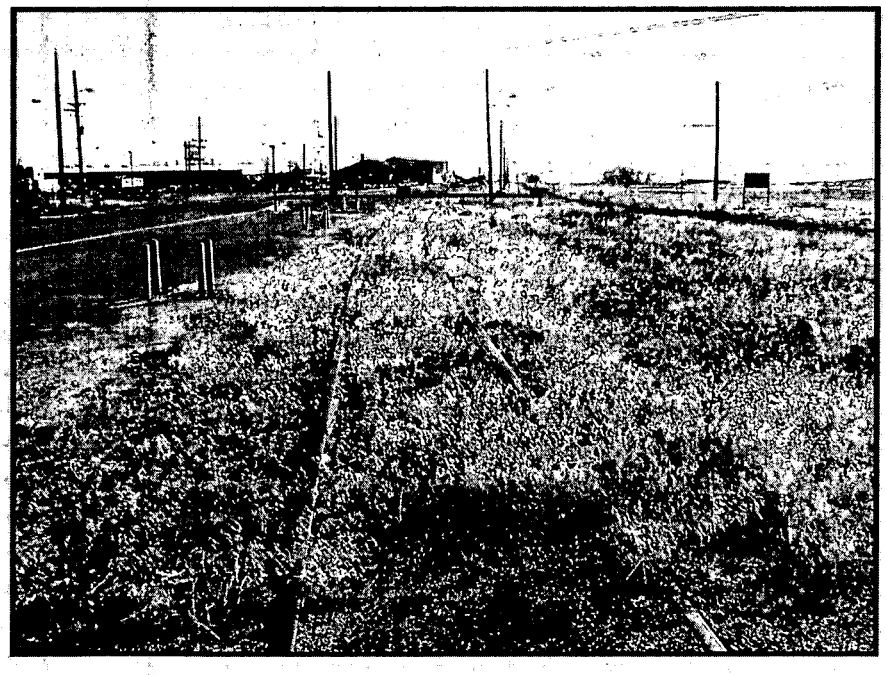


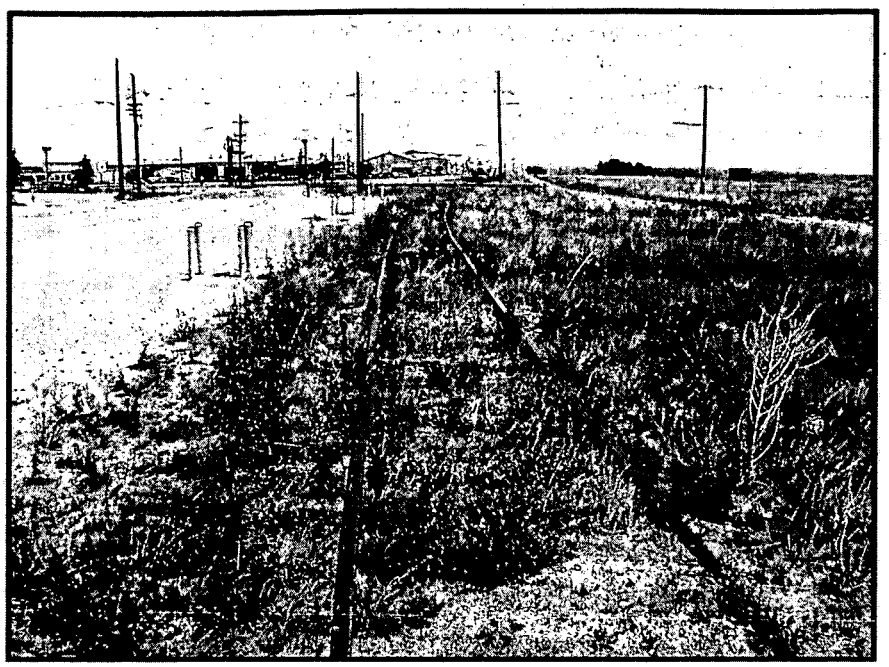


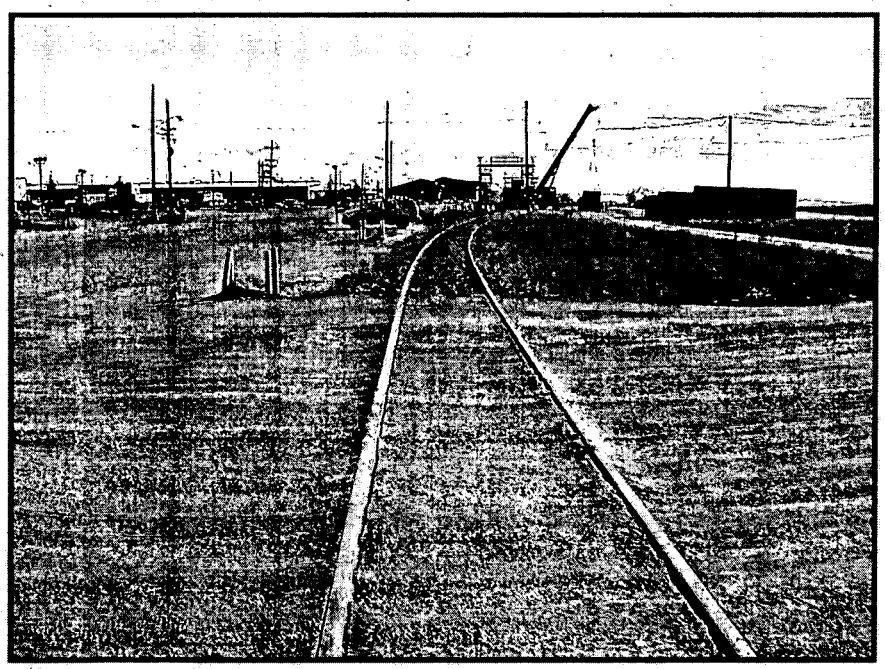






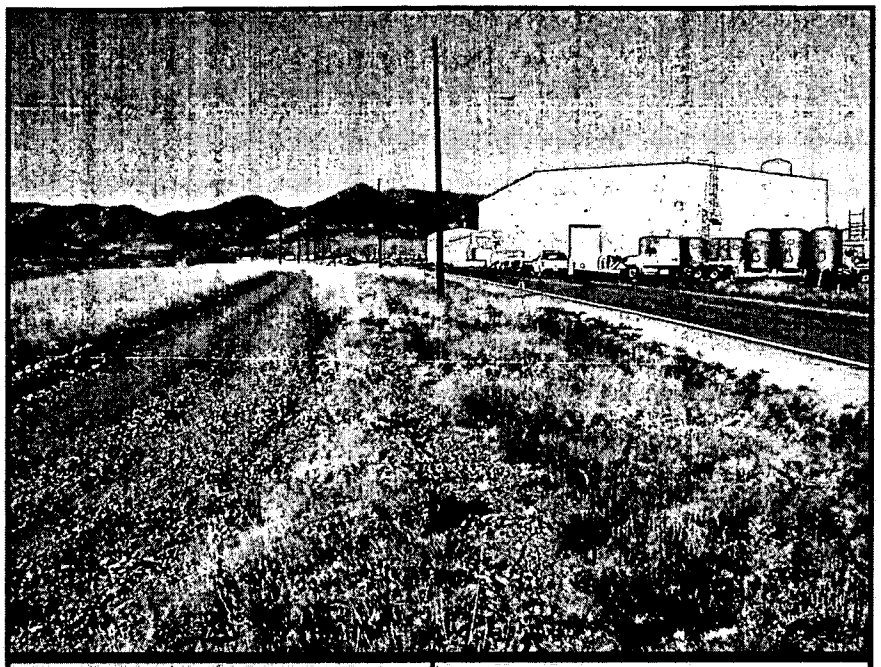






IA Photopoint #2

October 2003



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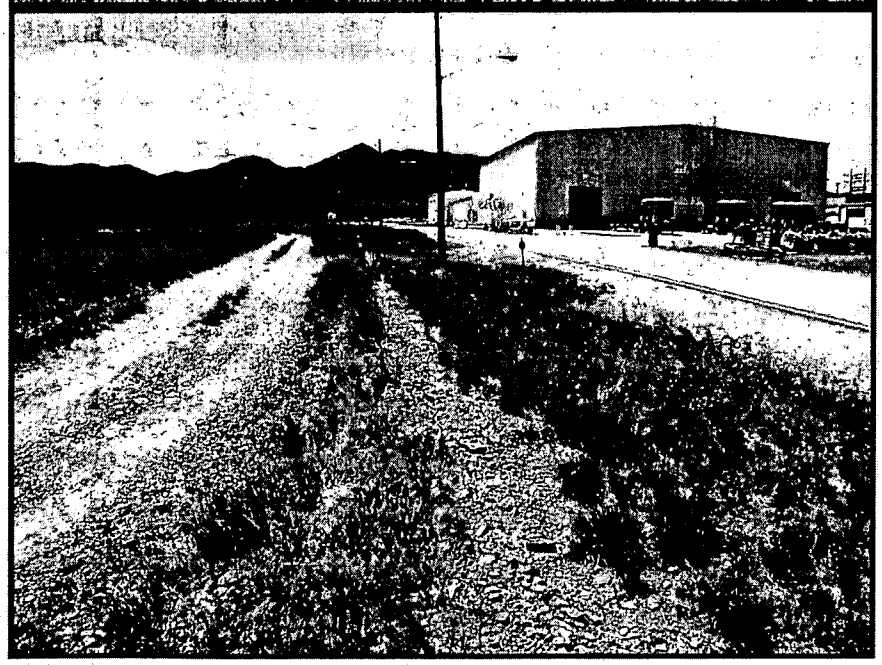

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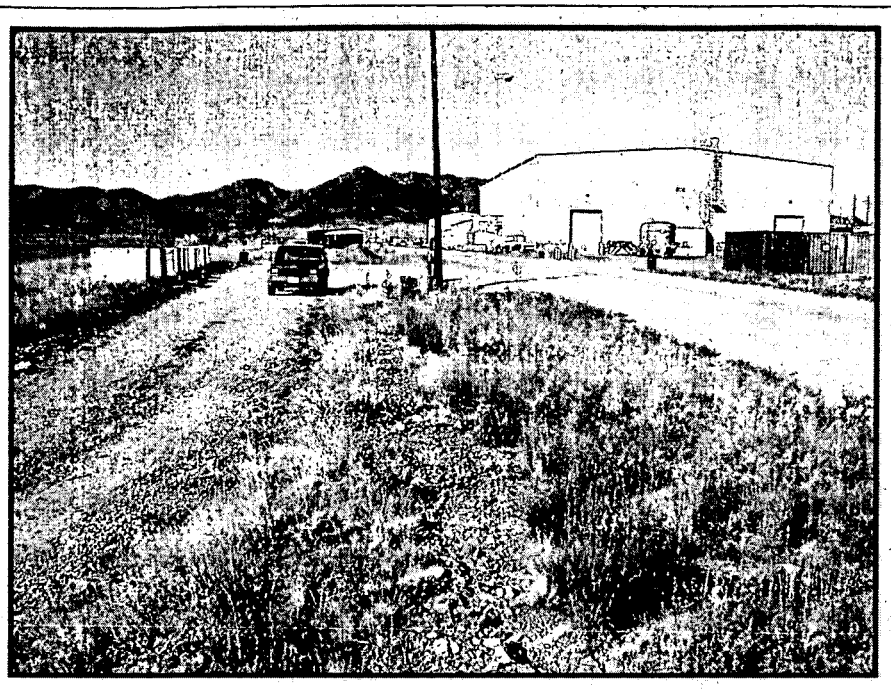
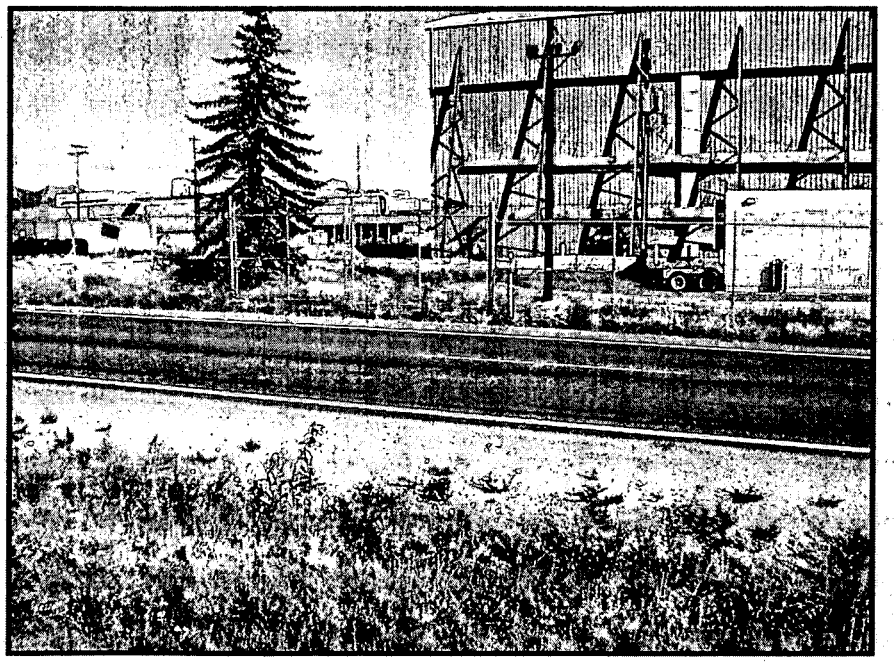
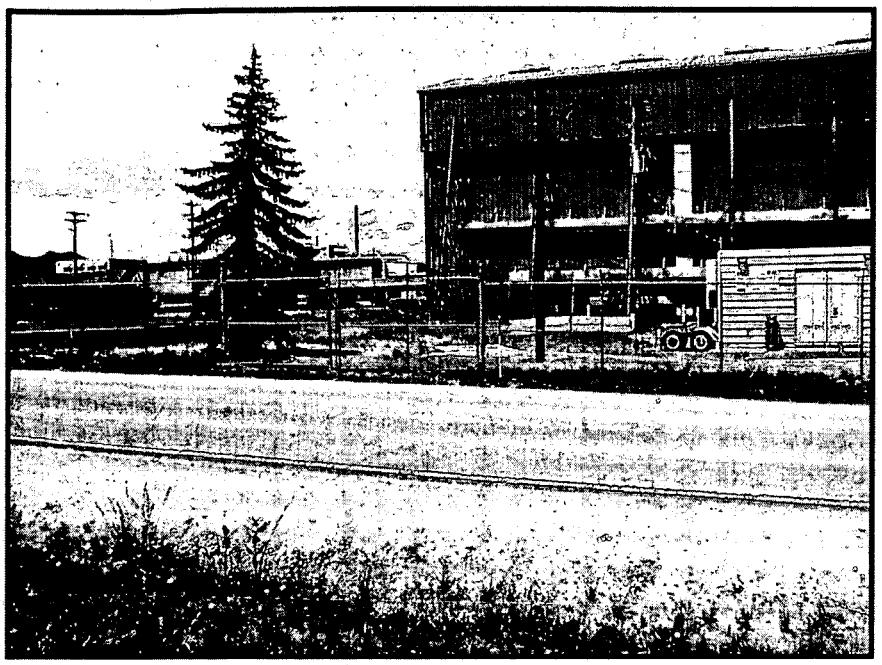
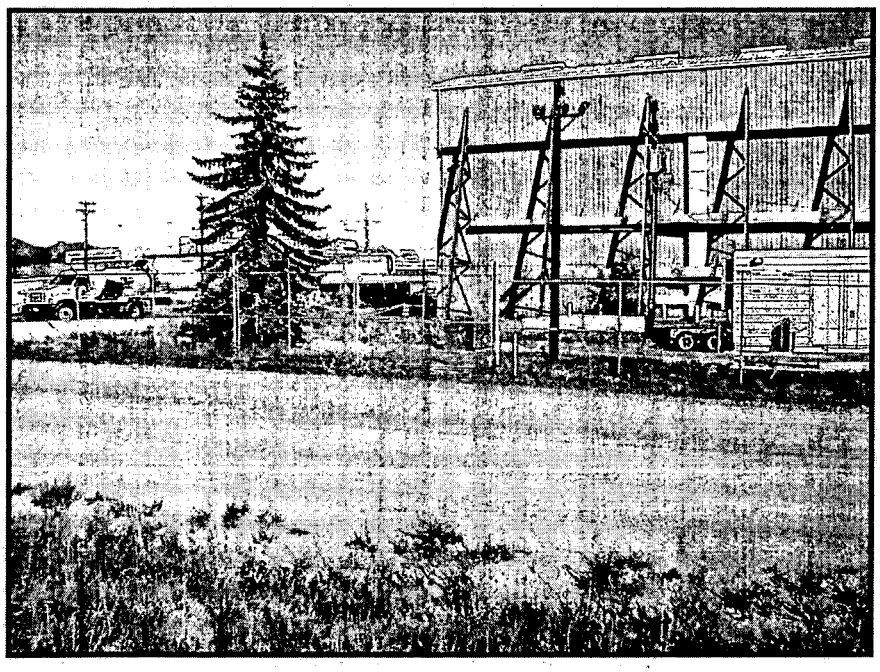
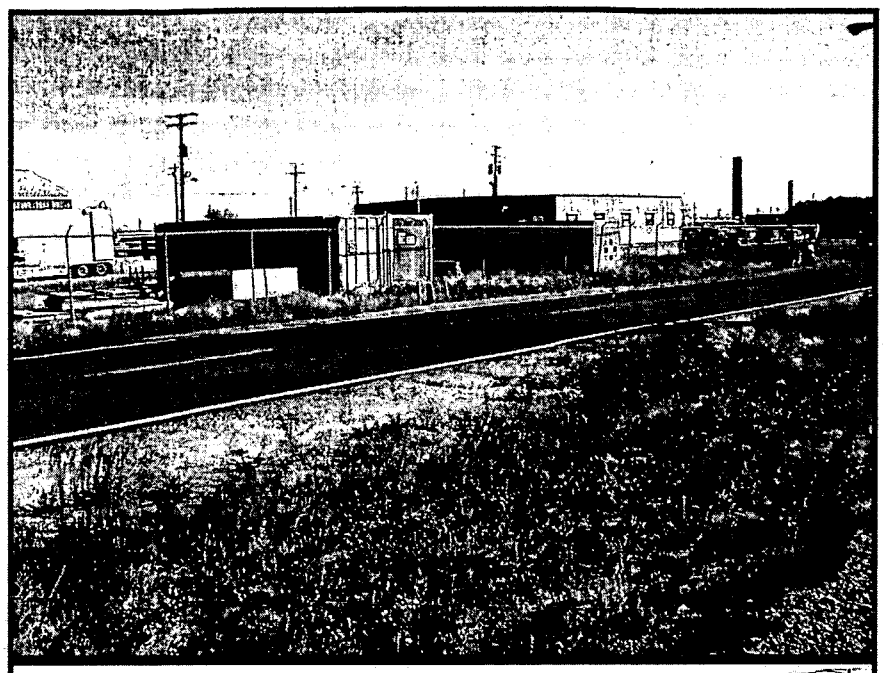
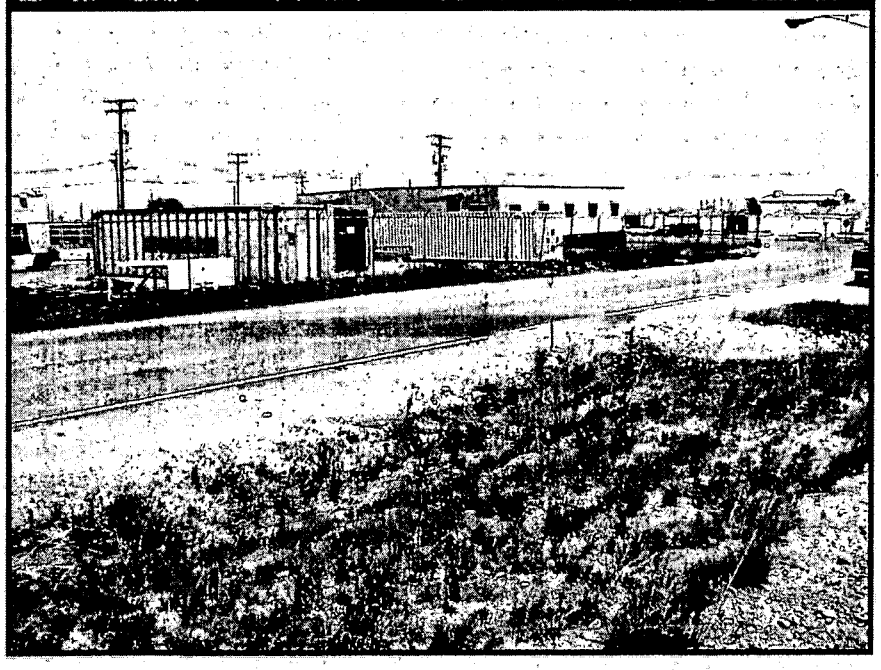


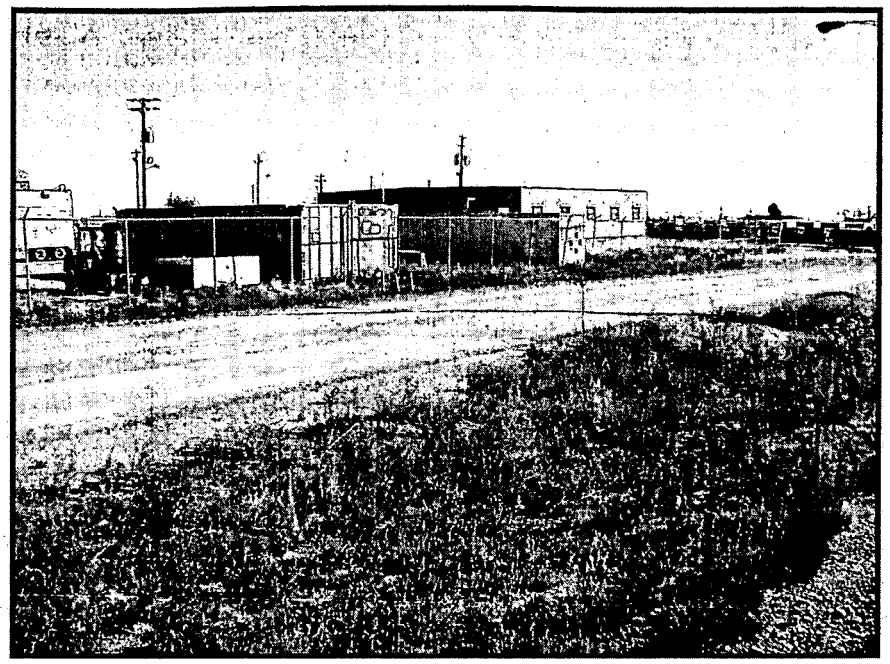


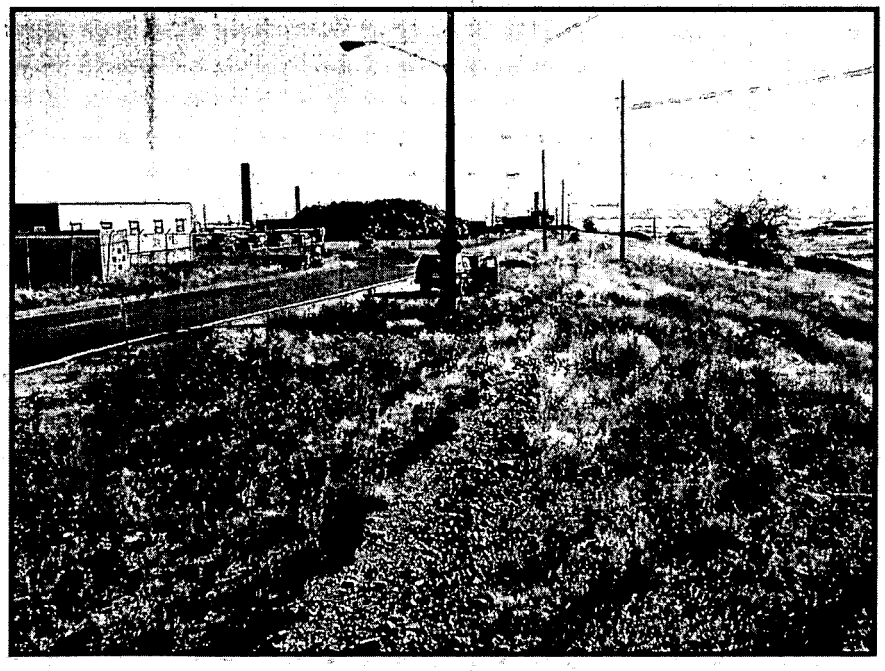


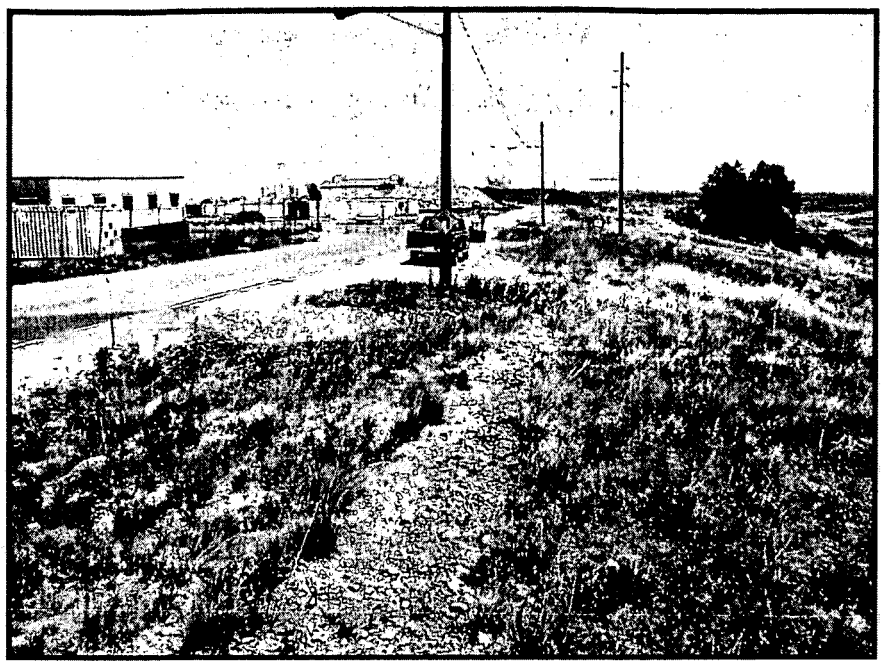


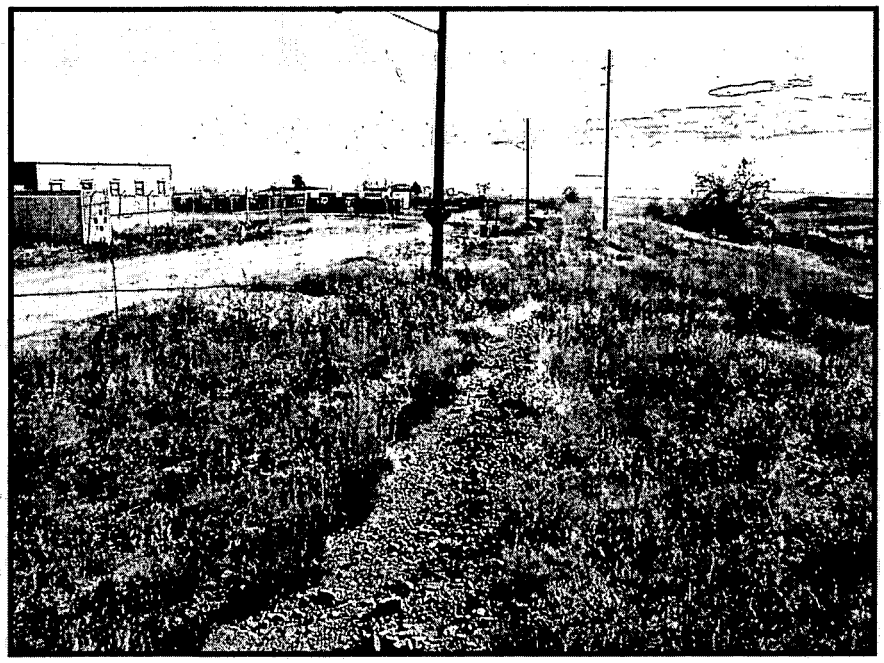






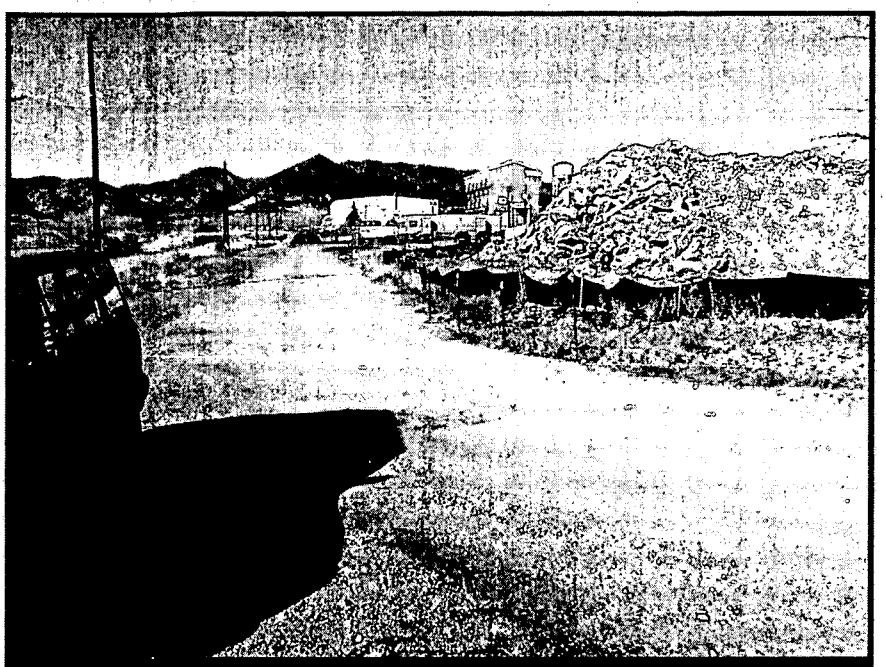






IA Photopoint #3

October 2003



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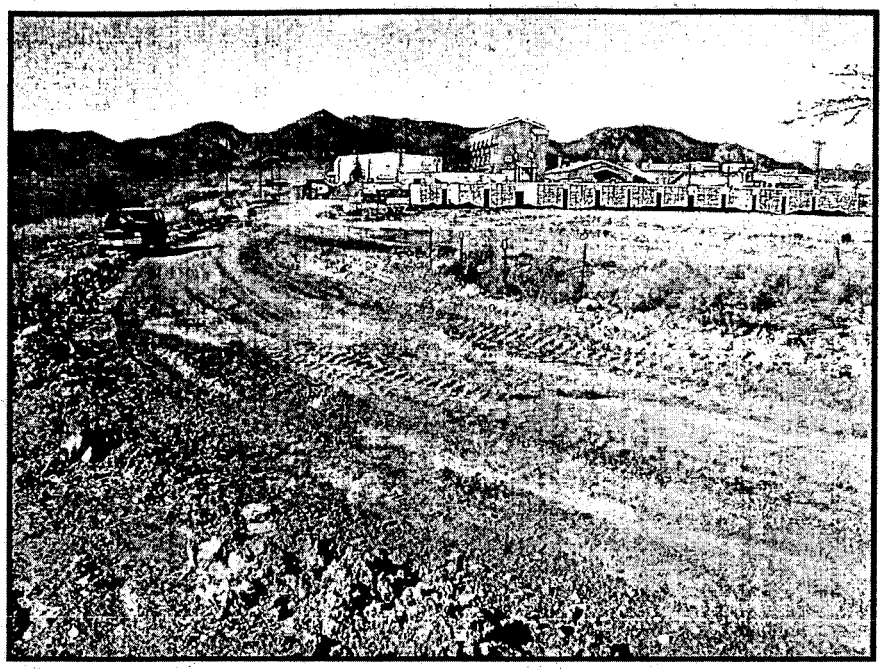
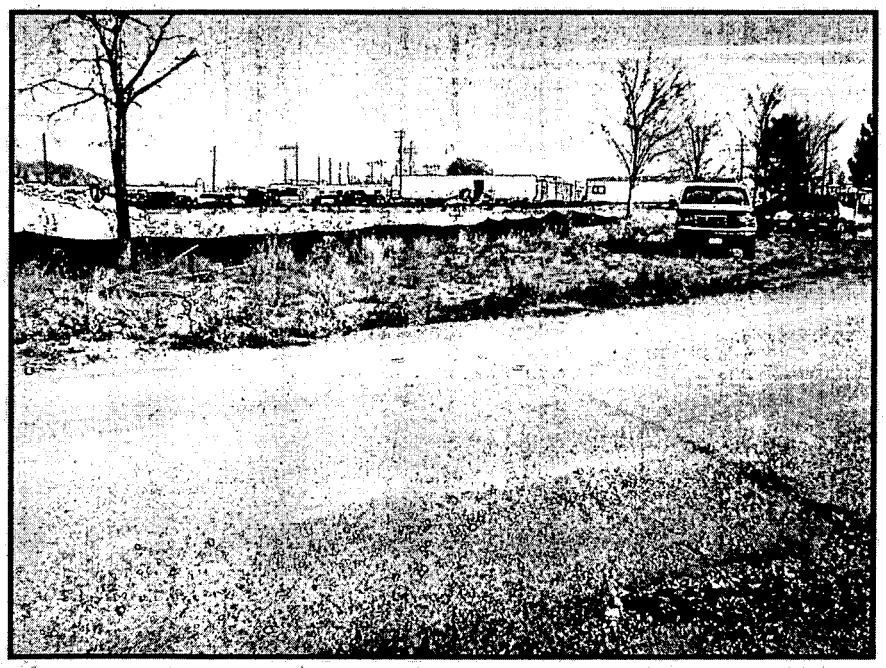
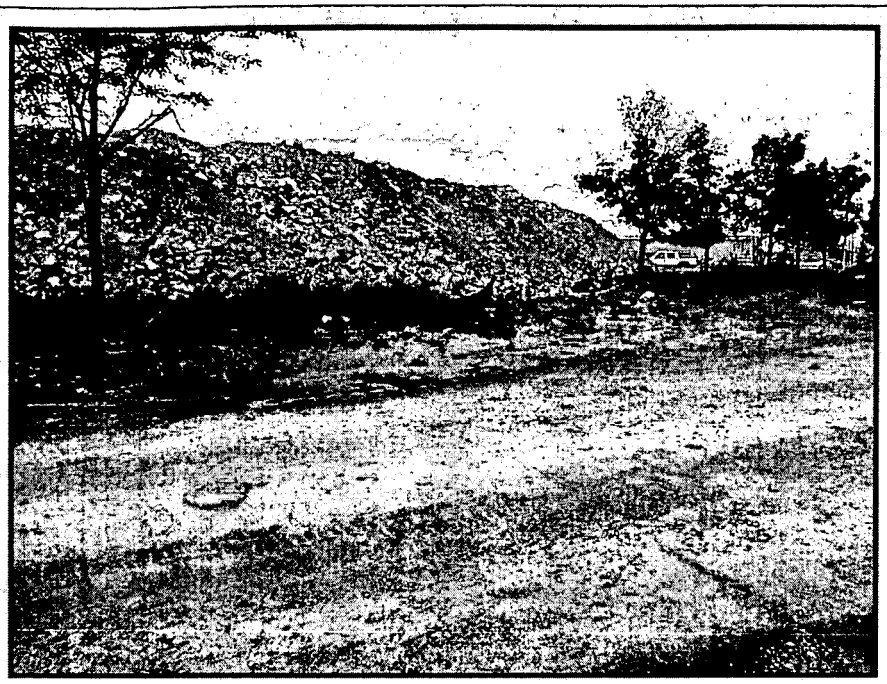
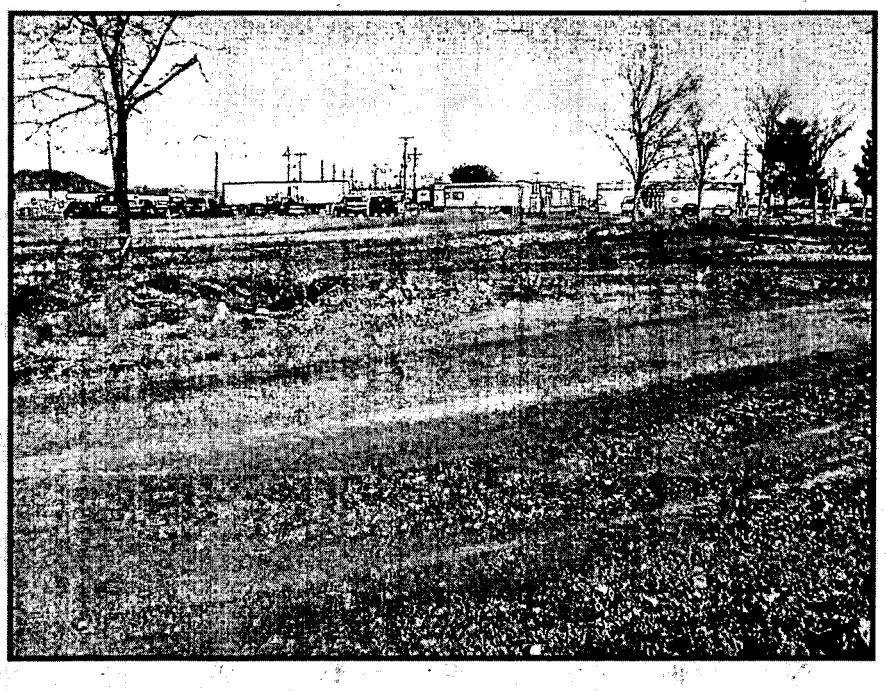
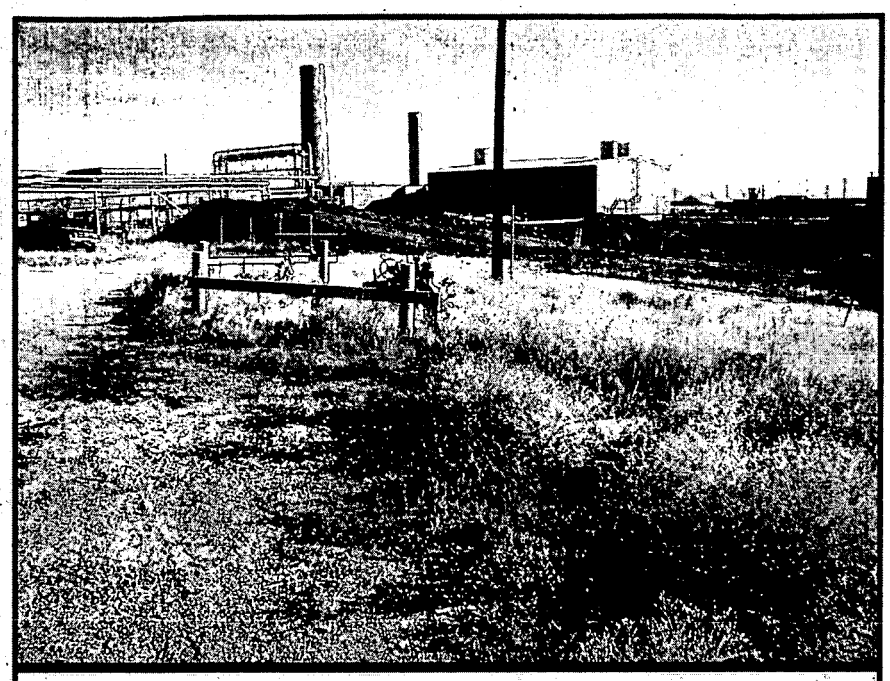
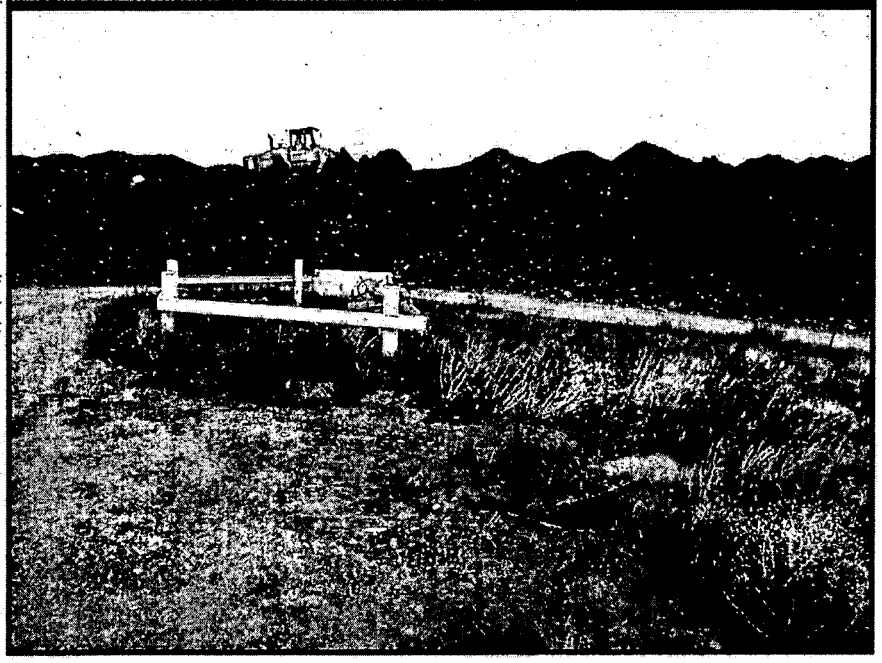


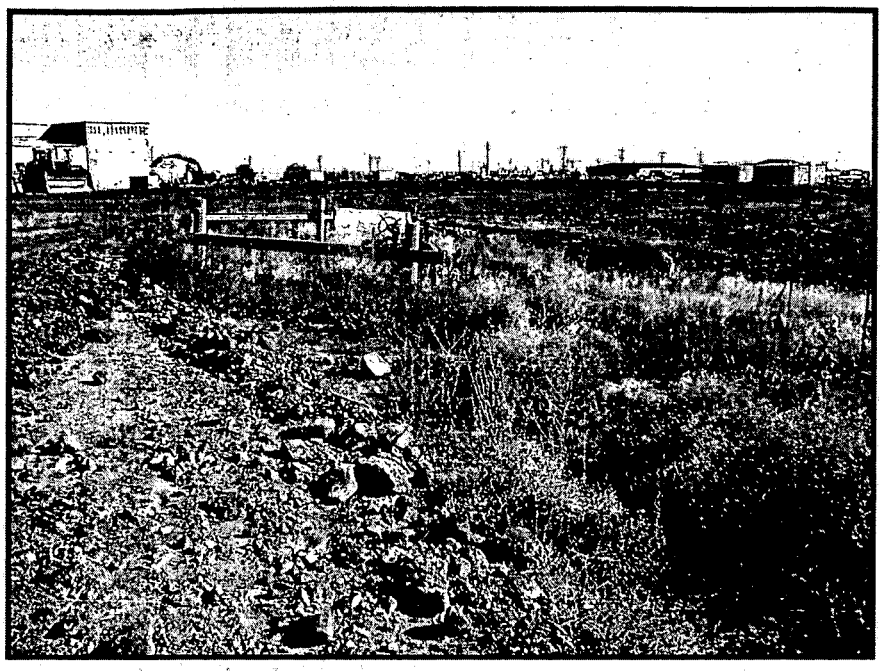


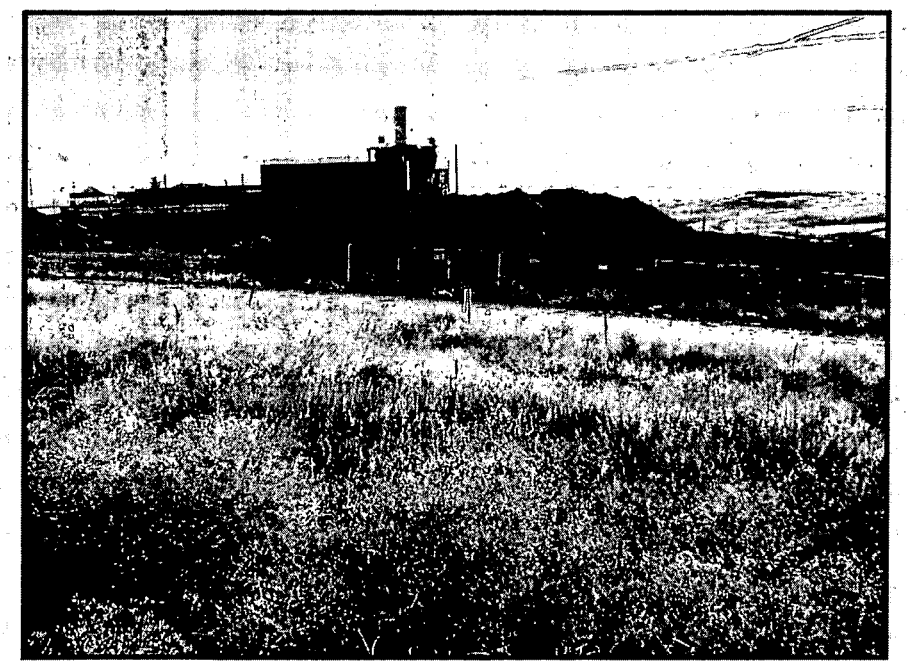


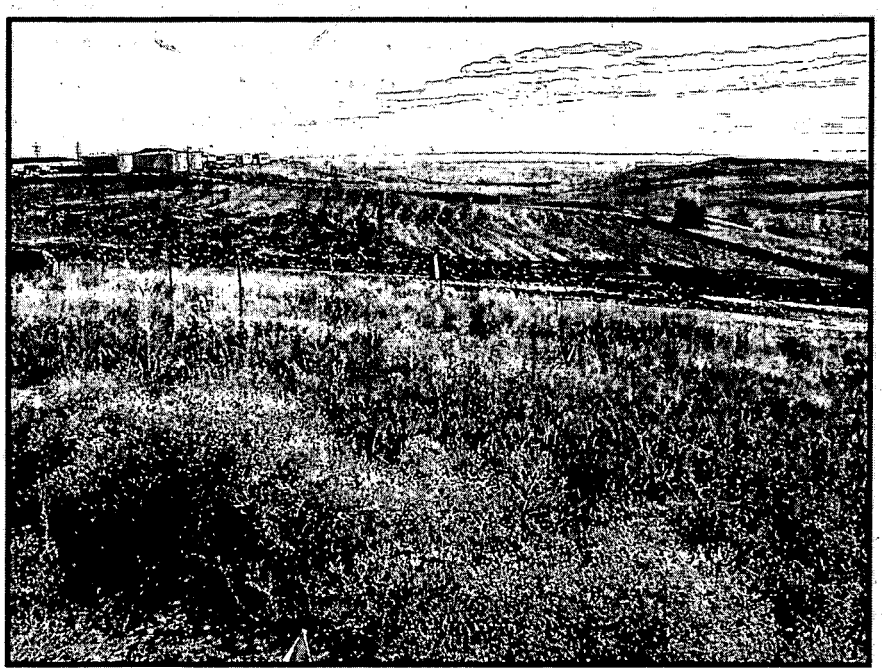


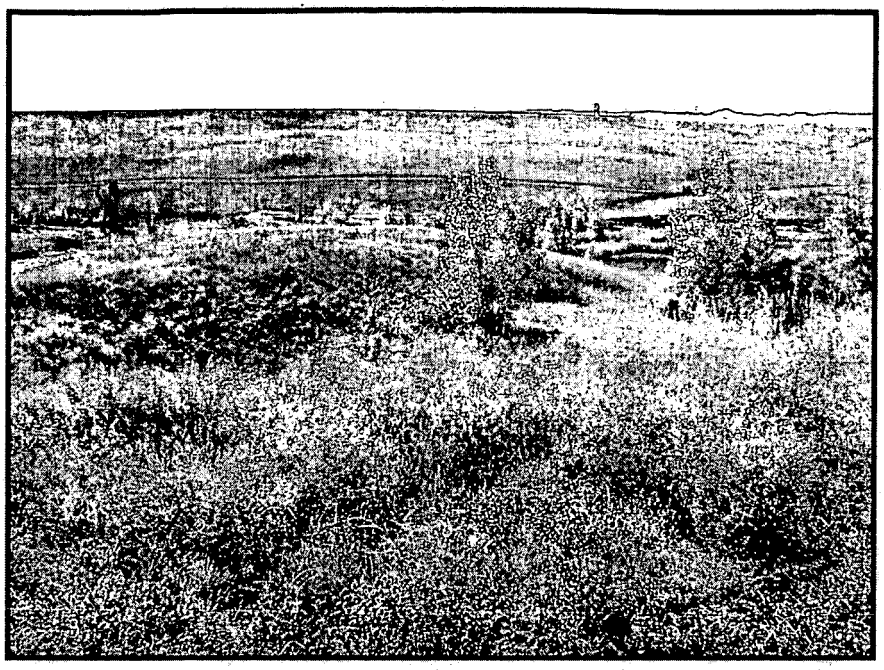






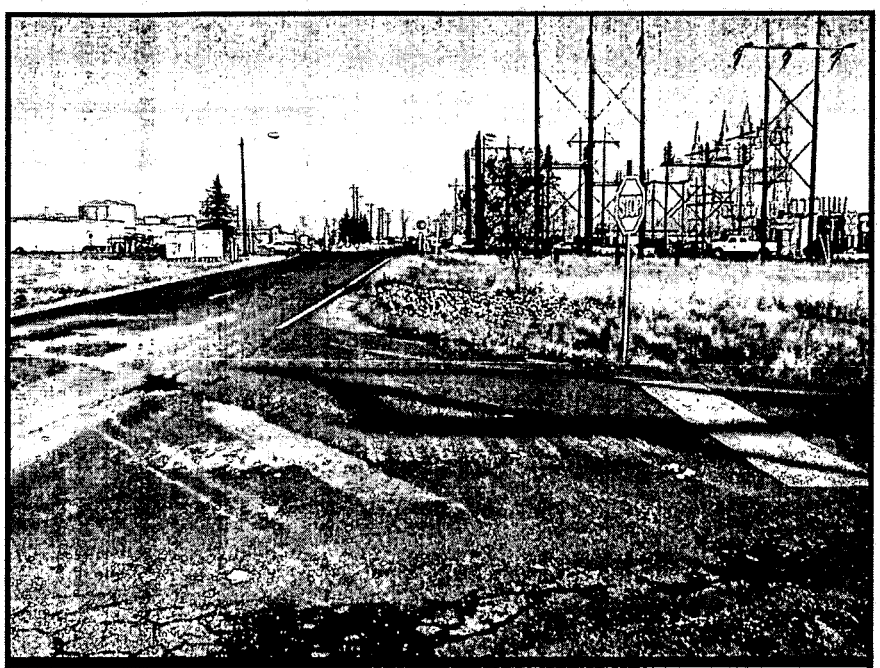






IA Photopoint #4

October 2003



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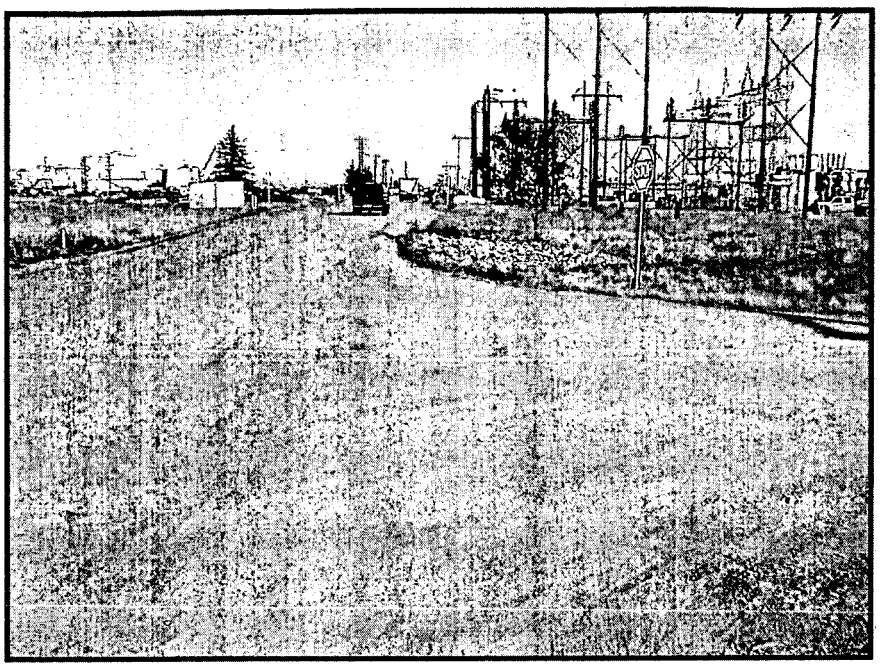
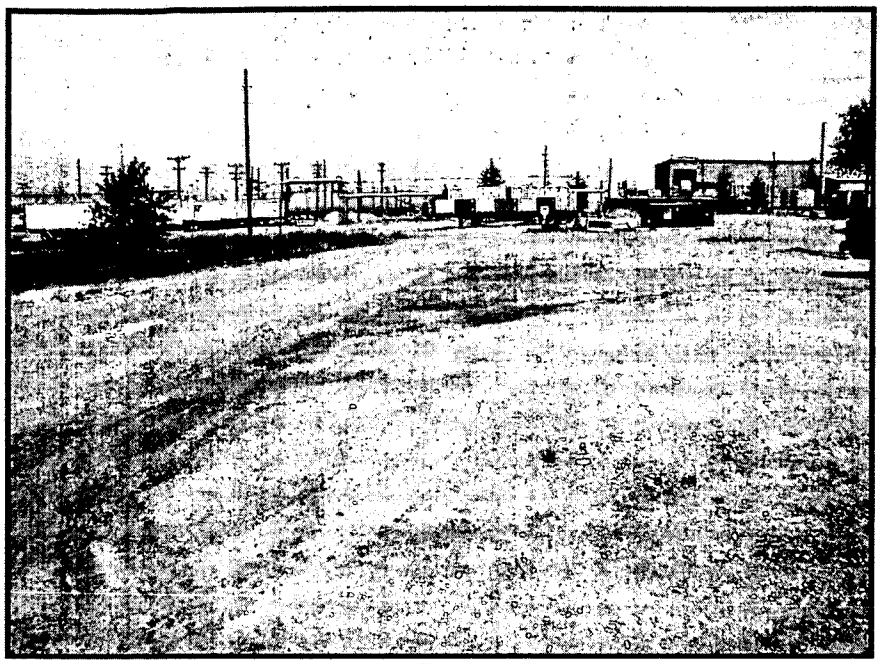
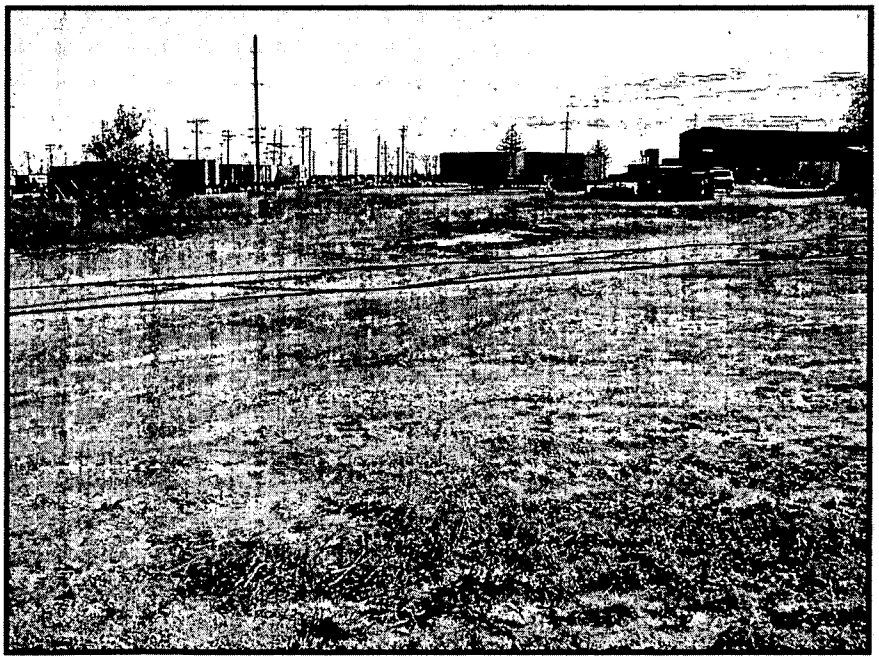
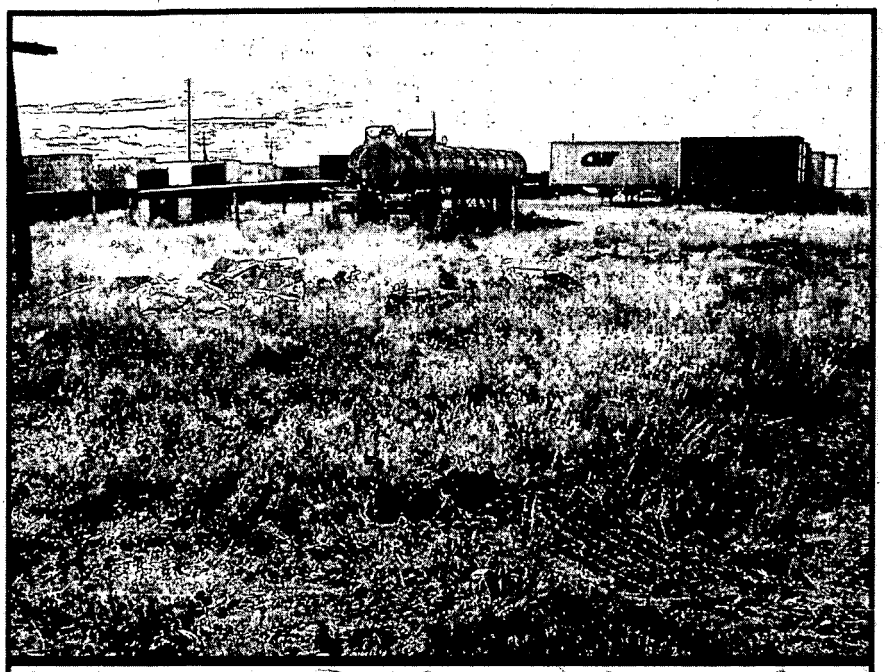
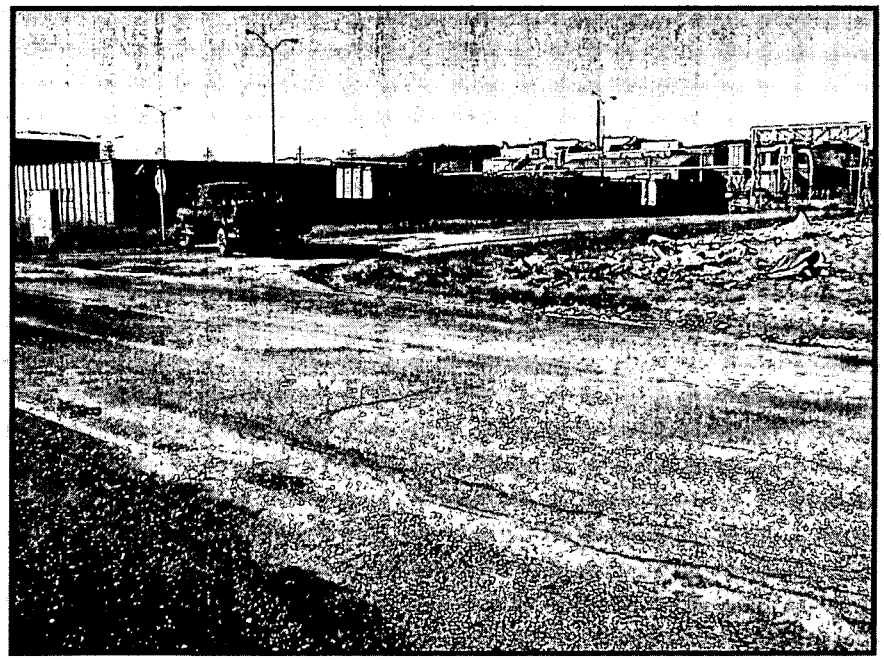
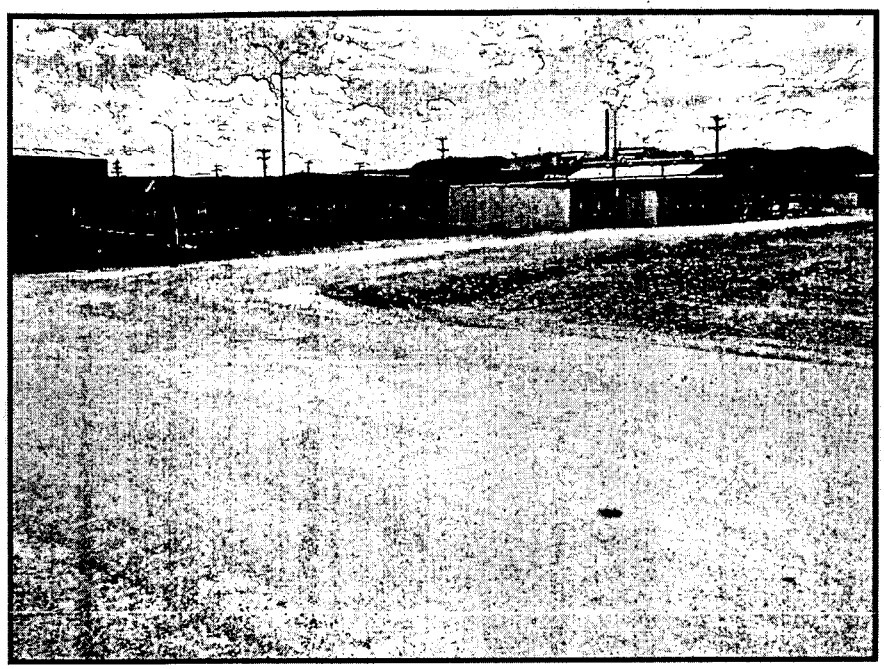


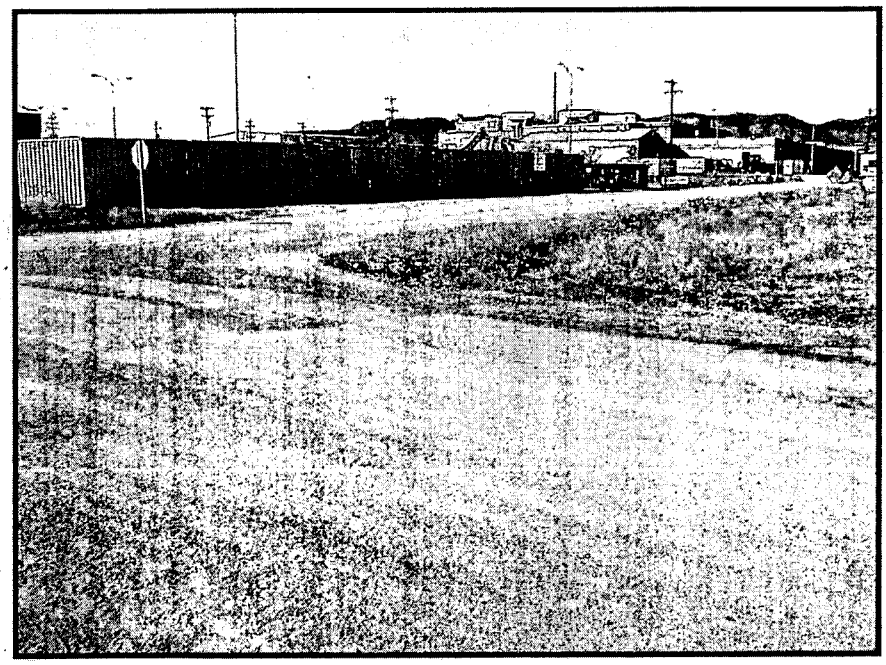


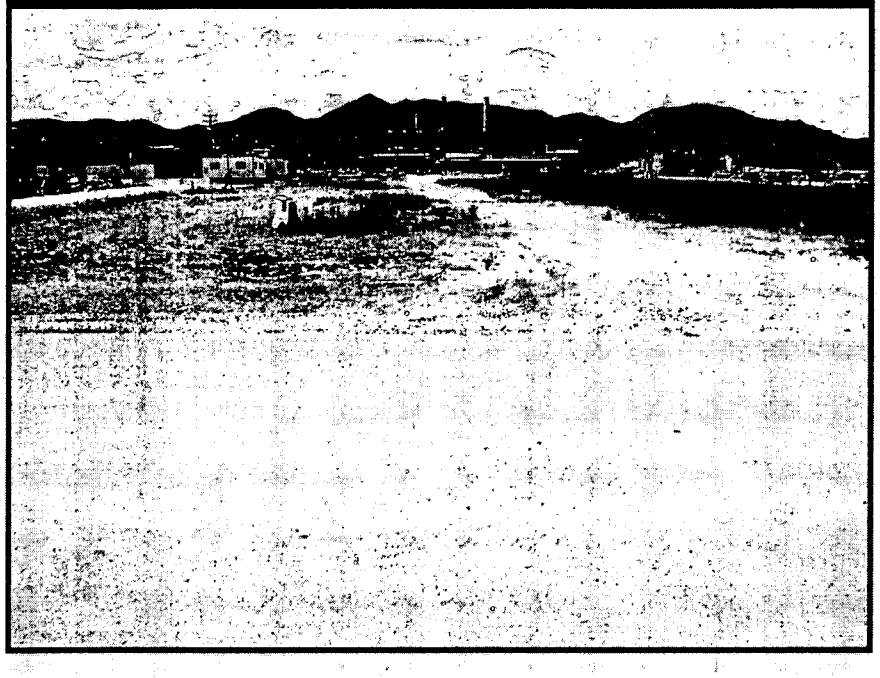


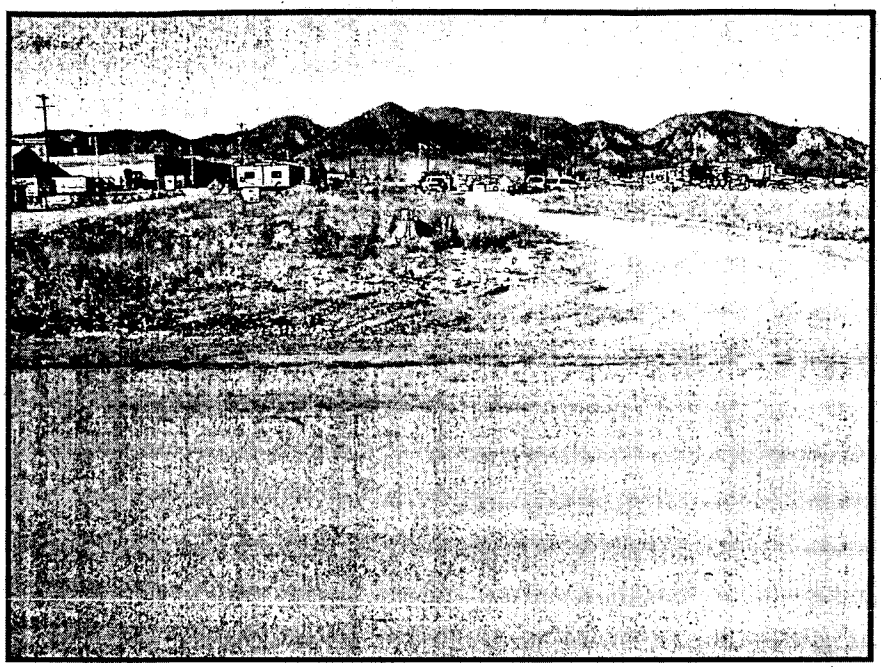


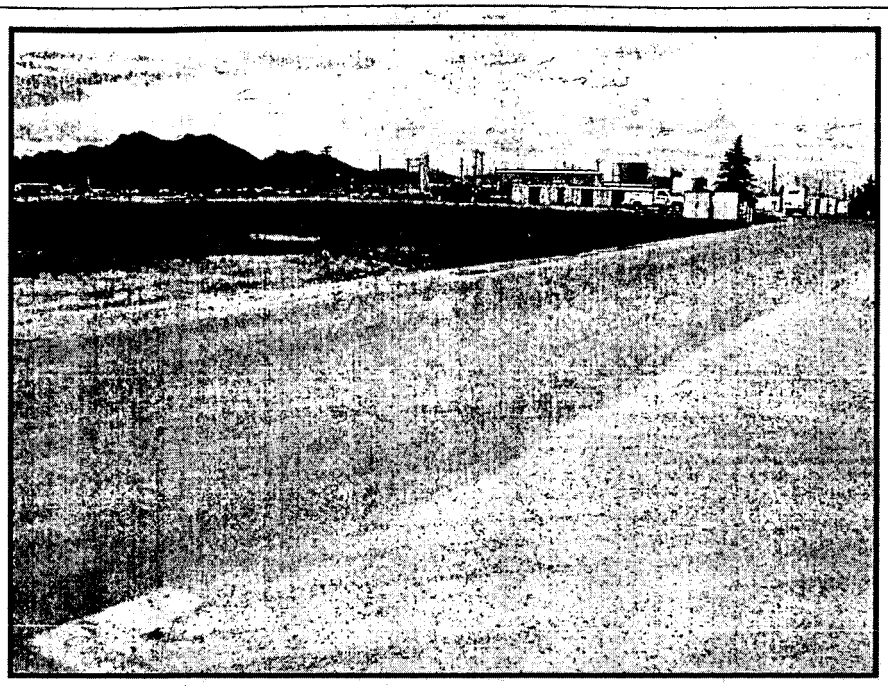


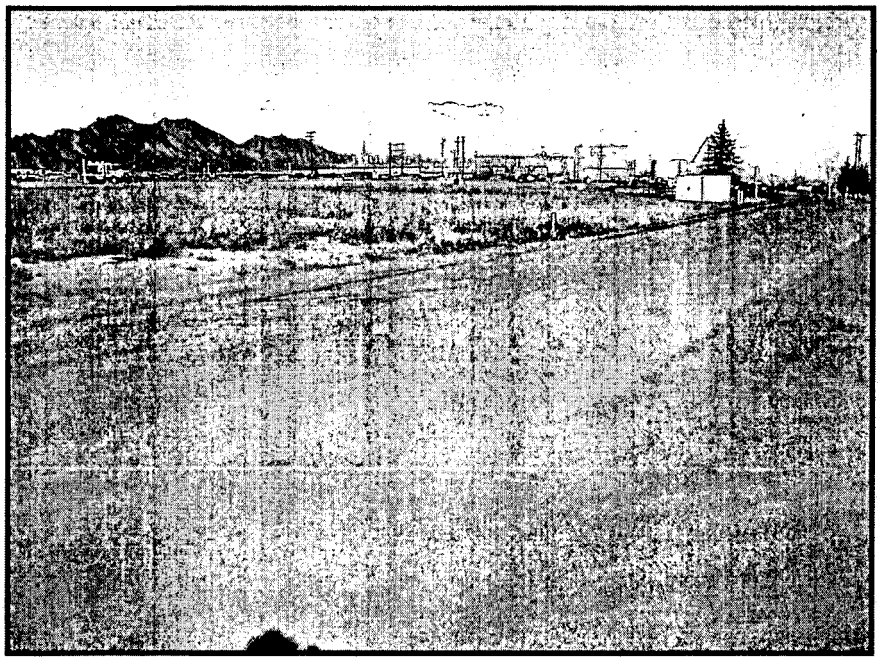






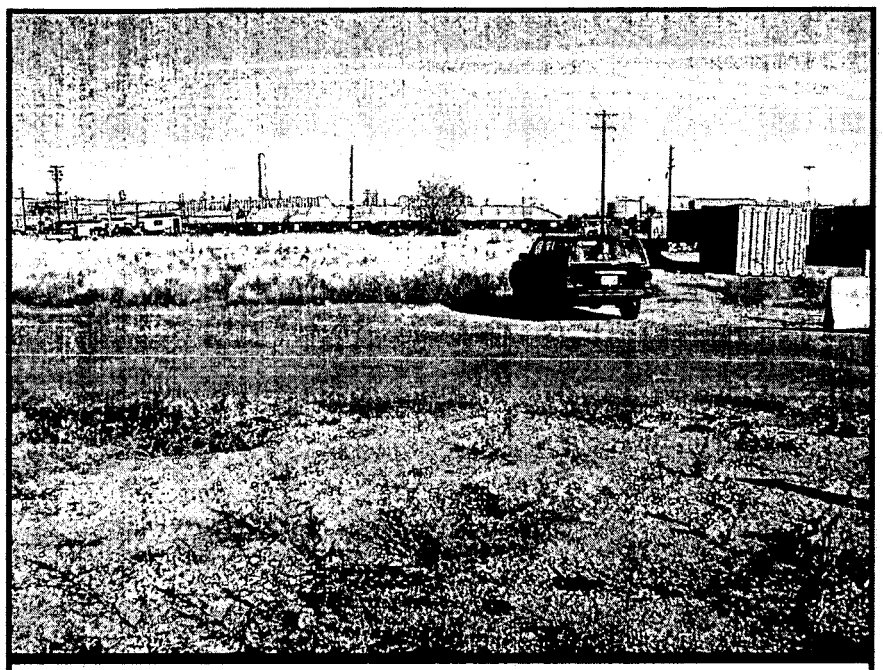






IA Photopoint #5

October 2003



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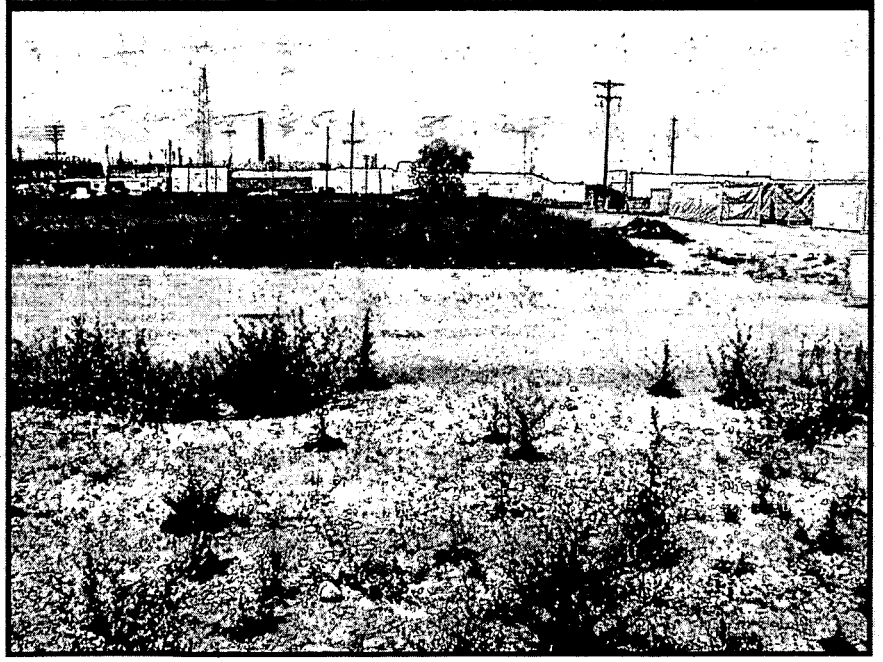

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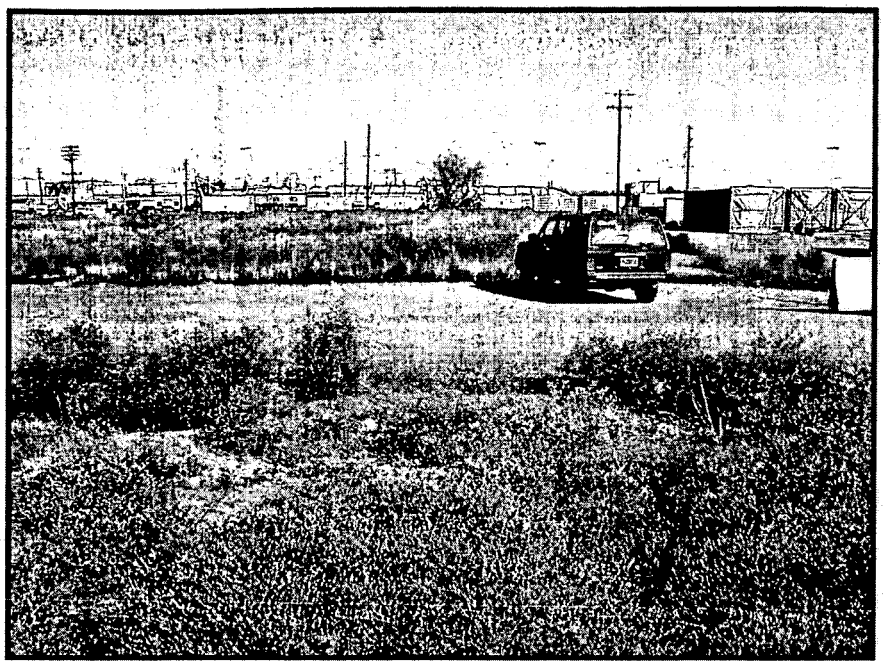

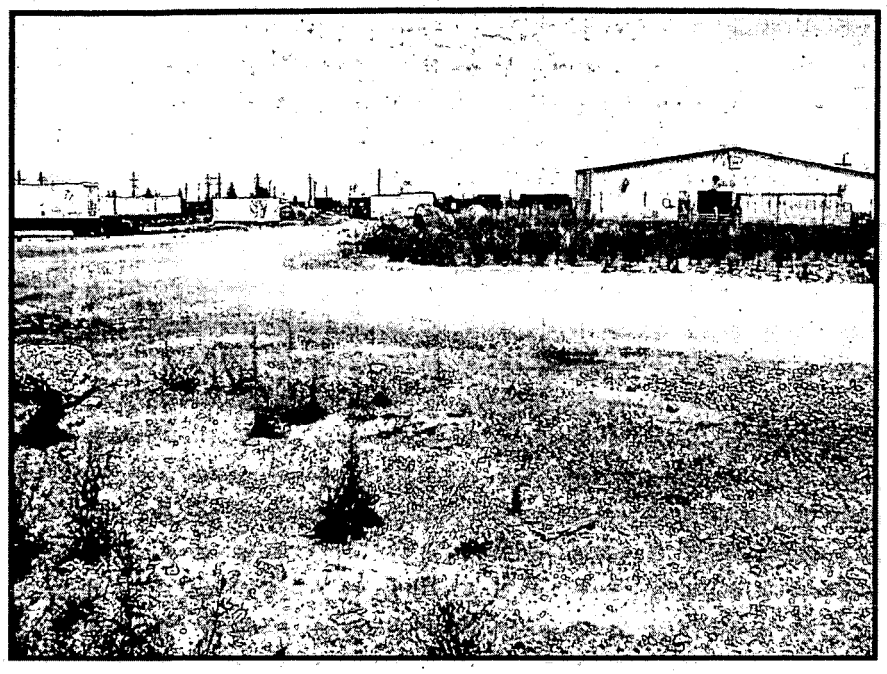

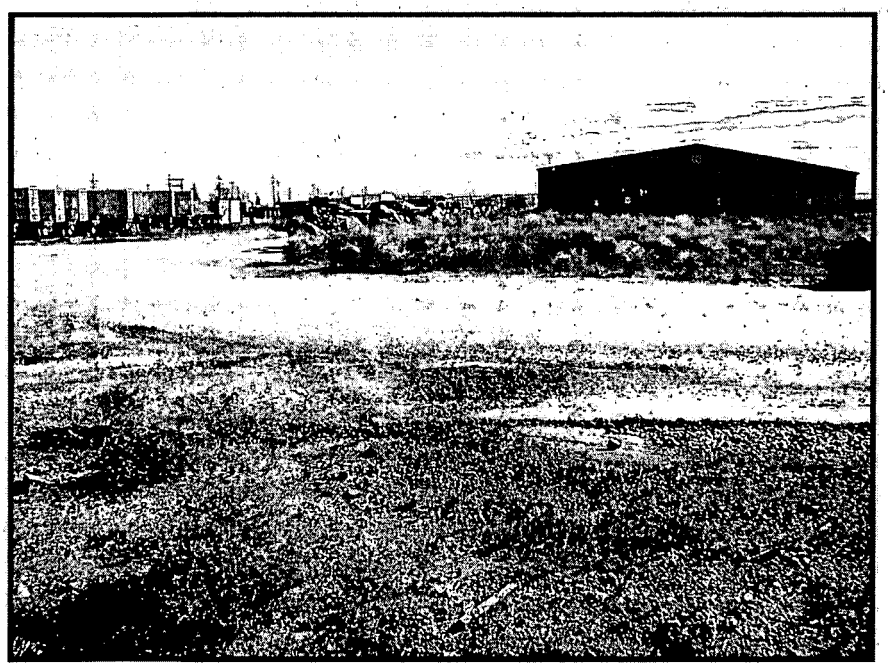

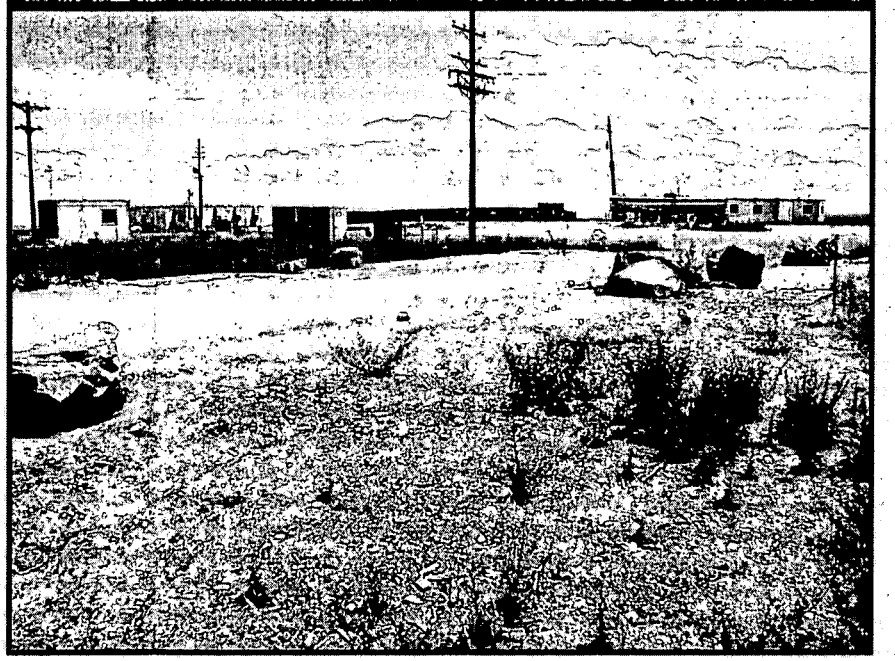

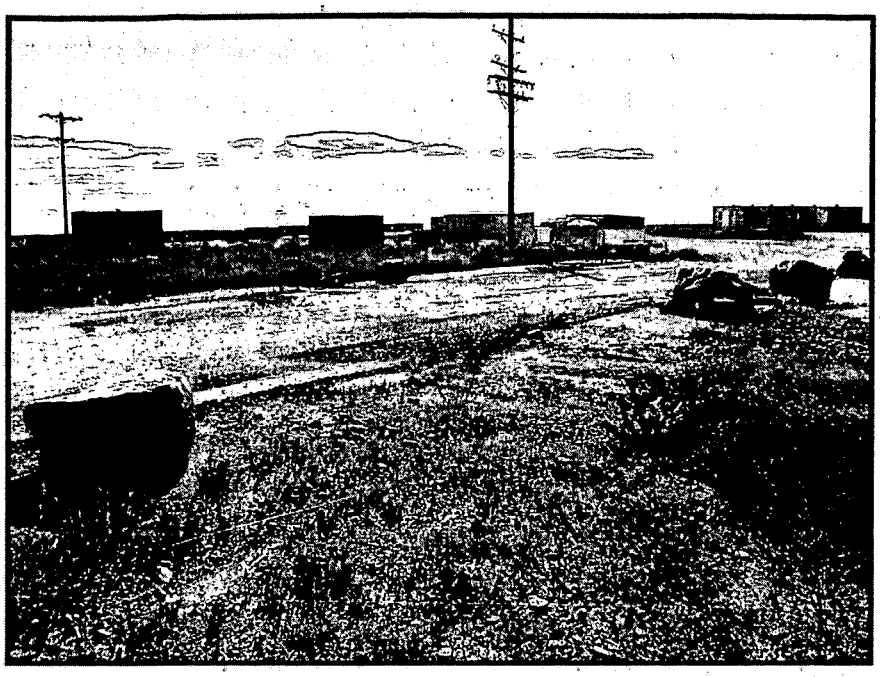

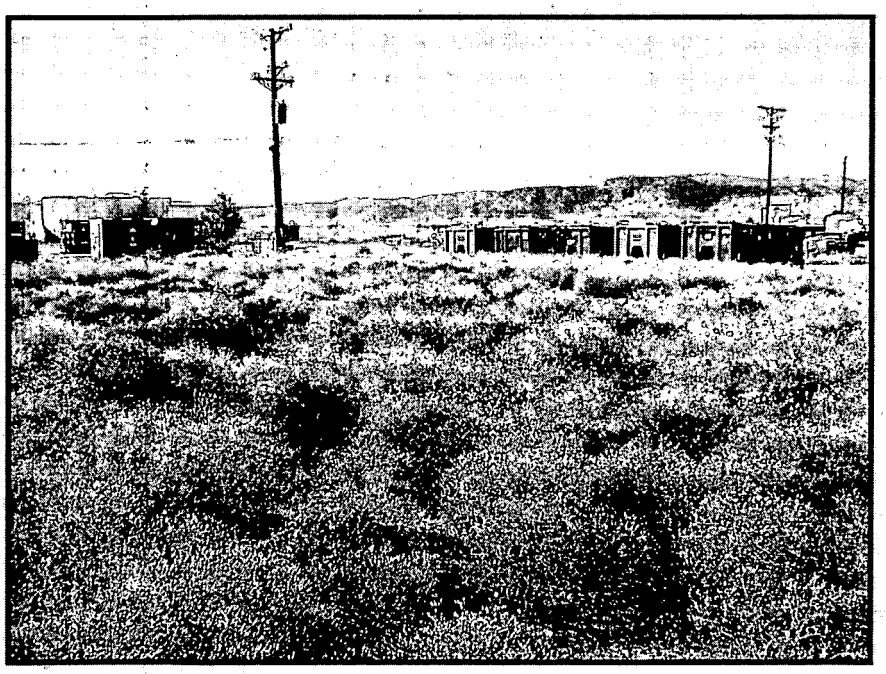

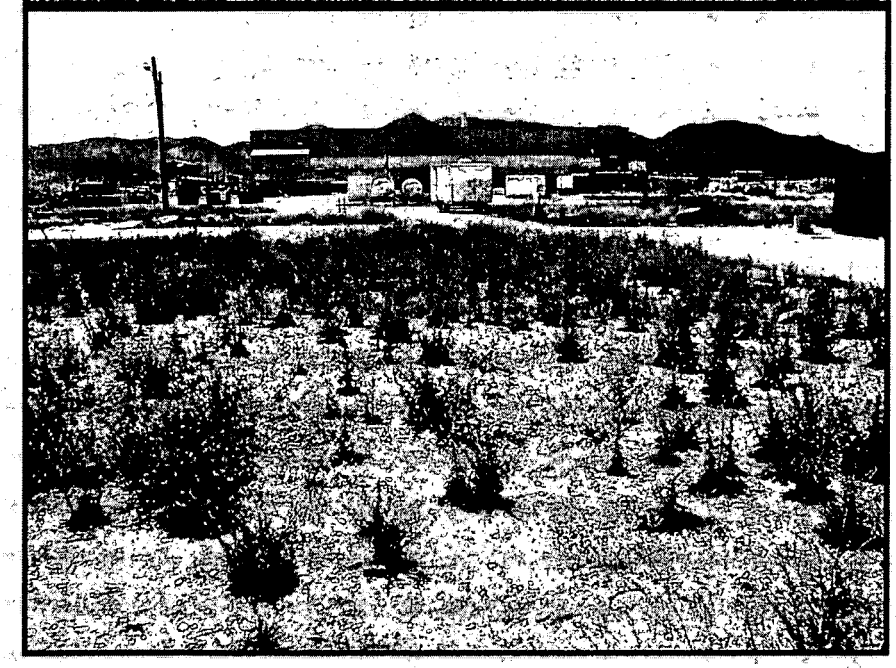

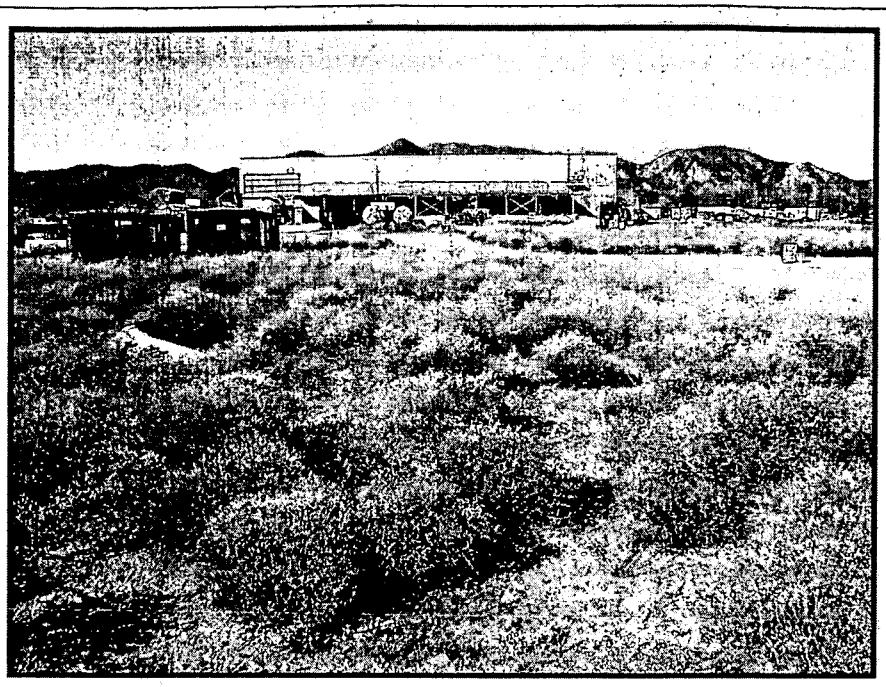

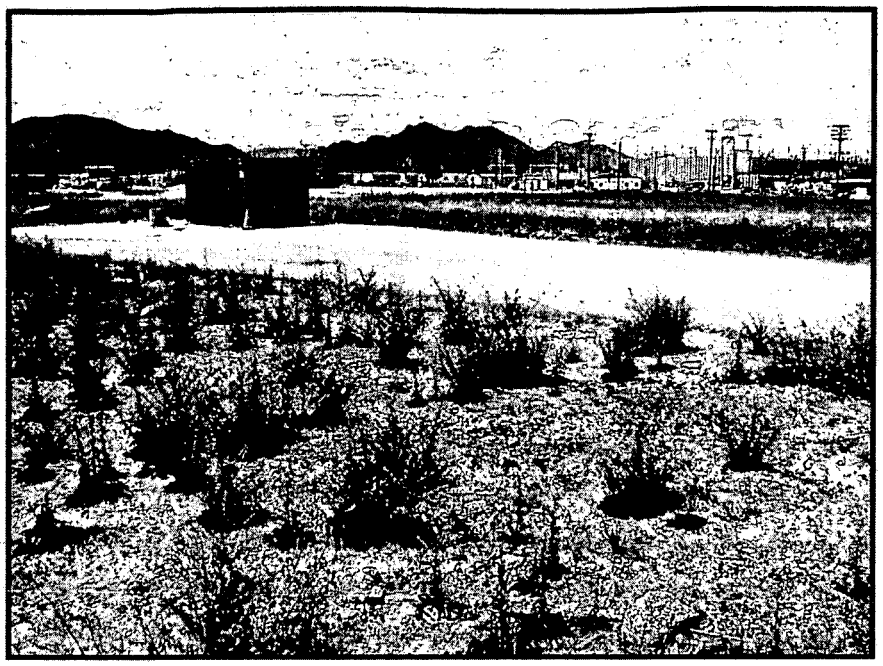

IA Photopoint #6

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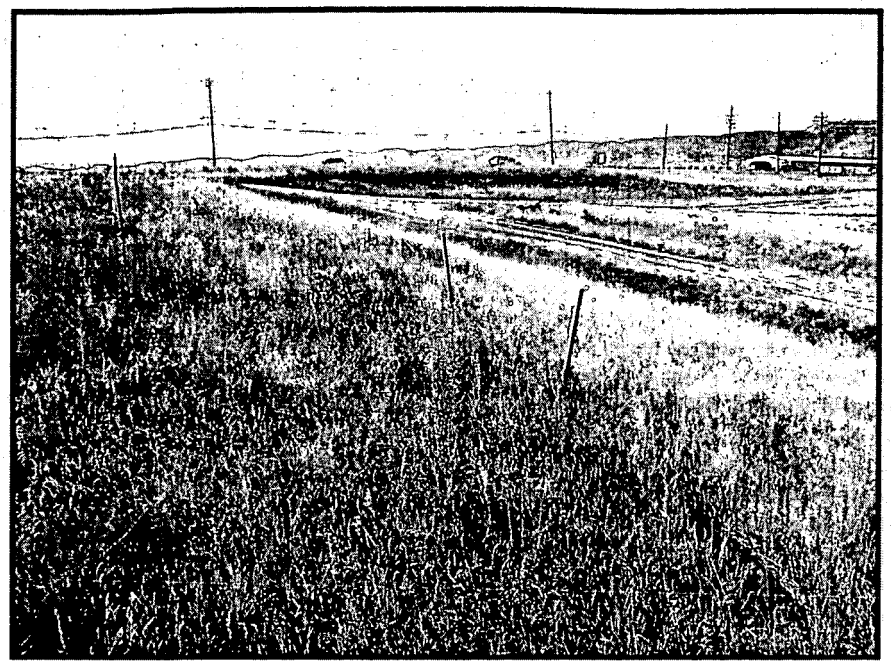
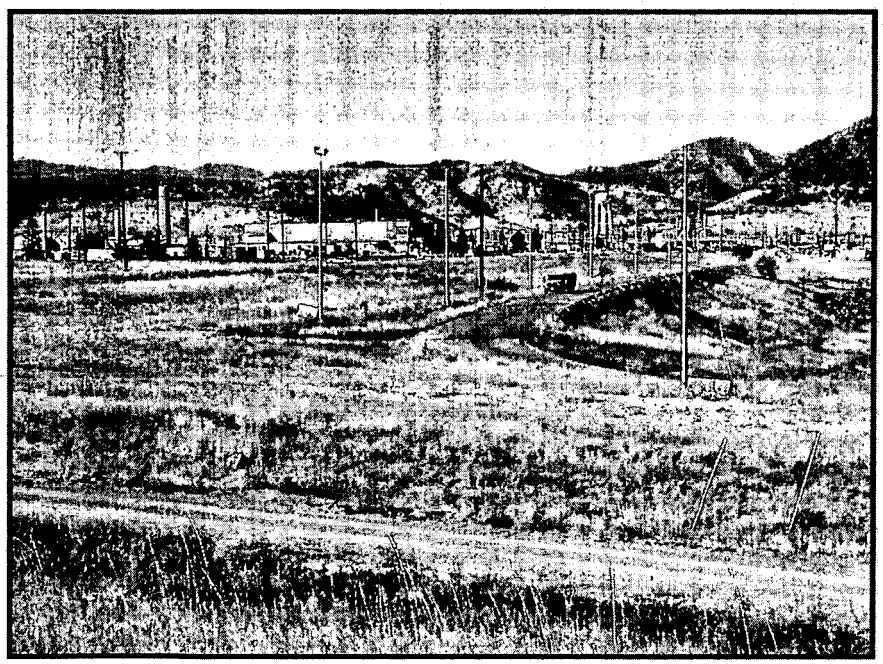
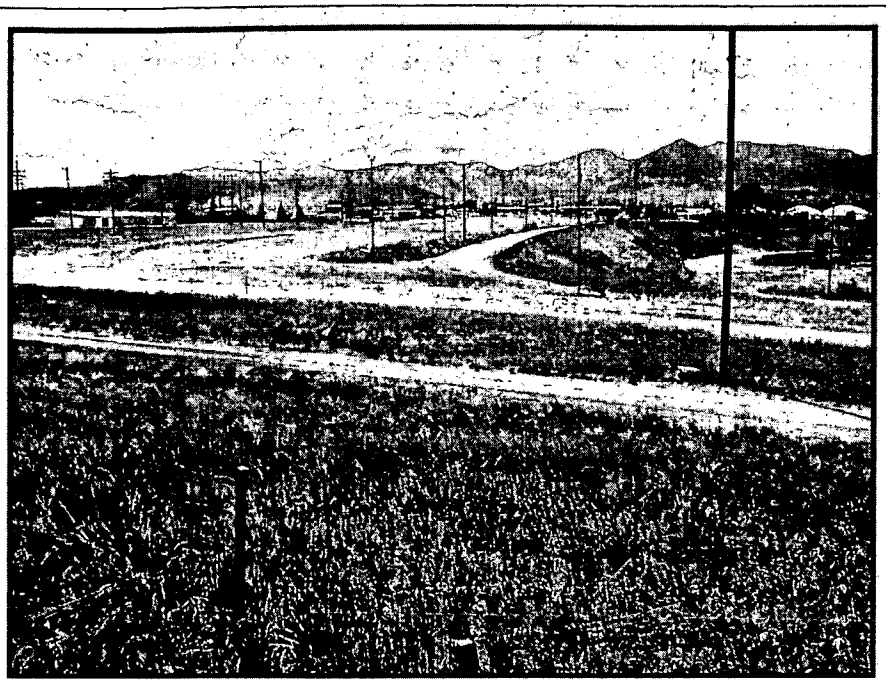
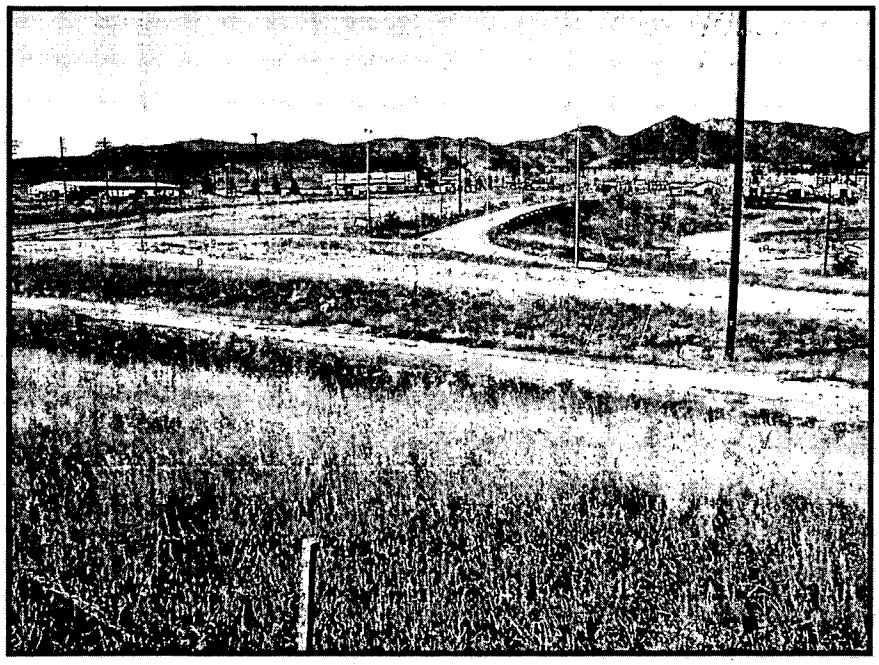
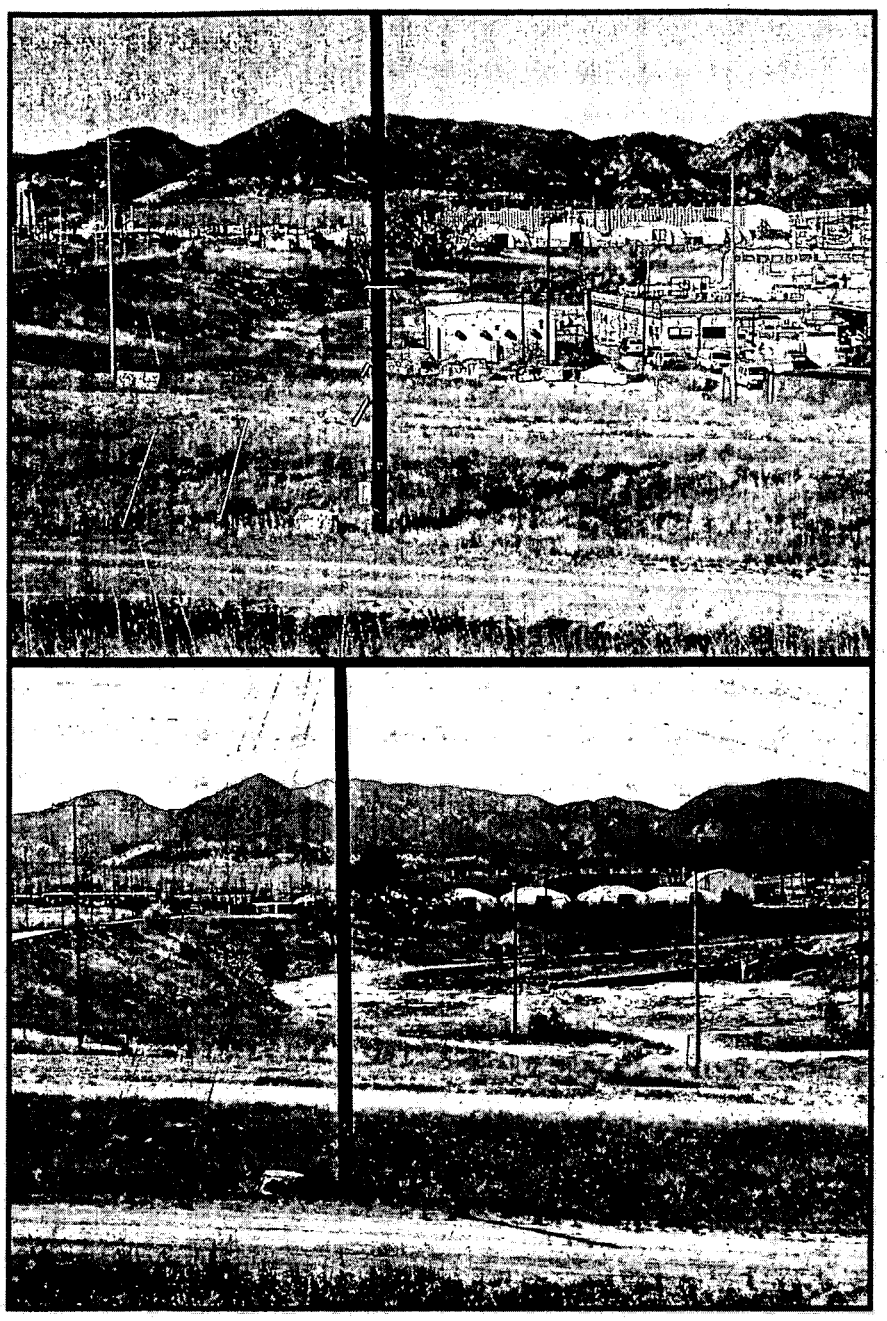
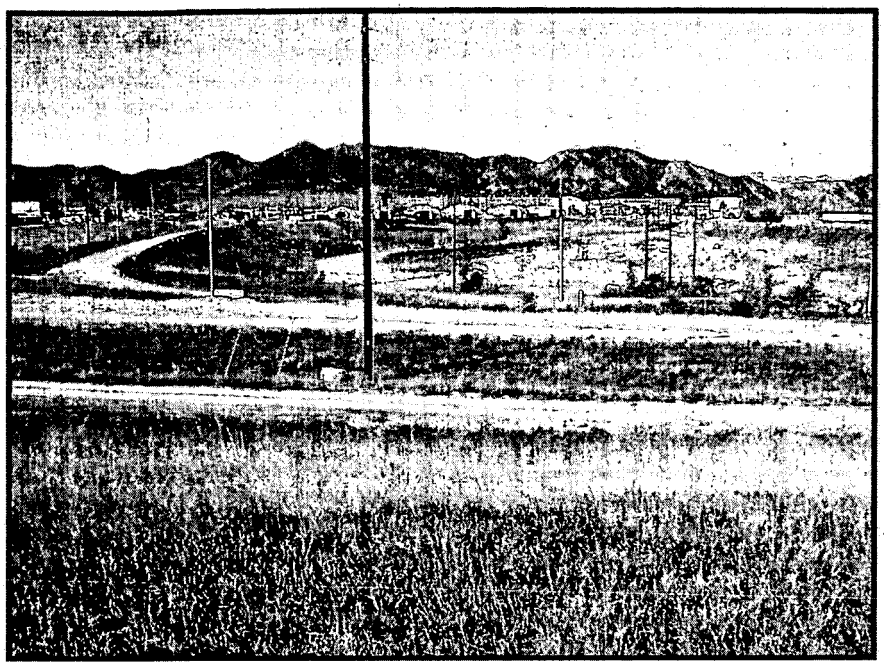


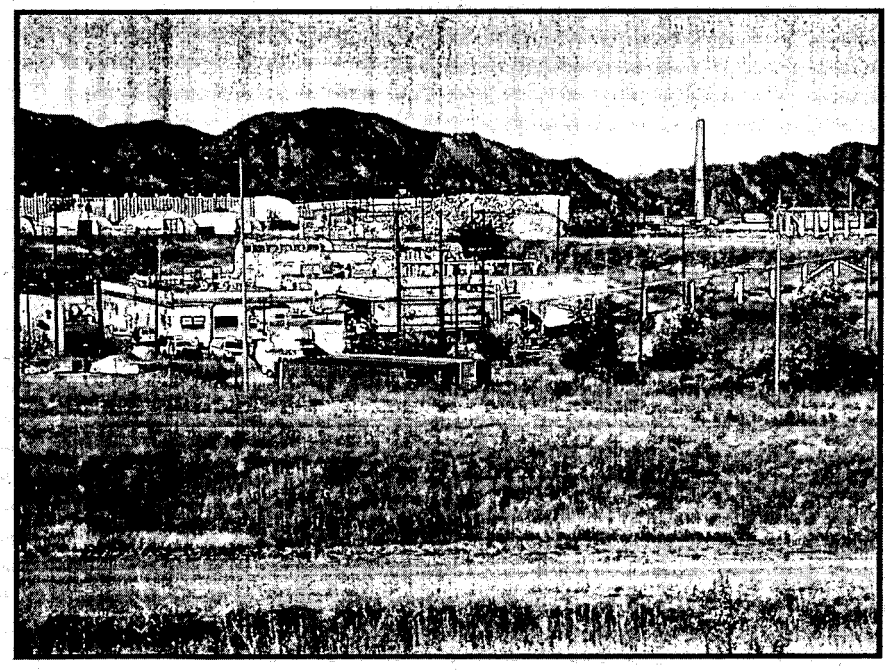


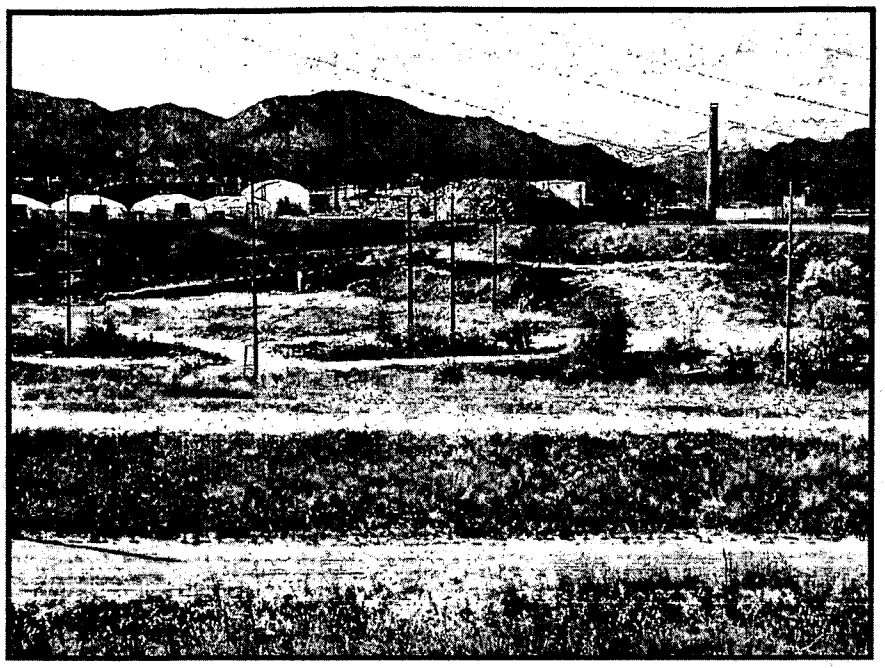


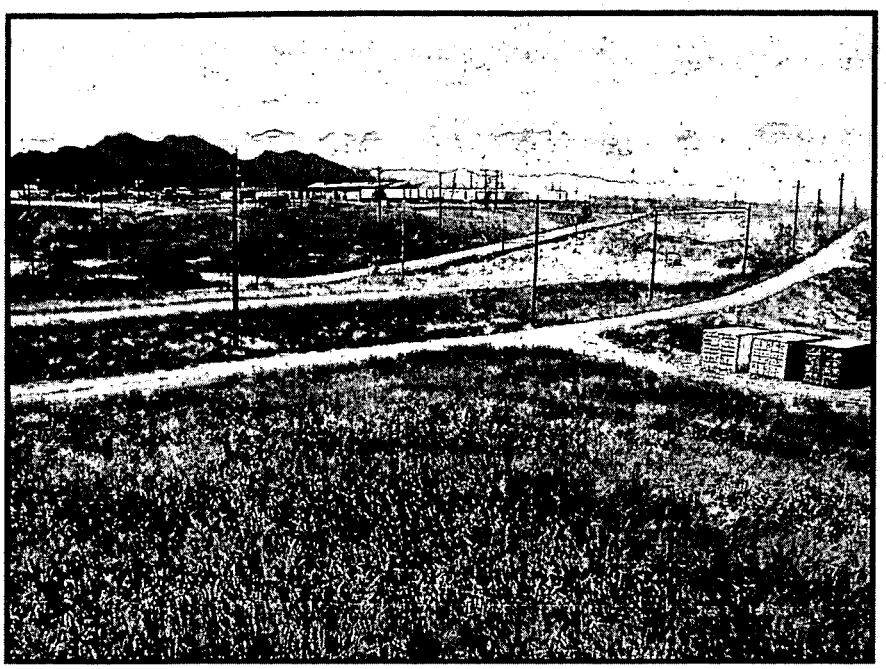


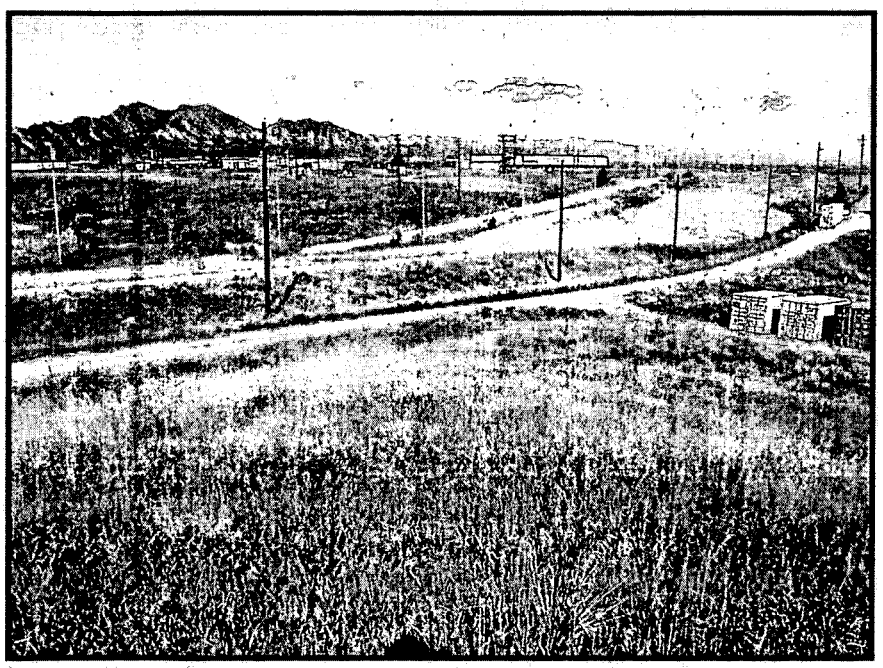


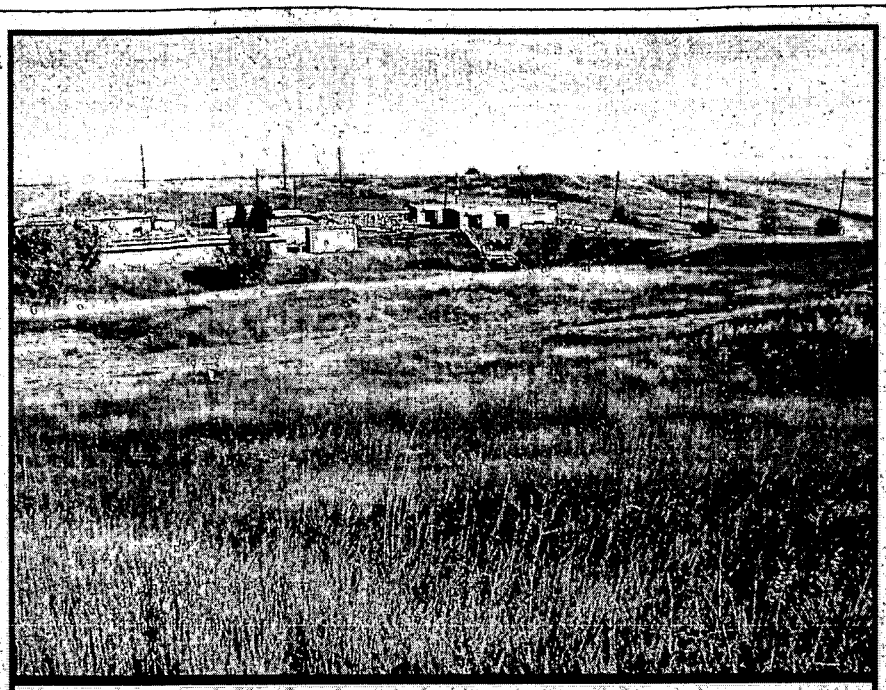


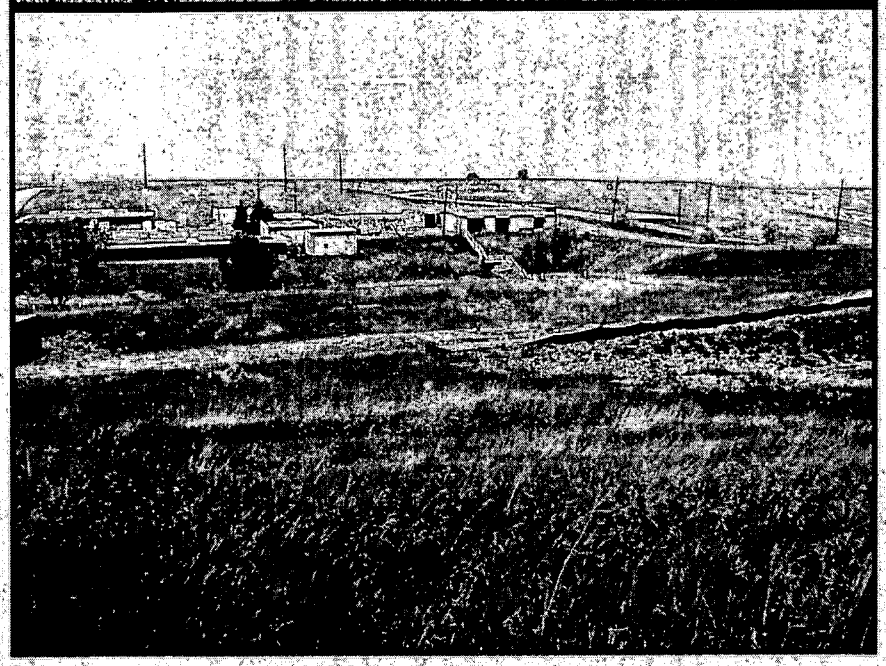


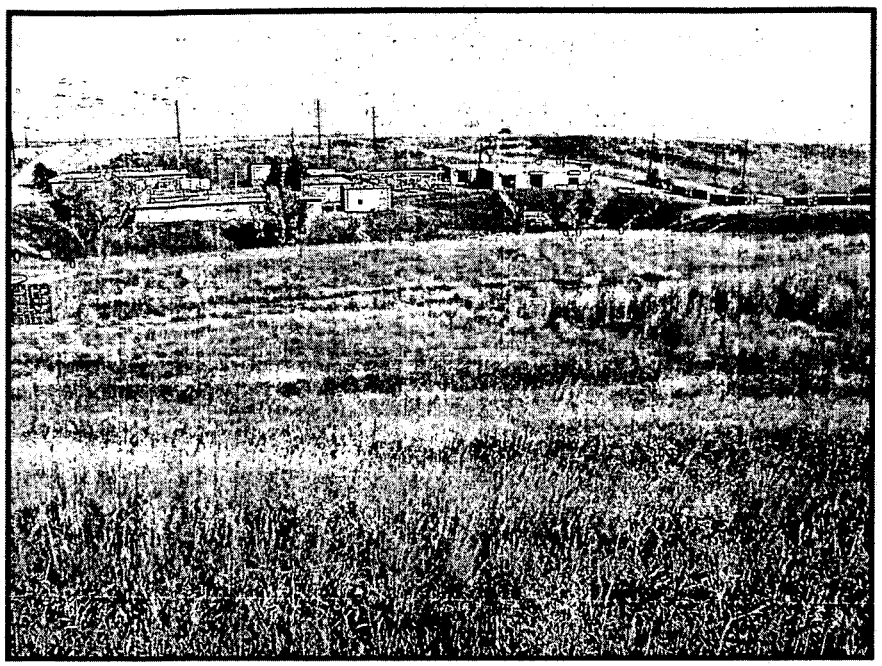






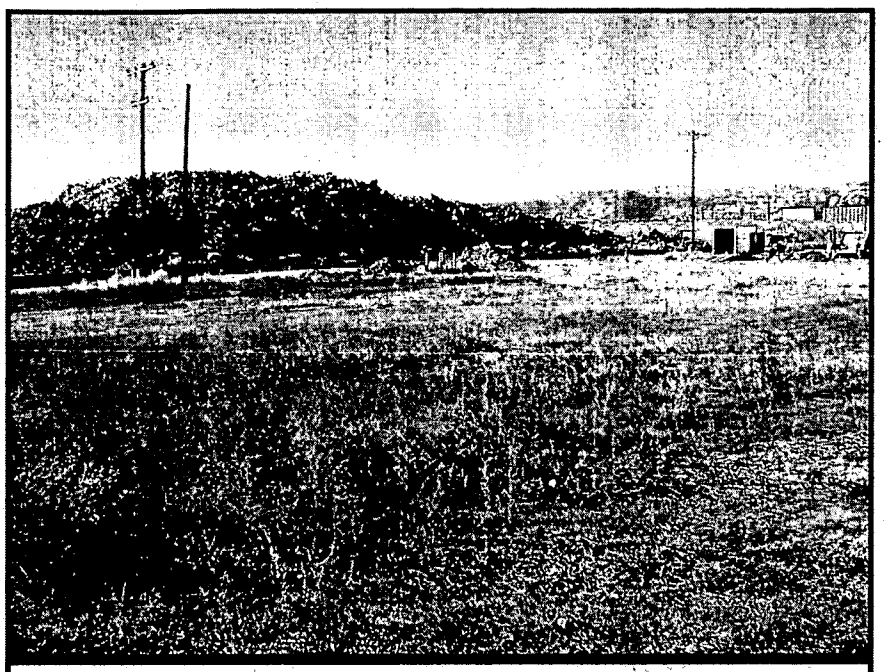




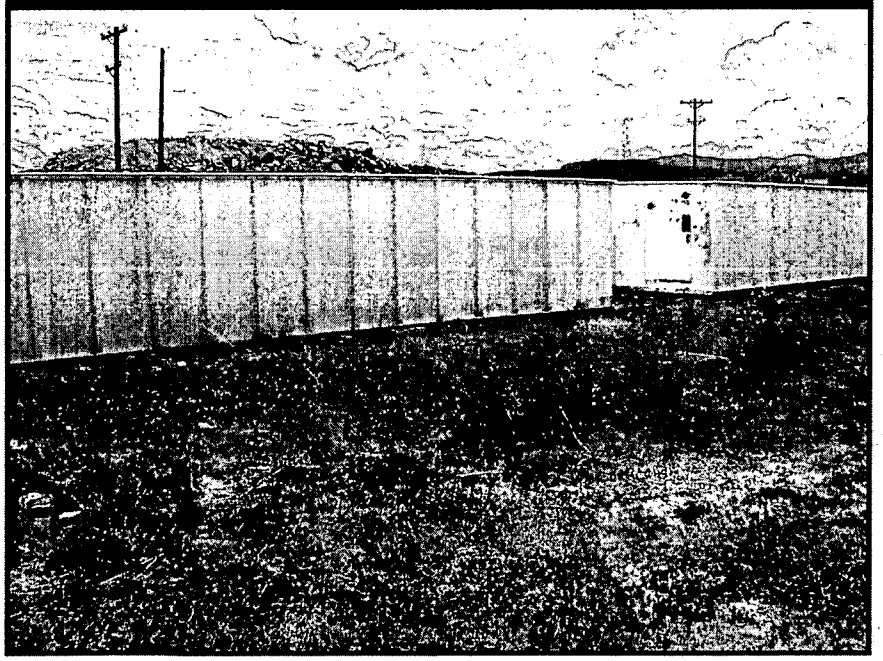


IA Photopoint #7

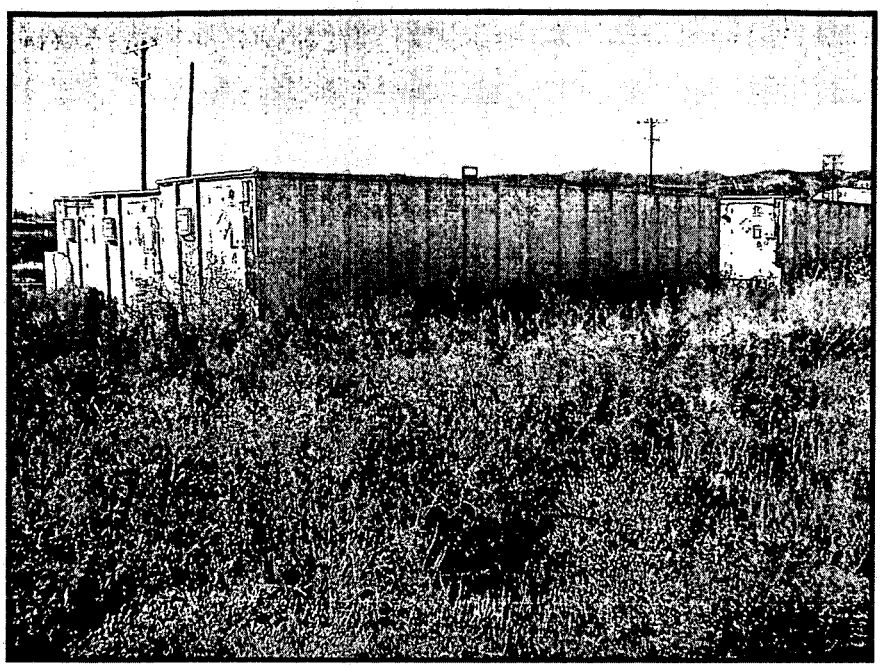
October 2003

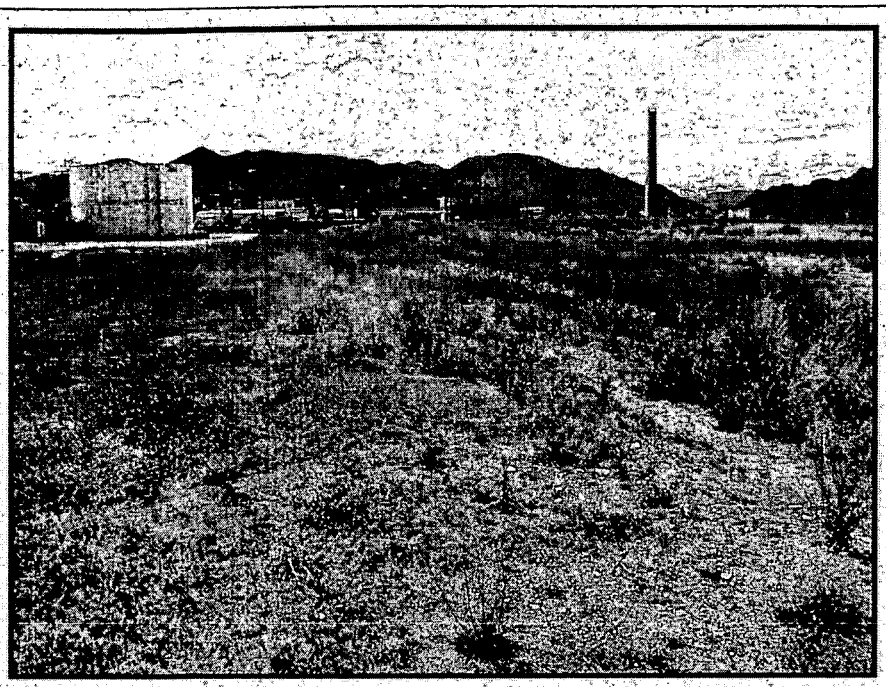


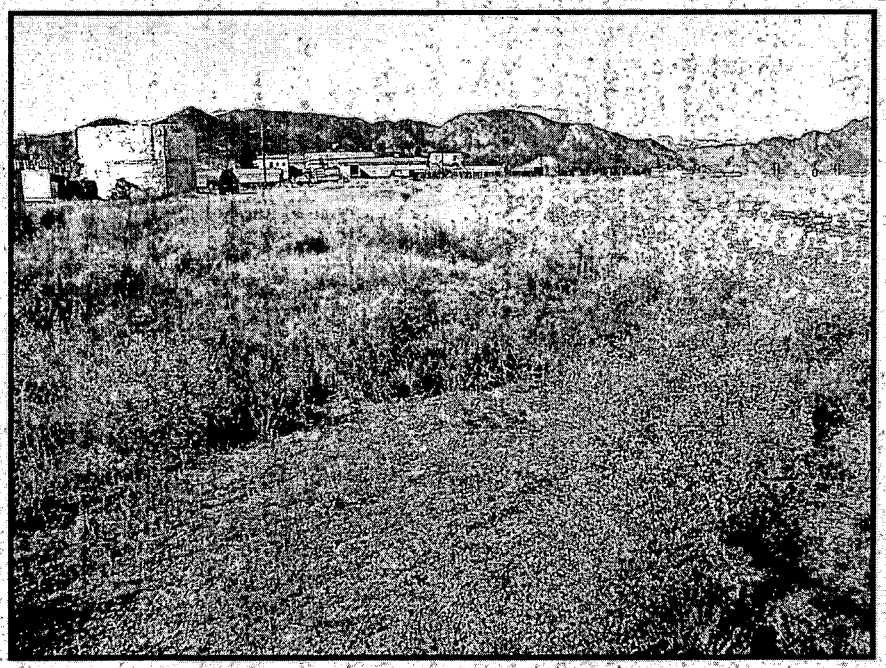
May 2004



October 2004

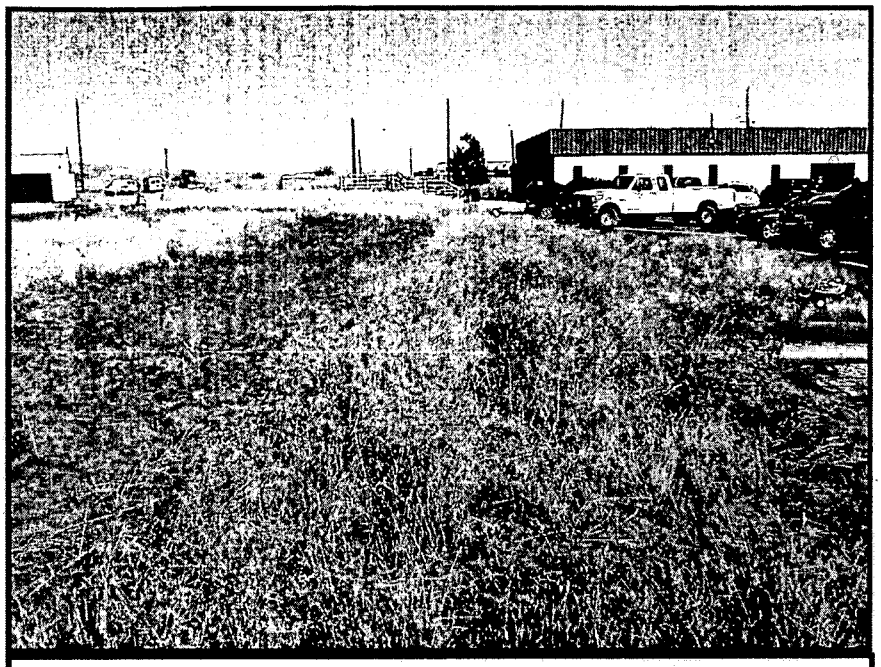






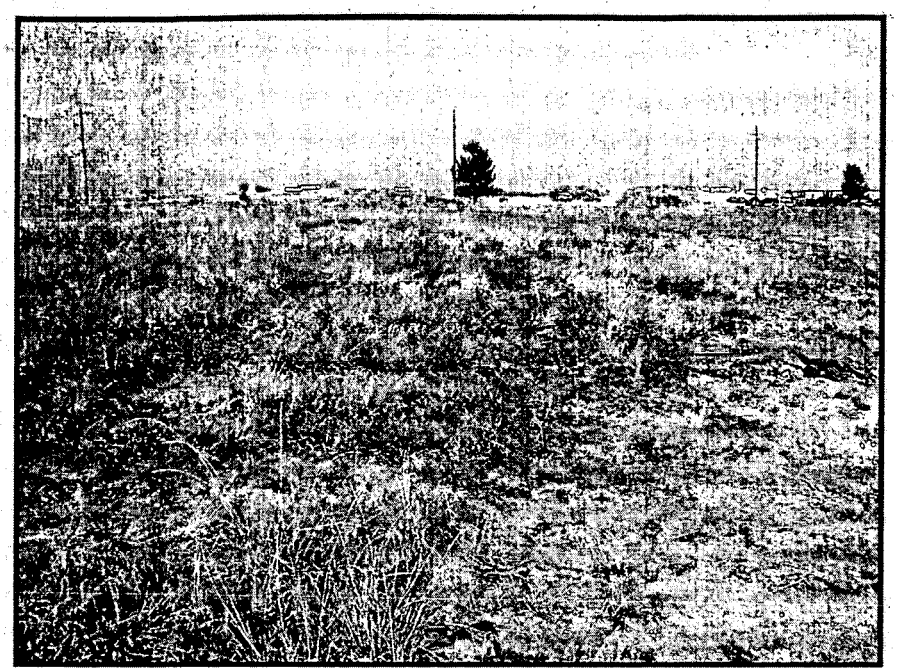
IA Photopoint #8

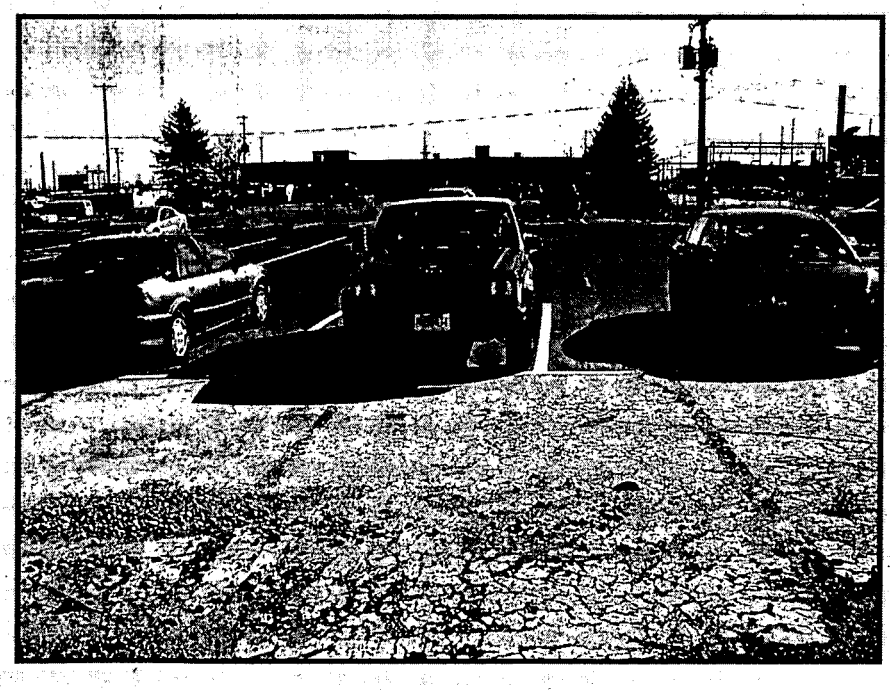
October 2003

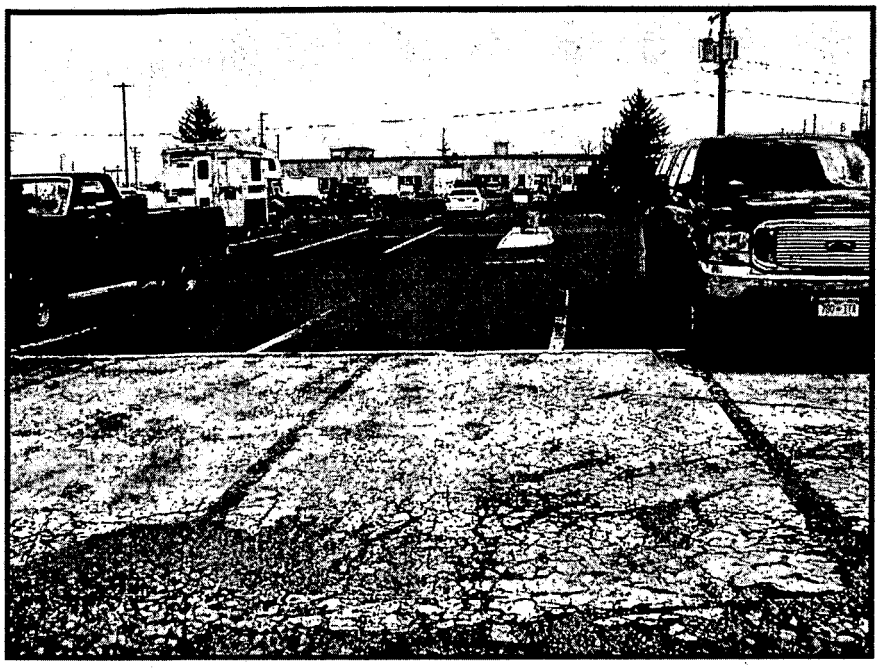


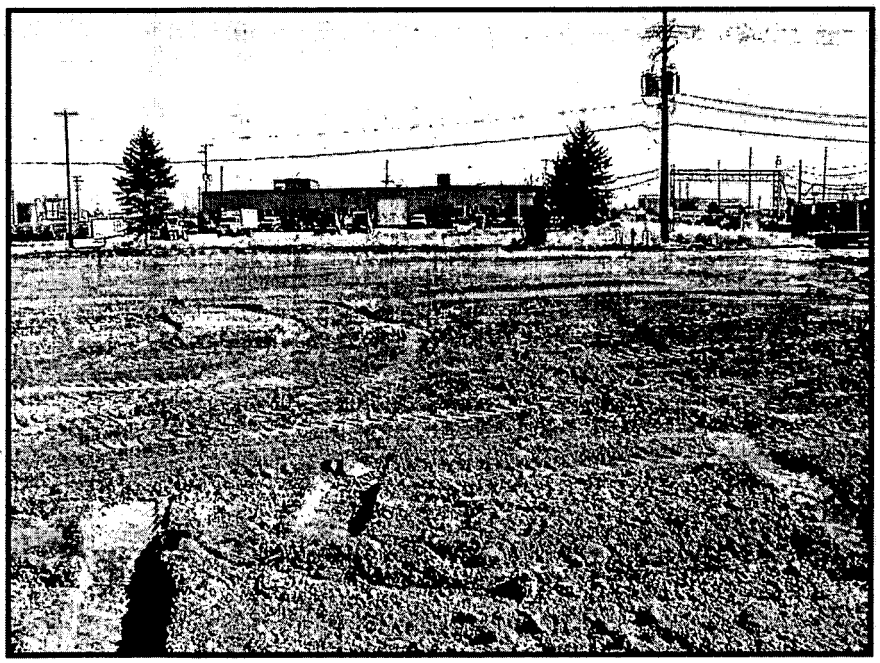
May 2004

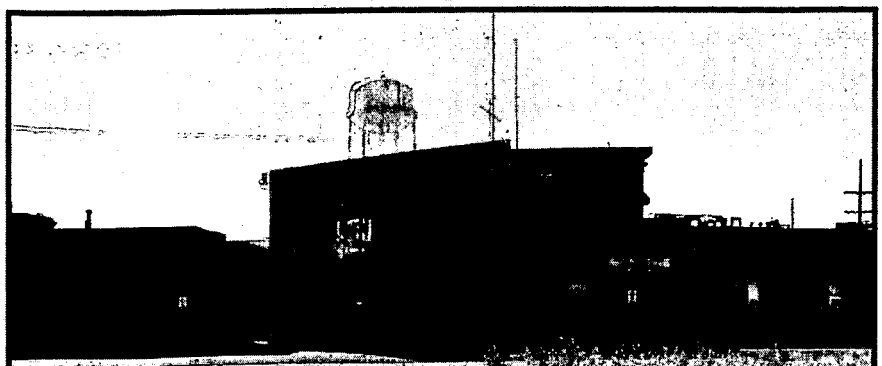
October 2004

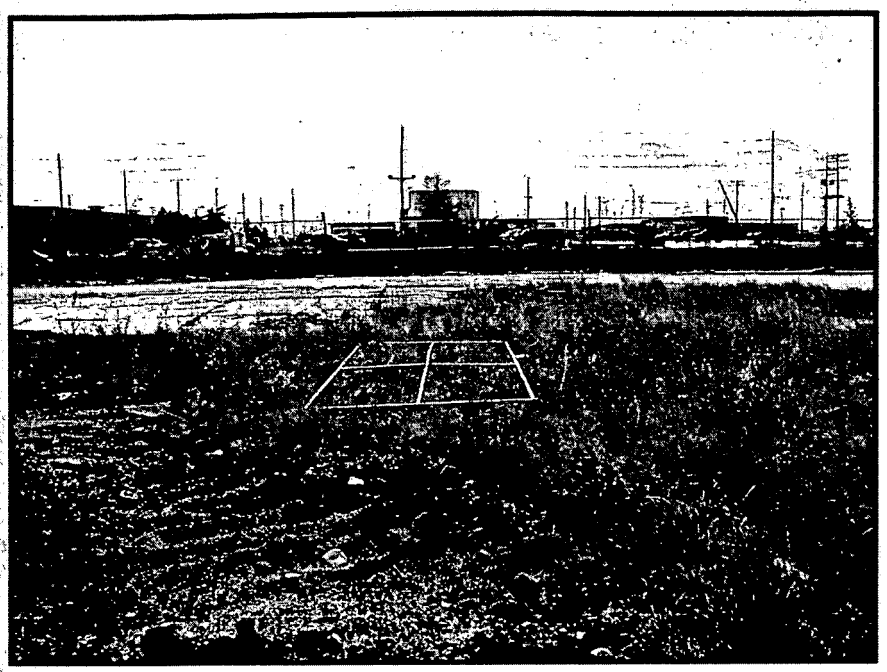


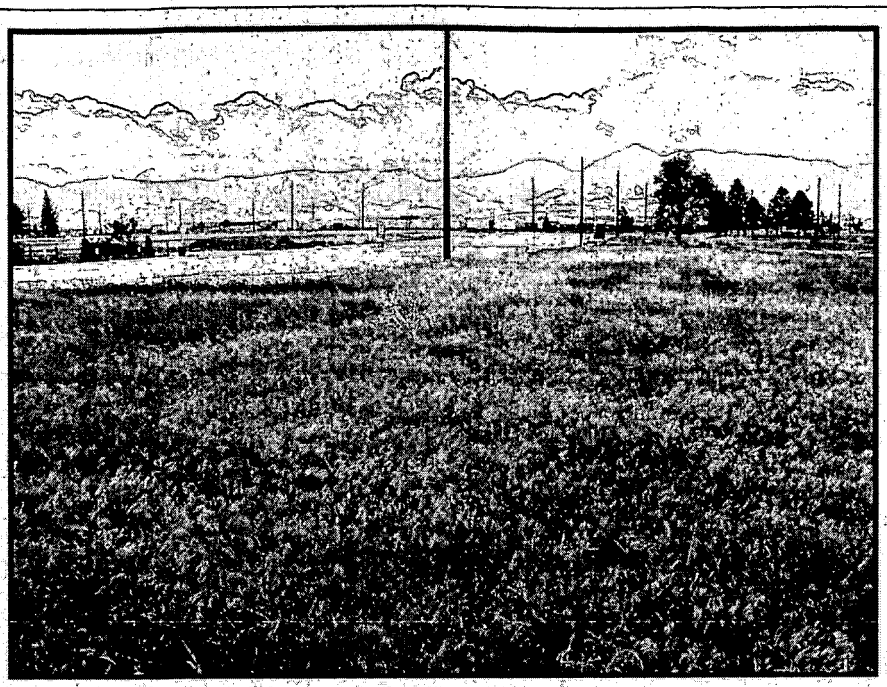


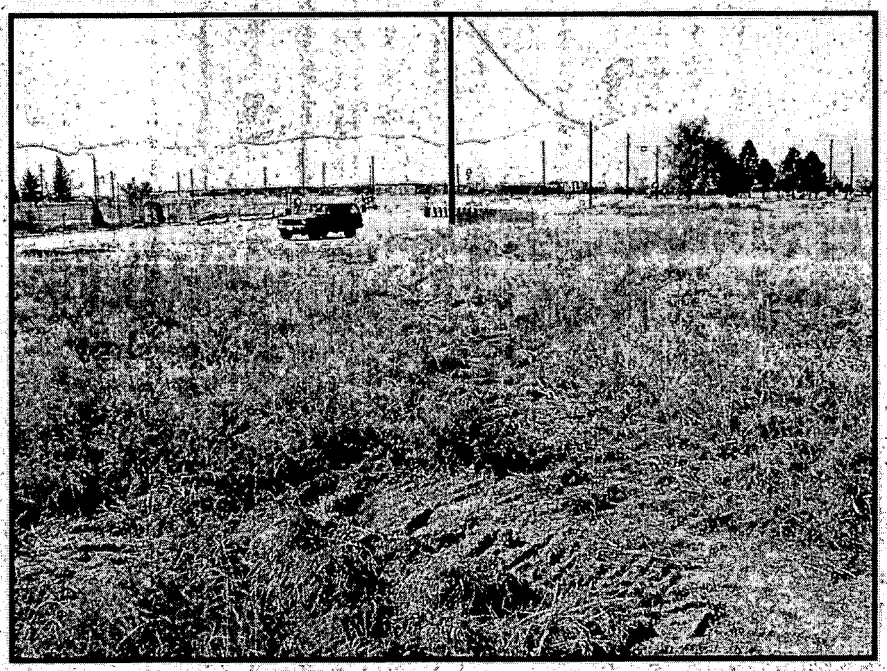


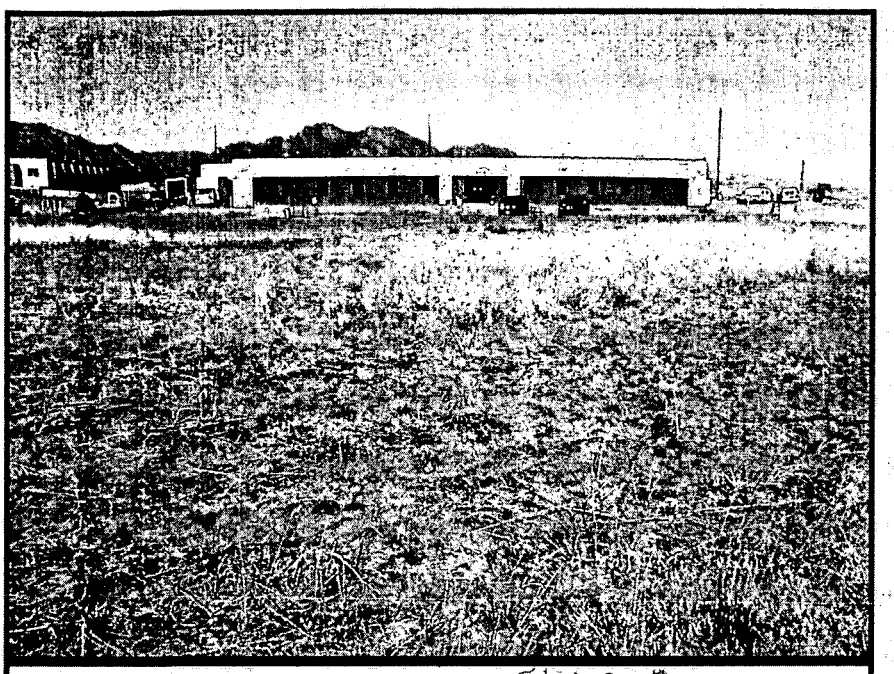


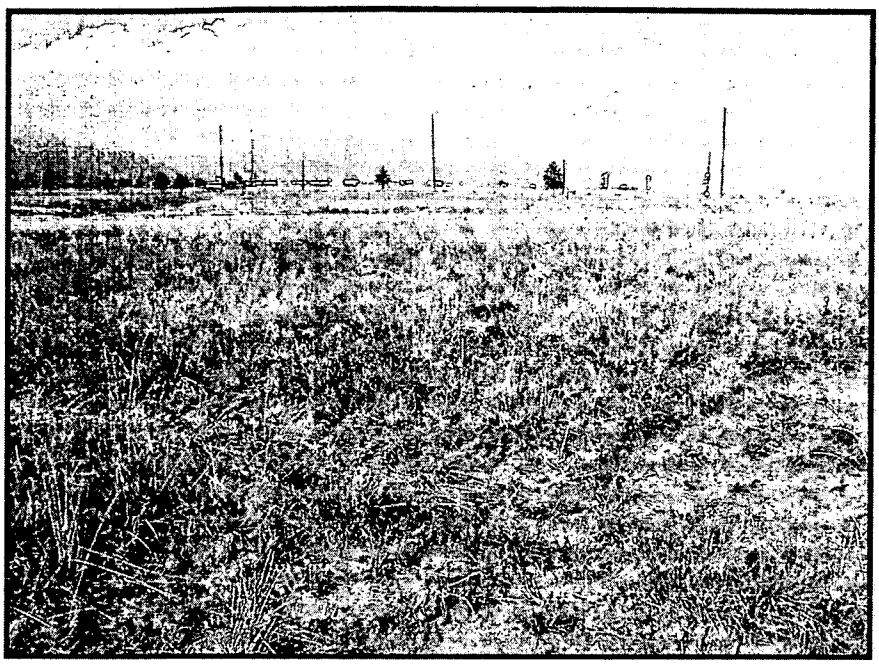








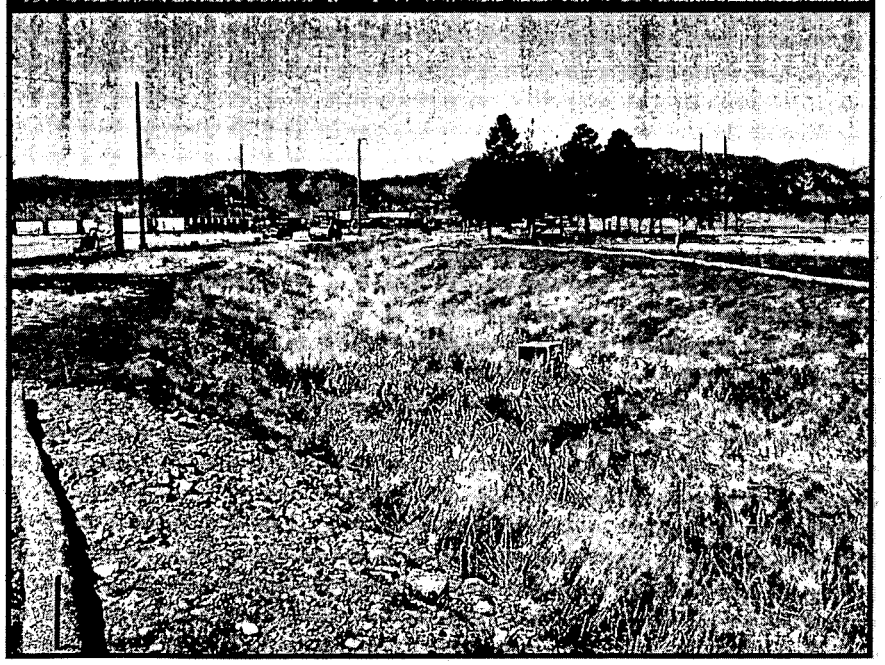




IA Photopoint #9a

October 2003

May 2004



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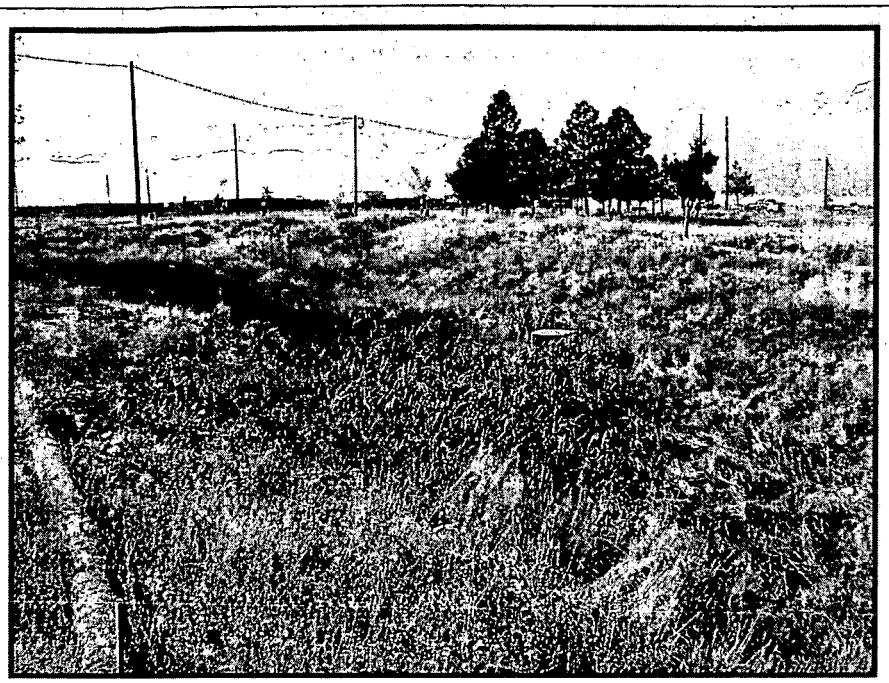
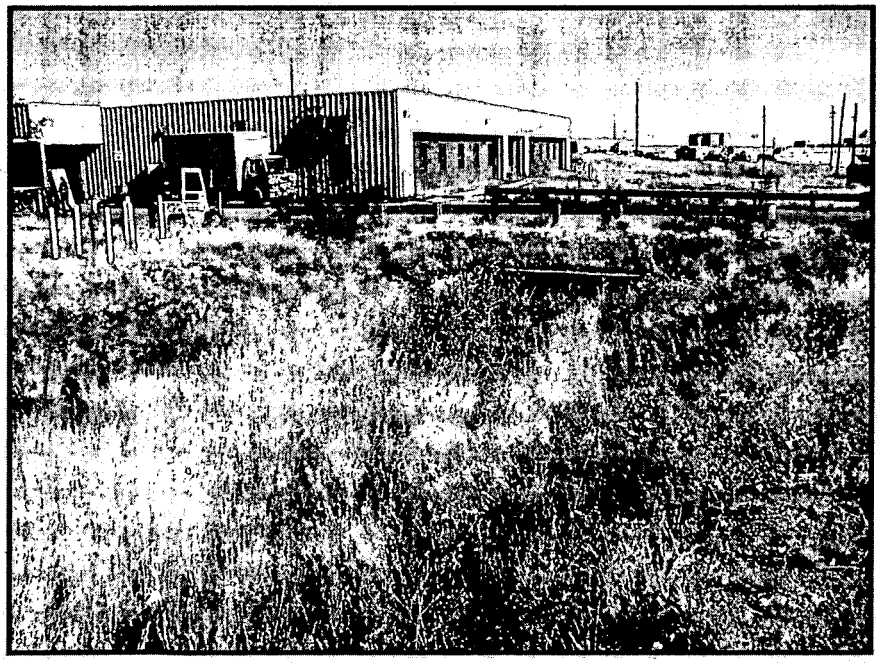
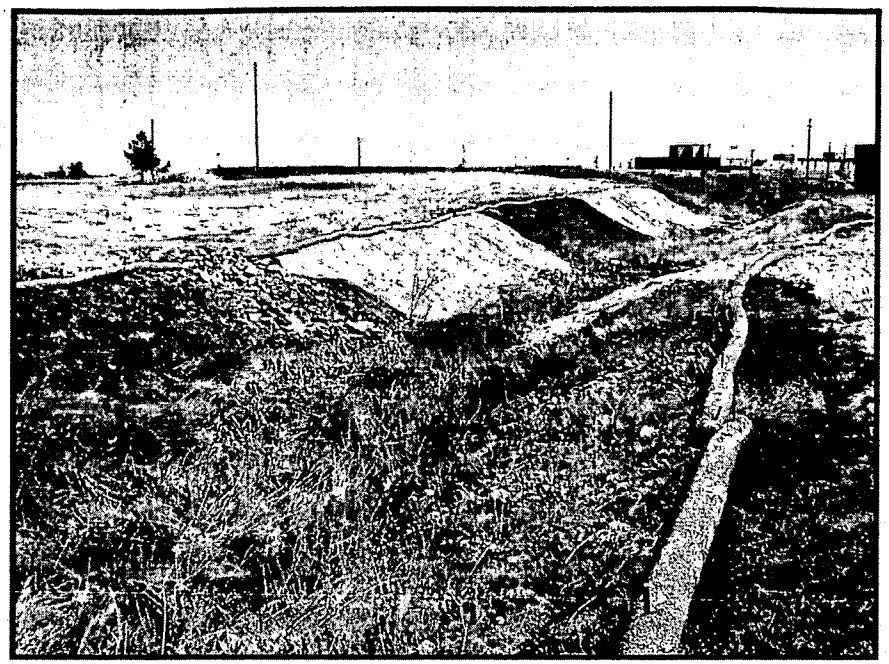
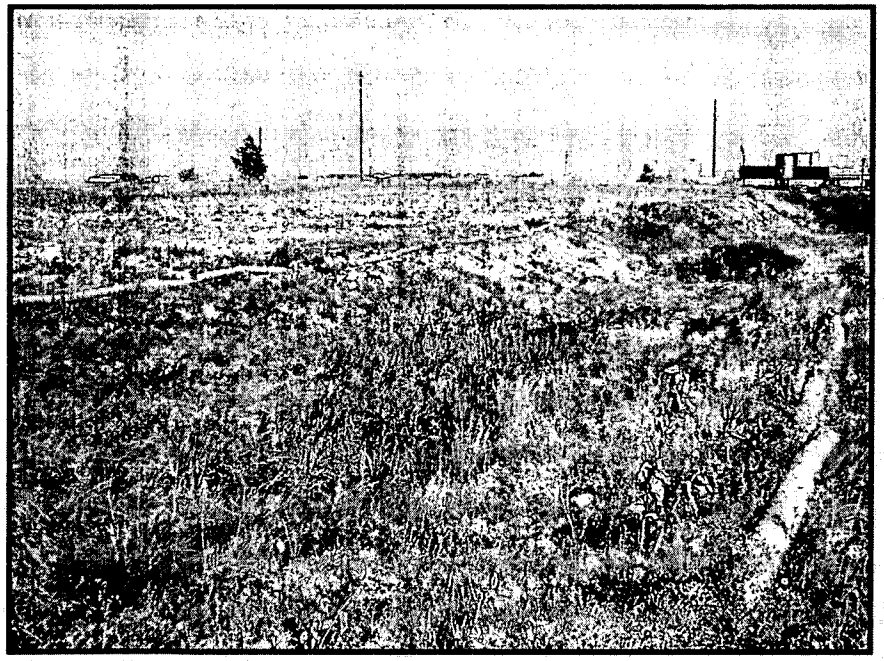




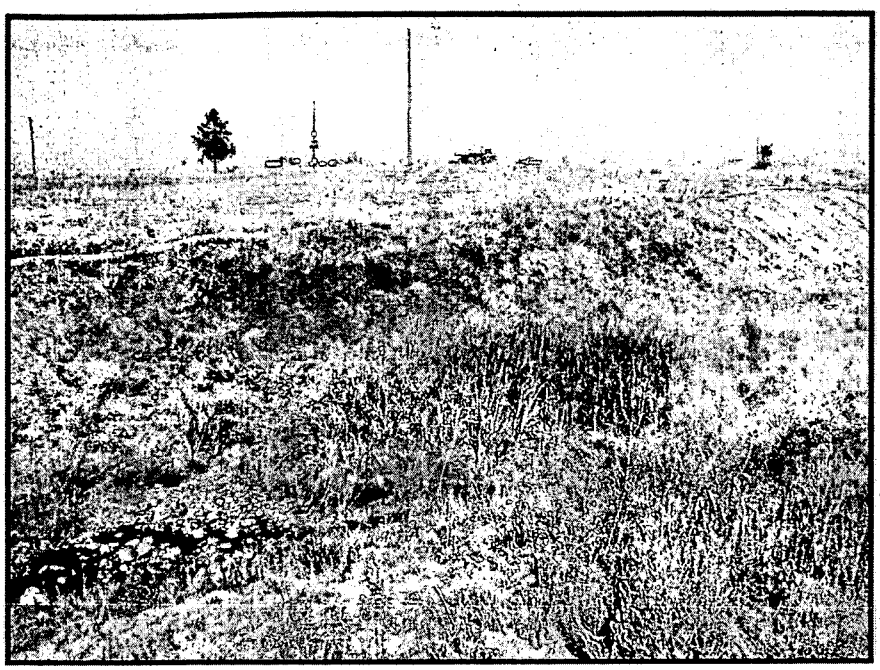


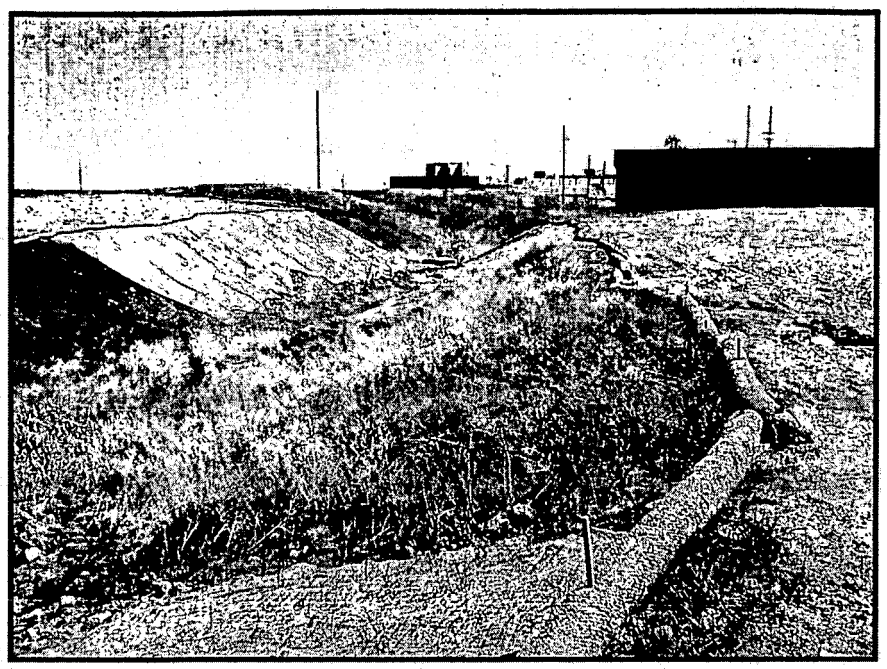


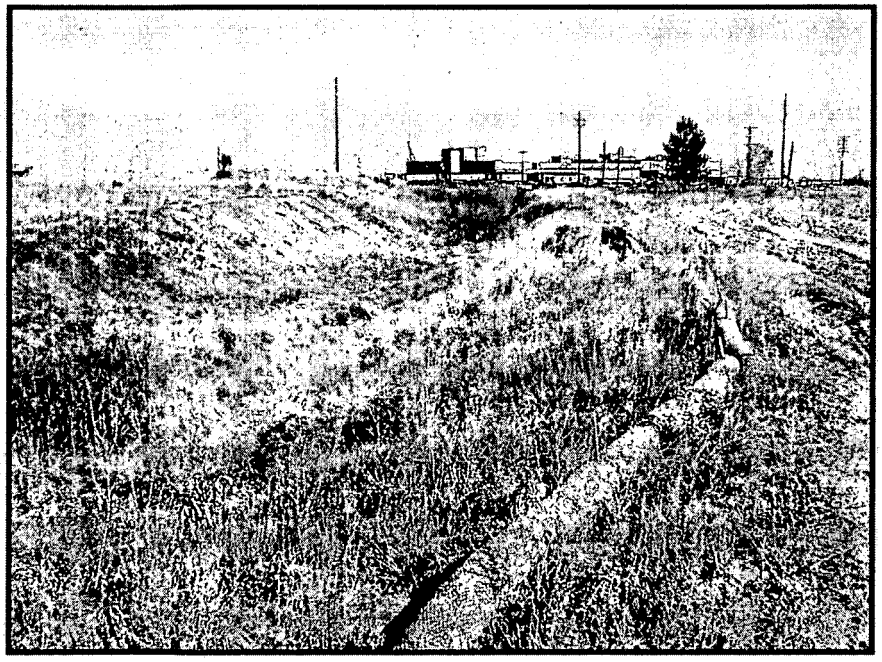
IA Photopoint #9b

October 2003 May 2004

October 2004

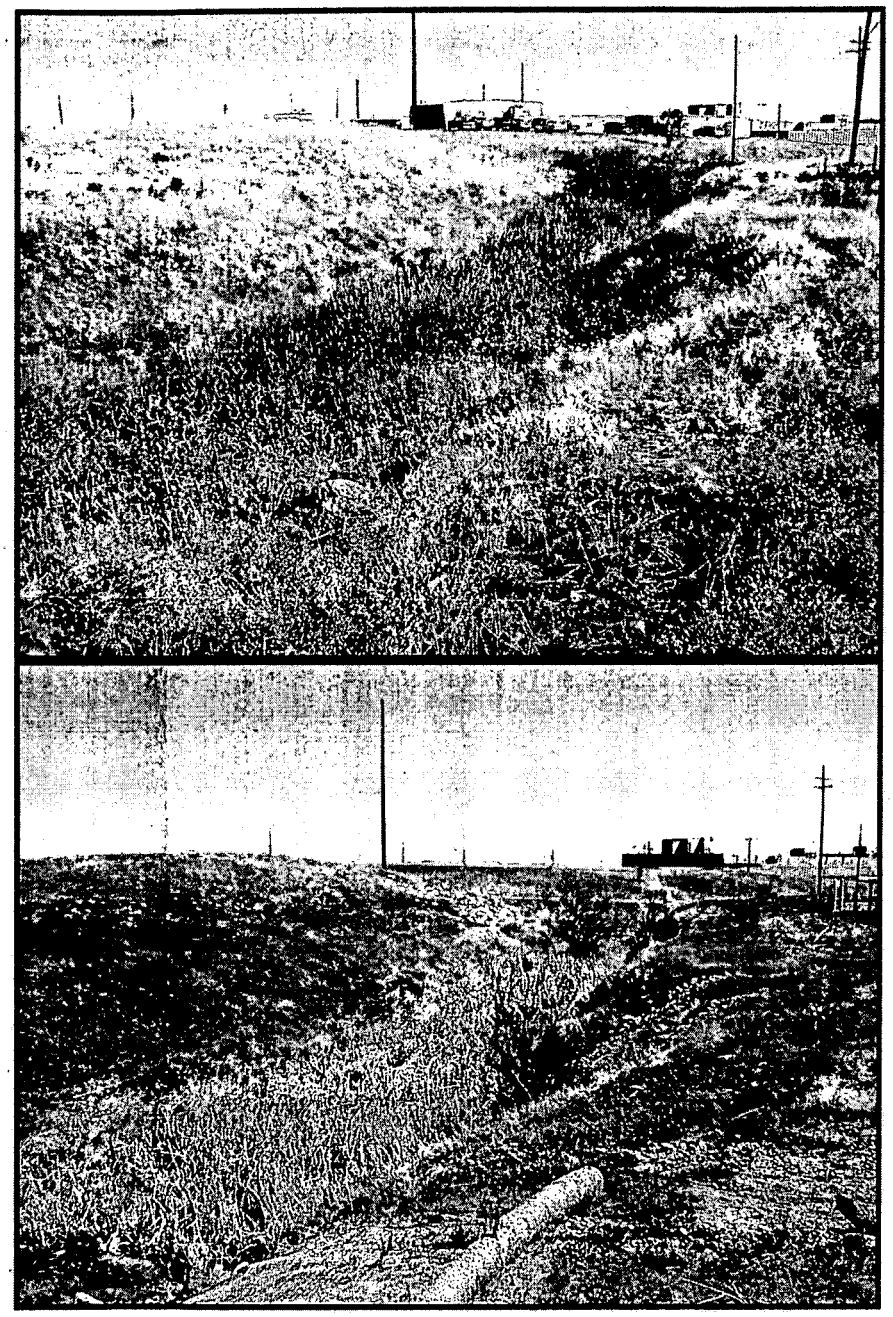






IA Photopoint #9c

October 2003 May 2004



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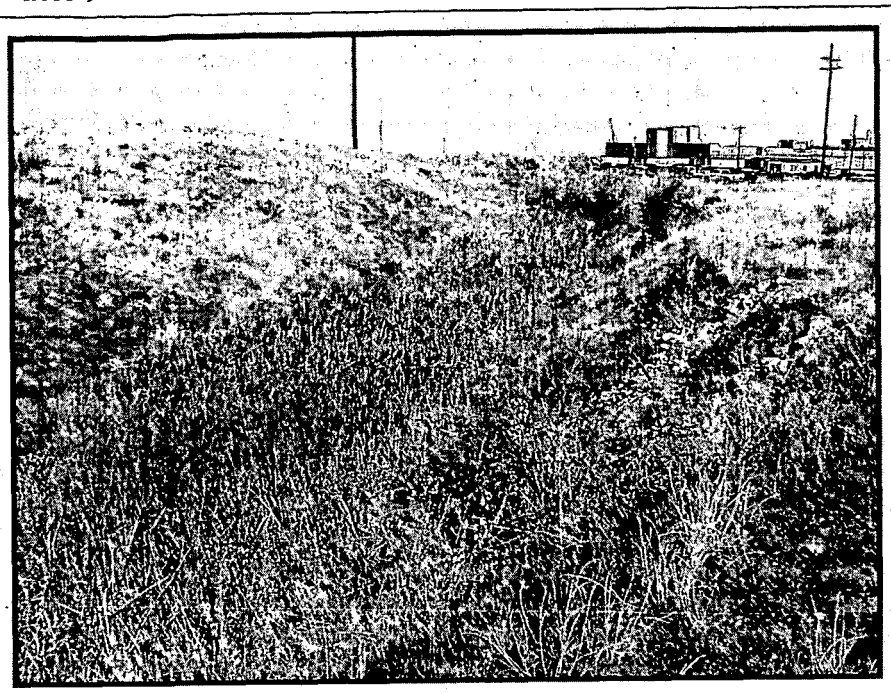

IA Photopoint #10

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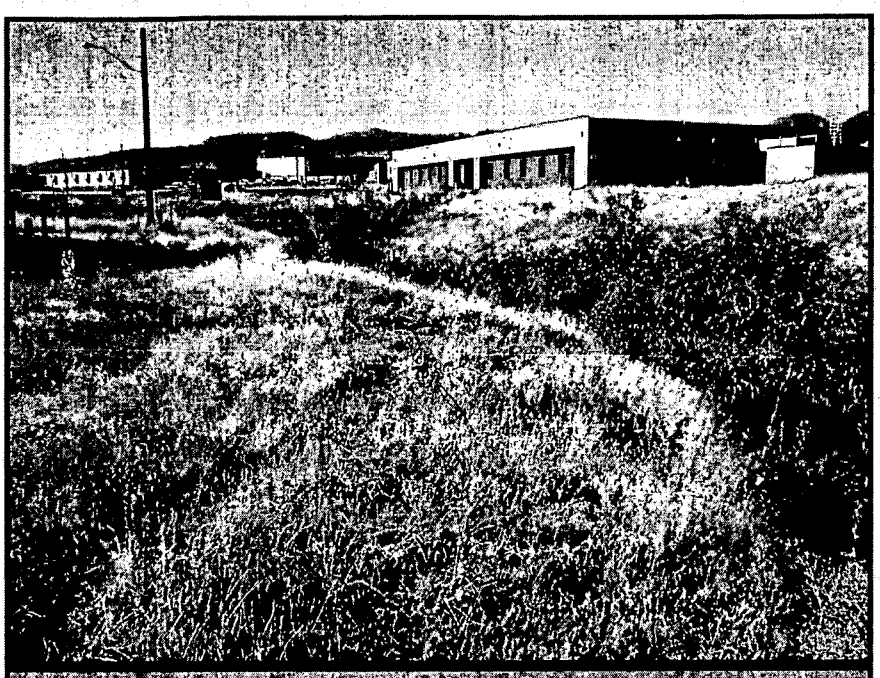
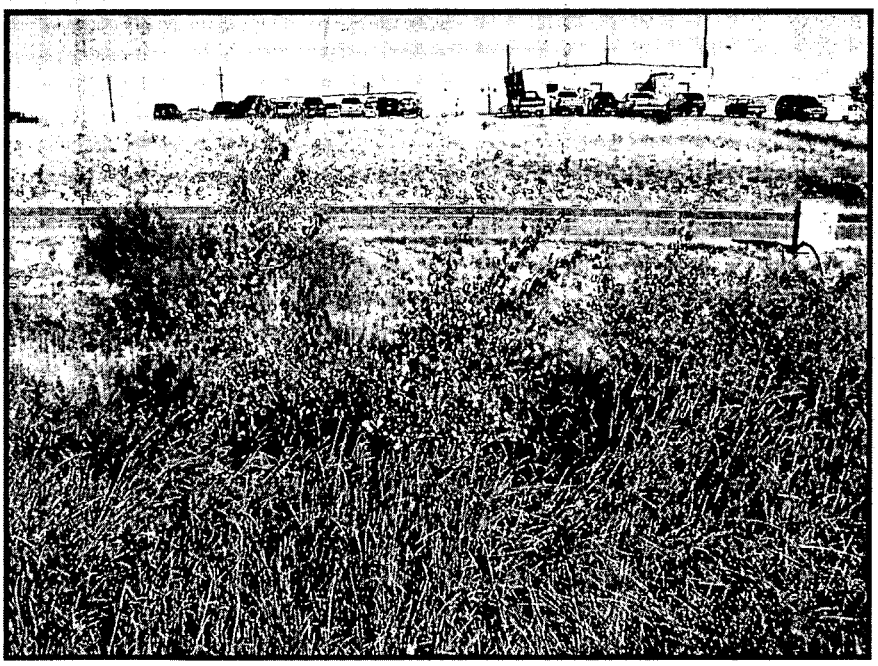
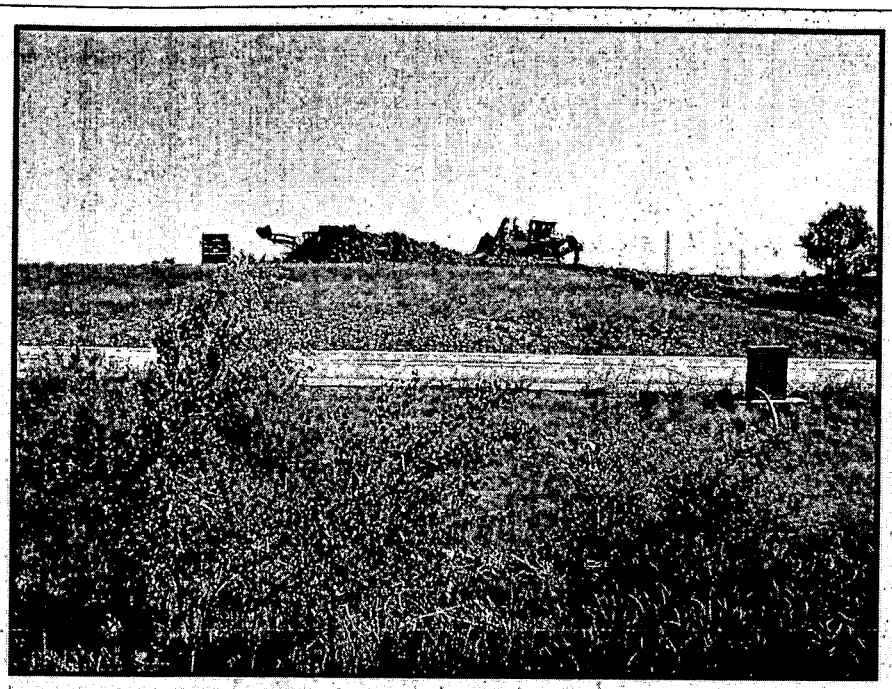
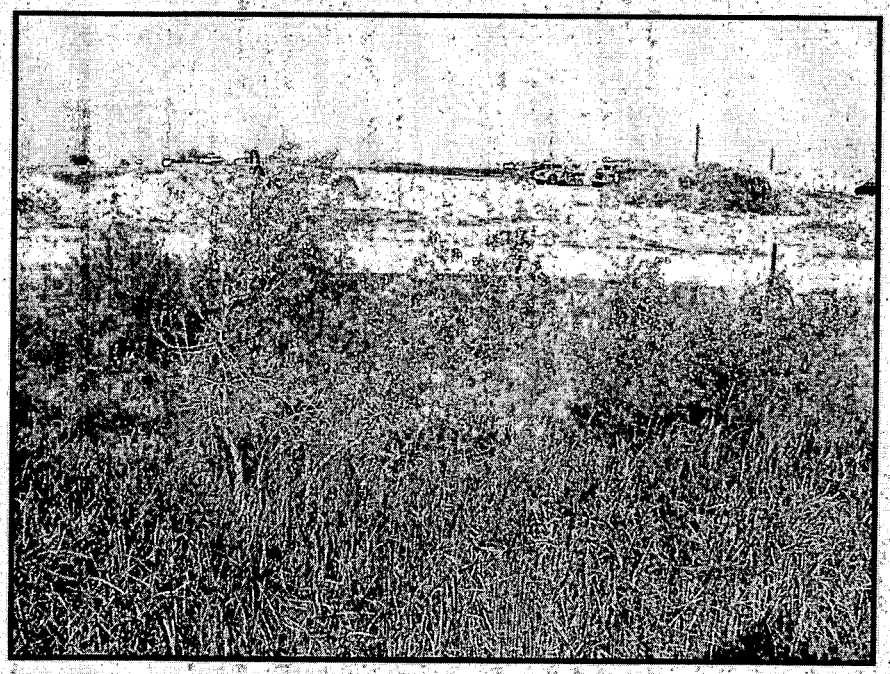


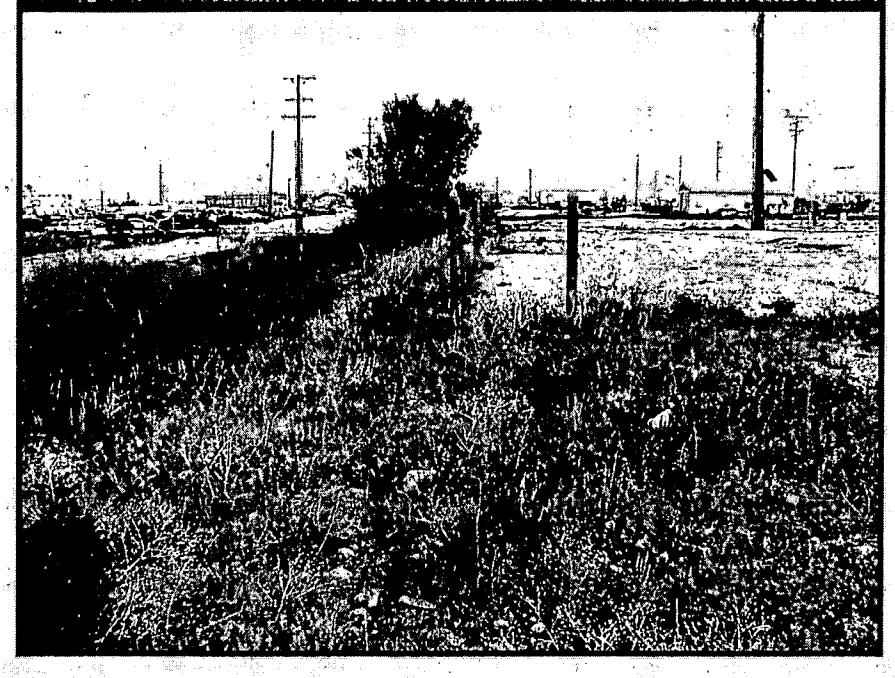
May 2004

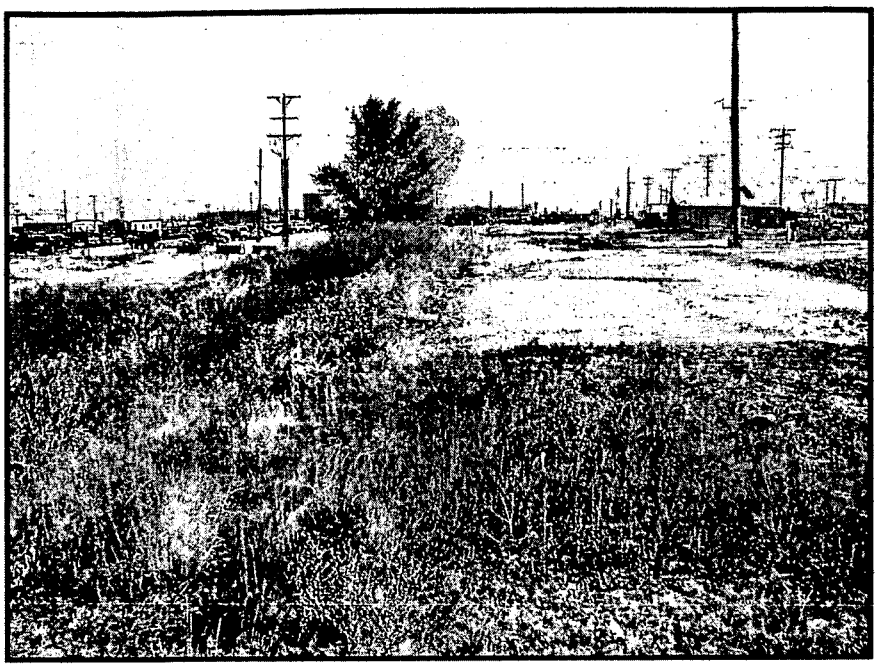
October 2004

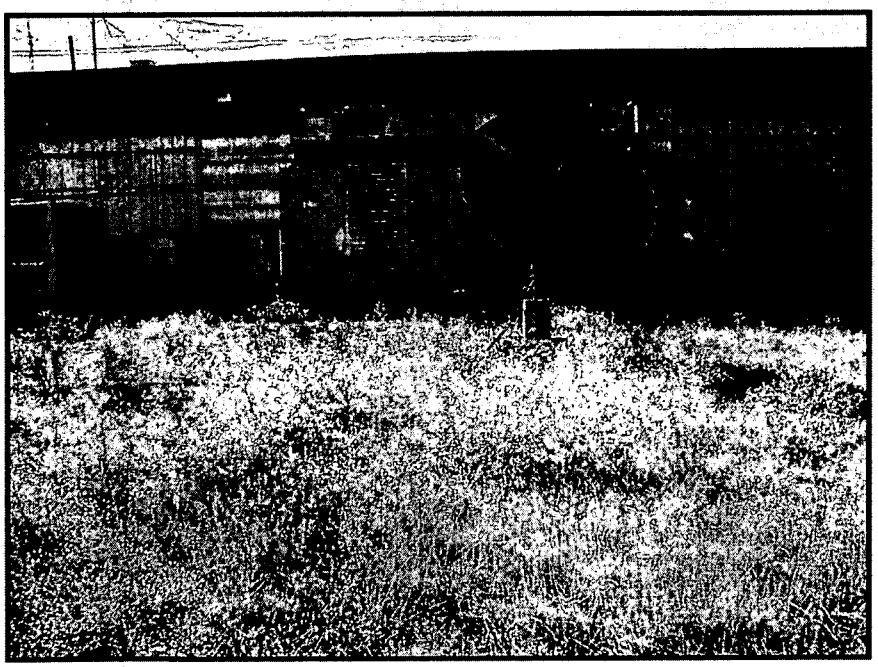


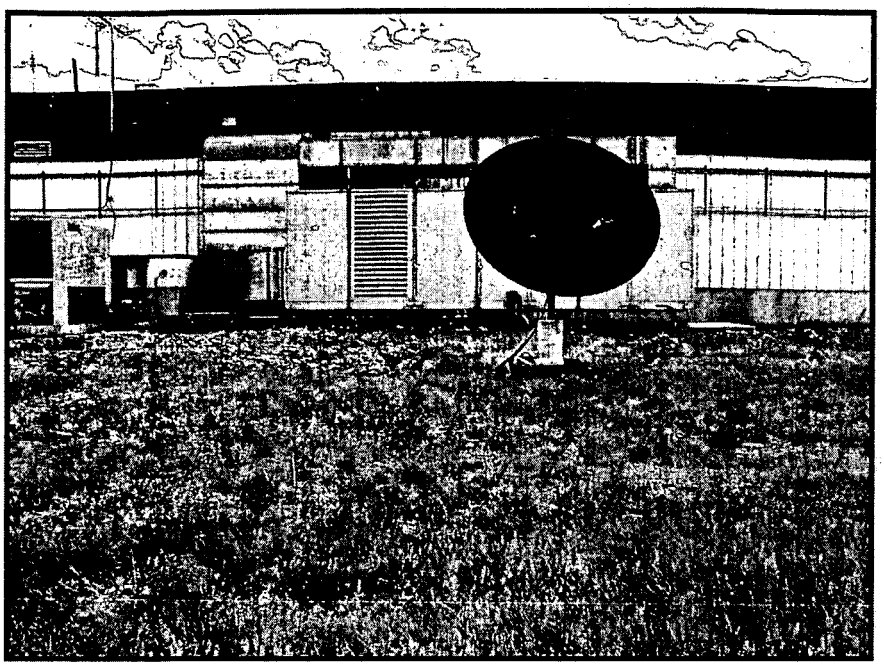


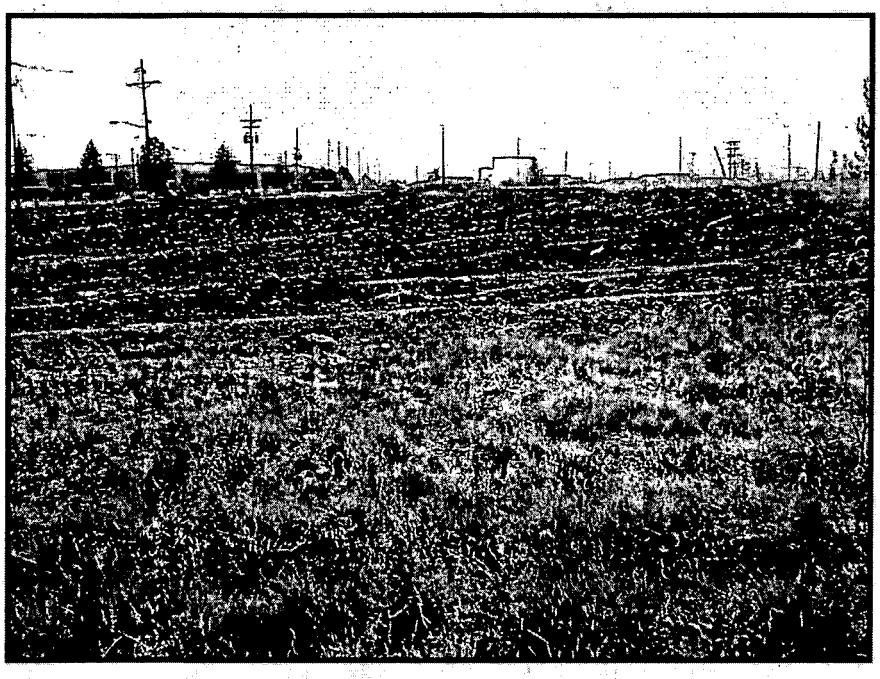






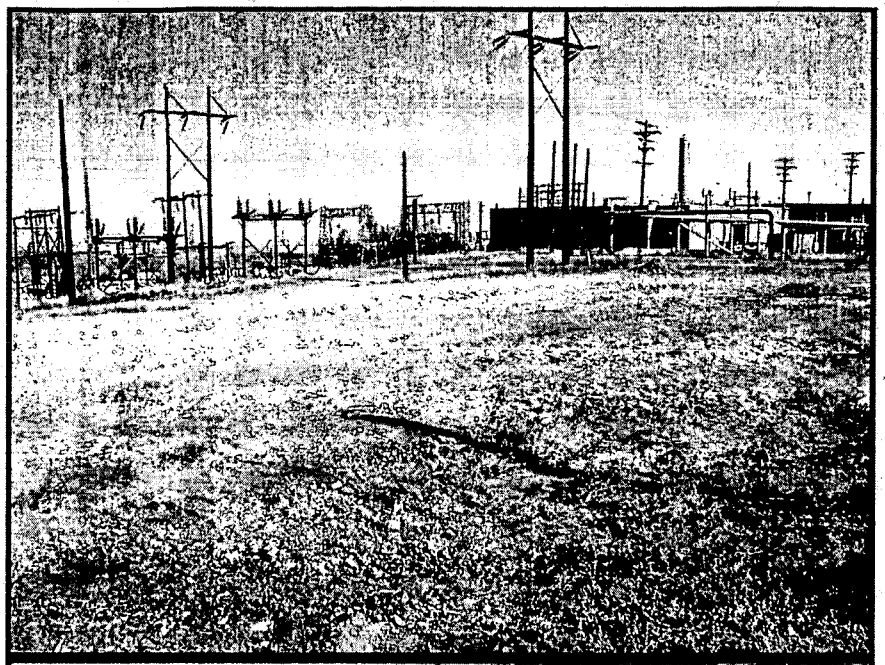






IA Photopoint #11

October 2003



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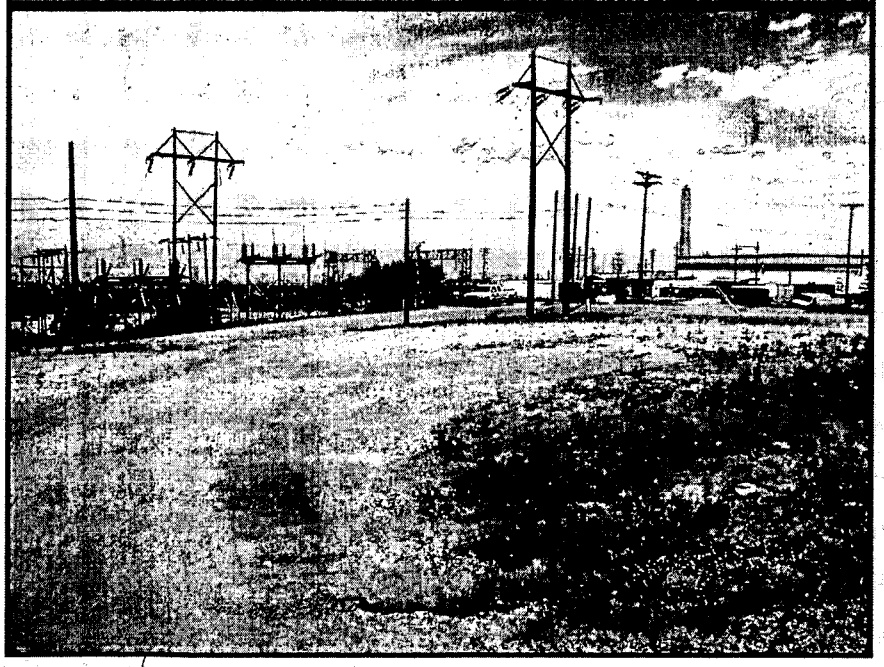
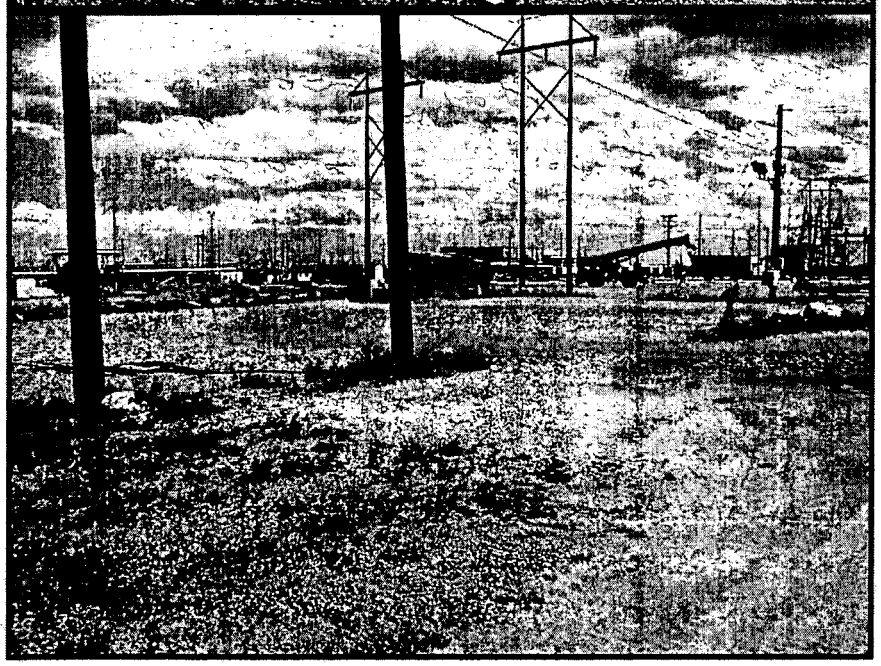
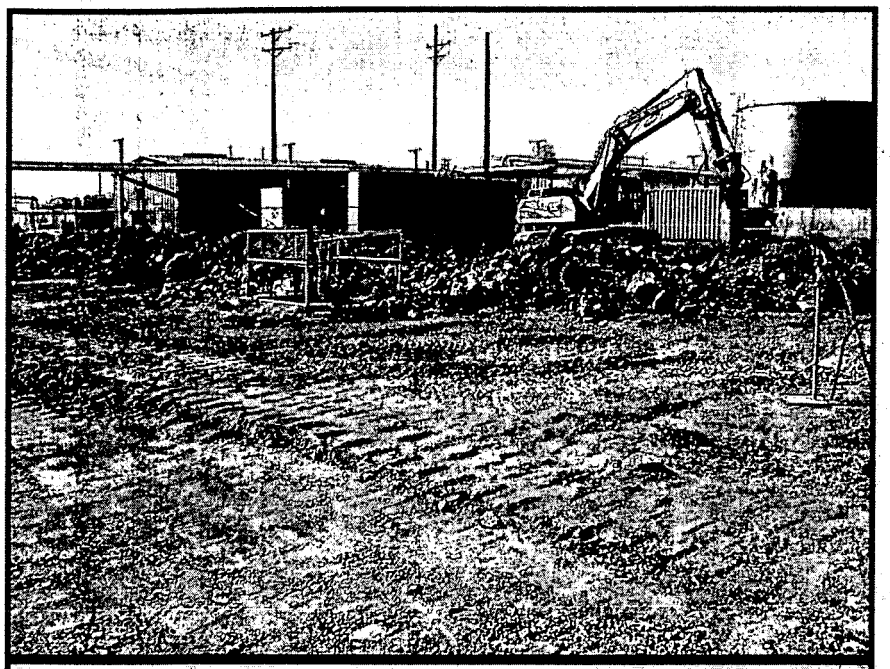
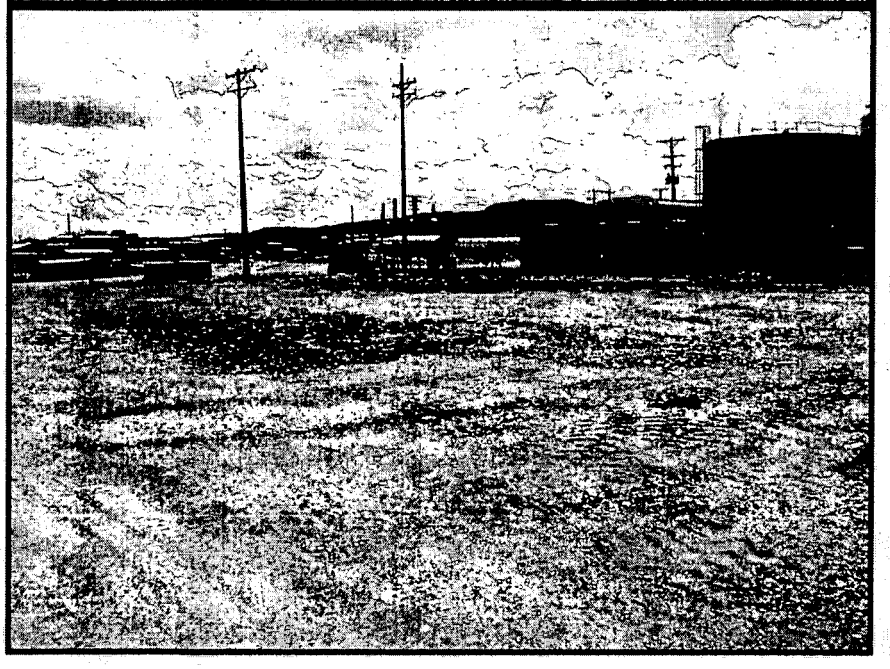
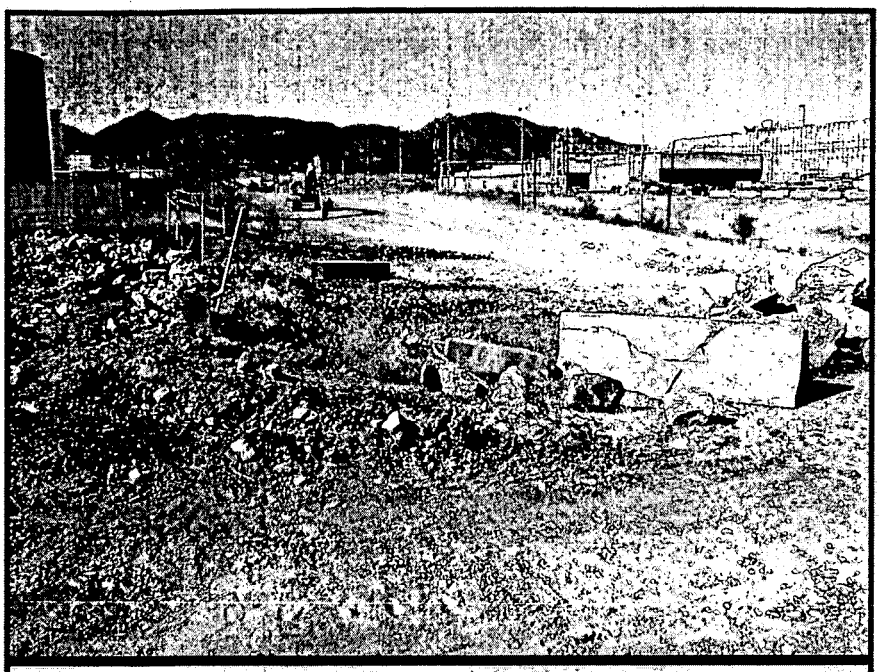
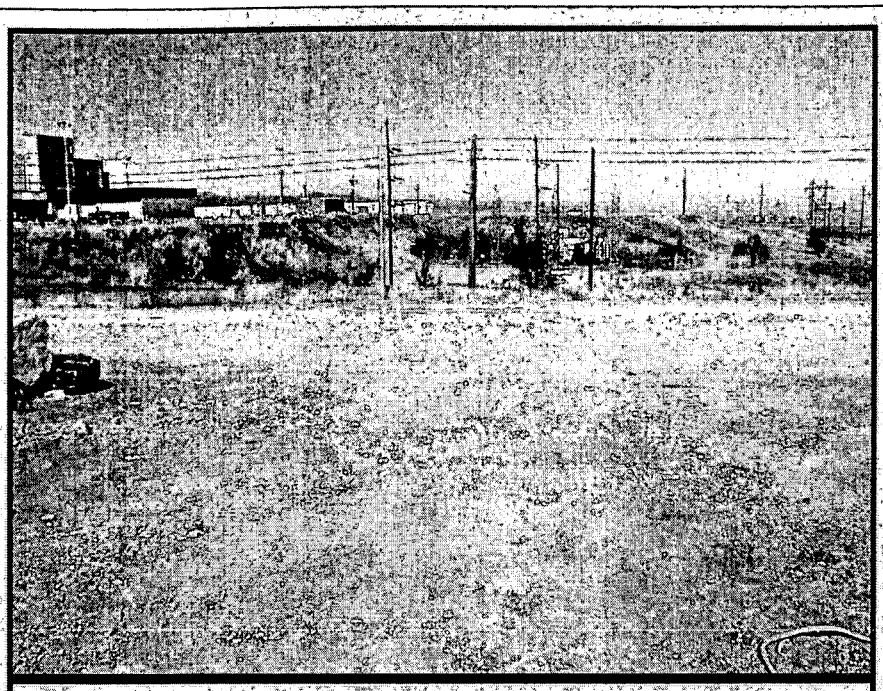


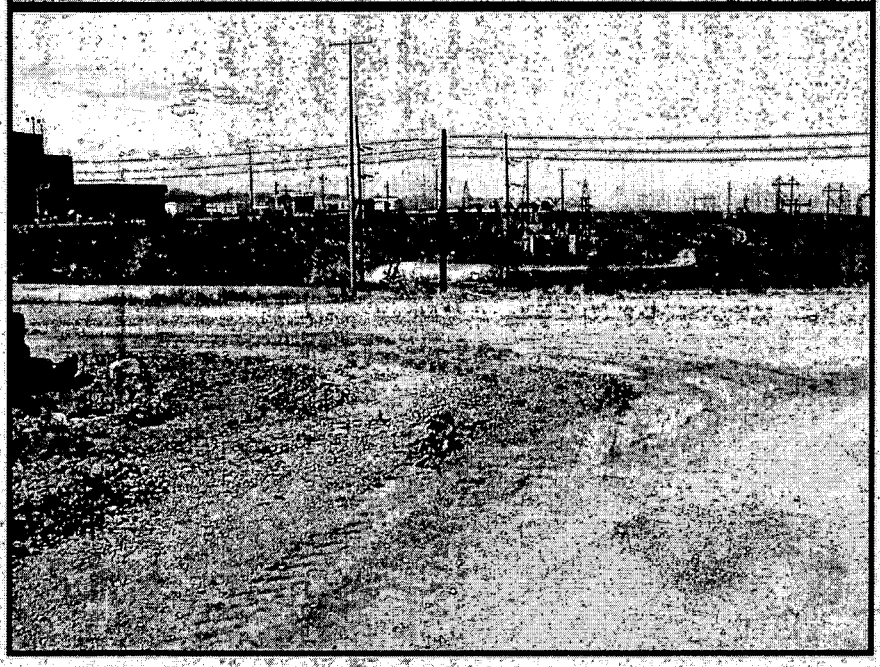






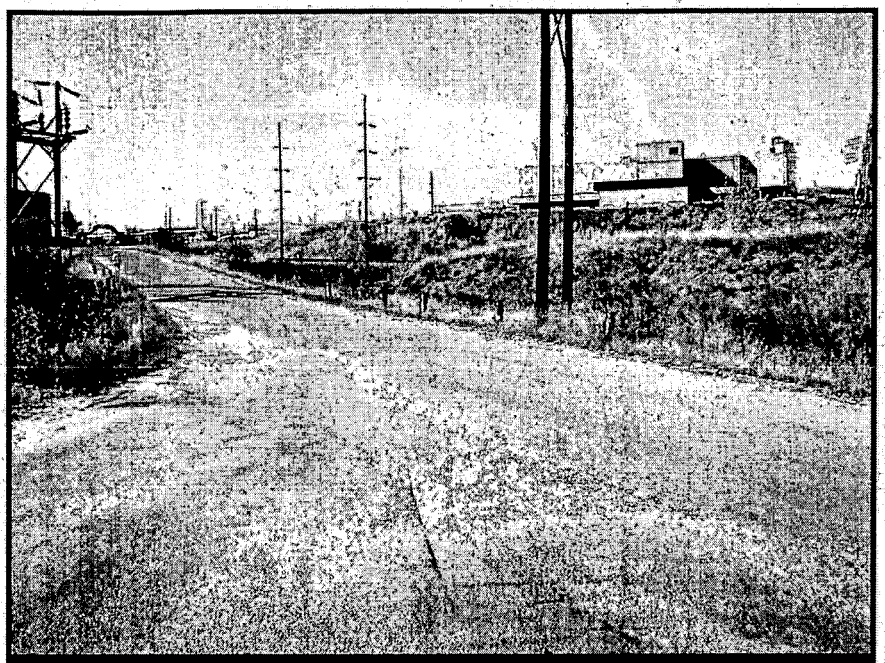






IA Photopoint #12a

October 2003



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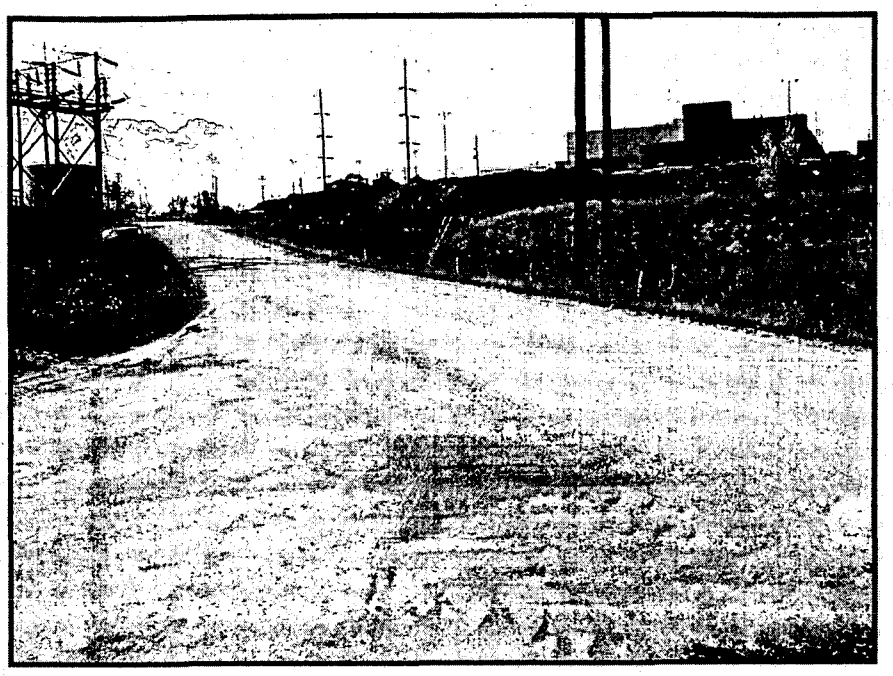
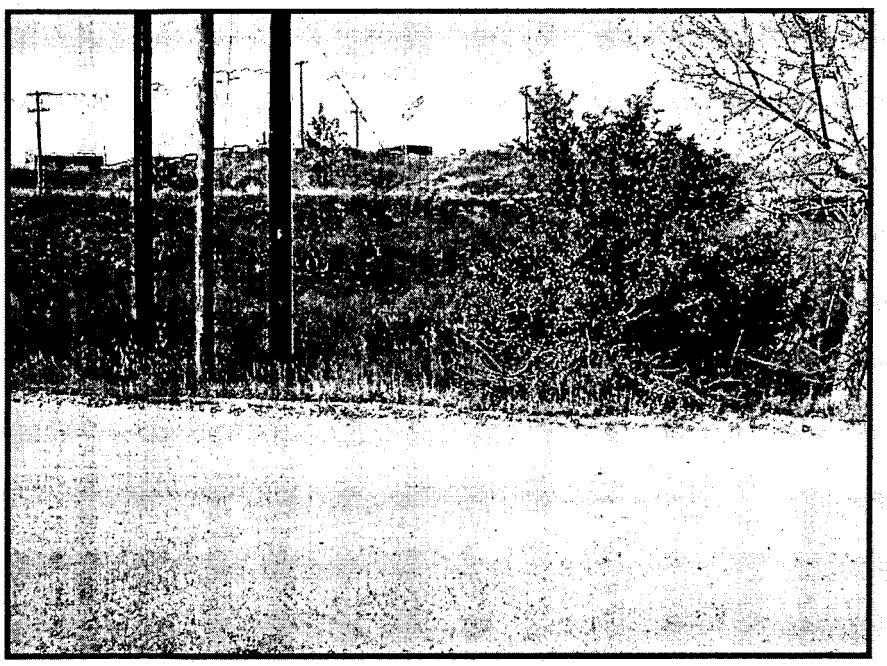
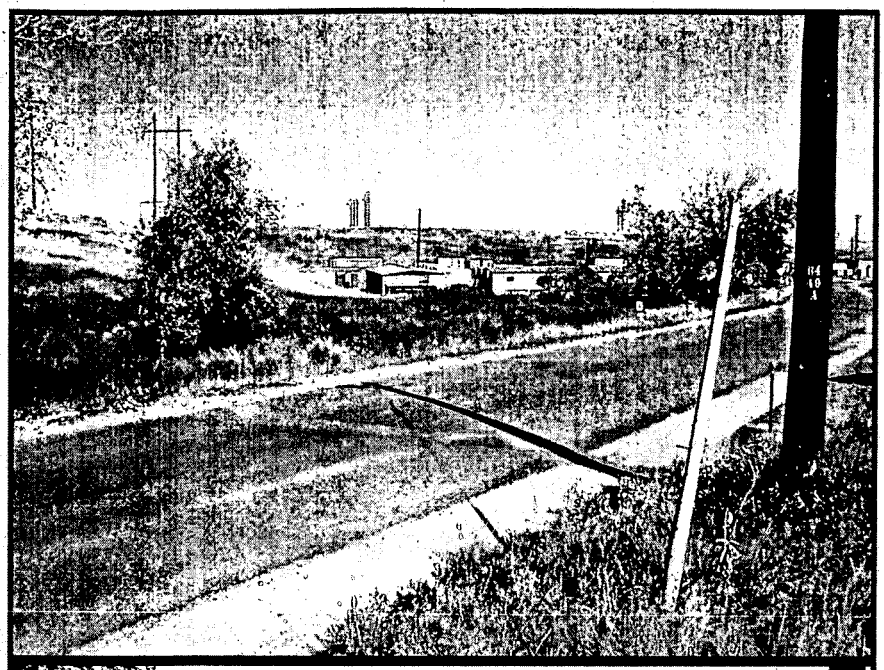
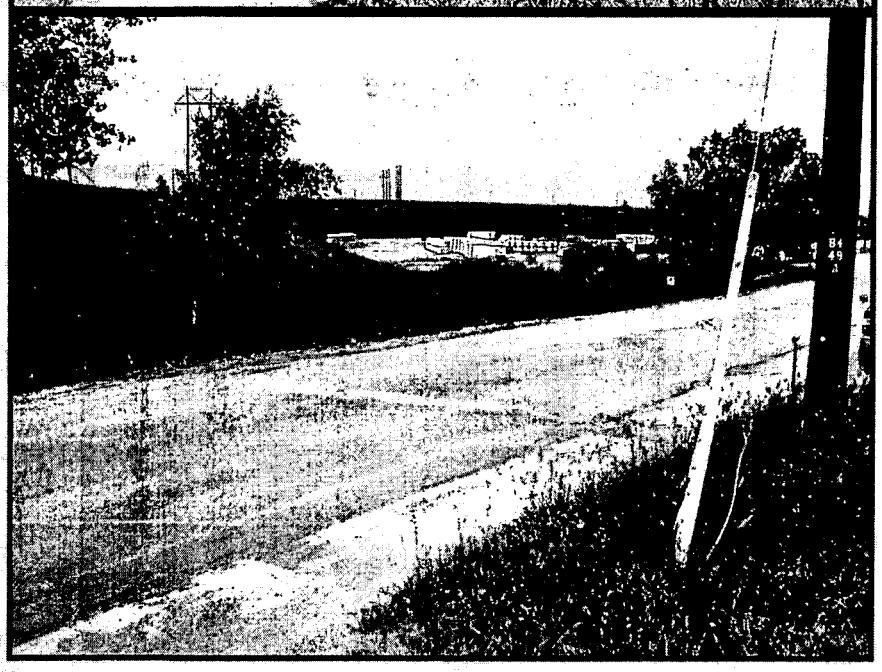
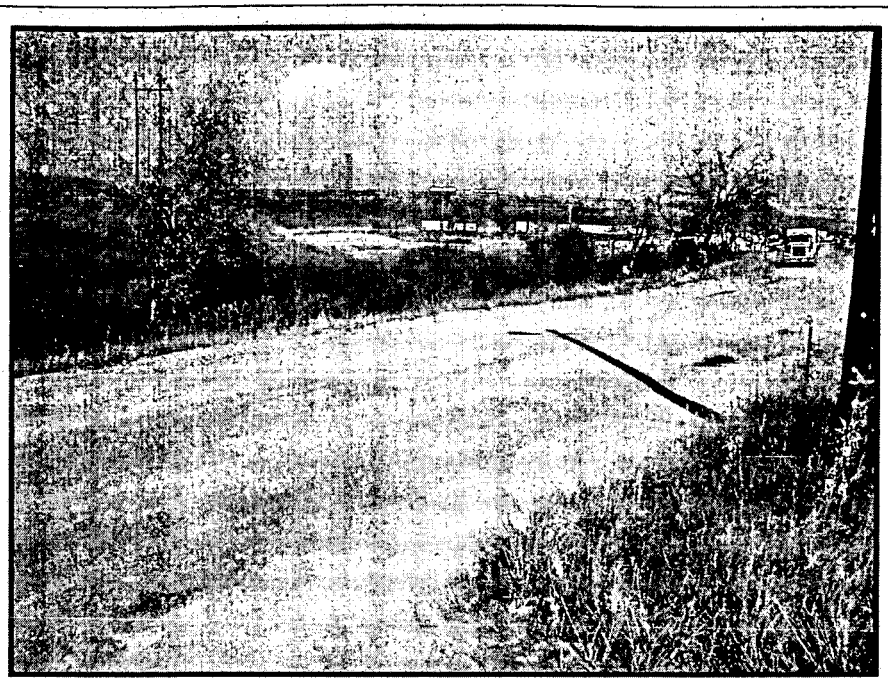


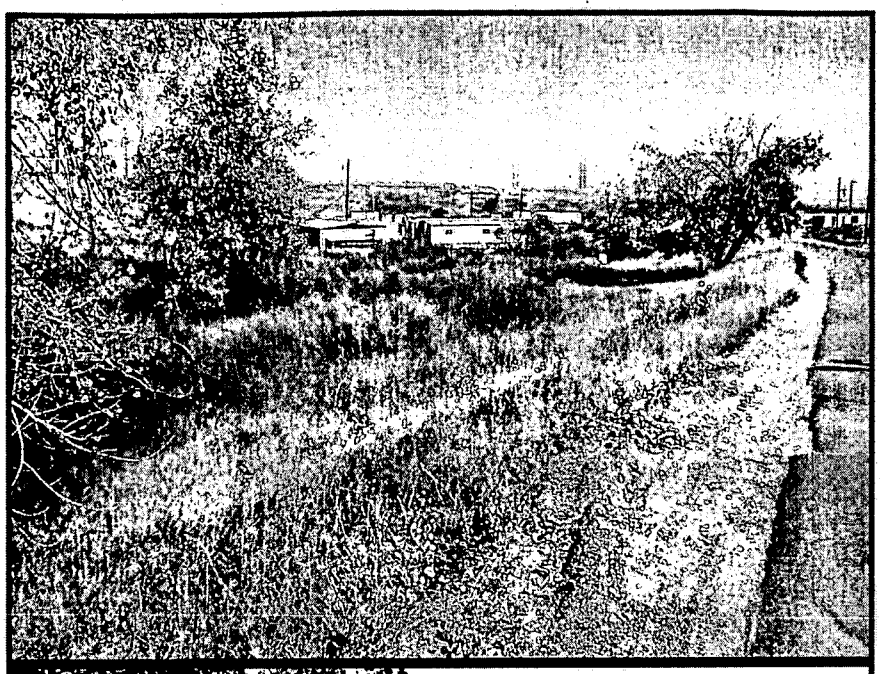


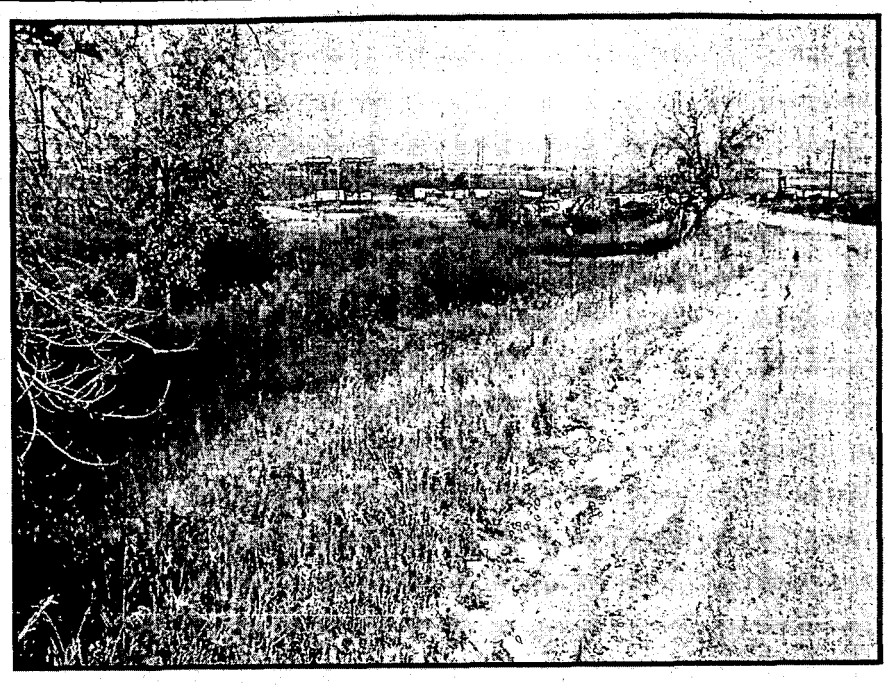






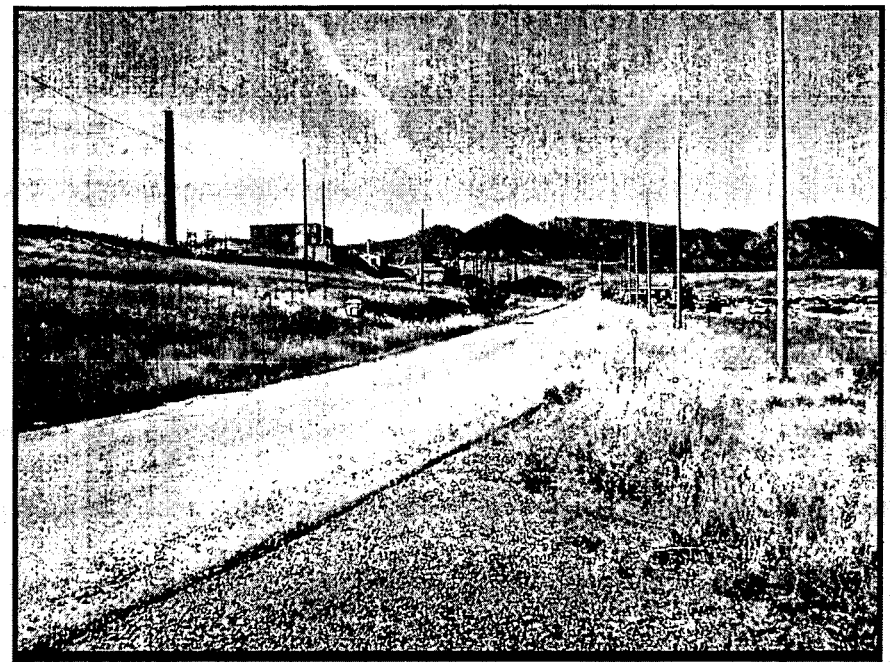
IA Photopoint #12b





IA Photopoint #13

October 2003



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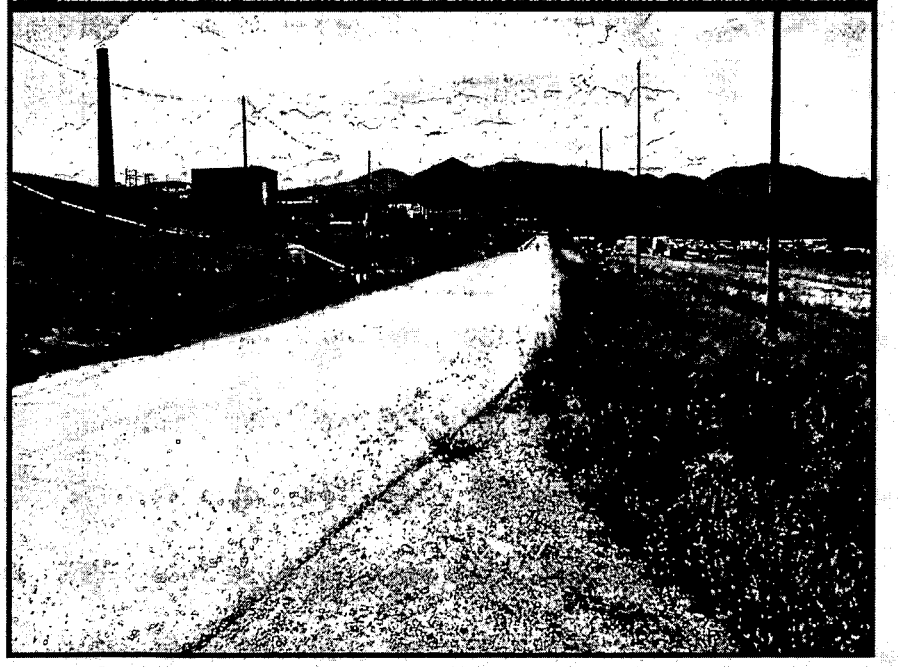
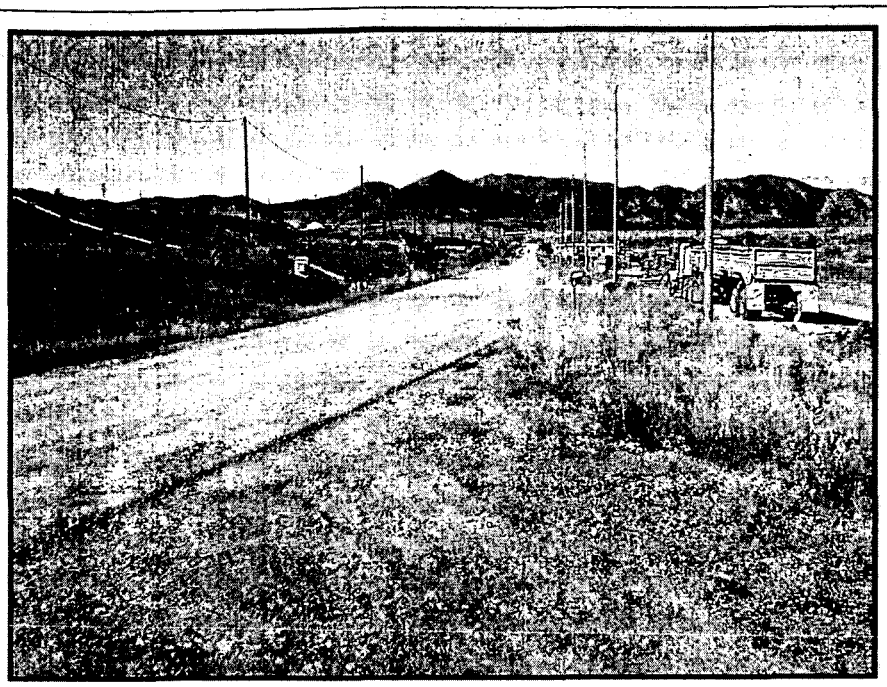
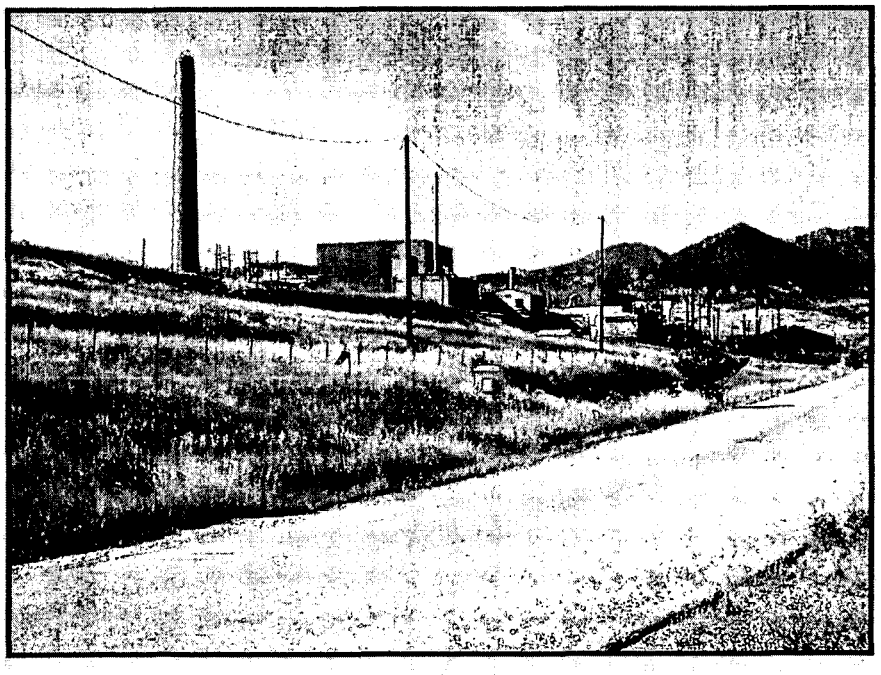
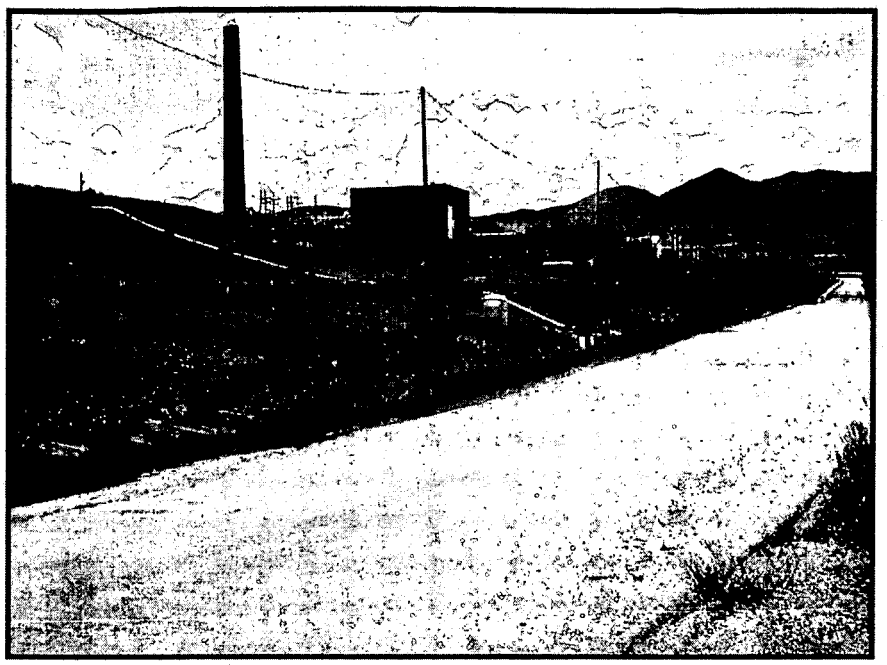
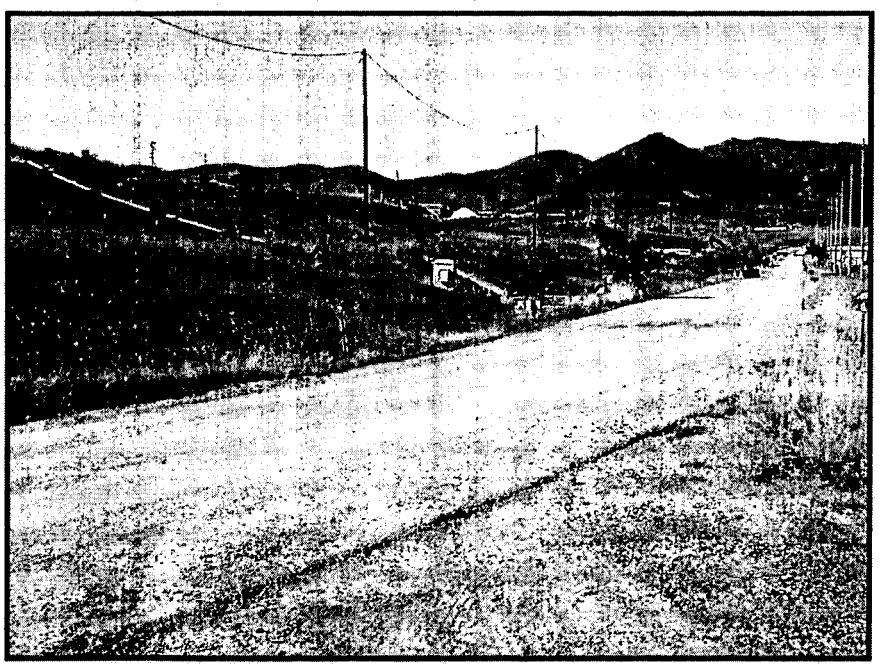


October 2004









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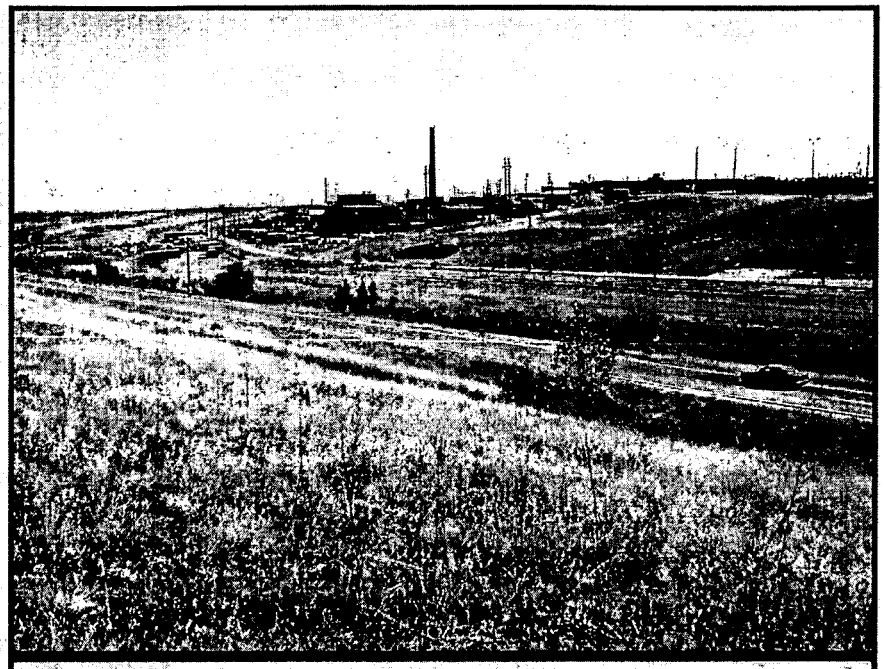
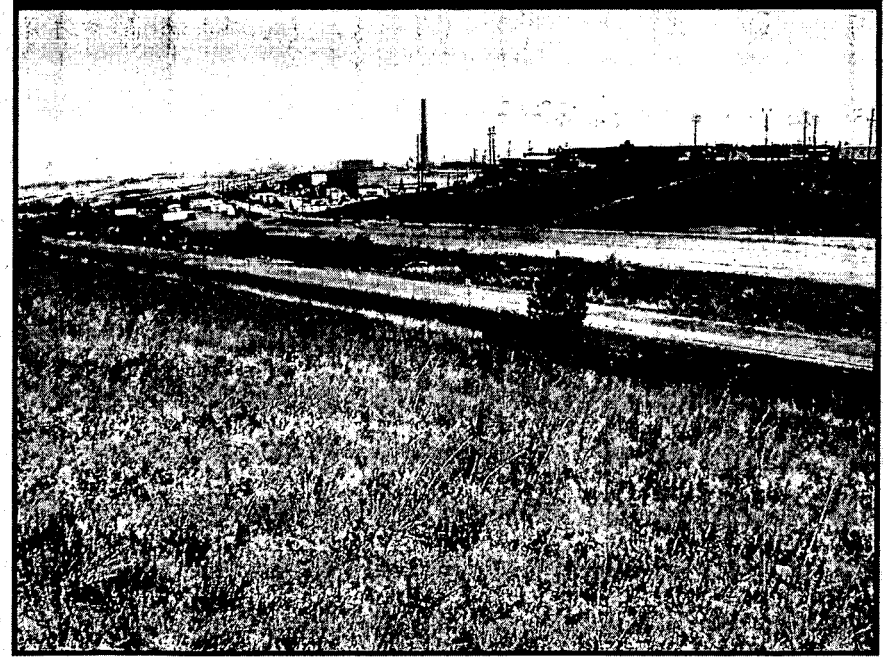


May 2004



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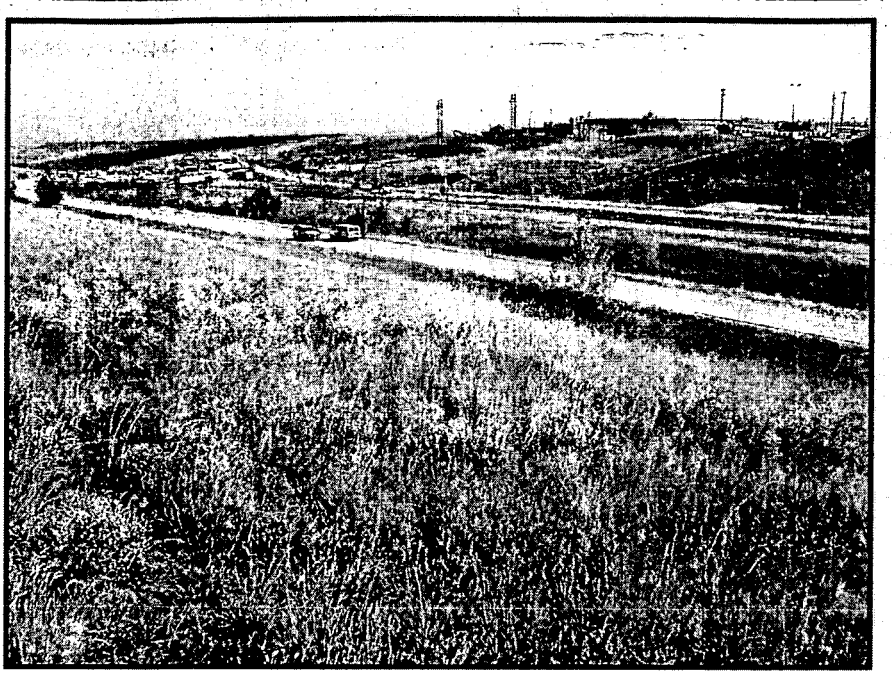

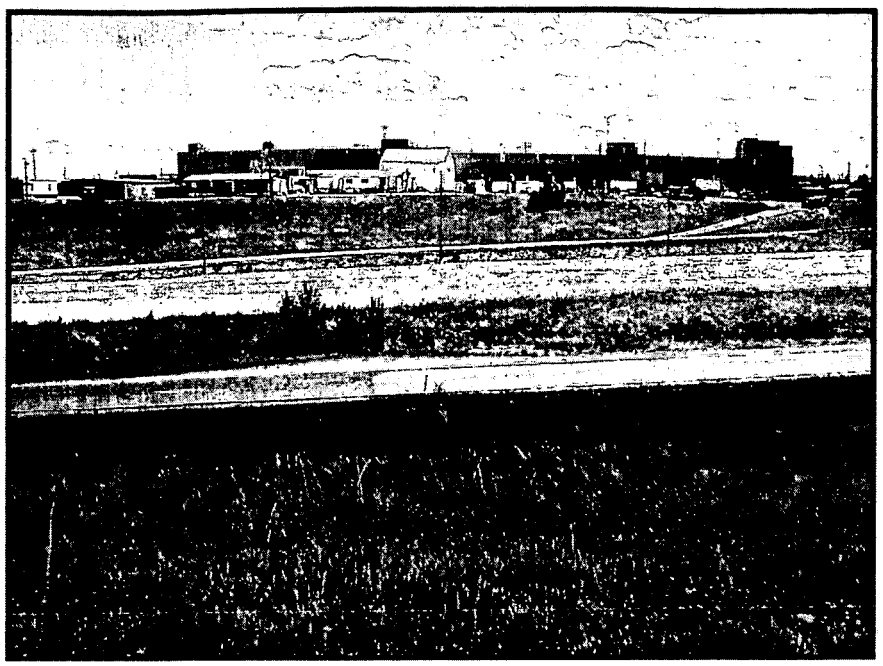

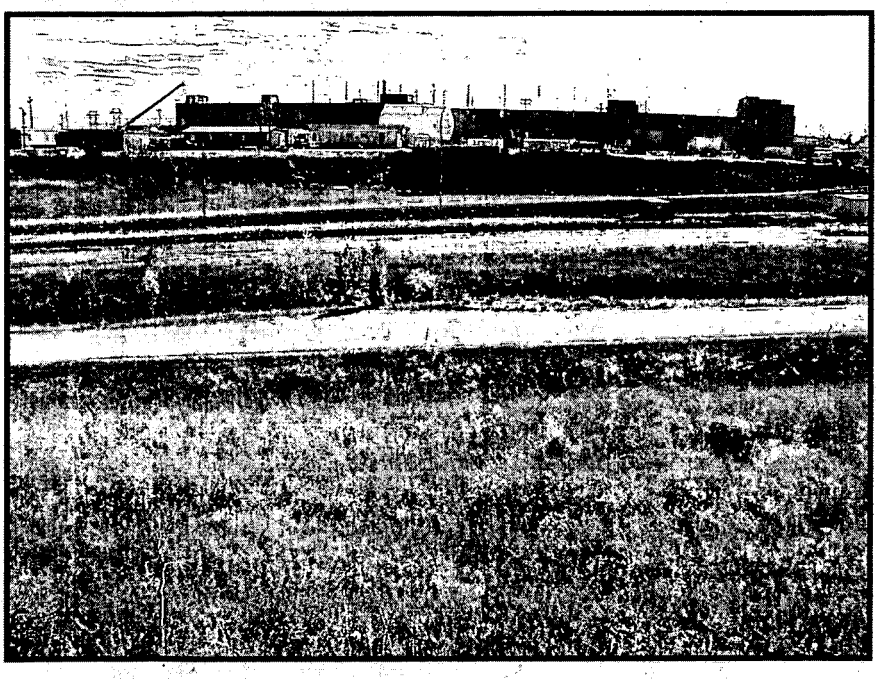

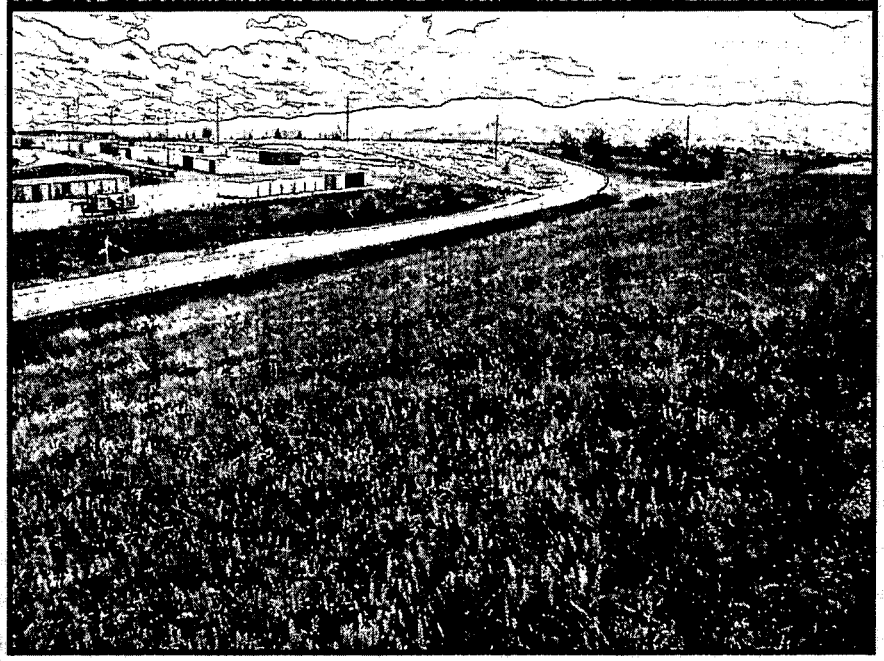

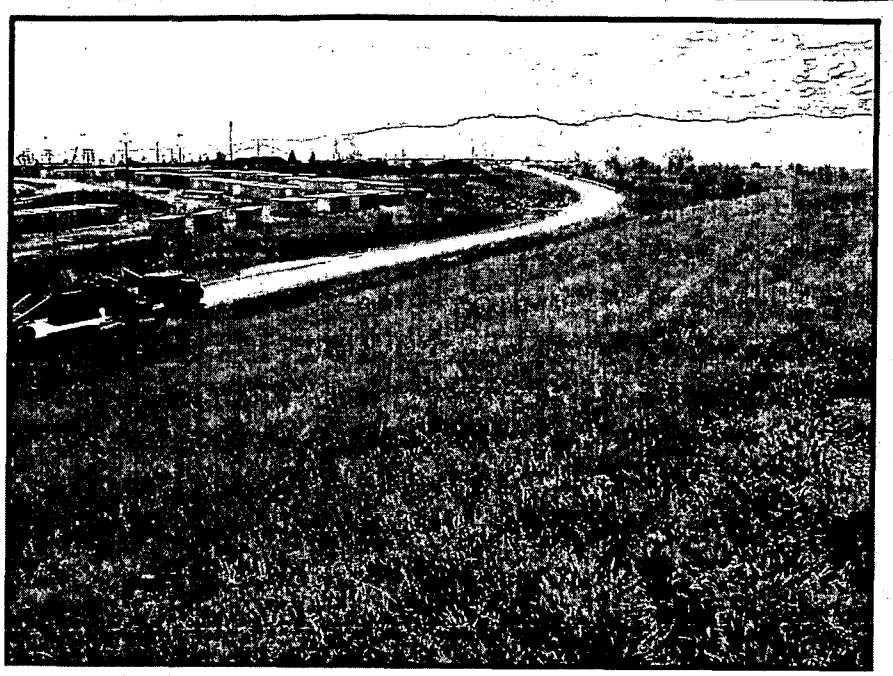

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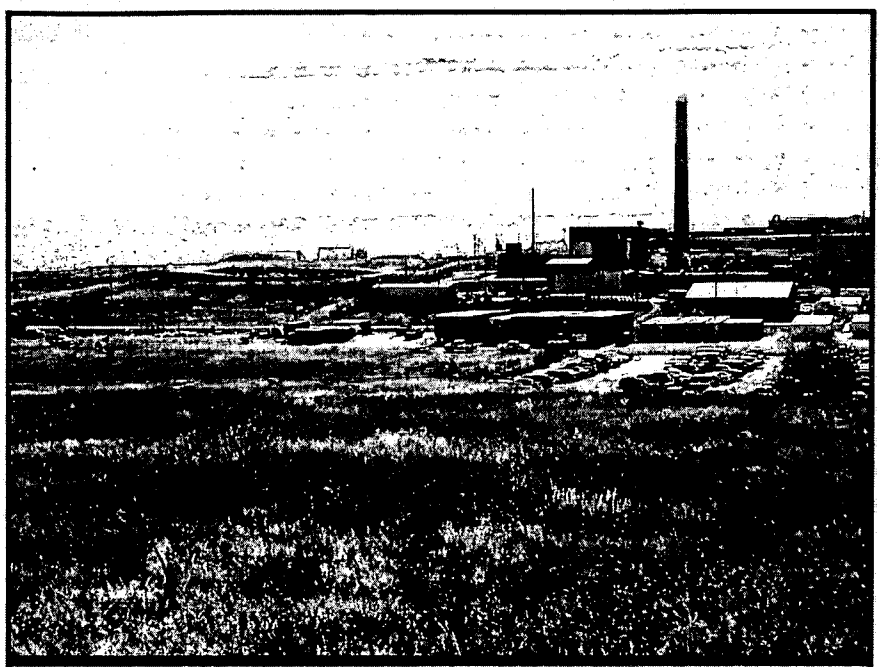

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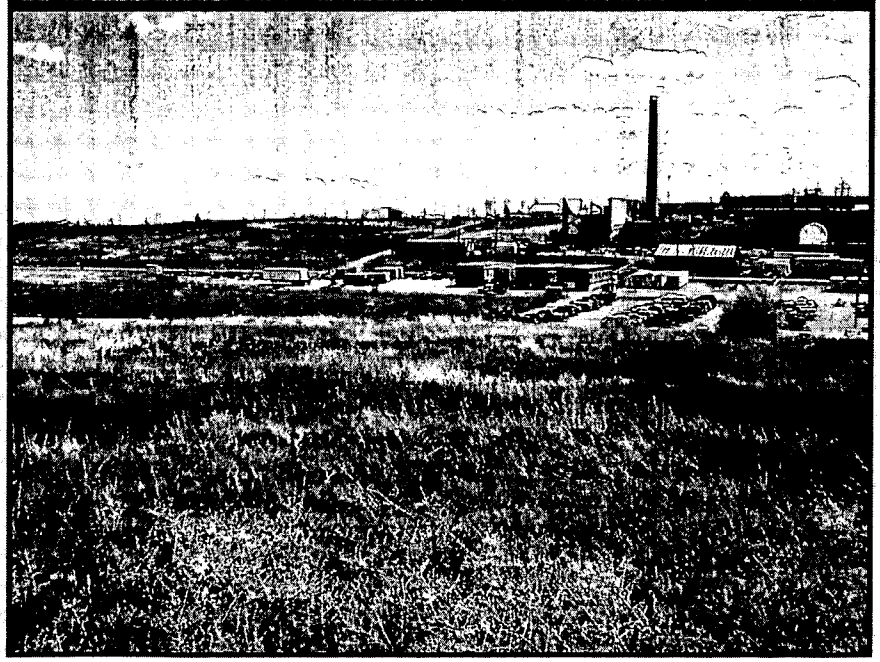

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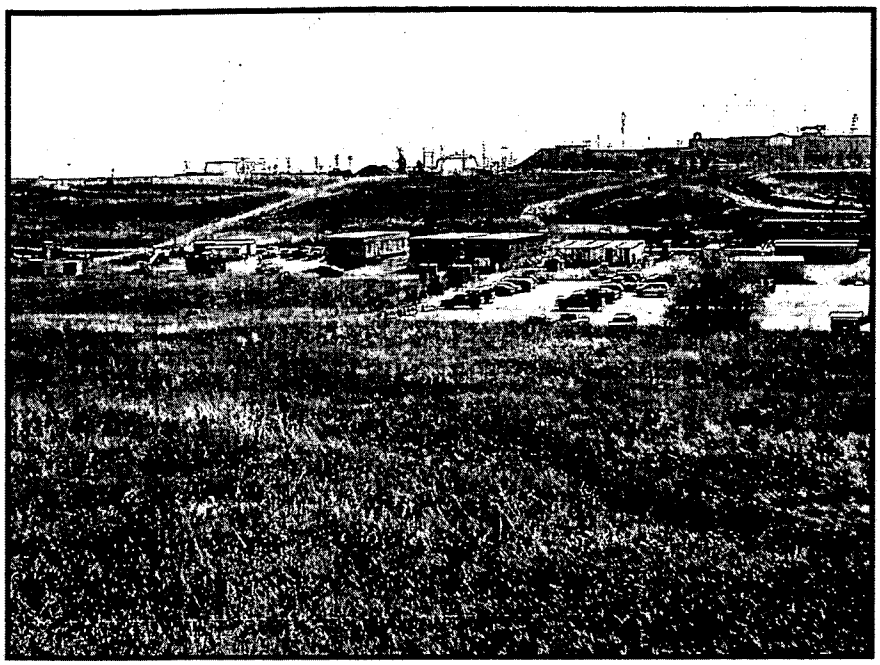
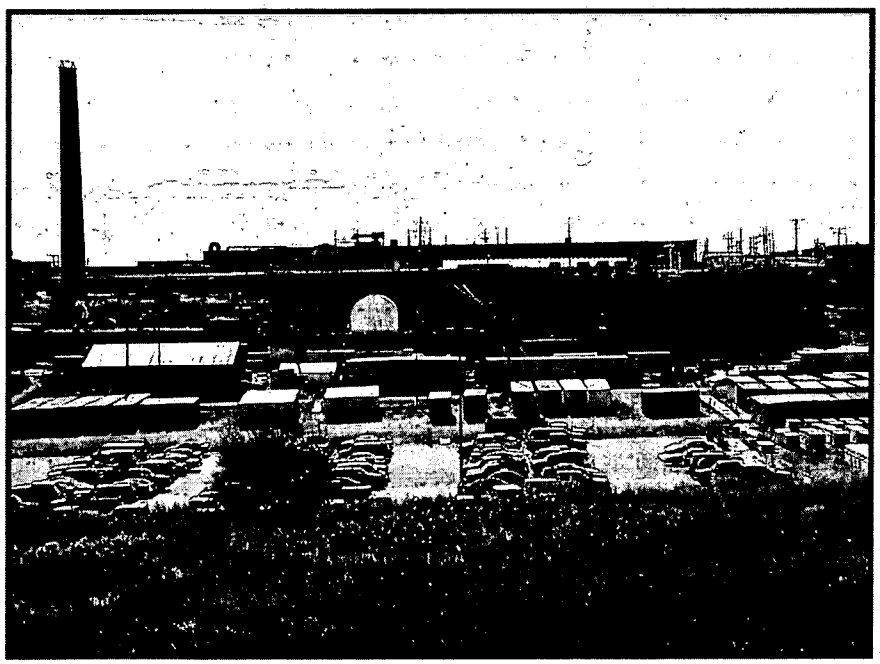
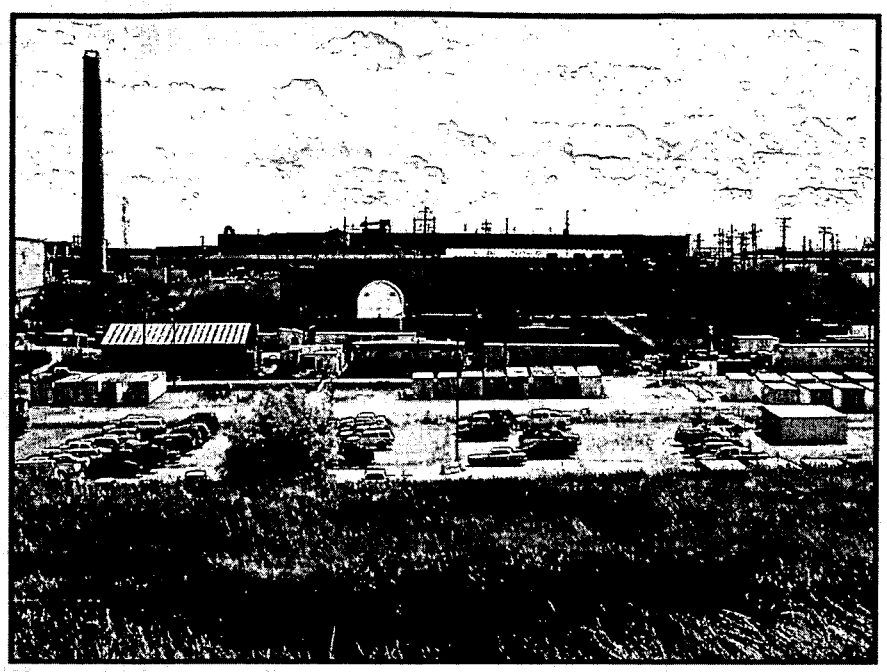
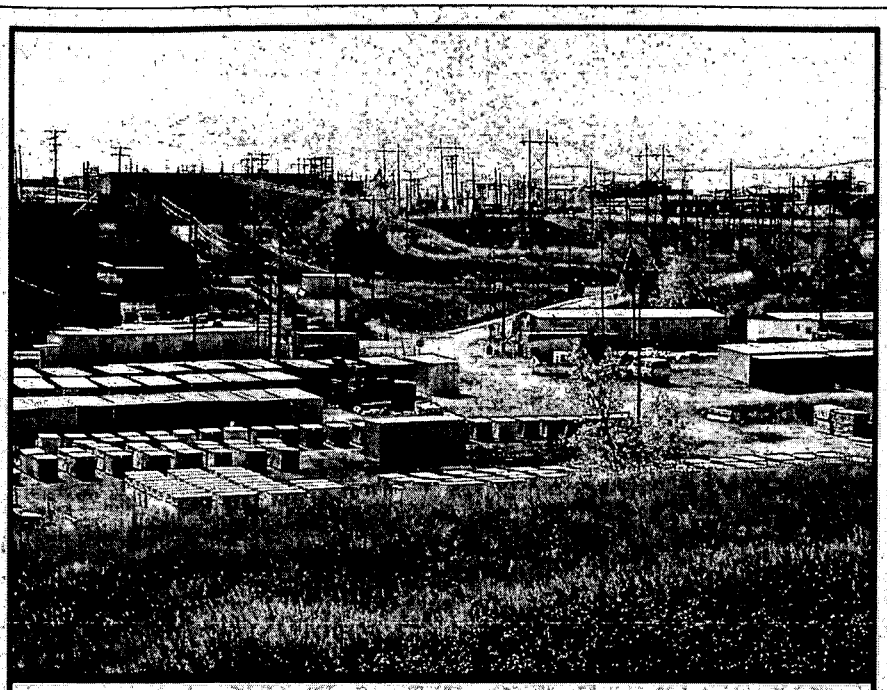
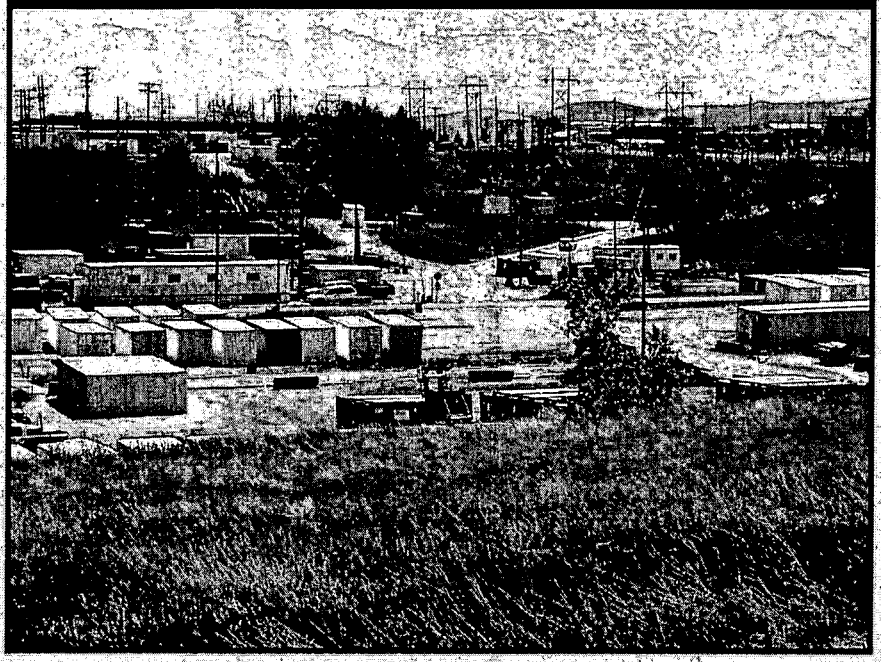
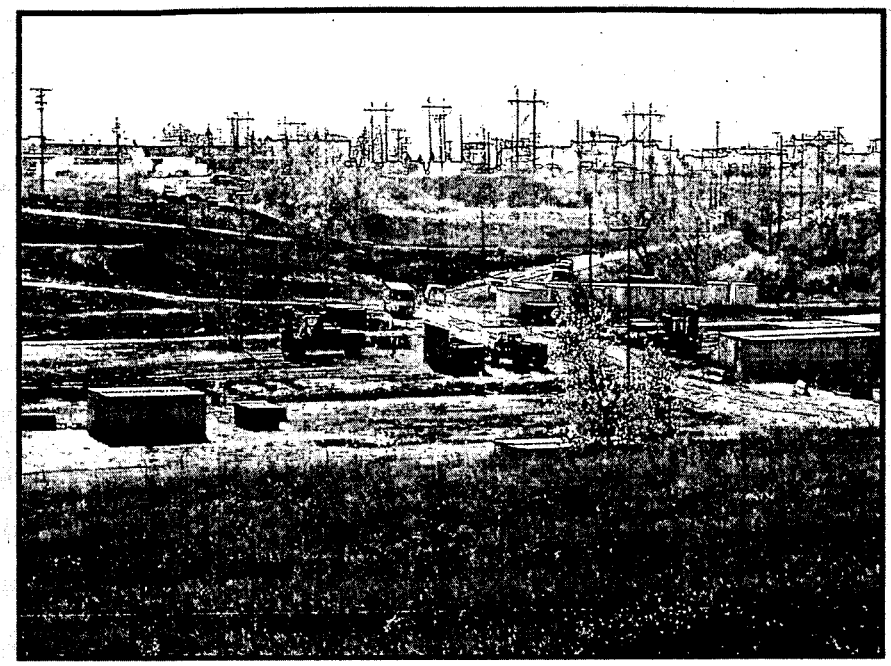


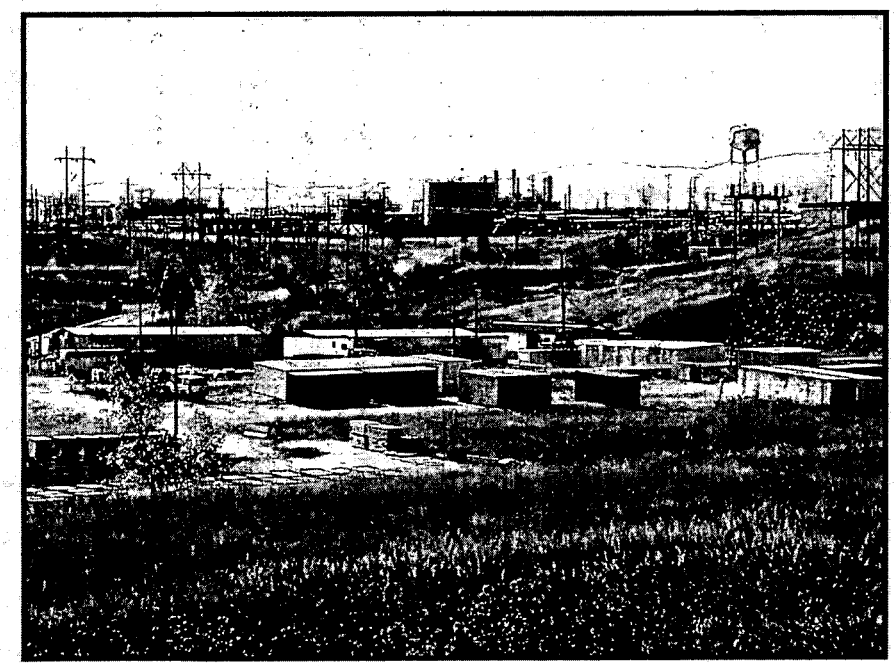


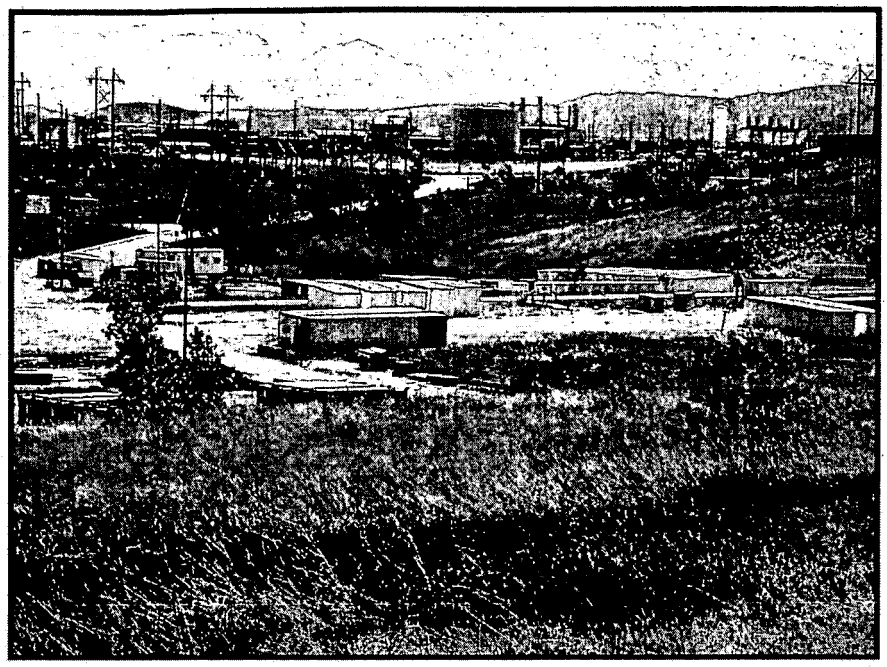


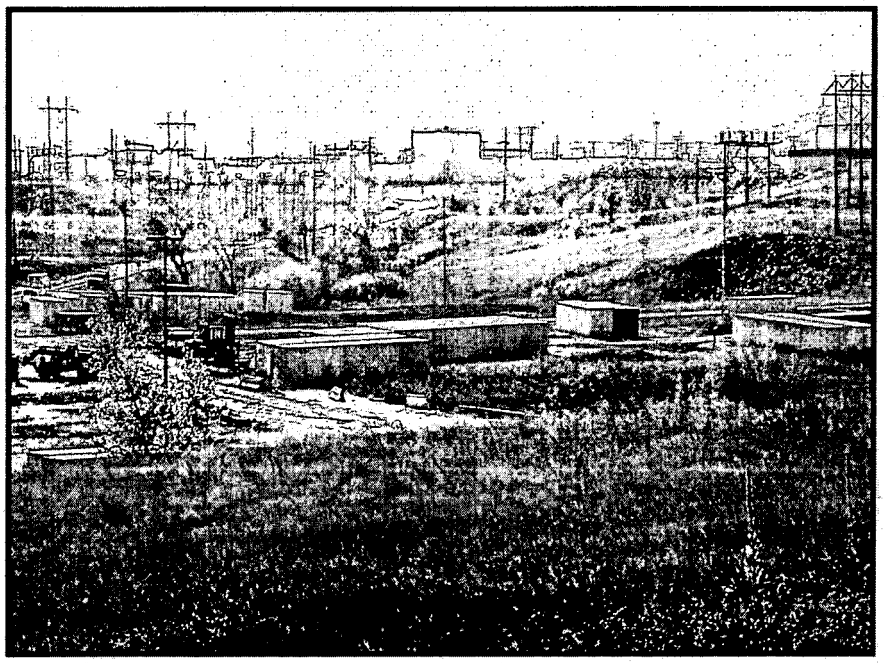


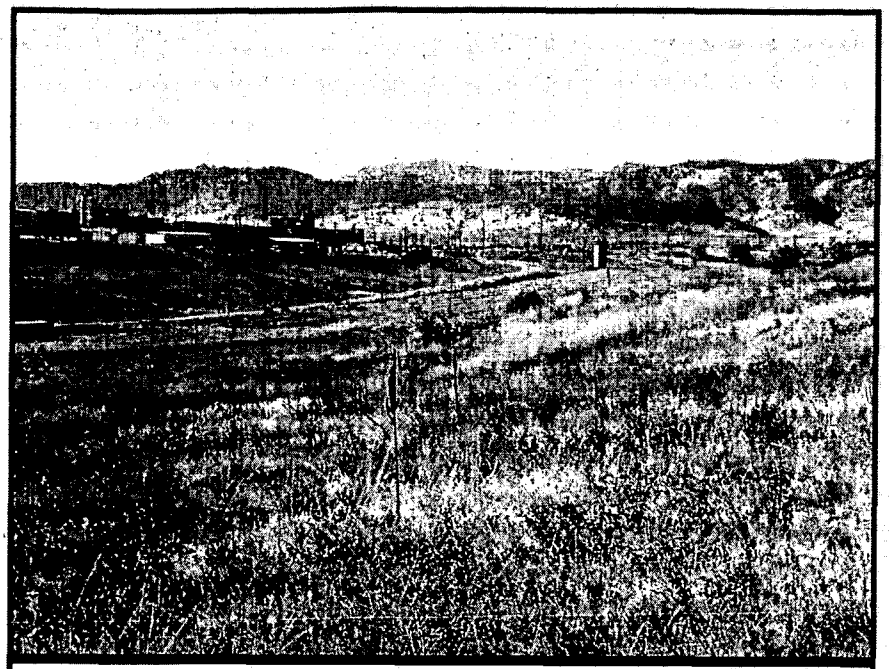


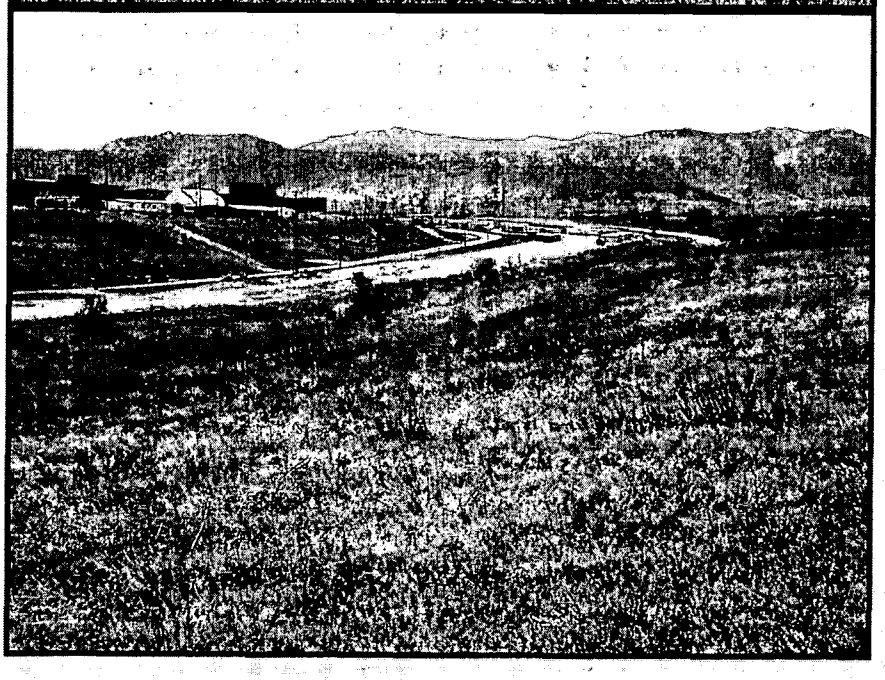












Appendix F

2004 RFETS Flora List

The following species list contains the complete list of vascular plants that have been found to date at the Rocky Flats Environmental Technology Site. Plant nomenclature follows that of GPFA (1896), Weber (1976), and Weber (1990), in that order of determination.

GPFA. 1986. Flora of the Great Plains, 2nd printing with 1991 supplement. Great Plains Flora Association. University Press of Kansas, Lawrence, KS. 1402 p.

Weber, W.A. 1976. Rocky Mountain flora. Colorado Associated University Press, Boulder, CO.

Weber, W.A. 1990. Colorado flora: Eastern Slope. University Press of Colorado, Niwot, CO.

Voucher specimens have been deposited at the University of Colorado Herbarium in Boulder, CO (COLO).

Family	Scientific Name	Speccode
ACERACEAE	Acer glabrum Torr.	ACGL1
ACERACEAE	Acer negundo L. var. interius (Britt.) Sarg.	ACNE1
ACERACEAE	Acer platanoides L.	ACPL1
AGAVACEAE	Yucca glauca Nutt.	YUGL1
ALISMATACEAE	Alisma trivale Pursh	ALTR1
ALISMATACEAE	Sagittaria latifolia Willd.	SALA1
AMARANTHACEAE	Amaranthus albus L.	AMAL2
AMARANTHACEAE	Amaranthus graecizans L.	AMGR1
AMARANTHACEAE	Amaranthus retroflexus L.	AMRE1
ANACARDIACEAE	Rhus aromatica Ait. var. trilobata (Nutt.) A. Gray	RHAR1
ANACARDIACEAE	Toxicodendron rydbergii (Small) Greene	TORY1
APIACEAE	Berula erecta (Huds.) Cov. var. incisum	BEER1
APIACEAE	Cicuta maculata L. var. angustifolia Hook.	CIMA1
APIACEAE	Conium maculatum L.	COMA1
APIACEAE	Daucus carota L.	DACA2
APIACEAE	Harbouria trachypleura (Gray) C. & R.	HATR1
APIACEAE	Heracleum sphondylium L. ssp. montanum (Schleich.) Briq.	HESP1
APIACEAE	Ligusticum porteri C. & R.	LIPO1
APIACEAE	Lomatium orientale Coult. & Rose	LOOR1
APIACEAE	Musineon divaricatum (Pursh.) Nutt. var. hookeri T. & G.	MUDI1
APIACEAE	Osmorhiza chiliensis H. & A.	OSCH1
APIACEAE	Osmorhiza longistylis (Torr.) DC var. longistylis	OSLO1
APOCYNACEAE	Apocynum androsaemifolium L.	APAN1
APOCYNACEAE	Apocynum cannabinum L.	APCA1
ASCLEPIADACEAE	Asclepias incarnata L.	ASIN1
ASCLEPIADACEAE	Asclepias pumila (Gray) Vail	ASPU1
ASCLEPIADACEAE	Asclepias speciosa Torr.	ASSP1
ASCLEPIADACEAE	Asclepias stenophylla A. Gray	ASST1
ASCLEPIADACEAE	Asclepias viridiflora Raf.	ASVI1

ASTERACEAE	Achillea millefolium L. ssp. lanulosa (Nutt.) Piper	ACMI1
ASTERACEAE	Agoseris glauca (Pursh.) Dietr.	AGGL1
ASTERACEAE	Ambrosia artemisiifolia L.	AMAR1
ASTERACEAE	Ambrosia psilostachya DC.	AMPS1
ASTERACEAE	Ambrosia trifida L.	AMTR1
ASTERACEAE	Antennaria microphylla Rydb.	ANMI1
ASTERACEAE	Antennaria parvifolia Nutt.	ANPA1
ASTERACEAE	Anthemis cotula L.	ANCO1
ASTERACEAE	Arctium minus Bernh.	ARMI1
ASTERACEAE	Arnica fulgens Pursh.	ARFU1
ASTERACEAE	Artemisia campestris L. ssp. caudata (Michx.) Hall & Clem.	ARCA1
ASTERACEAE	Artemisia dracunculus L.	ARDR1
ASTERACEAE	Artemisia frigida Willd.	ARFR1
ASTERACEAE	Artemisia ludoviciana Nutt. var. ludoviciana	ARLU1
ASTERACEAE	Aster campestris Nutt.	ASCA2
ASTERACEAE	Aster falcatus Lindl.	ASFA1
ASTERACEAE	Aster fendleri A. Gray	ASFE1
ASTERACEAE	Aster hesperius A. Gray var. hersperius	ASHE1
ASTERACEAE	Aster laevis L. var. geyeri A. Gray	ASLA1
ASTERACEAE	Aster porteri Gray	ASPO1
ASTERACEAE	Bidens cernua L.	BICE1
ASTERACEAE	Bidens frondosa L.	BIFR1
ASTERACEAE	Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi	CANU1
ASTERACEAE	Centaurea diffusa Lam.	CEDI1
ASTERACEAE	Centaurea repens L.	CERE1
ASTERACEAE	Centaurea solstitialis L.	CESO1
ASTERACEAE	Chrysanthemum leucanthemum L.	CHLE1
ASTERACEAE	Chrysopsis fulcrata Greene	CHFU1
ASTERACEAE	Chrysopsis villosa Pursh.	CHVI1
ASTERACEAE	Chrysothamnus nauseosus (Pall.) Britt. ssp. graveolens (Nutt.) Piper	CHNA1
ASTERACEAE	Chrysothamnus nauseosus (Pall.) Britt. ssp. nauseosus	CHNA2
ASTERACEAE	Cichorium intybus L.	CIIN1
ASTERACEAE	Cirsium arvense (L.) Scop.	CIAR1
ASTERACEAE	Cirsium flodmanni (Rydb.) Arthur	CIFL1
ASTERACEAE	Cirsium ochrocentrum A. Gray	CIOC1
ASTERACEAE	Cirsium undulatum (Nutt.) Spreng.	CIUN1
ASTERACEAE	Cirsium vulgare (Savi) Ten.	CIVU1
ASTERACEAE	Conyza canadensis (L.) Cronq.	COCA1
ASTERACEAE	Crepis occidentalis Nutt.	CROC1
ASTERACEAE	Crepis runcinata (James) T. & G.	CRRU1
ASTERACEAE	Dyssodia papposa (Vent) Hitchc.	DYPA1
ASTERACEAE	Erigeron canus A. Gray	ERCA1
ASTERACEAE	Erigeron compositus Pursh var. dicoideus A. Gray	ERCO1
ASTERACEAE	Erigeron divergens T. & G.	ERDI1
ASTERACEAE	Erigeron flagellaris A. Gray	ERFL1
ASTERACEAE	Erigeron pumilus Nutt.	ERPU1

ASTERACEAE	Erigeron speciosa (Lindl.) DC. var. macranthus (Nutt.) Cronq.	ERSP1
ASTERACEAE	Erigeron strigosus Muhl. ex Willd.	ERST1
ASTERACEAE	Erigeron vetensis Rydb.	ERVE1
ASTERACEAE	Gaillardia aristata Pursh.	GAAR1
ASTERACEAE	Gnapthalium chilense Spreng.	GNCH1
ASTERACEAE	Grindelia squarrosa (Pursh.) Dun.	GRSQ1
ASTERACEAE	Gutierrezia sarothrae (Pursh.) Britt. & Rusby	GUSA1
ASTERACEAE	Happlopappus spinulosus (Pursh) DC.	HASP1
ASTERACEAE	Helianthus annuus L.	HEAN1
ASTERACEAE	Helianthus ciliaris DC.	HECI1
ASTERACEAE	Helianthus maximilianii Schrad.	HEMA1
ASTERACEAE	Helianthus nuttallii T. & G.	HENU1
ASTERACEAE	Helianthus petiolaris Nutt.	HEPE1
ASTERACEAE	Helianthus pumilus Nutt.	HEPU1
ASTERACEAE	Helianthus rigidus (Cass.) Desf. ssp. subrhomboideus (Rydb.) Heiser	HERI1
ASTERACEAE	Heliomeris multiflora Nuttall	HEMU1
ASTERACEAE	Hymenopappus filifolius Hook. var. cinereus (Rydb.) I. M. Johnst.	HYFI1
ASTERACEAE	Iva axillaris Pursh.	IVAX1
ASTERACEAE	Iva xanthifolia Nutt.	IVXA1
ASTERACEAE	Kuhnia chlorolepis Woot. & Standl.	KUCH1
ASTERACEAE	Kuhnia eupatorioides L.	KUEU1
ASTERACEAE	Lactuca oblongifolia Nutt.	LAOB1
ASTERACEAE	Lactuca serriola L.	LASE1
ASTERACEAE	Leucelene ericoides (Torr.) Greene	LEER1
ASTERACEAE	Liatris punctata Hook.	LIPU1
ASTERACEAE	Lygodesmia juncea (Pursh.) Hook.	LYJU1
ASTERACEAE	Machaeranthera bigelovii (Gray) Greene	MABI1
ASTERACEAE	Machaeranthera canescens (Pursh) A. Gray	MACA1
ASTERACEAE	Madia glomerata Hook.	MAGL1
ASTERACEAE	Microseris cuspidata (Pursh.) Sch. Bip.	MICU1
ASTERACEAE	Onopordum acanthium L.	ONAC1
ASTERACEAE	Picradeniopsis oppositifolia (Nutt.) Rydb.	PIOP1
ASTERACEAE	Ratibida columnifera (Nutt.) Woot. & Standl.	RACO1
ASTERACEAE	Rudbeckia ampla Nelson	RUAM1
ASTERACEAE	Scorzonera laciniata L.	SCLA1
ASTERACEAE	Senecio fendleri Gray	SEFE1
ASTERACEAE	Senecio integerrimus Nutt.	SEIN1
ASTERACEAE	Senecio plattensis Nutt.	SEPL1
ASTERACEAE	Senecio spartioides T. & G.	SESP1
ASTERACEAE	Senecio tridenticulatus Rydb.	SETR1
ASTERACEAE	Solidago canadensis L.	SOCA1
ASTERACEAE	Solidago gigantea Ait.	SOGI1
ASTERACEAE	Solidago missouriensis Nutt.	SOMI1
ASTERACEAE	Solidago mollis Bart.	SOMO1
ASTERACEAE	Solidago nana Nutt.	SONA1
ASTERACEAE	Solidago rigida L.	SORI1

ASTERACEAE	Sonchus arvensis L. ssp. uglinosus (Bieb.) Nyman	SOAR2
ASTERACEAE	Sonchus asper (L.) Hill	SOAS1
ASTERACEAE	Stephanomeria pauciflora (Torr.) A. Nels.	STPA1
ASTERACEAE	Taraxacum laevigatum (Willd.) DC.	TALA1
ASTERACEAE	Taraxacum officinale Weber	TAOF1
ASTERACEAE	Thelesperma megapotanicum (Spreng.) O. Ktze.	THME1
ASTERACEAE	Townsendia grandiflora (Nutt.)	TOGR1
ASTERACEAE	Townsendia hookeri Beaman	TOHO1
ASTERACEAE	Tragopogon dubius Scop.	TRDU1
ASTERACEAE	Tragopogon porrifolius L.	TRPO1
ASTERACEAE	Verbesina encelioides (Cau) Benth. & Hook. ssp. exauriculata (Robins & Greenm.) Coleman	VEEN1
ASTERACEAE	Xanthium strumarium L.	XAST1
BERBERIDACEAE	Berberis repens Lindl.	BERE1
BETULACEAE	Alnus incana (L.) Moench ssp. tenuifolia (Nuttall) Breitung	ALIN1
BETULACEAE	Betula occidentalis Hook.	BEOC1
BORAGINACEAE	Asperugo procumbens L.	ASPR1
BORAGINACEAE	Cryptantha virgata (Porter) Payson	CRVI1
BORAGINACEAE	Cynoglossum officinale L.	CYOF1
BORAGINACEAE	Hackelia floribunda (Lehm.) I. M. Johnst.	HAFL1
BORAGINACEAE	Lappula redowskii (Hornem.) Greene	LARE1
BORAGINACEAE	Lithospermum incisum Lehm.	LIIN1
BORAGINACEAE	Lithospermum multiflorum Torr.	LIMU1
BORAGINACEAE	Mertensia lanceolata (Pursh.) A. DC.	MELA1
BORAGINACEAE	Onosmodium molle Michx. var. occidentale (Mack.) Johnst.	ONMO1
BORAGINACEAE	Plagiobothrys scouleri (H. & A.) I. M. Johnst.	PLSC1
BRASSICACEAE	Alyssum alyssoides (L.) L.	ALAL1
BRASSICACEAE	Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley	ALMI1
BRASSICACEAE	Arabis fendleri (S. Wats.) Greene var. fendleri	ARFE3
BRASSICACEAE	Arabis glabra (L.) Bernh.	ARGL1
BRASSICACEAE	Arabis hirsuta (L.) Scop. var. pynocarpa (Hopkins) Rollins	ARHI1
BRASSICACEAE	Barbarea vulgaris R. Br.	BAVU1
BRASSICACEAE	Camelina microcarpa Andrz. ex DC.	CAMI1
BRASSICACEAE	Capsella bursa-pastoris (L.) Medic.	CABU1
BRASSICACEAE	Cardaria chalepensis (L.) Hand-Mazz	CACH1
BRASSICACEAE	Cardaria draba (L.) Desv.	CADR1
BRASSICACEAE	Chorispora tenella (Pall.) DC.	CHTE1
BRASSICACEAE	Conringia orientalis (L.) Dum.	COOR1
BRASSICACEAE	Descurainia pinnata (Walt.) Britt.	DEPI1
BRASSICACEAE	Descurainia richardsonii (Sweet) Schultz	DERI1
BRASSICACEAE	Descurainia sophia (L.) Webb ex Prantl.	DESO1
BRASSICACEAE	Draba nemorosa L.	DRNE1
BRASSICACEAE	Draba reptans (Lam.) Fern.	DRRE1
BRASSICACEAE	Erysimum capitatum (Nutt.) DC.	ERCA2
BRASSICACEAE	Erysimum repandum L.	ERRE1
BRASSICACEAE	Hesperis matronalis L.	HEMA2
BRASSICACEAE	Lepidium campestre (L.) R. Br.	LECA1

BRASSICACEAE	Lepidium densiflorum Schrad.	LEDE1
BRASSICACEAE	Lesquerella montana (A. Gray) Wats.	LEMO1
BRASSICACEAE	Nasturtium officinale R. Br.	NAOF1
BRASSICACEAE	Physaria vitulifera Rydb.	PHVI1
BRASSICACEAE	Rorippa palustris (L.) Bess. ssp. hispida (Desv.) Jonsell	ROPA1
BRASSICACEAE	Sisymbrium altissimum L.	SIAL1
BRASSICACEAE	Thlaspi arvense L.	THAR1
CACTACEAE	Coryphantha missouriensis (Sweet) Britt. & Rose	COMI1
CACTACEAE	Echinocereus viridiflorus Engelm.	ECVI1
CACTACEAE	Opuntia fragilis (Nutt.) Haw.	OPFR1
CACTACEAE	Opuntia macrorhiza Engelm.	OPMA1
CACTACEAE	Opuntia polyacantha Haw.	OPPO1
CACTACEAE	Pediocactus simpsonii (Engelm.) Britt. & Rose	PESI1
CALLITRICHACEAE	Callitriche verna L.	CAVE1
CAMPANULACEAE	Campanula rotundifolia L.	CARO1
CAMPANULACEAE	Lobelia siphilitica L. var. ludoviciana A. DC.	LOSI1
CAMPANULACEAE	Triodanis leptocarpa (Nutt.) Nieuw.	TRLE1
CAMPANULACEAE	Triodanis perfoliata (L.) Nieuw.	TRPE1
CANNABACEAE	Humulus lupulus L. var. lupuloides E. Small	HULU1
CAPPARACEAE	Cleome serrulata Pursh.	CLSE1
CAPPARACEAE	Polansia dodecandra (L.) DC. ssp. trachysperma (T. & G.) Iltis	PODO2
CAPRIFOLIACEAE	Symphoricarpos occidentalis Hook.	SYOC1
CAPRIFOLIACEAE	Symphoricarpos oreophilus Gray	SYOR1
CAPRIFOLIACEAE	Viburnum opulus L. var. americanum Ait	VIOP1
CARYOPHYLLACEAE	Arenaria fendleri A. Gray	ARFE2
CARYOPHYLLACEAE	Cerastium arvense L.	CEAR1
CARYOPHYLLACEAE	Cerastium vulgatum L.	CEVU1
CARYOPHYLLACEAE	Cerastium brachypodum (Engelm. ex A. Gray) Robins.	CEBR1
CARYOPHYLLACEAE	Conosilene conica (L.) Fourreau ssp. conoidea (L.) Love & Kjellqvist	COCO1
CARYOPHYLLACEAE	Paronychia jamesii T. & G.	PAJA1
CARYOPHYLLACEAE	Saponaria officinalis L.	SAOF1
CARYOPHYLLACEAE	Silene antirrhina L.	SIAN1
CARYOPHYLLACEAE	Silene drummondii Hook.	SIDR1
CARYOPHYLLACEAE	Silene pratensis (Raf.)Godr. & Gren	SIPR1
CARYOPHYLLACEAE	Spergularia rubra (L.) K. Presl.	SPRU1
CARYOPHYLLACEAE	Stellaria longifolia Muhl. ex Willd.	STLO1
CARYOPHYLLACEAE	Vaccaria pyramidata Medic.	VAPY1
CERATOPHYLLACEAE	Ceratophyllum demersum L.	CEDE1
CHENOPODIACEAE	Atriplex canescens (Pursh.) Nutt.	ATCA1
CHENOPODIACEAE	Chenopodium album L.	CHAL1
CHENOPODIACEAE	Chenopodium atrovirens Nutt.	CHAT1
CHENOPODIACEAE	Chenopodium berlandieri Moq.	CHBE1
CHENOPODIACEAE	Chenopodium botrys L.	CHBO1
CHENOPODIACEAE	Chenopodium dessicatum A. Nels.	CHDE1
CHENOPODIACEAE	Chenopodium fremontii S. Wats.	CHFR1
CHENOPODIACEAE	Chenopodium leptophyllum Nutt. ex Moq.	CHLE2

CHENOPODIACEAE	Chenopodium overi Aellen	CHOV1
CHENOPODIACEAE	Kochia scoparia (L.) Schrad.	KOSC1
CHENOPODIACEAE	Salsola iberica Senn. & Pau.	SAIB1
CLUSIACEAE	Hypericum majus (A. Gray) Britt.	HYMA1
CLUSIACEAE	Hypericum perforatum L.	HYPE1
COMMELINACEAE	Tradescantia occidentalis (Britt.) Smyth	TROC1
CONVOLVULACEAE	Calystegia macouni (Greene) Brummitt	CAMA1
CONVOLVULACEAE	Calystegia sepium (L.) R. Br. ssp. angulata Brummitt	CASE1
CONVOLVULACEAE	Convolvulus arvensis L.	COAR1
CONVOLVULACEAE	Evolvulus nuttallianus R. & S.	EVNU1
CRASSULACEAE	Sedum lanceolatum Torr.	SELA1
CUPRESSACEAE	Juniperus communis L.	JUCO1
CUPRESSACEAE	Juniperus scopulorum Sarg.	JUSC1
CUSCUTACEAE	Cuscuta approximata Bab.	CUAP1
CYPERACEAE	Carex athrostachya Olney	CAAT1
CYPERACEAE	Carex aurea Nutt.	CAAU1
CYPERACEAE	Carex bebbii (Bailey) Fern	CABE1
CYPERACEAE	Carex brevior (Dew.) Mack. ex Lunell.	CABR1
CYPERACEAE	Carex douglasii F. Boott.	CADO1
CYPERACEAE	Carex eleocharis Bailey	CAEL1
CYPERACEAE	Carex emoryi Dew.	CAEM1
CYPERACEAE	Carex filifolia Nutt.	CAFI1
CYPERACEAE	Carex heliophila Mack.	CAHE1
CYPERACEAE	Carex hystericina Muhl. ex Willd.	CAHY1
CYPERACEAE	Carex interior Bailey	CAIN1
CYPERACEAE	Carex lanuginosa Michx.	CALA1
CYPERACEAE	Carex nebrascensis Dew.	CANE1
CYPERACEAE	Carex oreocharis Holm.	CAOR1
CYPERACEAE	Carex praegracilis W. Boott.	CAPR1
CYPERACEAE	Carex rostrata Stokes ex Willd.	CARO2
CYPERACEAE	Carex scoparia Schkuhr. ex Willd.	CASC1
CYPERACEAE	Carex simulata Mack.	CASI1
CYPERACEAE	Carex stipata Muhl.	CAST1
CYPERACEAE	Carex vulpinoidea Michx.	CAVU1
CYPERACEAE	Cyperus acuminatus Torr. & Hook.	CYAC1
CYPERACEAE	Eleocharis acicularis (L.) R. & S.	ELAC1
CYPERACEAE	Eleocharis compressa Sulliv.	ELCO1
CYPERACEAE	Eleocharis macrostachya Britt.	ELMA1
CYPERACEAE	Eleocharis obtusa (Willd.) J.A. Schult.	ELOB1
CYPERACEAE	Eleocharis parvula Link ex Boff. & Fingerbr. var. anachaeta (Torr.) Svens.	ELPA1
CYPERACEAE	Scirpus acutus Muhl.	SCAC1
CYPERACEAE	Scirpus pallidus (Britt.) Fern	SCPA1
CYPERACEAE	Scirpus pungens Vahl	SCPU1
CYPERACEAE	Scirpus validus Vahl.	SCVA1
ELAEAGNACEAE	Elaeagnus angustifolia L.	ELAN1
EQUISETACEAE	Equisetum arvense L.	EQAR1

EQUISETACEAE	Equisetum laevigatum A. Br.	EQLA1
EQUISETACEAE	Equisetum variegatum Schleich.	EQVA1
EUPHORBIACEAE	Euphorbia dentata Michx.	EUDE1
EUPHORBIACEAE	Euphorbia fendleri T. & G.	EUFE1
EUPHORBIACEAE	Euphorbia marginata Pursh.	EUMA1
EUPHORBIACEAE	Euphorbia robusta (Engelm.) Small	EURO1
EUPHORBIACEAE	Euphorbia serpyllifolia Pers.	EUSE1
EUPHORBIACEAE	Euphorbia spathulata Lam.	EUSP1
EUPHORBIACEAE	Tragia ramosa Nutt.	TRRA1
FABACEAE	Amorpha fruticosa L.	AMFR1
FABACEAE	Amorpha nana Nutt.	AMNA1
FABACEAE	Astragalus adsurgens Pall. var. robustior Hook.	ASAD1
FABACEAE	Astragalus agrestis Dougl. ex G. Don	ASAG1
FABACEAE	Astragalus bisulcatus (Hook.) A. Gray	ASBI1
FABACEAE	Astragalus canadensis L.	ASCA1
FABACEAE	Astragalus crassicarpus Nutt.	ASCR1
FABACEAE	Astragalus drummondii Dougl. ex Hook.	ASDR1
FABACEAE	Astragalus flexuosus (Hook.) G. Don	ASFL1
FABACEAE	Astragalus lotiflorus Hook.	ASLO1
FABACEAE	Astragalus parryi Gray	ASPA1
FABACEAE	Astragalus shortianus Nutt. ex T.&G.	ASSH1
FABACEAE	Astragalus spathulatus Sheld.	ASSP2
FABACEAE	Astragalus tridactylicus Gray	ASTR1
FABACEAE	Coronilla varia L.	COVA1
FABACEAE	Dalea candida Michx. ex Willd. var. oligophylla (Torr.) Shinners.	DACA1
FABACEAE	Dalea purpurea Vent	DAPU1
FABACEAE	Glycyrrhiza lepidota Pursh.	GLLE1
FABACEAE	Lathyrus eucosmus Butters and St. John	LAEU1
FABACEAE	Lotus corniculatus L.	LOCO1
FABACEAE	Lupinus argenteus Pursh ssp. ingratus (Greene) Harmon	LUAR2
FABACEAE	Lupinus argenteus Pursh var. argenteus	LUAR1
FABACEAE	Medicago lupulina L.	MELU1
FABACEAE	Medicago sativa L. ssp. sativa	MESA1
FABACEAE	Melilotus alba Medic.	MEAL1
FABACEAE	Melilotus officinalis (L.) Pall.	MEOF1
FABACEAE	Oxytropis lambertii Pursh.	OXLA1
FABACEAE	Psoralea tenuiflora Pursh.	PSTE1
FABACEAE	Robinia pseudo-acacia L.	ROPS1
FABACEAE	Thermopsis rhombifolia var. divaricarpa (Nels.) Isely	THRH1
FABACEAE	Trifolium hybridum L.	TRHY1
FABACEAE	Trifolium pratense L.	TRPR1
FABACEAE	Trifolium repens L.	TRRE1
FABACEAE	Vicia americana Muhl. ex Willd.	VIAM1
FUMARIACEAE	Fumaria vaillentii Lois	FUVA1
GENTIANACEAE	Gentiana affinis Griseb.	GEAF1
GENTIANACEAE	Swertia radiata (Kell.) O. Ktze.	SWRA1

GERANIACEAE	Erodium cicutarium (L.) L'Her.	ERCI1
GERANIACEAE	Geranium caespitosum James ssp. caespitosum	GECA1
GROSSULARIACEAE	Ribes aureum Pursh	RIAU1
GROSSULARIACEAE	Ribes cereum Dougl.	RICE1
GROSSULARIACEAE	Ribes inerme Rydb.	RIIN1
HALORAGACEAE	Myriophyllum exalbescens Fern.	MYEX1
HYDROPHYLLACEAE	Hydrophyllum fendleri (Gray) Heller	HYFE1
HYDROPHYLLACEAE	Phacelia heterophylla Pursh.	PHHE1
IRIDACEAE	Iris missouriensis Nutt.	IRMI1
IRIDACEAE	Sisyrinchium montanum Greene	SIMO1
JUNCACEAE	Juncus articulatus L.	JUAR1
JUNCACEAE	Juncus balticus Willd.	JUBA1
JUNCACEAE	Juncus bufonius L.	JUBU1
JUNCACEAE	Juncus dudleyi Wieg.	JUDU1
JUNCACEAE	Juncus ensifolius Wikst. var. montanus (Englm.) C. L. Hitchc.	JUEN1
JUNCACEAE	Juncus interior Wieg.	JUIN1
JUNCACEAE	Juncus longistylis Torr.	JULO1
JUNCACEAE	Juncus nodosus L.	JUNO1
JUNCACEAE	Juncus torreyi Cov.	JUTO1
JUNCACEAE	Juncus tracyi Rydb.	JUTR1
LAMIACEAE	Dracocephalum parviflorum Nutt.	DRPA1
LAMIACEAE	Hedeoma hispidum Pursh.	HEHI1
LAMIACEAE	Lycopus americanus Muhl. ex Barton	LYAM1
LAMIACEAE	Lycopus asper Greene	LYAS1
LAMIACEAE	Marrubium vulgare L.	MAVU1
LAMIACEAE	Mentha arvensis L.	MEAR1
LAMIACEAE	Monarda fistulosa L. var. menthifolia (Grah.) Fern.	MOFI1
LAMIACEAE	Monarda pectinata Nutt.	MOPE1
LAMIACEAE	Nepeta cataria L.	NECA1
LAMIACEAE	Prunella vulgaris L.	PRVU1
LAMIACEAE	Salvia reflexa Hornem.	SARE1
LAMIACEAE	Scutellaria brittonii Porter	SCBR1
LAMIACEAE	Stachys palustris L. ssp. pilosa (Nutt.) Epling	STPA2
LEMNACEAE	Lemna minor L.	LEMI1
LILIACEAE	Allium cernuum Roth	ALCE1
LILIACEAE	Allium geyeri S. Wats.	ALGE1
LILIACEAE	Allium textile A. Nels. & Macbr.	ALTE1
LILIACEAE	Asparagus officinalis L.	ASOF1
LILIACEAE	Calochortus gunnisonii S. Wats.	CAGU1
LILIACEAE	Leucocrinum montanum Nutt.	LEMO2
LILIACEAE	Smilacina stellata (L.) Desf.	SMST1
LILIACEAE	Zigadenus venenosus Wats. var. gramineus (Rydb.) Walsh ex Peck	ZIVE1
LINACEAE	Linum perenne L. var. lewisii (Pursh.) Eat. & Wright	LIPE1
LINACEAE	Linum pratense (Nort.) Small	LIPR1
LINACEAE	Linum puberulum (Englem.) Heller	LIPU2
LYTHRACEAE	Ammania robusta Herr & Regel.	AMRO1

LYTHRACEAE	Lythrum alatum Pursh.	LYAL1
MALVACEAE	Malva neglecta Wallr.	MANE1
MALVACEAE	Sidalcea candida Gray	SICA1
MALVACEAE	Sidalcea neomexicana Gray	SINE1
MALVACEAE	Sphaeralcea coccinea (Pursh.) Rydb.	SPCO1
MALVACEAE	Sphaeralcea parvifolia A. Nelson	SPPA1
NYCTAGINACEAE	Mirabilis hirsuta (Pursh.) MacM.	MIHI1
NYCTAGINACEAE	Mirabilis linearis (Pursh.) Heimerl	MILI1
NYCTAGINACEAE	Mirabilis nyctaginea (Michx.) MacM.	MINY1
OLEACEAE	Fraxinus pennsylvanica Marsh	FRPE1
ONAGRACEAE	Calylophus serrulatus (Nutt.) Raven	CASE2
ONAGRACEAE	Epilobium ciliatum Raf. ssp. glandulosum (Lehm.) Hock & Raven	EPCI1
ONAGRACEAE	Epilobium paniculatum Nutt.	EPPA1
ONAGRACEAE	Gaura coccinea Pursh.	GACO1
ONAGRACEAE	Gaura parviflora Dougl.	GAPA1
ONAGRACEAE	Oenothera flava (A. Nels.) Garrett	OEFL1
ONAGRACEAE	Oenothera howardii (A. Nels.) W. L. Wagner	OEHO1
ONAGRACEAE	Oenothera villosa Thunb. ssp. strigosa (Rydb.) Dietrich & Raven	OEVI1
ONAGRACEAE	Onothera albicaulis Pursh	ONAL1
ORCHIDACEAE	Habenaria hyperborea (L.) R. Br.	HAHY1
OROBANCHACEAE	Orobanche fasciculata Nutt.	ORFA1
OXALIDACEAE	Oxalis dillenii Jacq.	OXDI1
PAPAVERACEAE	Argemone polyanthemos (Fedde) G. Ownbey	ARPO1
PAPAVERACEAE	Eschscholzia californica Chamisso	ESCA1
PINACEAE	Picea pungens Engelm.	PIPU1
PINACEAE	Pinus ponderosa Laws	PIPO1
PINACEAE	Pseudotsuga menziesii (Mirb.) Franco	PSME1
PLANTAGINACE	Plantago lanceolata L.	PLLA1
PLANTAGINACE	Plantago major L.	PLMA1
PLANTAGINACE	Plantago patagonica Jacq.	PLPA1
POACEAE	Aegilops cylindrica Host	AECY1
POACEAE	X Agrohordeum macounii (Vasey) Lepage	AGMA1
POACEAE	Agropyron caninum (L.) Beauv. ssp. majus (Vasey) C. L. Hitchc.	AGCA1
POACEAE	Agropyron cristatum (L.) Gaertn.	AGCR1
POACEAE	Agropyron dasystachyum (Hook.) Scribn.	AGDA1
POACEAE	Agropyron desertorum (Fisch.) Schult.	AGDE1
POACEAE	Agropyron elongatum (Host) Beauv.	AGEL1
POACEAE	Agropyron griffithsii Scribn. & Smith	AGGR1
POACEAE	Agropyron intermedium (Host) Beauv.	AGIN1
POACEAE	Agropyron repens (L.) Beauv.	AGRE1
POACEAE	Agropyron smithii Rydb.	AGSM1
POACEAE	Agropyron spicatum (Pursh) Scribn. and Sm.	AGSP1
POACEAE	Agrostis scabra Willd.	AGSC1
POACEAE	Agrostis stolonifera L.	AGST1
POACEAE	Alopecurus geniculatus L.	ALGE2
POACEAE	Andropogon gerardii Vitman	ANGE1

POACEAE	Andropogon saccharoides Sw. var. torreyanus (Steud.) Hack.	ANSA1
POACEAE	Andropogon scoparius Michx.	ANSC1
POACEAE	Apera interrupta (L.) Beauvois	APIN1
POACEAE	Aristida basiramea Engelm. ex Vasey var. basiramea	ARBA1
POACEAE	Aristida purpurea Nutt. var. longiseta (Steud.) Vasey	ARFE1
POACEAE	Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr	ARLO1
POACEAE	Avena fatua var. sativa (L.) Hausskn.	AVFA1
POACEAE	Bouteloua curtipendula (Michx.) Torr.	BOCU1
POACEAE	Bouteloua gracilis (H. B. K.) Lag ex Griffiths	BOGR1
POACEAE	Bouteloua hirsuta Lag	BOHI1
POACEAE	Bromus briziformis F. & M.	BRBR1
POACEAE	Bromus inermis Leyss. ssp. inermis	BRIN1
POACEAE	Bromus japonicus Thunb. ex Murr.	BRJA1
POACEAE	Bromus tectorum L.	BRTE1
POACEAE	Buchloe dactyloides (Nutt.) Engelm.	BUDA1
POACEAE	Calamagrostis stricta (Timm.) Koel	CAST2
POACEAE	Cenchrus longispinus (Hack.) Fern	CELO1
POACEAE	Ceratochloa marginata (Nees ex Stued.) Jackson	CEMA1
POACEAE	Cynodon dactylon (L.) Pers.	CYDA1
POACEAE	Dactylis glomerata L.	DAGL1
POACEAE	Danthonia spicata (L.) Beauv. ex R. & S.	DASP1
POACEAE	Dichanthelium linearifolium (Scribn.) Gould	DILI1
POACEAE	Dichanthelium oligosanthes (Schultz) Gould var. scribnerianum (Nash) G	DIOL1
POACEAE	Digitaria sanguinalis (L.) Scop.	DISA1
POACEAE	Distichlis spicata (L.) Greene var. stricta (Torr.) Beetle	DISP1
POACEAE	Echinochloa crusgallii (L.) Beauv.	ECCR1
POACEAE	Elymus canadensis L.	ELCA1
POACEAE	Elymus juncea Fisch.	ELJU1
POACEAE	Eragrostis cilianensis (All.) E. Mosher	ERCI2
POACEAE	Eragrostis curvula (Schrad.) Nees	ERCU1
POACEAE	Eragrostis minor Host	ERMI1
POACEAE	Eragrostis pilosa (L.) Beauv.	ERPI1
POACEAE	Eragrostis trichodes (Nutt.) Wood	ERTR1
POACEAE	Festuca octoflora Walt.	FEOC1
POACEAE	Festuca ovina L. var. rydbergii St. Yves	FEOV1
POACEAE	Festuca pratensis Huds.	FEPR1
POACEAE	Glyceria grandis S. Wats. ex A. Gray	GLGR1
POACEAE	Glyceria striata (Lam.) Hitchc.	GLST1
POACEAE	Hordeum brachyantherum Nevski	HOBR1
POACEAE	Hordeum jubatum L.	HOJU1
POACEAE	Hordeum pusillum Nutt.	HOPU1
POACEAE	Koeleria pyramidata (Lam.) Beauv.	KOPY1
POACEAE	Leersia oryzoides (L.) Sw.	LEOR1
POACEAE	Lolium perenne L. var. aristatum Willd.	LOPE1
POACEAE	Lolium perenne L. var. perenne	LOPE2
POACEAE	Lycurus phleoides H.B.K.	LYPH1

POACEAE	Muhlenbergia asperifolia (Nees. & Mey.) Parodi	MUAS1
POACEAE	Muhlenbergia filiformis (Thurb.) Rydb.	MUFI1
POACEAE	Muhlenbergia montana (Nutt.) Hitchc.	MUMO1
POACEAE	Muhlenbergia racemosa (Michx.) B. S. P.	MURA1
POACEAE	Muhlenbergia wrightii Vasey	MUWR1
POACEAE	Oryzopsis hymenoides (R. & S.) Ricker	ORHY1
POACEAE	Panicum capillare L.	PACA1
POACEAE	Panicum dichotomiflorum Michx.	PADI1
POACEAE	Panicum virgatum L.	PAVI1
POACEAE	Phalaris arundinacea L.	PHAR1
POACEAE	Phleum pratense L.	PHPR1
POACEAE	Phragmites australis (Cav.) Trin. ex Steud.	PHAU1
POACEAE	Poa bulbosa L.	POBU1
POACEAE	Poa canbyi (Scribn.) Piper	POCA1
POACEAE	Poa compressa L.	POCO1
POACEAE	Poa fendleriana (Steud.) Vasey	POFE1
POACEAE	Poa juncifolia Scribn.	POJU1
POACEAE	Poa palustris L.	POPA1
POACEAE	Poa pratensis L.	POPR1
POACEAE	Polypogon monspeliensis (L.) Desf.	POMO1
POACEAE	Schedonnardus paniculatus (Nutt.) Trel.	SCPA2
POACEAE	Secale cereale L.	SECE1
POACEAE	Setaria viridis (L.) Beauv.	SEVI1
POACEAE	Sitanion hystrix (Nutt.) Sm. var. brevifolium (Sm.) Hitchc.	SIHY1
POACEAE	Sorghastrum nutans (L.) Nash	SONU1
POACEAE	Spartina pectinata Link	SPPE1
POACEAE	Sphenopholis obtusata (Michx.) Scribn.	SPOB1
POACEAE	Sporobolus asper (Michx.) Kunth	SPAS1
POACEAE	Sporobolus cryptandrus (Torr.) A. Gray	SPCR1
POACEAE	Sporobolus heterolepis (A. Gray) A. Gray	SPHE1
POACEAE	Sporobolus neglectus Nash	SPNE1
POACEAE	Stipa comata Trin. & Rupr.	STCO1
POACEAE	Stipa neomexicana (Thur.) Scribn.	STNE1
POACEAE	Stipa robusta (Vasey) Scribn.	STRO1
POACEAE	Stipa spartea Trinius	STSP1
POACEAE	Stipa viridula Trin.	STVI1
POACEAE	Triticum aestivum L.	TRAE1
POLEMONIACEAE	Collomia linearis Nutt.	COLI1
POLEMONIACEAE	Gilia opthalmoides Brand. ssp. clokeyi (Mason) A. & V. Grant	GIOP1
POLEMONIACEAE	Ipomopsis spicata (Nutt.) V. Grant ssp. spicata	IPSP1
POLEMONIACEAE	Microsteris gracilis (Hook.) Greene	MIGR1
POLEMONIACEAE	Navarretia minima Nutt.	NAMI1
POLYGONACEAE	Eriogonum alatum Torr.	ERAL1
POLYGONACEAE	Eriogonum effusum Nutt.	EREF1
POLYGONACEAE	Eriogonum jamesii Benth.	ERJA1
POLYGONACEAE	Eriogonum umbellatum Torr.	ERUM1

POLYGONACEAE	Polygonum arenastrum Jord. ex Bor.	POAR1
POLYGONACEAE	Polygonum convolvulus L.	POCO2
POLYGONACEAE	Polygonum douglasii Greene	PODO1
POLYGONACEAE	Polygonum hydropiper L.	POHY1
POLYGONACEAE	Polygonum lapathifolium L.	POLA1
POLYGONACEAE	Polygonum pensylvanicum L.	POPE1
POLYGONACEAE	Polygonum persicaria L.	POPE2
POLYGONACEAE	Polygonum ramosissimum Michx.	PORA1
POLYGONACEAE	Polygonum sawatchense Small	POSA1
POLYGONACEAE	Rumex acetosella L.	RUAC1
POLYGONACEAE	Rumex crispus L.	RUCR1
POLYGONACEAE	Rumex maritimus L.	RUMA1
POLYGONACEAE	Rumex obtusifolius L.	RUOB1
POLYGONACEAE	Rumex salicifolius Weinm. ssp. triangulivalvis Danser	RUSA1
POLYPODIACEAE	Cystopteris fragilis (L.) Bernh.	CYFR1
PORTULACACEAE	Claytonia rosea Rydb.	CLRO1
PORTULACACEAE	Portulaca oleracea L.	POOL1
PORTULACACEAE	Talinum parviflorum Nutt.	TAPA1
POTAMOGETONACEAE	Potamogeton foliosus Raf.	POFO1
POTAMOGETONACEAE	Potamogeton natans L.	PONA1
PRIMULACEAE	Androsace occidentalis Pursh.	ANOC1
PRIMULACEAE	Dodecatheon pulchellum (Raf.) Merrill	DOPU1
PRIMULACEAE	Lysimachia ciliata L.	LYCI1
RANUNCULACEAE	Anemone cylindrica A. Gray	ANCY1
RANUNCULACEAE	Anemone patens L.	ANPA2
RANUNCULACEAE	Clematis hirsutissima Pursh	CLHI1
RANUNCULACEAE	Clematis ligusticifolia Nutt.	CLLI1
RANUNCULACEAE	Delphinium nuttalianum Pritz. ex Walpers	DENU1
RANUNCULACEAE	Delphinium virescens Nutt. ssp. penardii (Huth) Ewan	DEVI1
RANUNCULACEAE	Myosurus minimus L.	MYMI1
RANUNCULACEAE	Ranunculus macounii Britt.	RAMA1
RANUNCULACEAE	Ranunculus scleratus L.	RASC1
RANUNCULACEAE	Ranunculus trichophyllus Chaix	RATR1
RANUNCULACEAE	Thalictrum dasycarpum Fisch. & Ave-Lall	THDA1
RHAMNACEAE	Ceanothus fendleri A. Gray	CEFE1
RHAMNACEAE	Ceanothus herbaceus Raf. var. pubescens (T. & G.)	CEHE1
ROSACEAE	Agrimonia striata Michx.	AGST2
ROSACEAE	Amelanchier alnifolia Nutt.	AMAL1
ROSACEAE	Crataegus erythropoda Ashe	CRER1
ROSACEAE	Crataegus succulenta Link var. occidentalis (Britton) E. J. Palm.	CRSU1
ROSACEAE	Geum aleppicum Jacq.	GEAL1
ROSACEAE	Geum macrophyllum Willd.	GEMA1
ROSACEAE	Physocarpus monogynus (Torr.) Coult.	PHMO1
ROSACEAE	Physocarpus opulifolius (L.) Raf.	PHOP1
ROSACEAE	Potentilla arguta Pursh	POAR2
ROSACEAE	Potentilla fissa Nutt.	POFI1

ROSACEAE	Potentilla gracilis Dougl. ex Hook. var. glabrata (Lehm.) C. L. Hitchc.	POGR1
ROSACEAE	Potentilla hippiana Lehm.	POHI1
ROSACEAE	Potentilla norvegica L.	PONO1
ROSACEAE	Potentilla paradoxa Nutt.	POPA2
ROSACEAE	Potentilla pensylvanica L.	POPE4
ROSACEAE	Potentilla pulcherrima x hippiana	POPU1
ROSACEAE	Potentilla rivalis Nutt.	PORI1
ROSACEAE	Prunus americana Marsh.	PRAM1
ROSACEAE	Prunus pumila L. var. besseyi (Bailey) Gl.	PRPU1
ROSACEAE	Prunus virginiana L. var. melanocarpa (A. Nels.) Sarg.	PRVI1
ROSACEAE	Pyrus malus L.	PYMA1
ROSACEAE	Rosa acicularis Lindl.	ROAC1
ROSACEAE	Rosa arkansana Porter	ROAR1
ROSACEAE	Rosa woodsii Lindl.	ROWO1
ROSACEAE	Rubus deliciosus Torr.	RUDE1
ROSACEAE	Rubus idaeus L. ssp. sachalinensis (Levl.) Focke var. sachalinensis	RUID1
ROSACEAE	Sanguisorba minor Scop.	SAMI1
ROSACEAE	Sorbus scopulina Greene	SOSC1
RUBIACEAE	Galium aparine L.	GAAP1
RUBIACEAE	Galium septentrionale Roemer & Schultes	GASE1
SALICACEAE	Populus alba L.	POAL1
SALICACEAE	Populus angustifolia James	POAN3
SALICACEAE	Populus deltoides Marsh. ssp. monilifera (Ait.) Eckenw.	PODE1
SALICACEAE	Populus x acuminata Rydb.	POAC1
SALICACEAE	Salix amygdaloides Anderss.	SAAM1
SALICACEAE	Salix exigua Nutt. ssp. exigua	SAEX2
SALICACEAE	Salix exigua Nutt. ssp. interior (Rowlee) Cronq.	SAEX1
SALICACEAE	Salix fragilis L.	SAFR1
SALICACEAE	Salix irrorata Andersson	SAIR1
SALICACEAE	Salix lutea Nutt.	SALU1
SANTALACEAE	Comandra umbellata (L.) Nutt.	COUM1
SAXIFRAGACEAE	Heuchera parvifolia Nutt. ex T.& G.	HEPA1
SAXIFRAGACEAE	Saxifraga rhomoidea Greene	SARH1
SCROPHULARIACEAE	Castilleja integra A. Gray	CAIN2
SCROPHULARIACEAE	Castilleja sessiliflora Pursh.	CASE3
SCROPHULARIACEAE	Collinsia parviflora Doug. ex Lindl.	COPA1
SCROPHULARIACEAE	Gratiola neglecta Torr.	GRNE1
SCROPHULARIACEAE	Limosella aquatica L.	LIAQ1
SCROPHULARIACEAE	Linaria canadensis (L.) Dum. var. texana (Scheele) Penn.	LICA1
SCROPHULARIACEAE	Linaria dalmatica (L.) Mill.	LIDA1
SCROPHULARIACEAE	Linaria vulgaris Hill	LIVU1
SCROPHULARIACEAE	Mimulus floribundus Dougl. ex Lindl.	MIFL1
SCROPHULARIACEAE	Mimulus glabratus H. B. K. var. fremontii (Benth.) A. L. Grant	MIGL1
SCROPHULARIACEAE	Penstemon albidus Nutt.	PEAL1
SCROPHULARIACEAE	Penstemon secundiflorus Benth.	PESE1
SCROPHULARIACEAE	Penstemon strictus Bentham in De Candolle	PEST1

SCROPHULARIACEAE	Penstemon virens Penn.	PEVI1	
SCROPHULARIACEAE	Penstemon virgatus Gray ssp. asa-grayi Crosswhite	PEVI2	
SCROPHULARIACEAE	Scrophularia lanceolata Pursh.	SCLA2	
SCROPHULARIACEAE	Verbascum blattaria L.	VEBL1	
SCROPHULARIACEAE	Verbascum thapsus L.	VETH1	
SCROPHULARIACEAE	Veronica americana (Raf.) Schwein. ex Benth.	VEAM1	
SCROPHULARIACEAE	Veronica anagallis-aquatica L.	VEAN1	
SCROPHULARIACEAE	Veronica catentata Penn.	VECA1	
SCROPHULARIACEAE	Veronica peregrina L. var. xalapensis (H. B. K.) St. John & Warren	VEPE1	
SELAGINELLACEAE	Selaginella densa Rydb.	SEDE1	
SMILACACEAE	Smilax herbacea L. var. lasioneura (Small) Rydb..	SMHE1	
SOLANACEAE	Physalis heterophylla Nees	PHHE2	
SOLANACEAE	Physalis pumila Nutt. ssp. Hispida (Waterfall) Hinton	PHPU1	
SOLANACEAE	Physalis virginiana P. Mill.	PHVI2	
SOLANACEAE	Quincula lobata (Torr.) Raf.	QULO1	
SOLANACEAE	Solanum rostratum Dun.	SORO1	
SOLANACEAE	Solanum triflorum Nutt.	SOTR1	
TAMARICACEAE	Tamarix ramosissima Ledeb.	TARA1	
TYPHACEAE	Typha angustifolia L.	TYAN1	
TYPHACEAE	Typha latifolia L.	TYLA1	
ULMACEAE	Ulmus pumila L.	ULPU1	
URTICACEAE	Parietaria pensylvanica Muhl. ex Willd.	PAPE1	
URTICACEAE	Urtica dioica L. ssp. gracilis (Ait.) Seland.	URDI1	
VERBENACEAE	Lippia cuneifolia (Torr.) Steud.	LICU1	
VERBENACEAE	Verbena bipinnatifida Nutt.	VEBI1	
VERBENACEAE	Verbena bracteata Lag. & Rodr.	VEBR1	
VERBENACEAE	Verbena hastata L.	VEHA1	
VIOLACEAE	Hybanthus verticillatus (Ort.) Baill.	HYVE1	
VIOLACEAE	Viola nuttallii Pursh.	VINU1	
VIOLACEAE	Viola rydbergii Greene	VIRY1	
VIOLACEAE	Viola scopulorum (Gray) Greene	VISC1	
VIOLACEAE	Viola sororia Willd.	VISO1	
VITACEAE	Vitis riparia Michx.	VIRI1	
ZYGOPHYLLACEAE	Tribulus terrestris L.	TRTE1	

Appendix G

Weed Distribution and Management History at the Rocky Flats Environmental Technology Site

To view maps of the distribution of various weeds or herbicide application locations on the Site, click on any of the links below.

Herbicide Application Maps

-

1997 and 1998 Ground Herbicide Application Locations

1999 Ground and Aerial Herbicide Application Locations

2000 Aerial Herbicide Application Locations

2000 Ground Herbicide Application Locations

2001 Aerial Herbicide Application Locations

2001 Ground Herbicide Application Locations

2002 Ground and Aerial Herbicide Application Locations

2003 Ground Herbicide Application Locations

2004 Ground Herbicide Application Locations

Weed Distribution Maps by Species

Musk Thistle (*Carduus Nutans*)

1997

1998

1999

2000

2001

2002

2003

Diffuse Knapweed (*Centaurea diffusa*)

1997

1998

1999

2000

2001

2002

2003

2004

Dalmatian Toadflax (*Linaria dalmatica*)

1997

1998

1999

2002

2003

Common Mullein (*Verbascum thapsus*)

1997

1998

1999

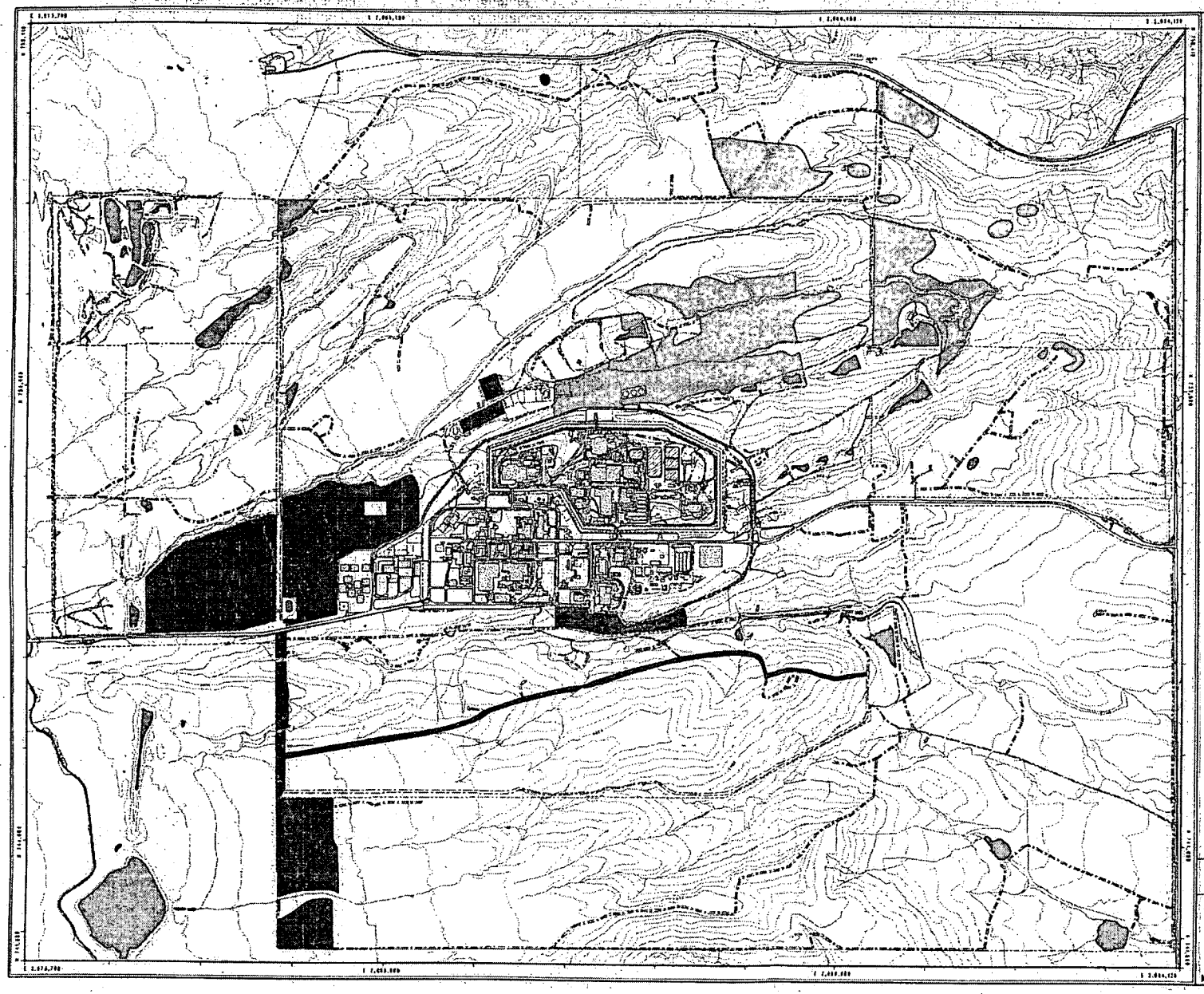
2000

2001

2004

2002

2003



FY1997-FY1998 Weed Control Efforts in the Buffer Zone
Figure 5-6

MAP LEGEND

Standard Map Features

- FY1997 - Truck/Tordon
- FY1997 - Truck/Transline
- FY1997 - Biocontrol/Diffuse Knapweed
- FY1997 - Biocontrol/Dalmation Toadflax
- FY1998 - Truck/Tordon
- Buildings and other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCE:
FY98-1998 Weed Control Information in the Buffer Zone of Rocky Flats Environmental Technology Site provided by Exponent Environmental Group.
NOTE: These data approximate the boundaries of the areas treated. The boundaries are not exact and should not be treated as such.

Scale = 1 : 21330
1 inch represents approximately 1778 feet

500 0 1000 2000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

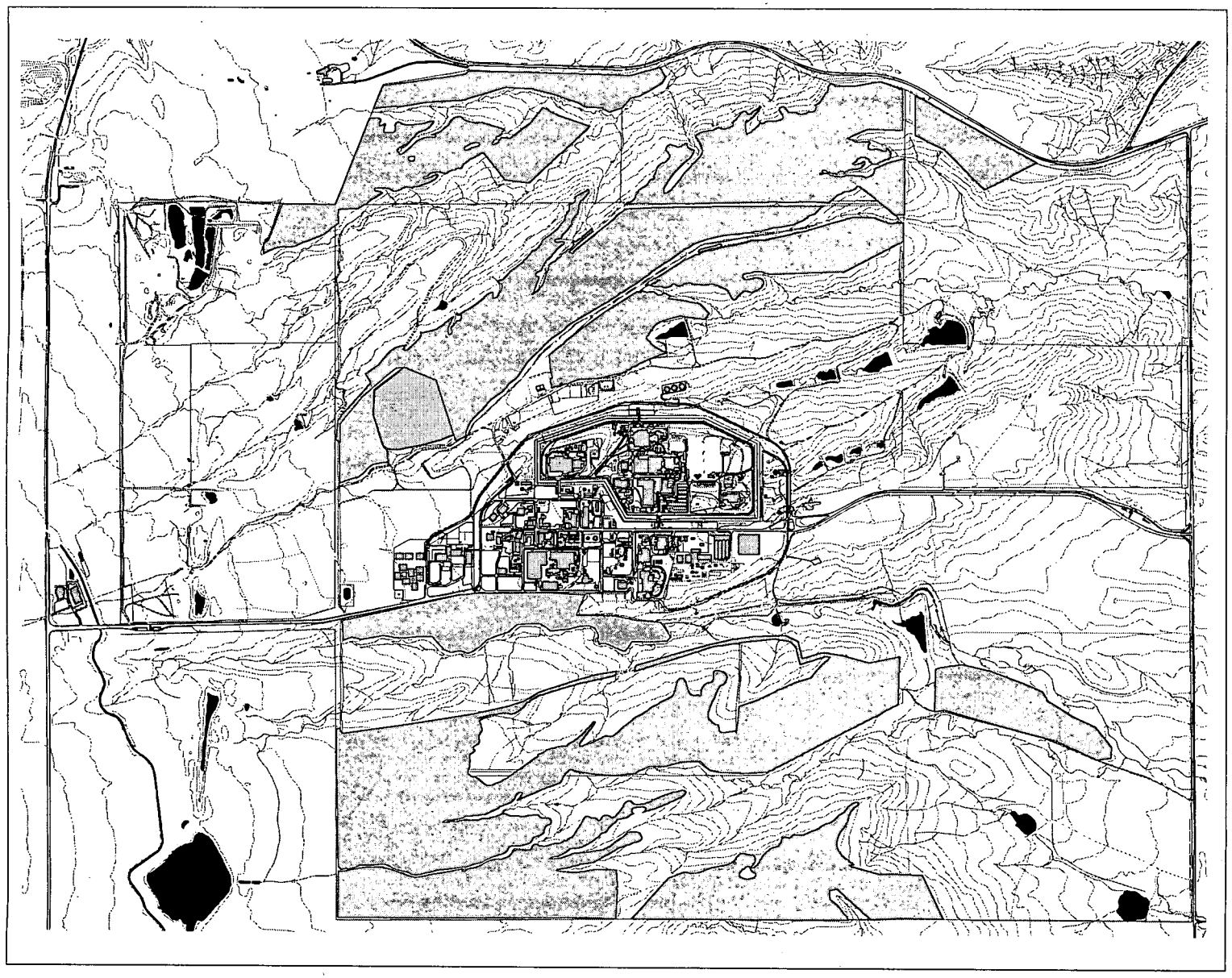
U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

Exponent

MAP ID: /home/r519055/

April 28, 1998



FY1999 Ground and Aerial Herbicide Application Locations Using Tordon 22K

Figure 15

MAP LEGEND

- Aerial Herbicide Application Locations
- Ground Herbicide Application Locations

Standard Map Features

- New Landfill
- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)
- Power Lines

DATA SOURCE:
Ground and Aerial Herbicide Locations provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

Note:
These locations are approximate.

N

1:23552

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

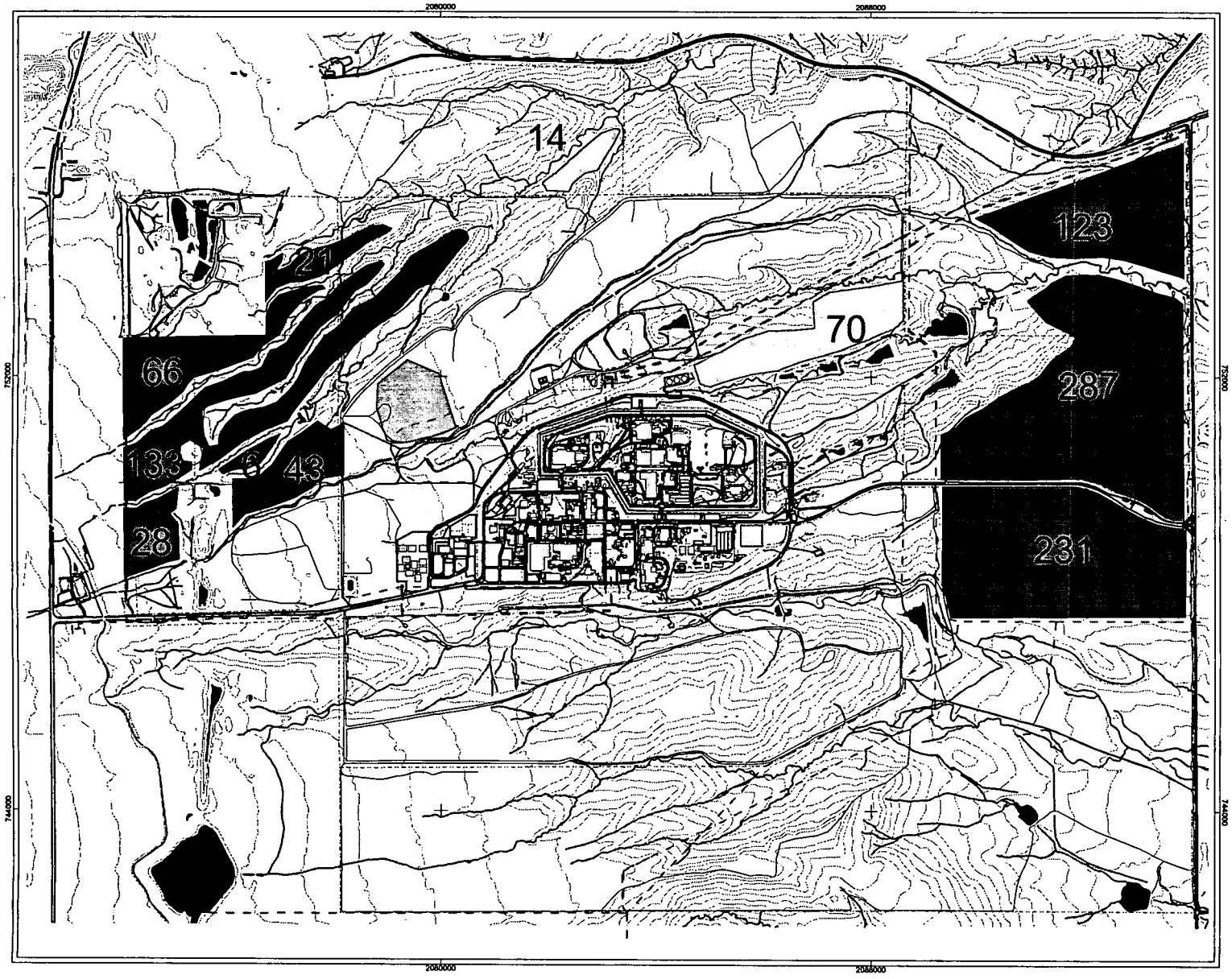
Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: K2-0018

March 14, 2000

\\Gisarv\GIS\ECO-projects\projects\k2-0016\aerialherbapp2k.apr\1999 Ground and Aerial Herbicide Application Locations



FY2000 Aerial Herbicide Application Locations

Figure 12

LEGEND

- Tordon Spray Locations
- Transline Spray Locations

(Numbers are acres treated)

Standard Features

- Buildings
- Lakes & ponds
- New Landfill
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)
- Power Lines

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

Data Source Ecology Features:
Location data provided by Exponent.
K-H Ecology Group POC: Karen North 303-966-9876.

N

1:23552

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent®

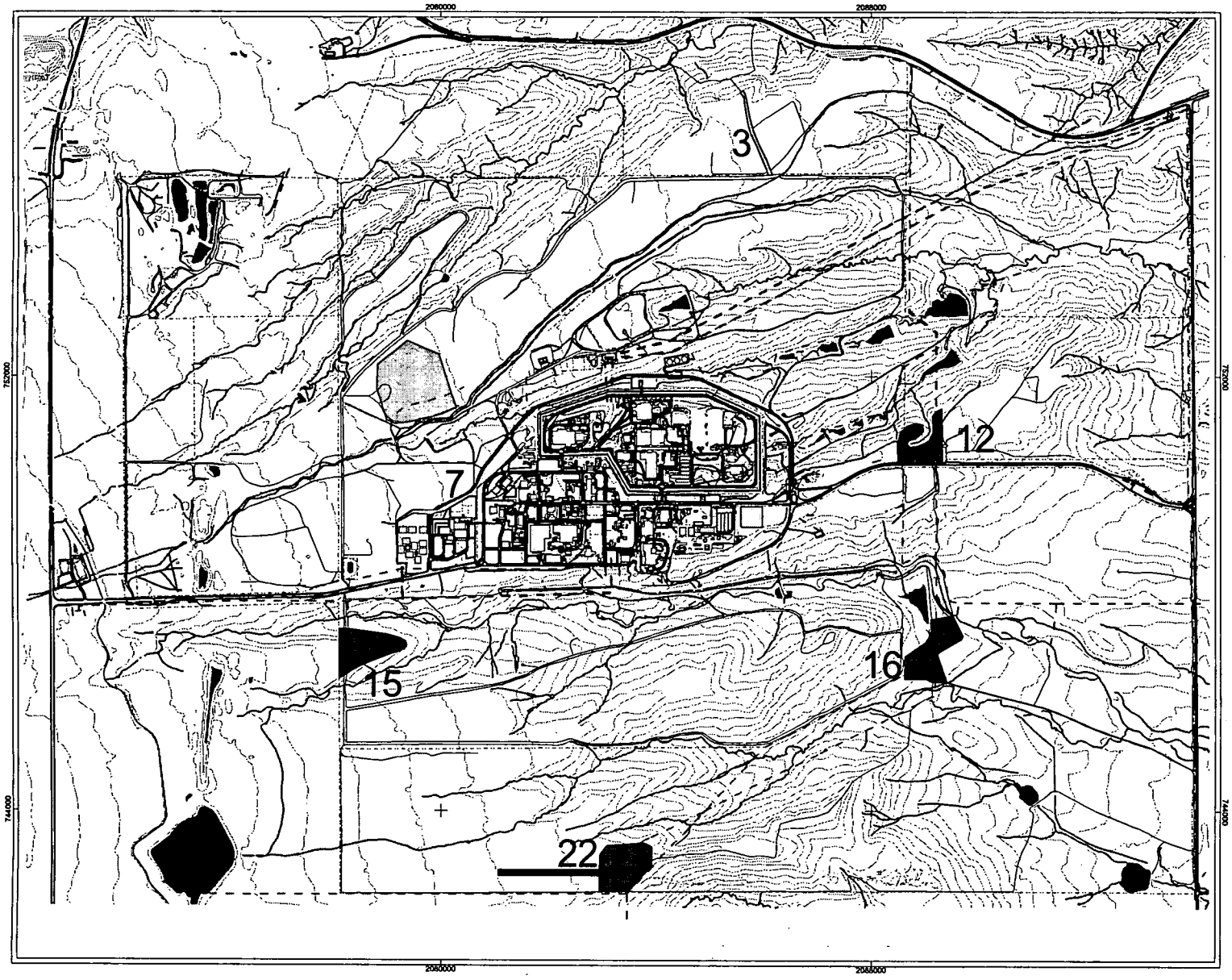
For: Kaiser-Hill Company, LLC

RFETS GIS Dept. 303-966-7707

MAP ID: 01-0404

May 3, 2001

\\Gisserv\GIS\ECO-projects\projects\01-0404\2000 aerial herbicide locations



FY2000 Ground Herbicide Application Locations

Figure 11

LEGEND

- Tordon Spray Locations
- Transline Spray Locations

(Numbers are acres treated)

Standard Features

- Buildings
- Lakes & ponds
- New Landfill
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)
- Power Lines

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

Data Source Ecology Features:
Location data provided by Exponent.
K-H Ecology Group POC: Karen North 303-966-9876.

N

1:23552

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent®

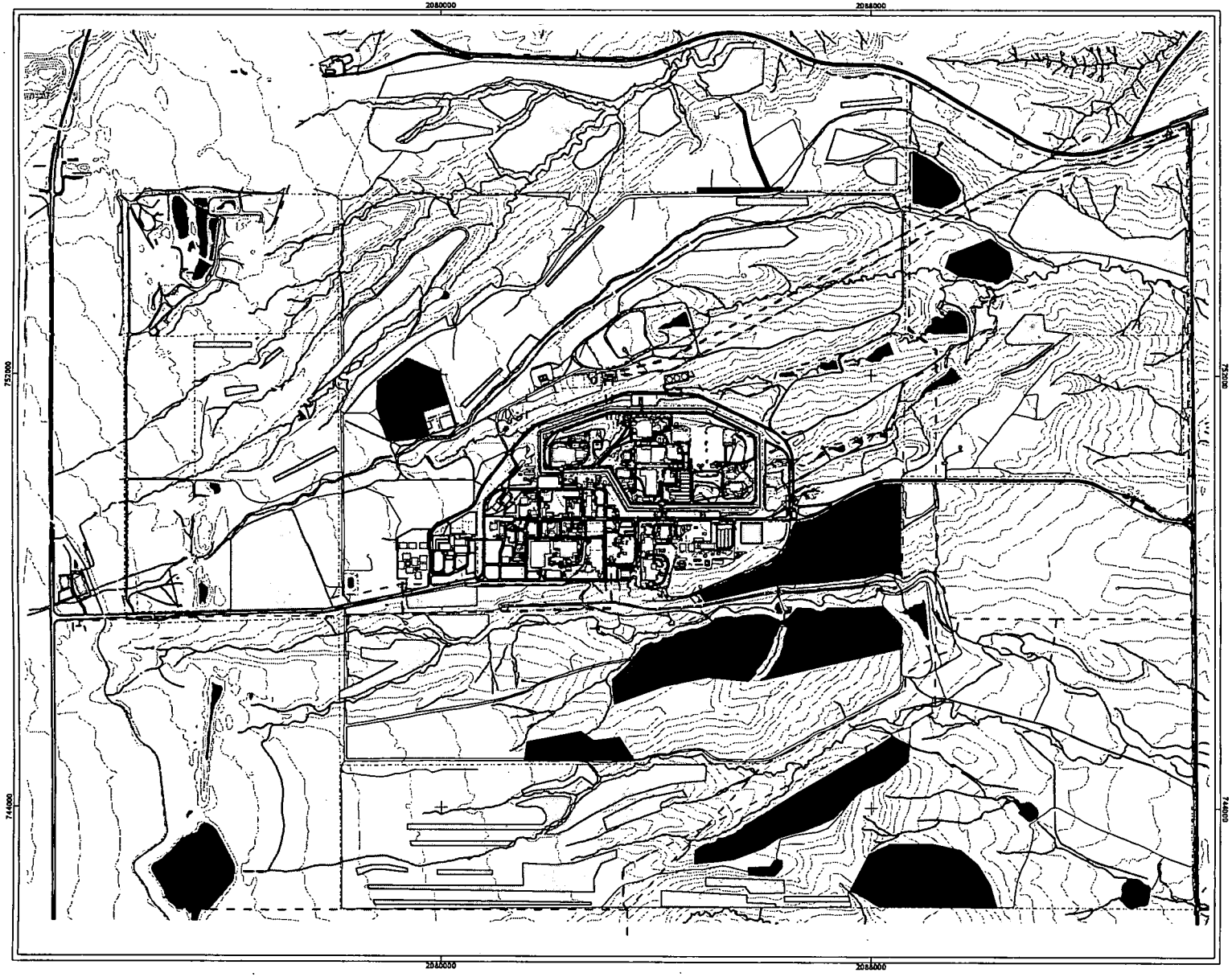
For: Kaiser-Hill Company, LLC

RFETS GIS Dept. 303-966-7707

MAP ID: 01-0404

May 3, 2001

\\Kaiser-H\GIS\ECO-projects\projects\01-0404\2000 ground applications locations (actual)



2001 Aerial Herbicide Application Locations (Broadcast)

Figure 3-6

MAP LEGEND

- Tordon 22K Locations
- Transline Locations

Standard Features

- Buildings
- Lakes & ponds
- Landfill
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

Data Source Ecology Features:
Location data provided by Exponent.
K-H Ecology Group POC; Karan North 303-966-9876.
All locations are approximate.

N

1:23552

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent®

For: Kaiser-Hill Company, LLC

RFETS GIS Dept. 303-966-7707

MAP ID: 02-0174

December 4, 2001

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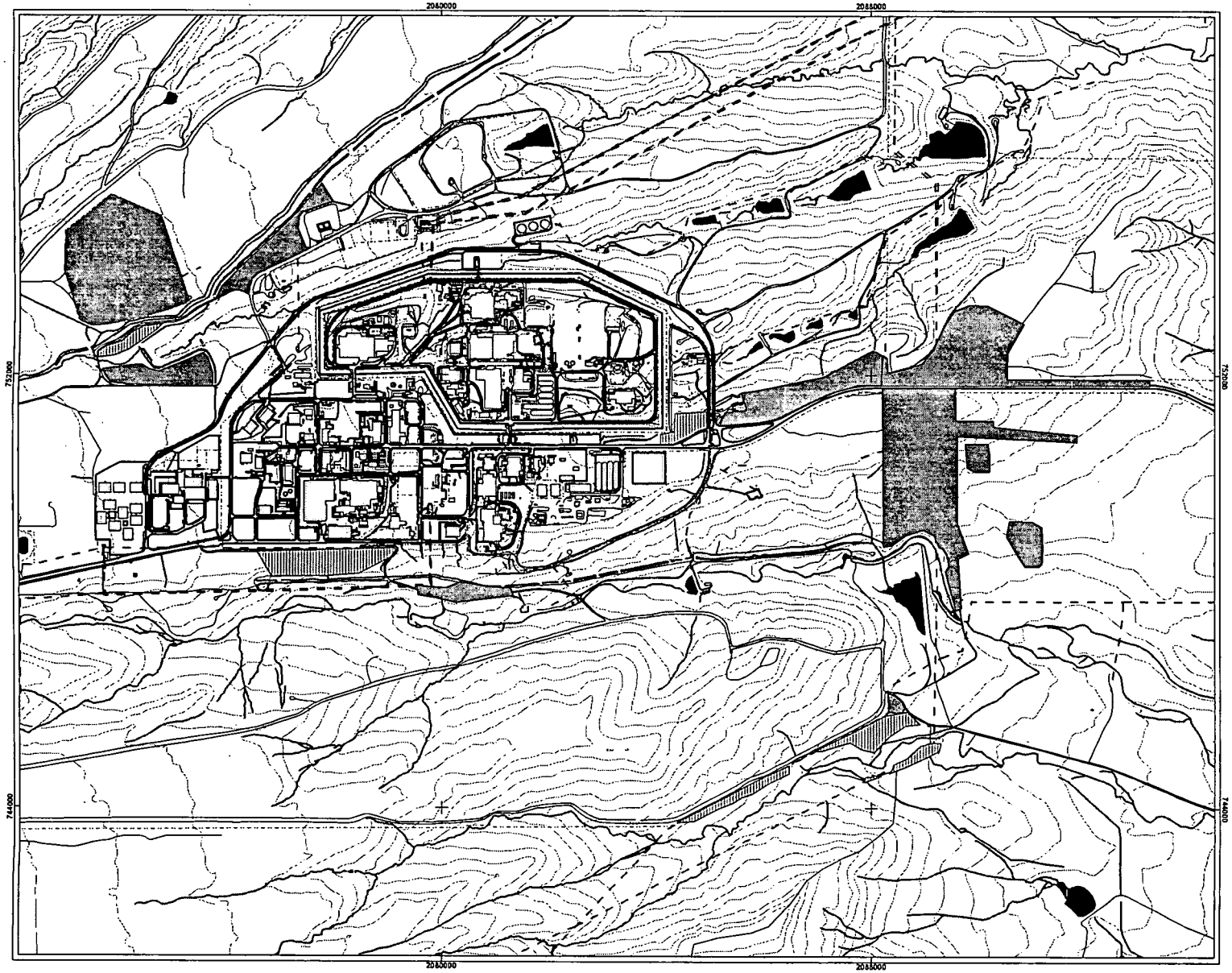

2001 Ground Herbicide Application Locations (Broadcast)

Figure 3-5

MAP LEGEND

- Tordon 22K Locations
- Transline Locations
- Telar Locations

Standard Features

- Buildings
- Lakes & ponds
- Landfill
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

Data Source Ecology Features:
Location data provided by Exponent.
K-H Ecology Group POC: Karan North 303-966-9876.
All locations are approximate.

N

1:15125

1000 0 1000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent®

For: Kaiser-Hill Company, LLC

RFETS GIS Dept. 303-966-7707

MAP ID: 02-0174

December 4, 2001

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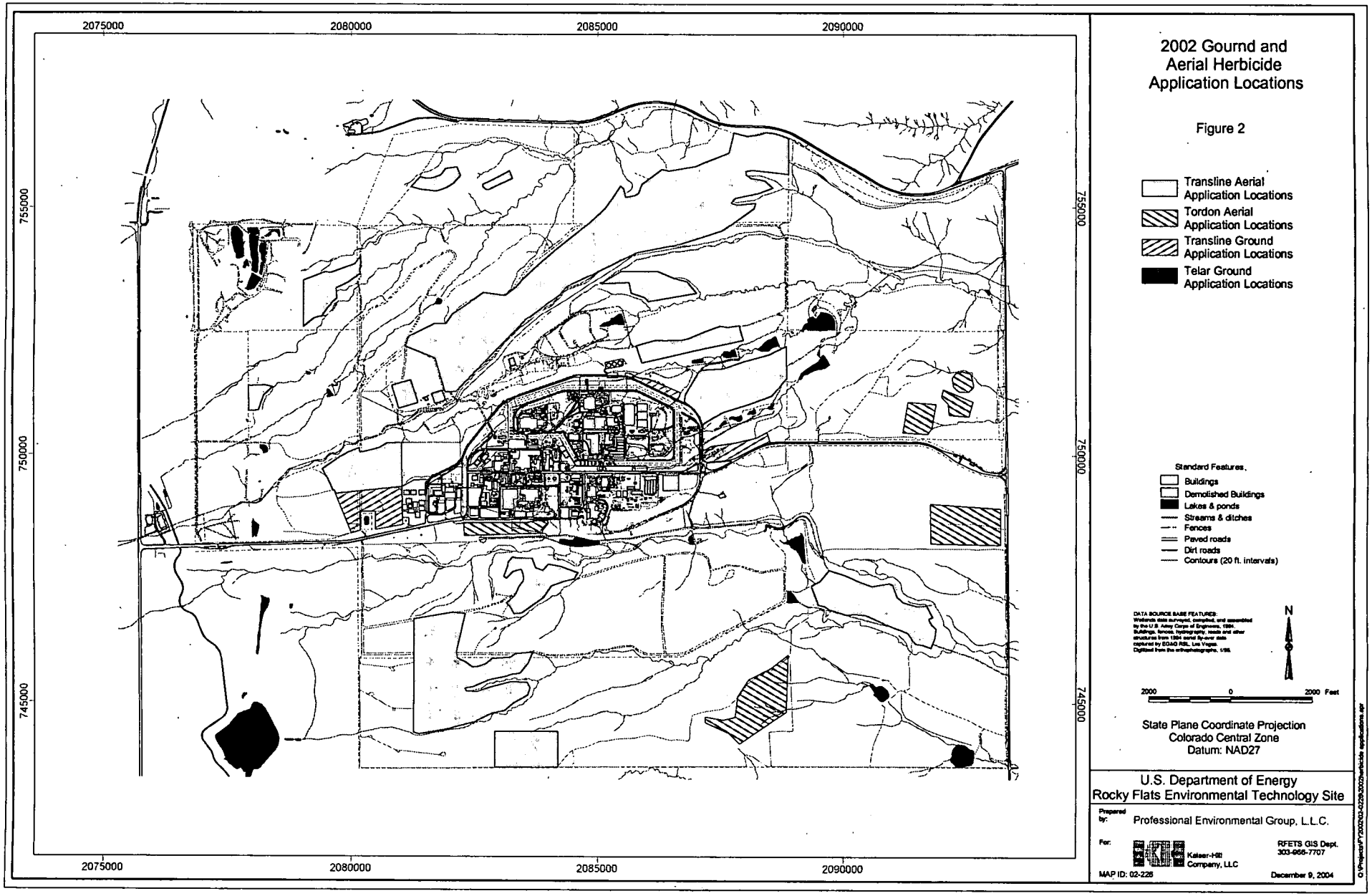
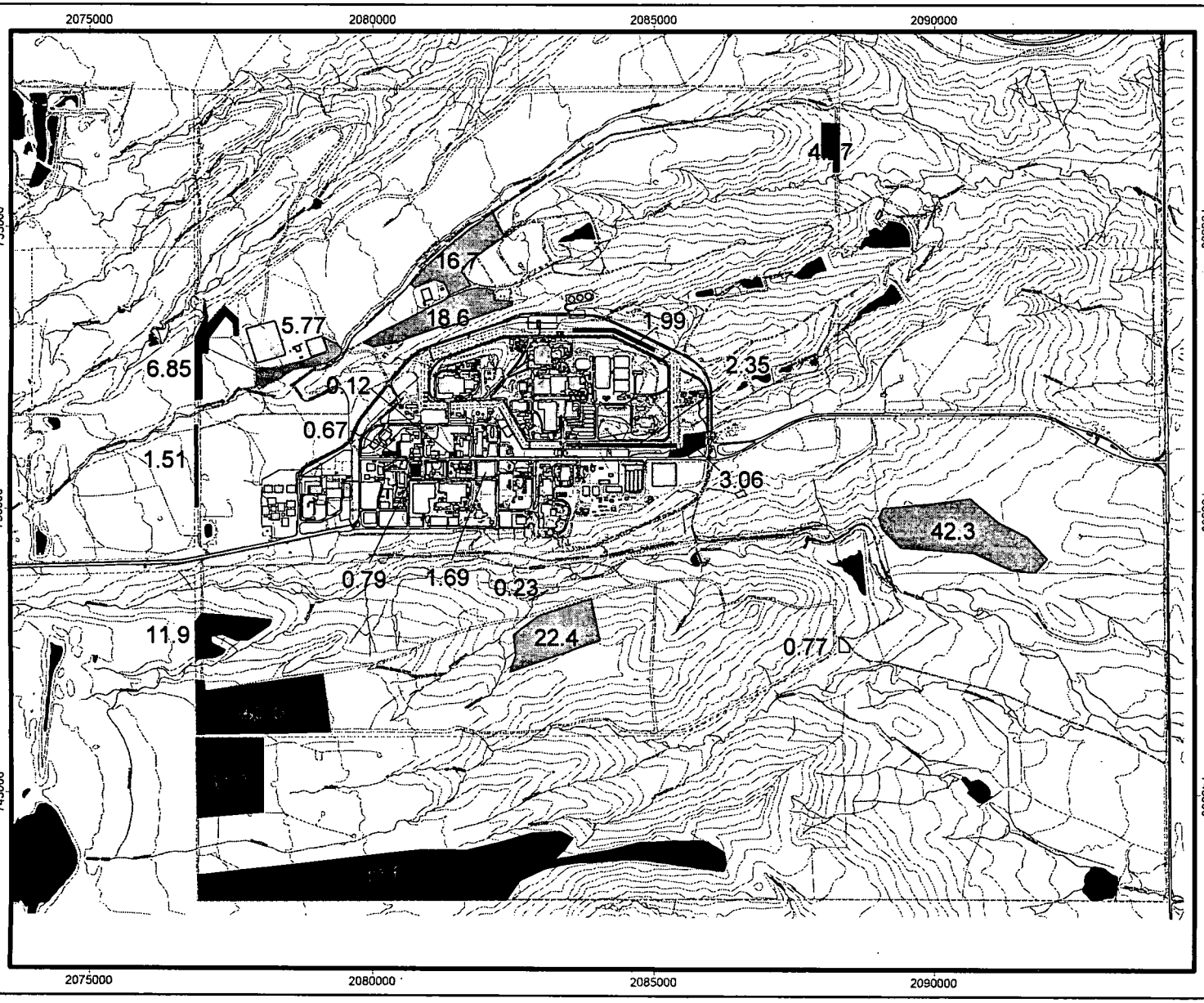

2075000
2080000
2085000
2090000
755000
750000
745000
2002 Gournd and Aerial Herbicide Application Locations
Figure 2
Transline Aerial Application Locations
Tordon Aerial Application Locations
Transline Ground Application Locations
Telar Ground Application Locations
Standard Features:
Buildings
Demolished Buildings
Lakes & ponds
Streams & ditches
Fences
Paved roads
Dirt roads
Contours (20 ft. intervals)
N
2000 0 2000 Feet
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27
U.S. Department of Energy
Rocky Flats Environmental Technology Site
Prepared by:
Professional Environmental Group, L.L.C.
For:
Kaiser-Hill Company, LLC
RFETS GIS Dept.
303-966-7707
MAP ID: 02-226
December 9, 2004



2003 Broadcast Herbicide Application Locations

Figure 4-6

Legend

- Telar Locations (3 acres)
- Transline Locations (24 acres)
- Roundup Locations (4 acres)
- Tordon 22K Locations (Spring; 212 acres)
- Tordon 22K Locations (Fall; 81 acres)

Standard Features

- Buildings
- Demolished Buildings
- Lakes & ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft. intervals)

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95.

N

1000 0 1000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Professional Environmental Group, LLC

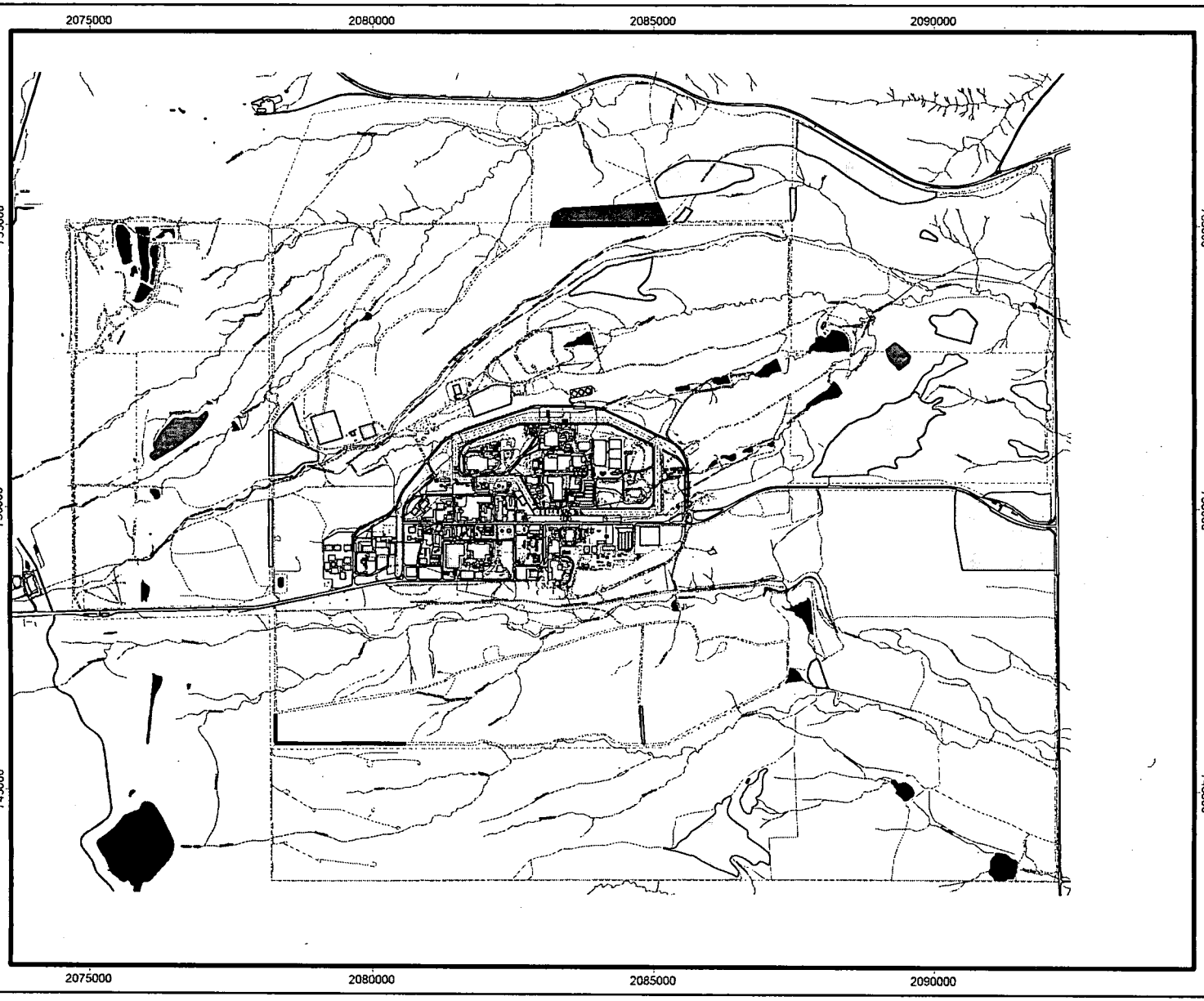
For: Kaiser-Hill Company, LLC

MAP ID: 03-0012

May 19, 2004

O:\Projects\2003\03-0012\2003 herbicide appl locations.apr\figure - 2003.aml.mxd

RFETS GIS Dep



2004 Broadcast Herbicide Application Locations

Figure 4-5

Legend

- Roundup
- Plateau
- Transline
- Tordon 22K 1pt/acre
- Tordon 22K 1 qt/acre

Standard Features

- Buildings
- Demolished Buildings
- Lakes & ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft. intervals)

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas
Digitized from the orthophotographs, 1/95.

N

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
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RFETS GIS Dept.
303-966-7707

MAP ID: 04-0021

May 11, 2005

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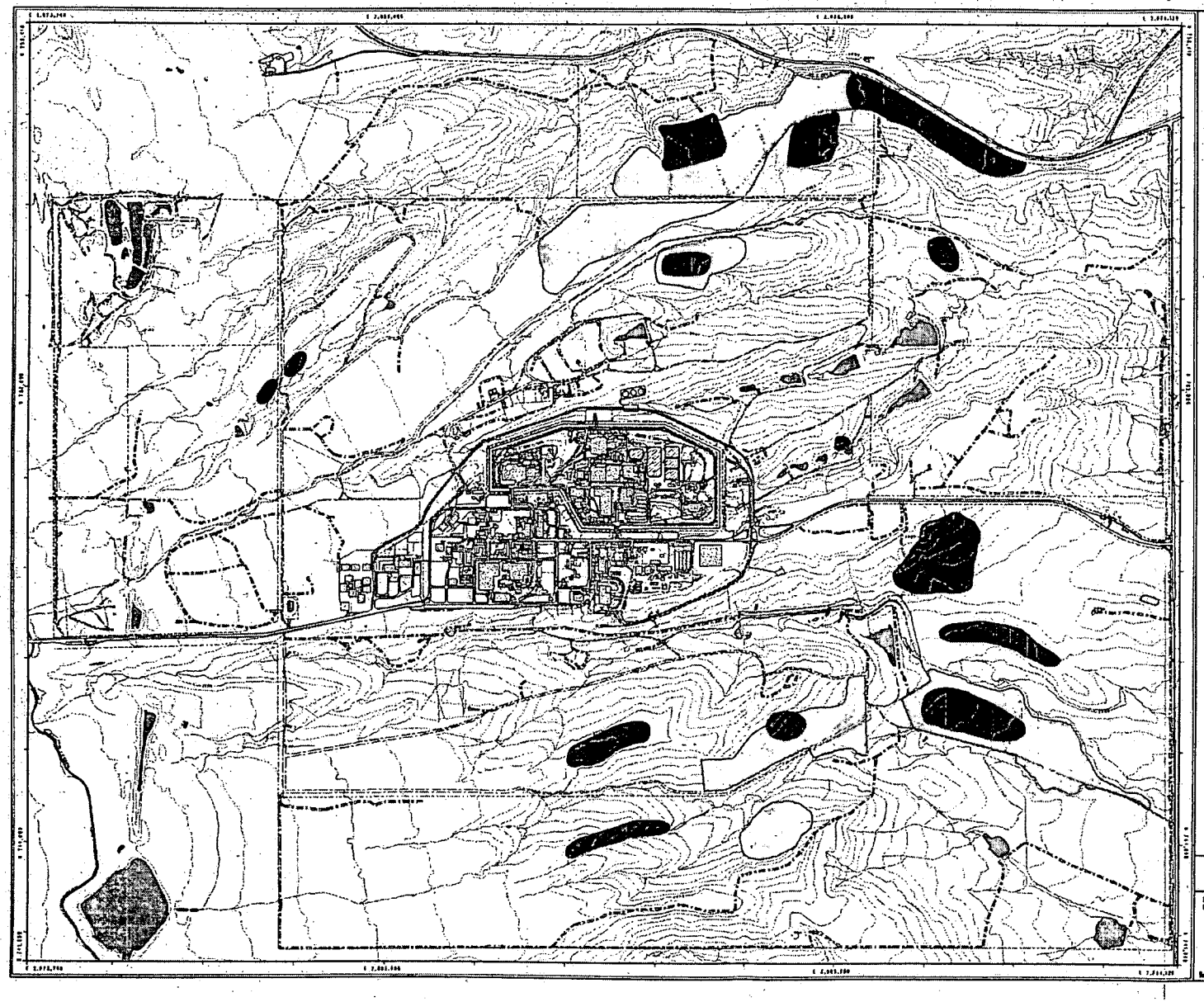


1997 Musk Thistle (Carduus nutans) Distribution Figure 5-3

MAP LEGEND

Standard Map Features

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Buildings and other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCES:
1997 Musk Thistle (Carduus nutans) density and distribution data provided by Exponent Environmental Group.
NOTE: These data approximate the boundaries of infestation areas. The boundaries are not exact and should not be treated as such. These areas may not represent infestations on site.

N

Scale = 1 : 21330
1 inch represents approximately 1778 feet

0 1000 2000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

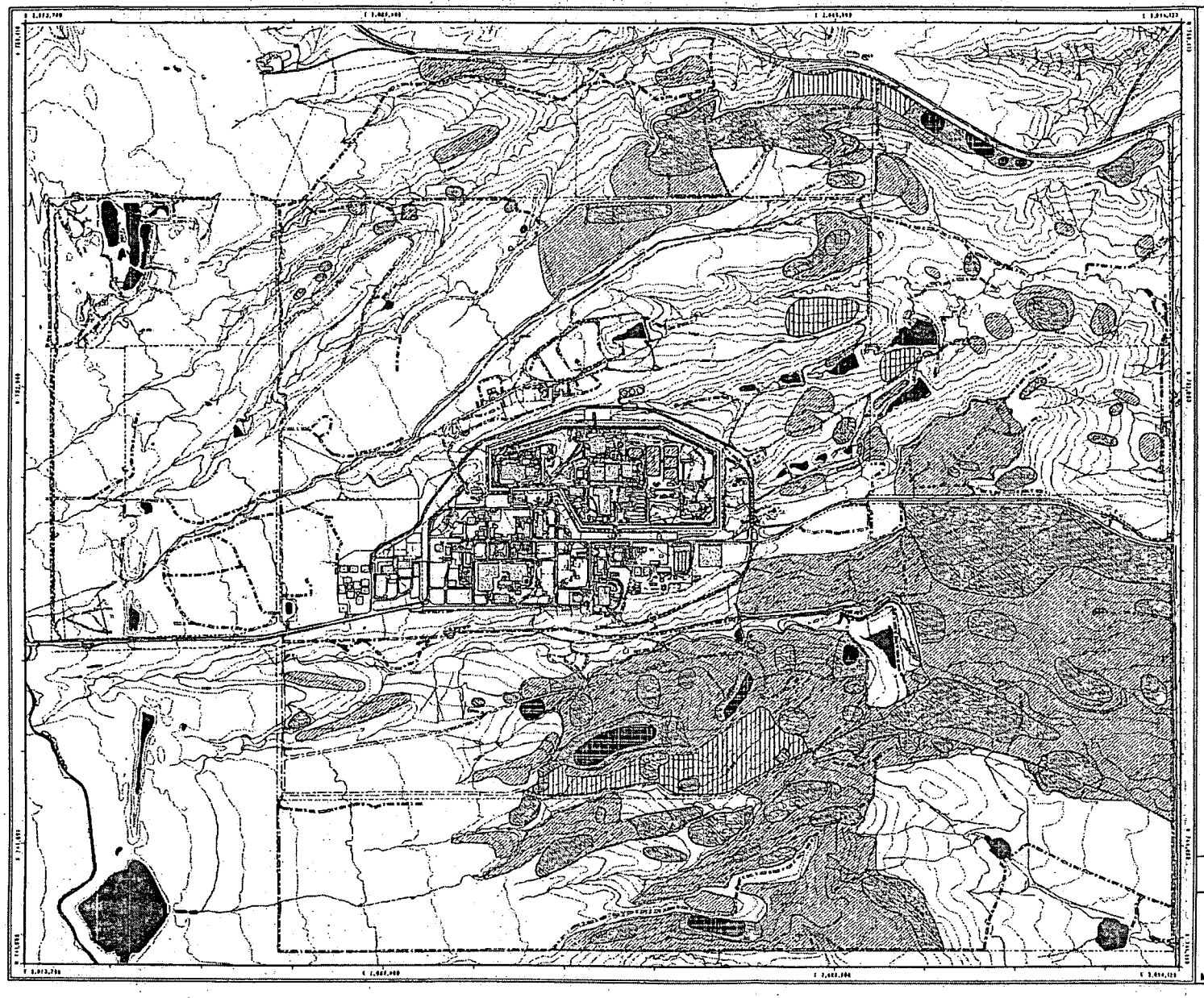
U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared for:

Exponent™

MAP ID: /home/h519665/

April 28, 1998



1998 Musk Thistle (Carduus nutans) Distribution
Figure 28

MAP LEGEND

Standard Map Features

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas
- Buildings and other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

Scale = 1 : 21330
1 inch represents approximately 1778 feet

500 0 1000 2000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

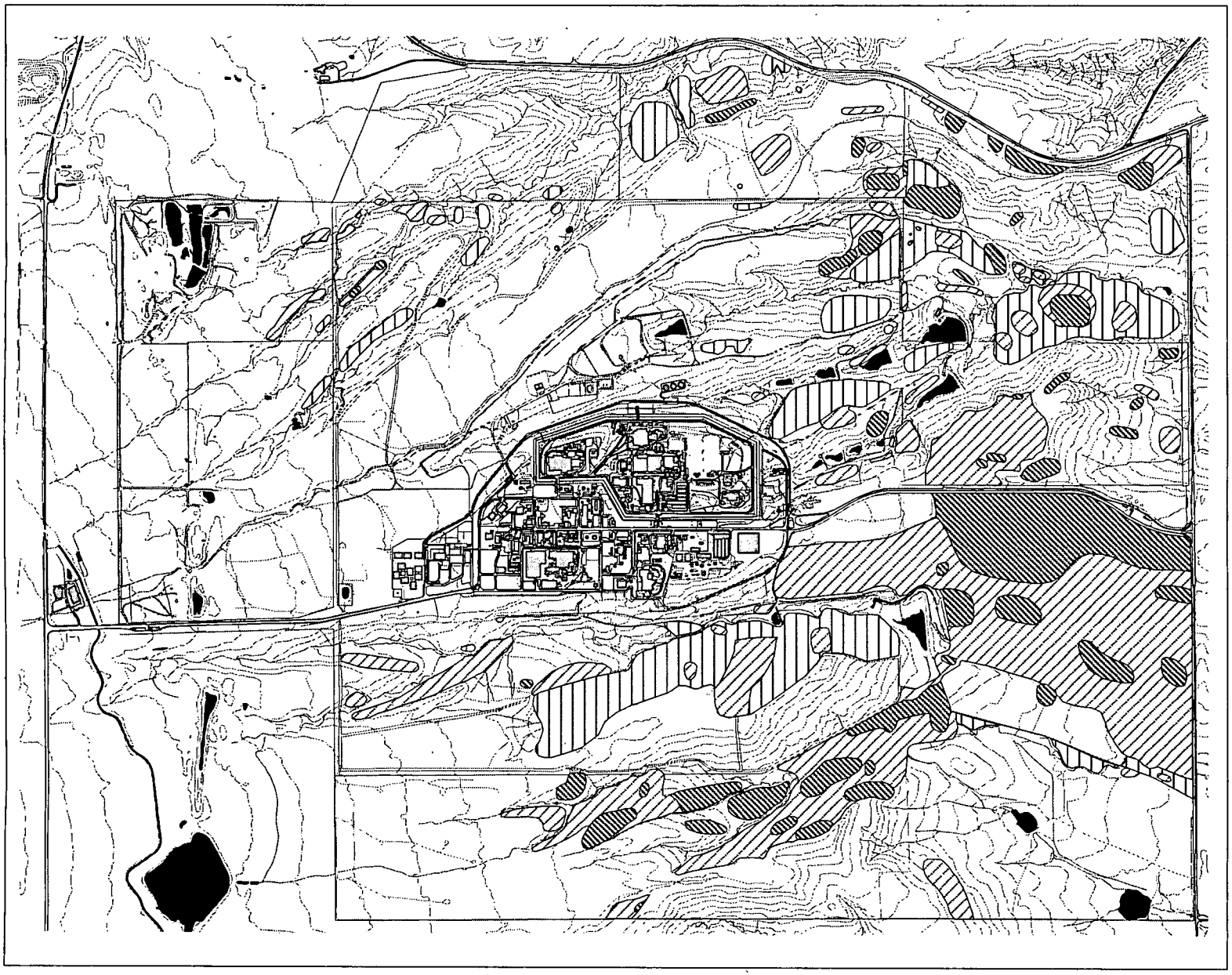
U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

Exponent™

MAP ID: /home/r519055/weedands/

March 23, 1999



1999 Musk Thistle (Carduus nutans) Distribution

Figure 22

MAP LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
1999 weed distributions provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

Note:

These locations approximate the boundaries of infestation areas. The boundaries are not exact and should not be treated as such. These areas may not represent all populations on Site.

N

1:23552

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

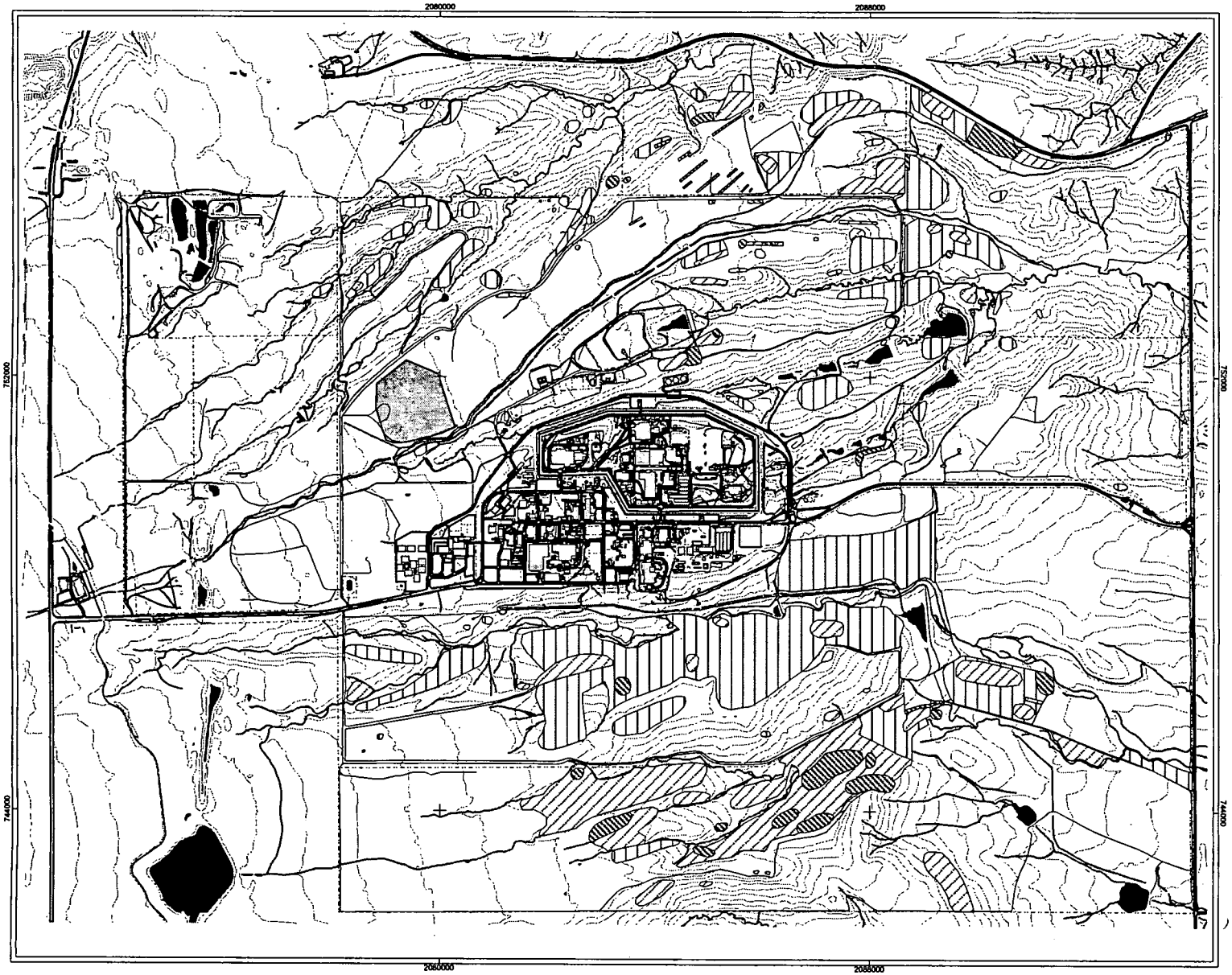
U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: K2-0019

March 14, 2000



2000 Musk Thistle (Carduus nutans) Distribution

Figure 14

MAP LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

Standard Features

- Buildings
- Lakes & ponds
- New Landfill
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

Data Source Ecology Features:
Weed distribution data provided by Exponent.
K-H Ecology Group POC; Karan North 303-966-9876.

N

1:23552

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent®

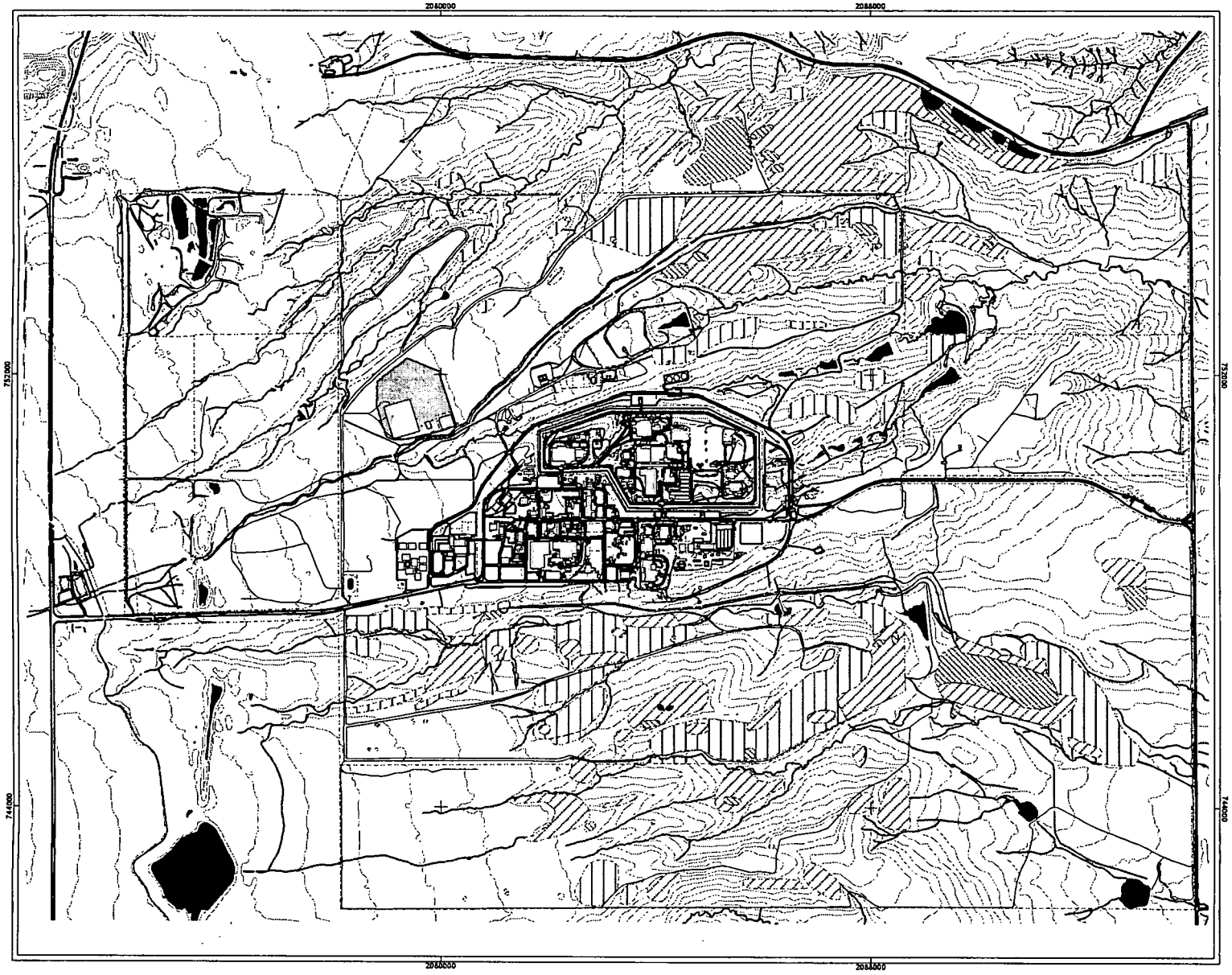
For: Kaiser-Hill Company, LLC

RFETS GIS Dept. 303-966-7707

MAP ID: 01-0063

May 3, 2001

\\Gisarv\GIS\ECO-projects\projects\01-0063\canu00.apr\2000 CANU1 Distribution



2001 Musk Thistle (Carduus nutans) Distribution

Figure 1-12

LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

Standard Features

- Buildings
- Lakes & ponds
- New Landfill
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

Data Source Ecology Features:
Location data provided by Exponent.
K-H Ecology Group POC; Karan North 303-966-9876.

N

1:23552

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

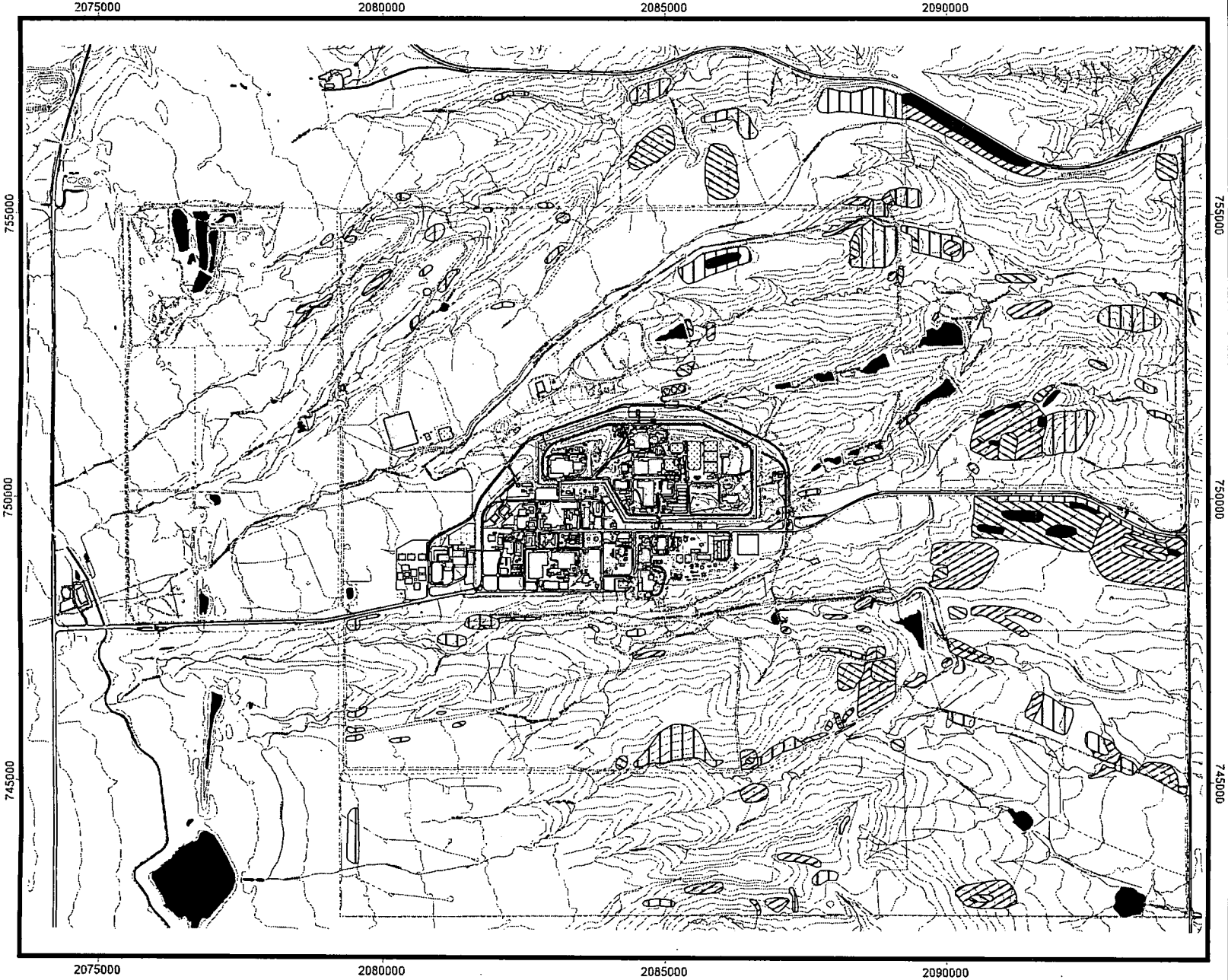
Prepared by: Exponent®

For: Kaiser-Hill Company, LLC

RFETS GIS Dept. 303-966-7707

MAP ID: 02-0006

February 14, 2002



2002 Musk Thistle (Carduus nutans) Distribution

Figure 4-4

LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

Standard Features

- Buildings
- Demolished Buildings
- Lakes & ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft. intervals)

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G REL, Las Vegas.
Digitized from the orthophotographs, 1/95.

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N

1:22209

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: LABAT

For: Kaiser-Hill Company, LLC

RFETS GIS Dept. 303-966-7707

MAP ID: 02-0017

May 5, 2003

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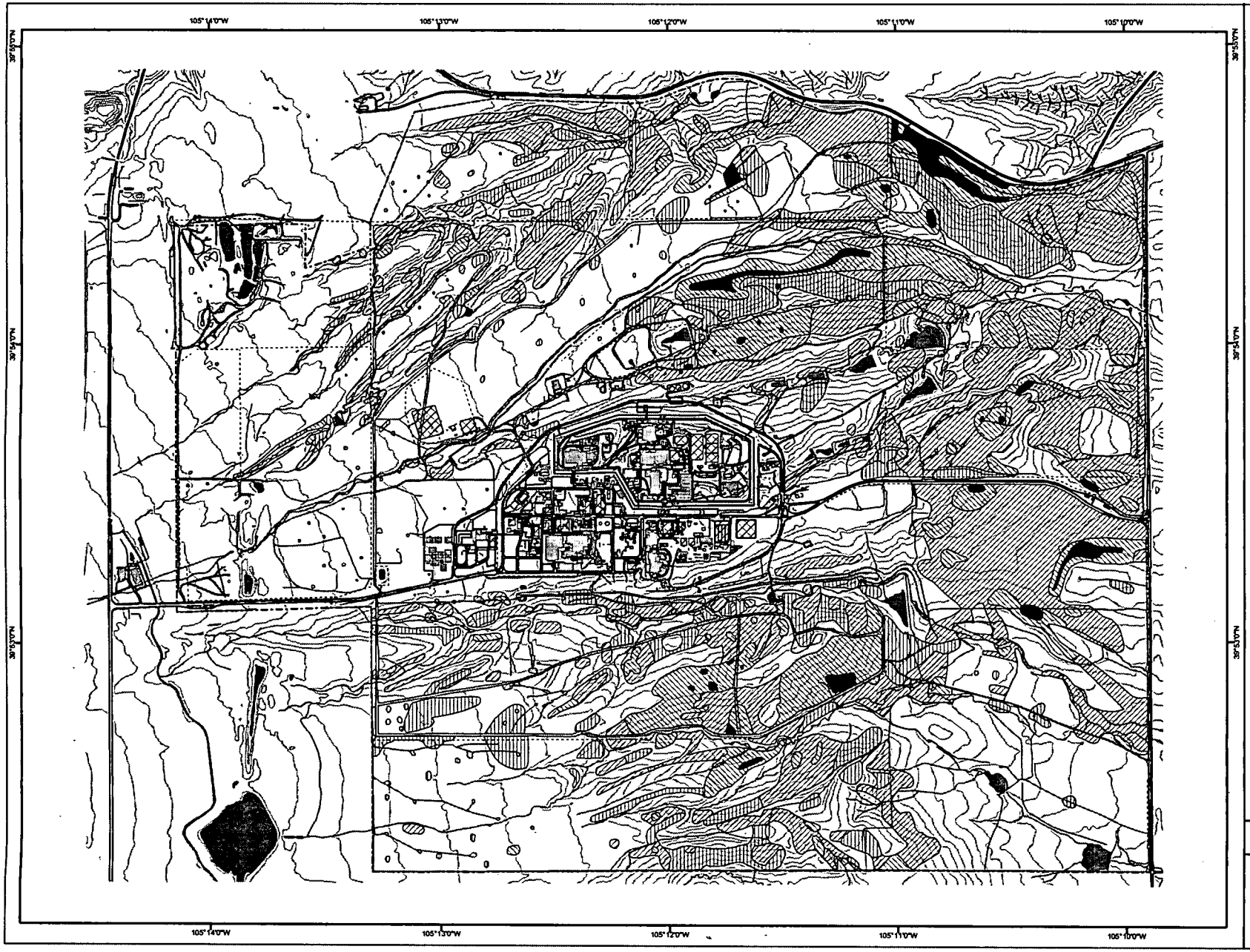

2003 Musk Thistle *(Cardus nutans)* Distribution

Figure 4-4

Legend

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

Standard Features

- Demolished Buildings
- Buildings
- Lakes
- Streams
- Boundary Fence
- Fences
- Trails
- Dirt Roads
- Paved Roads
- Contours (20 ft)

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs, 1/95.

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1,000 0 1,000 2,000
Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

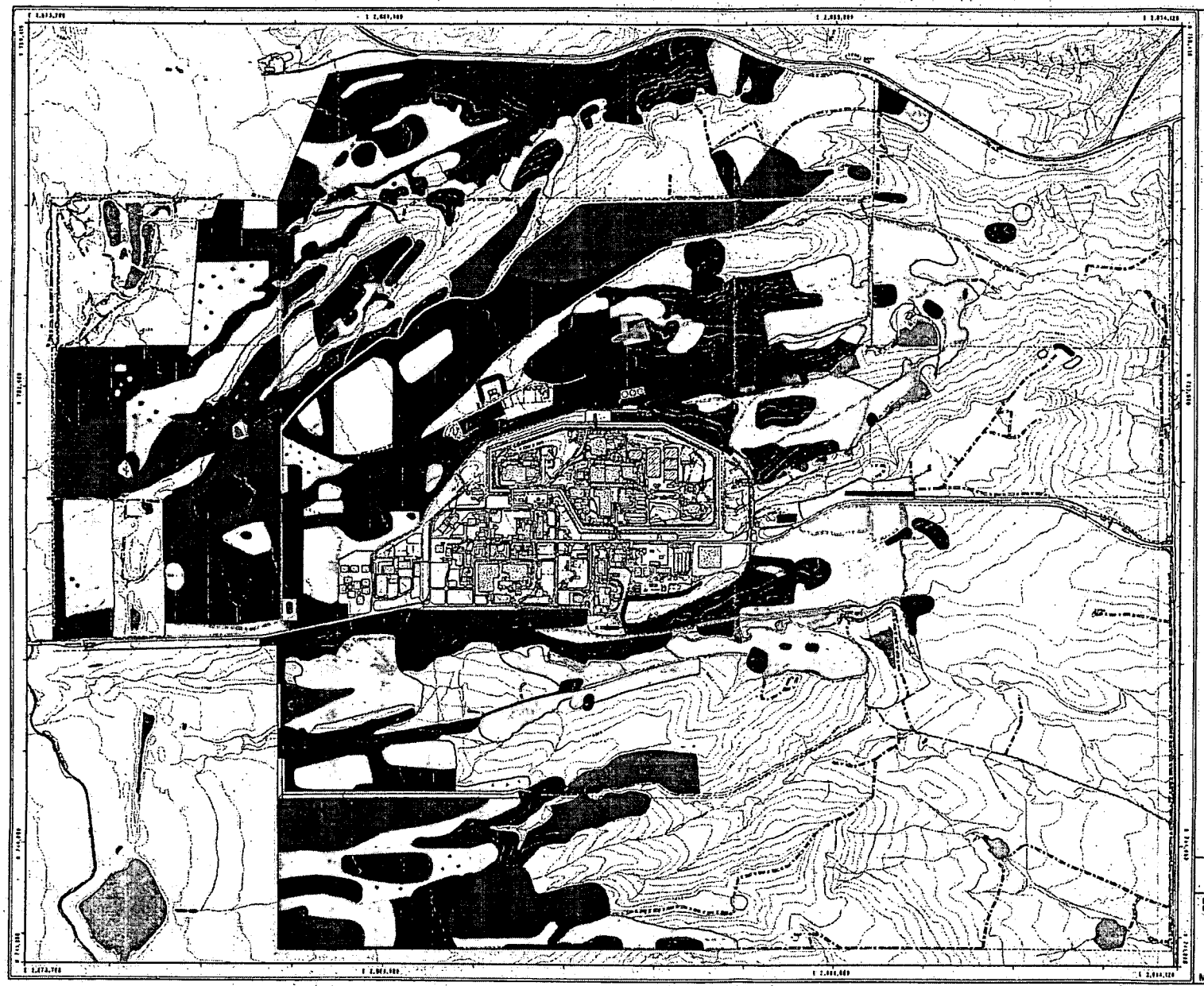
Prepared by: Professional Environmental Group, LLC

For: Kaiser-Hill Company, LLC

RFETS GIS Dept.
303-966-7707

MAP ID:04-0018

February 28, 2004



1997 Diffuse Knapweed (Centaurea diffusa) Distribution Figure 5-2

MAP LEGEND

Standard Map Features

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas
- Buildings and other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCES:
[illegible]

Scale = 1 : 21330
1 inch represents approximately 1778 feet

500 0 1000 2000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared for:

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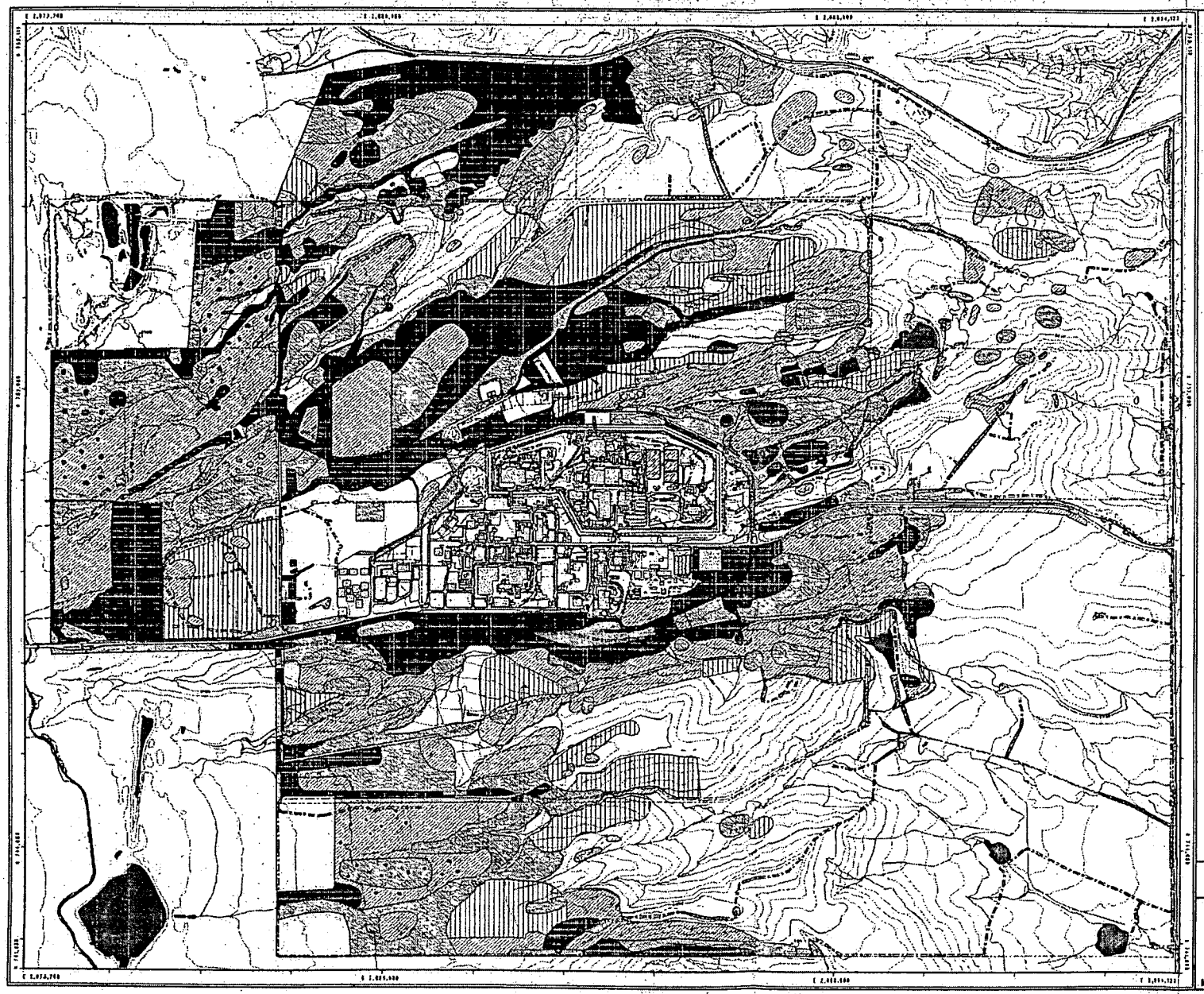
MAP ID: /home/h/51065G/

April 28, 1998



1998 Diffuse Knapweed (Centaurea diffusa) Distribution
Figure 27

MAP LEGEND

Standard Map Features

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas
- Buildings and other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCE:

Scale = 1 : 21330
1 inch represents approximately 1778 feet

500 0 1000 2000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

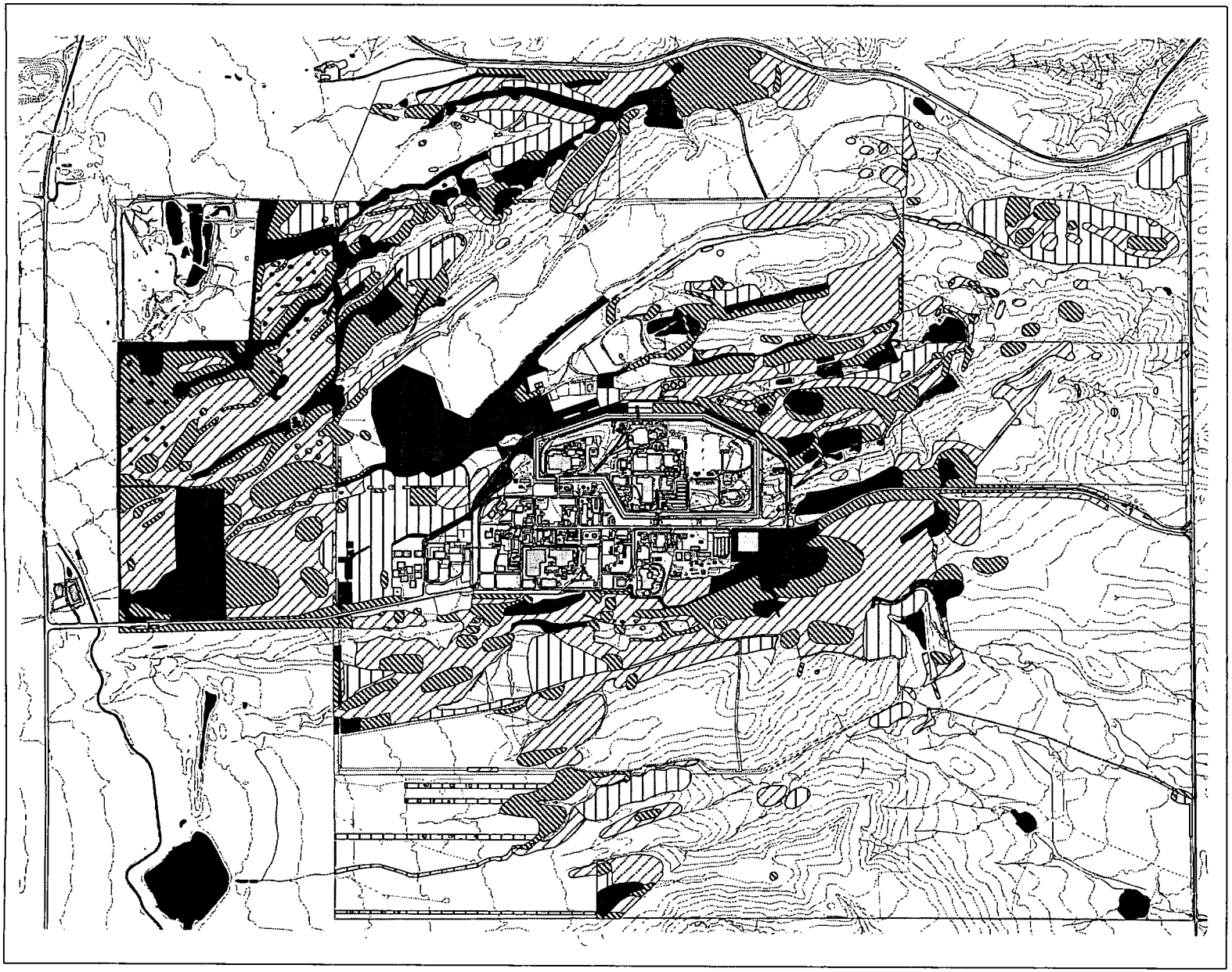
U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

Exponent™

MAP ID: /home/r6196557

March 23, 1999



1999 Diffuse Knapweed (Centaurea diffusa) Distribution

Figure 21

MAP LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
1999 weed distributions provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

Note:

These locations approximate the boundaries of infestation areas. The boundaries are not exact and should not be treated as such. These areas may not represent all populations on Site.

N

1:23552

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

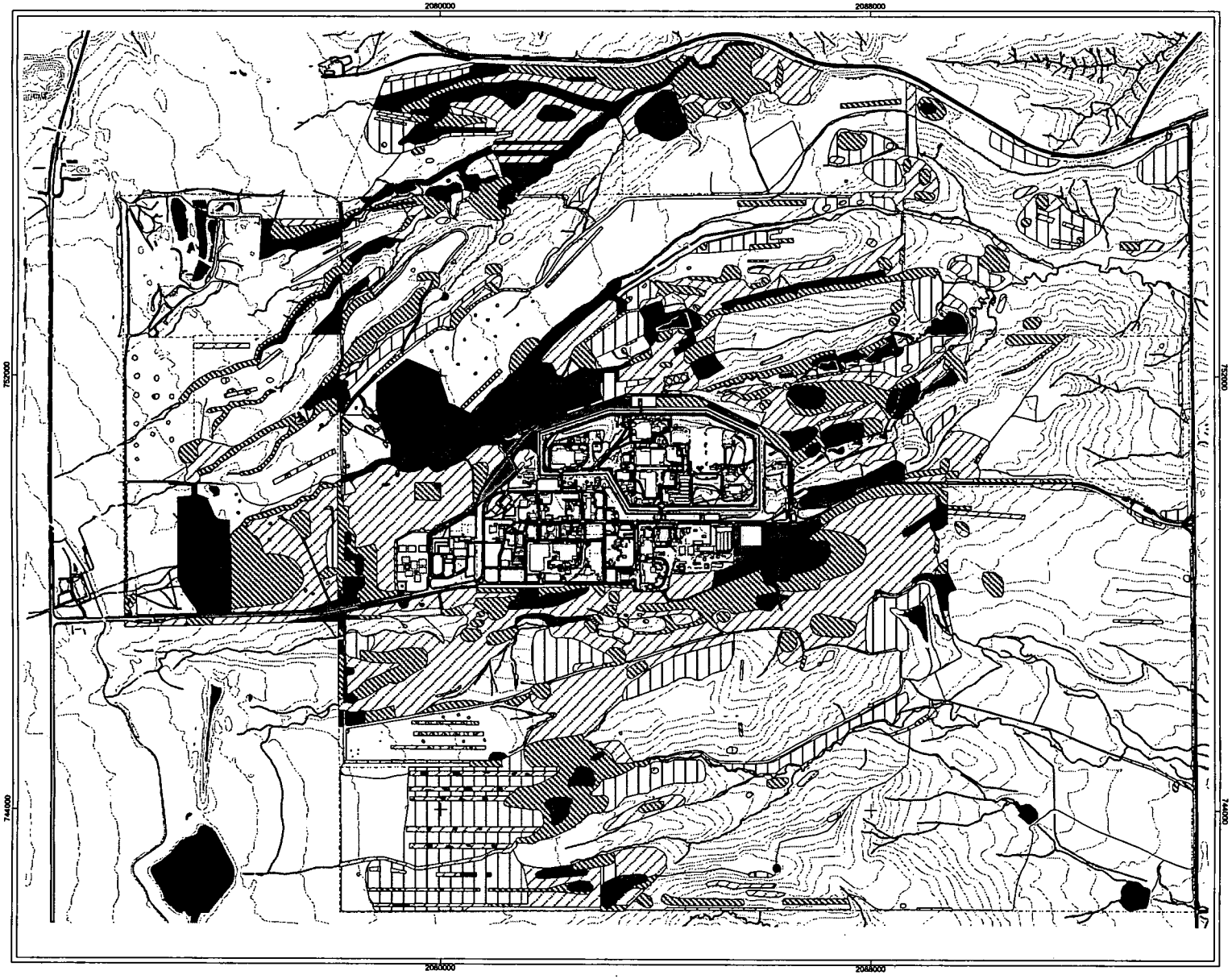
U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: K2-0017

March 14, 2000



2000 Diffuse Knapweed (Centaurea diffusa) Distribution

Figure 13

MAP LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

Standard Features

- Buildings
- Lakes & ponds
- New Landfill
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. The DEM post-processing performed by MK, Winter 1997.

Data Source Ecology Features:
Weed distribution data provided by Exponent.
K-H Ecology Group POC: Karen North 303-966-9876.

N

1:23552

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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MAP ID: 2K-0419

May 3, 2001

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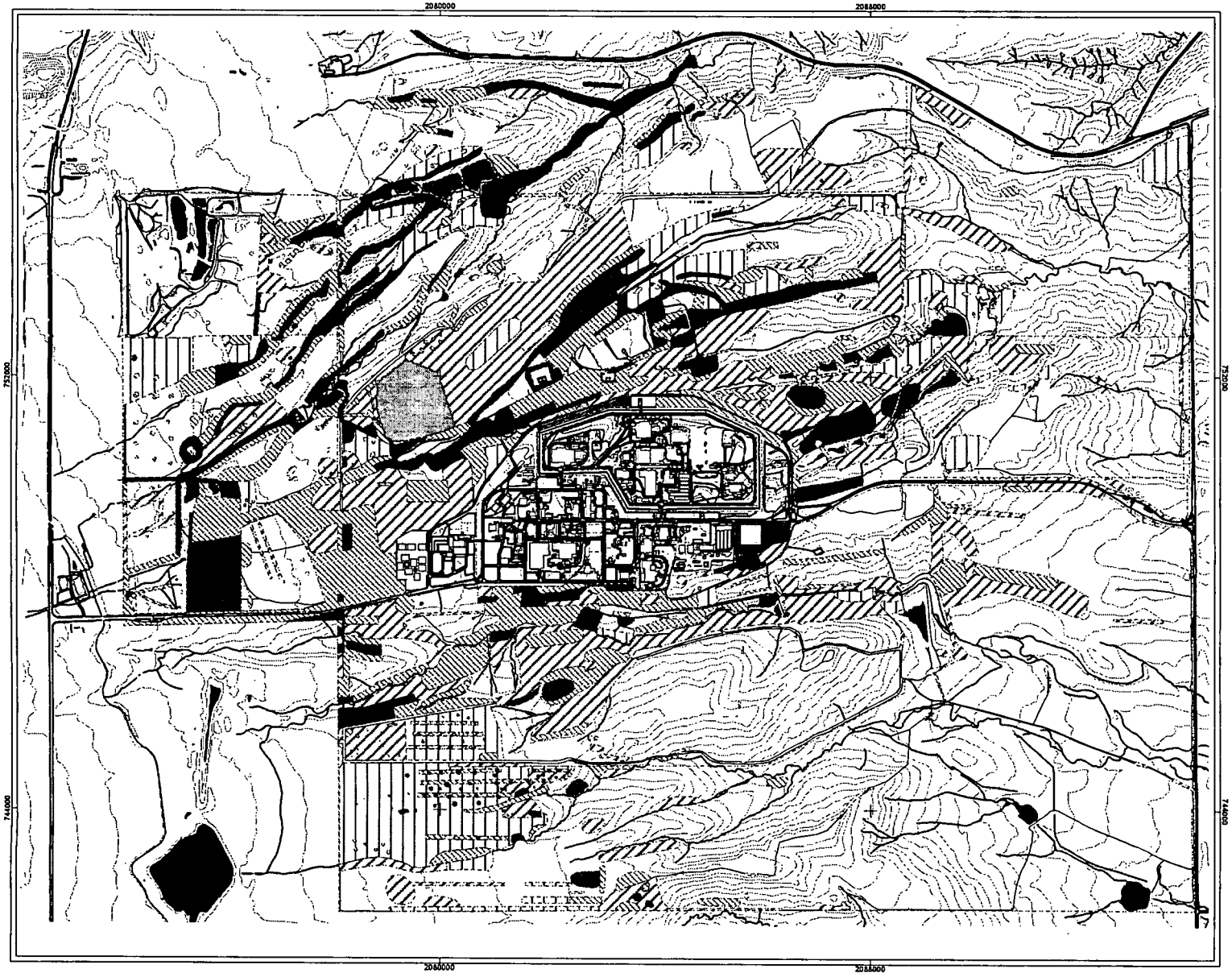

2001 Diffuse Knapweed (Centaurea diffusa) Distribution

Figure 1-11

LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

Standard Features

- Buildings
- Lakes & ponds
- New Landfill
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

Data Source Ecology Features:
Location data provided by Exponent.
K-H Ecology Group POC; Karan North 303-966-9876.

N

1:23552

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
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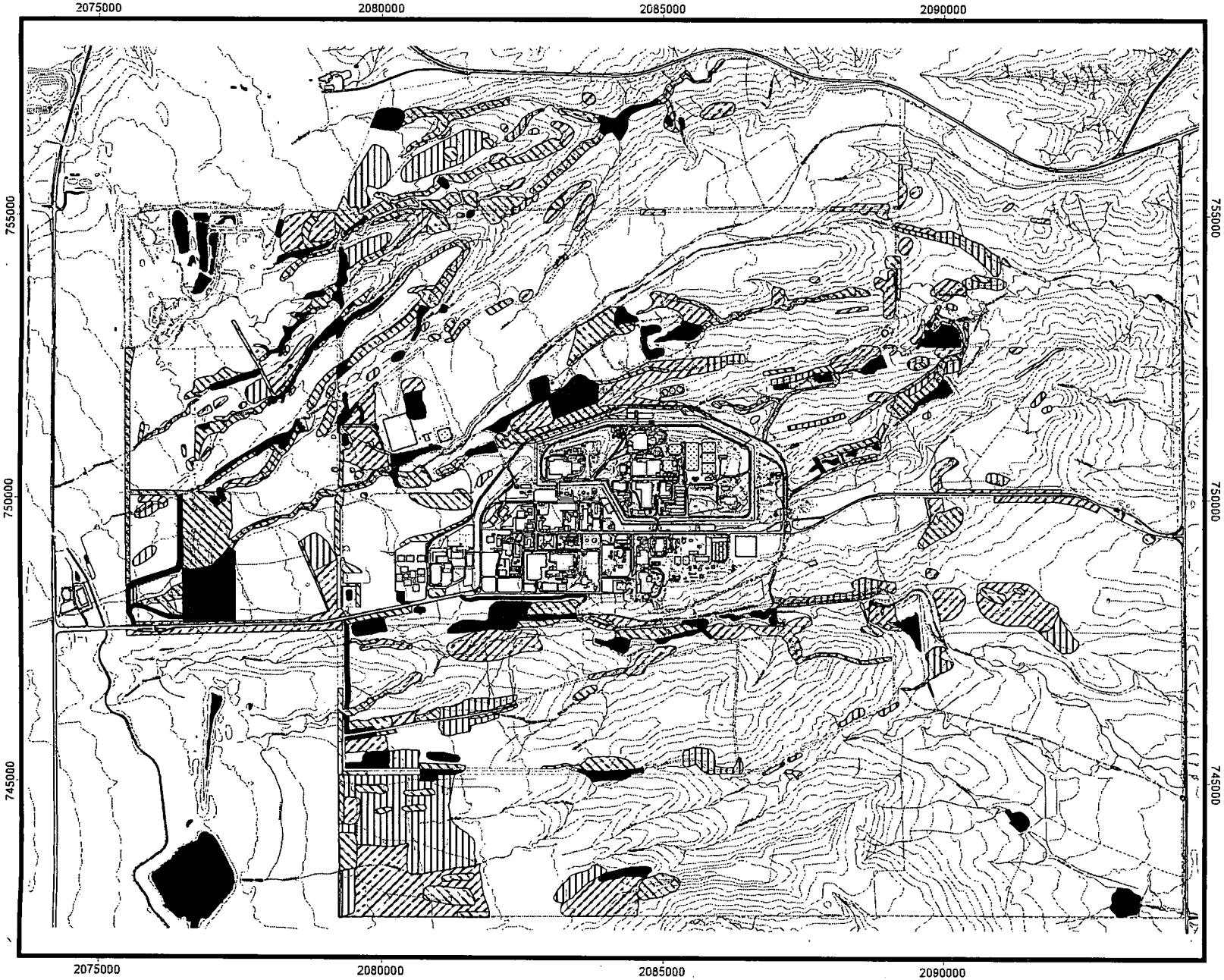
RFETS GIS Dept. 303-966-7707

MAP ID: 02-0147

November 28, 2001



2002 Diffuse Knapweed (Centaurea diffusa) Distribution

Figure 4-2

LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

Standard Features

- Buildings
- Demolished Buildings
- Lakes & ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft. intervals)

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95.

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N

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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For: Kaiser-Hill Company, LLC

RFETS GIS Dept. 303-966-7707

MAP ID: 02-0016

May 5, 2003

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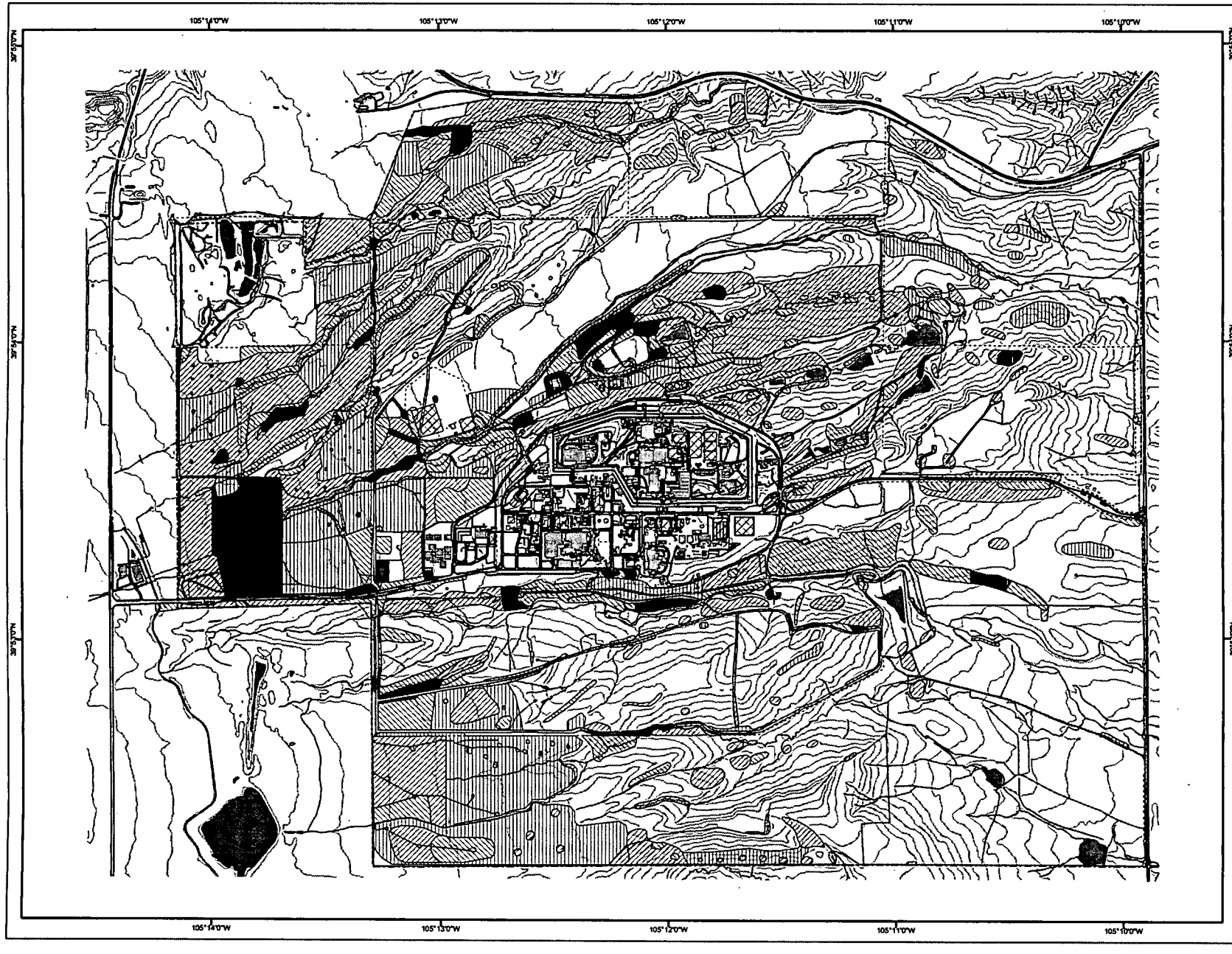

2003 Diffuse Knapweed *(Centaurea diffusa)* Distribution

Figure 4-2

Legend

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

Standard Features

- Demolished Buildings
- Buildings
- Lakes
- Streams
- Boundary Fence
- Fences
- Trails
- Dirt Roads
- Paved Roads
- Contours (20 ft)

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95.

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1,000 0 1,000 2,000
Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

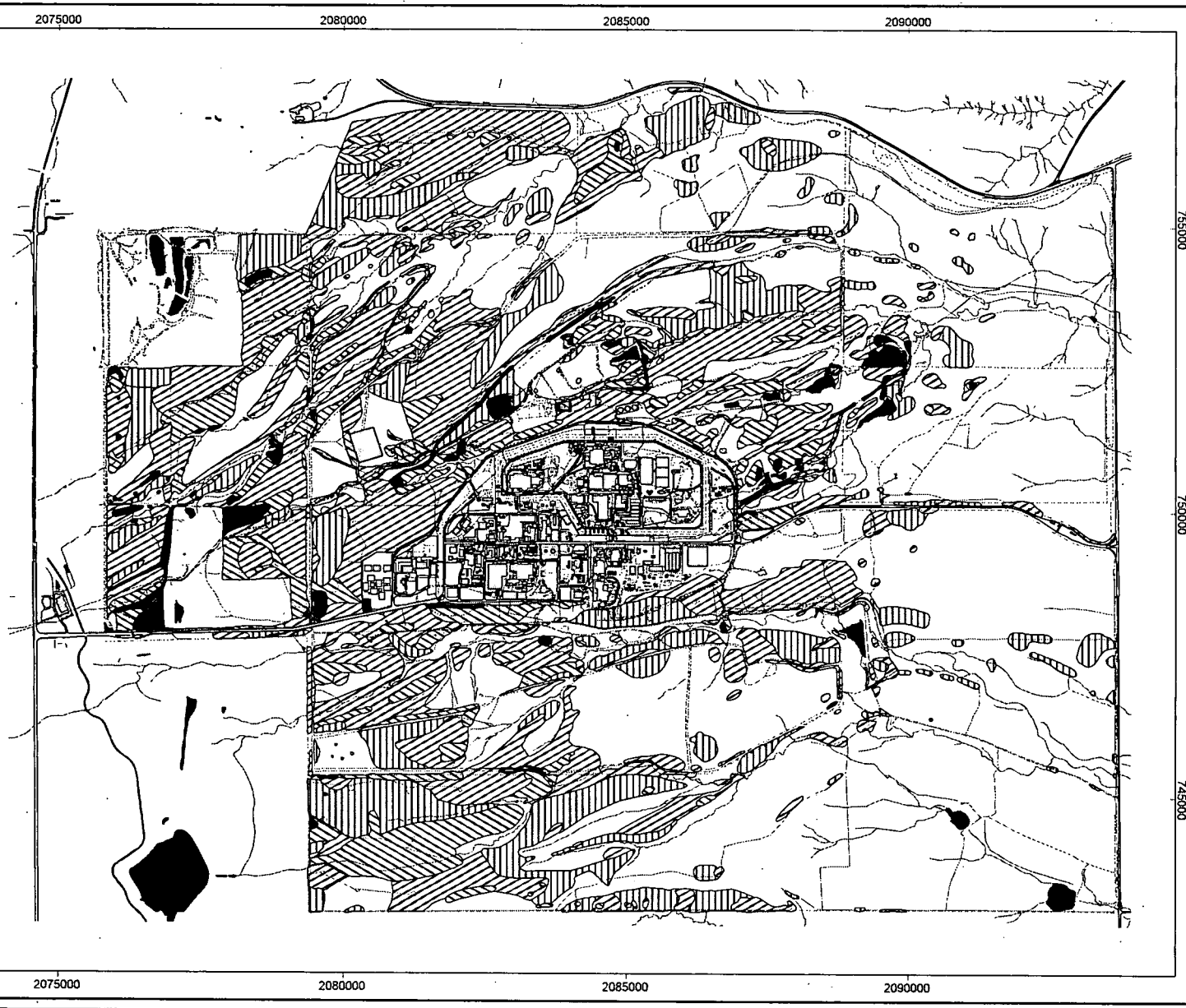
Prepared by: Professional Environmental Group, LLC

For: Kaiser-Hill Company, LLC

RFETS GIS Dept.
303-966-7707

MAP ID:04-0018

February 26, 2004



2004 Diffuse Knapweed
(Centaurea diffusa) Distribution
at the Rocky Flats Environmental
Technology Site

Figure 4-3

High Density Areas

Medium Density Areas

Low Density Areas

Scattered Density Areas

Standard Features

Buildings

Demolished Buildings

Lakes & ponds

Streams & ditches

Fences

Paved roads

Dirt roads

Contours (20 ft. intervals)

DATA SOURCE BASE FEATURES:
Wetlands data surveyed, compiled, and presented by the U.S. Army Corps of Engineers, 1994.
Buildings, fences, hydrography, roads and other structures from 1994 aerial flyover data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1995.

N

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Professional Environmental Group, L.L.C.

For: Kaiser-Hill Company, LLC

RFETS GIS Dept.
303-966-7707

MAP ID: 05-0025

May 11, 2005

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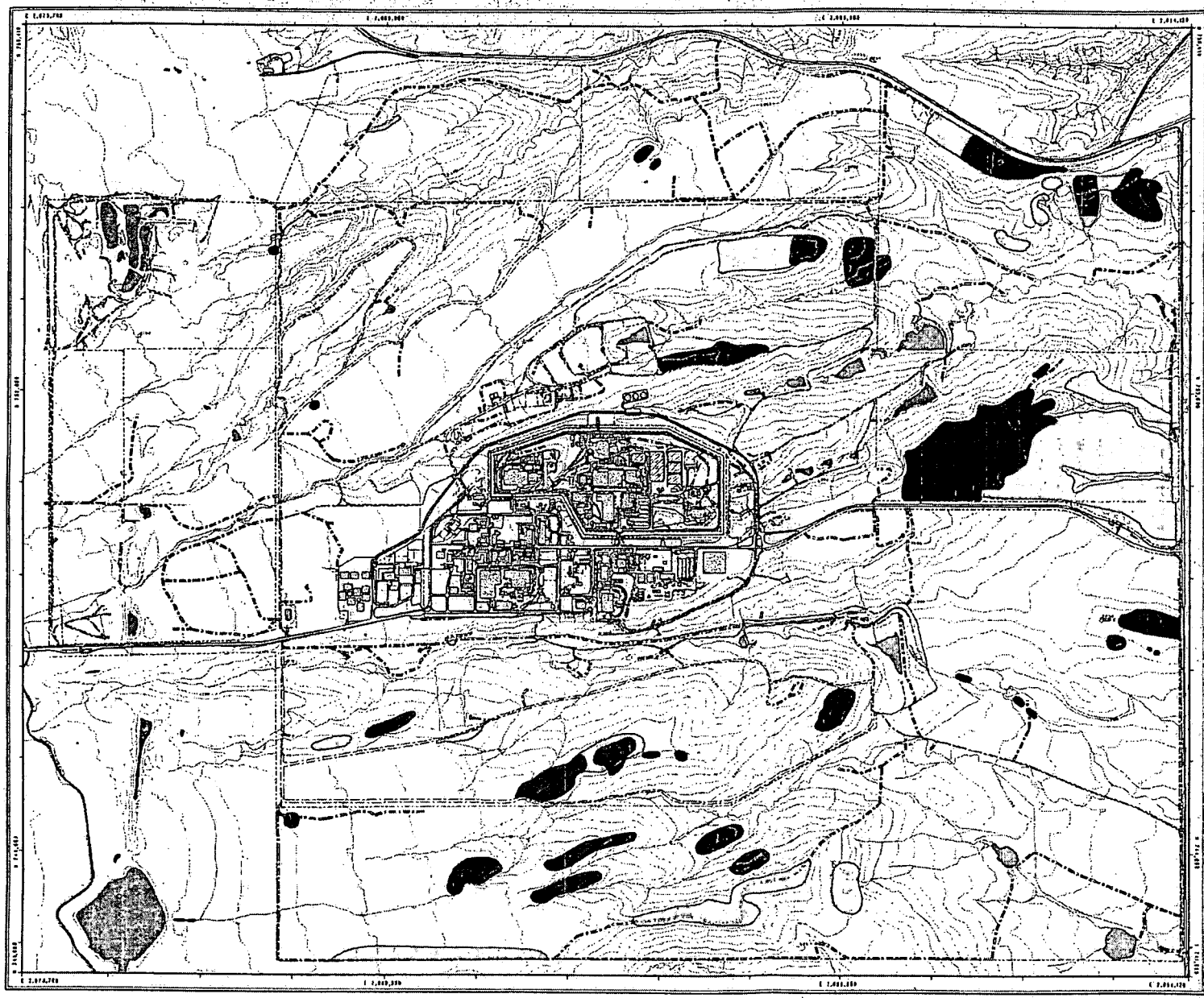


1997 Dalmatian Toadflax (Linaria dalmatica) Distribution
Figure 5-4

MAP LEGEND

Standard Map Features

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Buildings and other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCES:
1997 Dalmatian Toadflax (Linaria dalmatica) density and distributions provided by Exponent Environmental Group.
NOTE: These data approximate the boundaries of infestation areas. The boundaries are not exact and should not be treated as such. These areas may not represent all populations on site.

Scale = 1 : 21330
1 inch represents approximately 1778 feet

500 0 1000 2000m

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

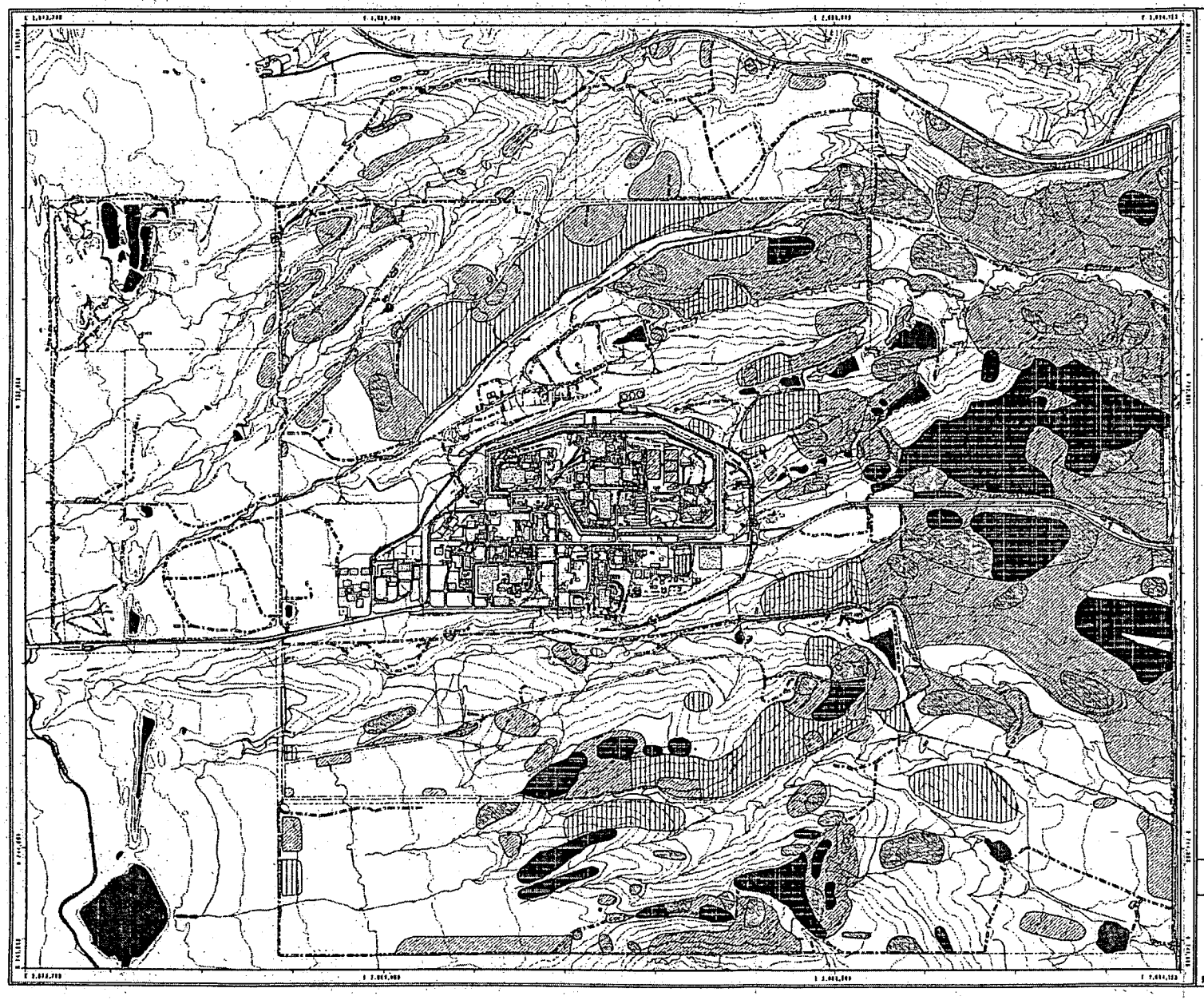
U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

Exponent

MAP ID: /home/r5196557

May 12, 1998



1998 Dalmatian Toadflax (Linaria dalmatica) Distribution
Figure 29

MAP LEGEND

Standard Map Features

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas
- Buildings and other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

Scale = 1 : 21330
1 inch represents approximately 1778 feet

500 0 1000 2000ft

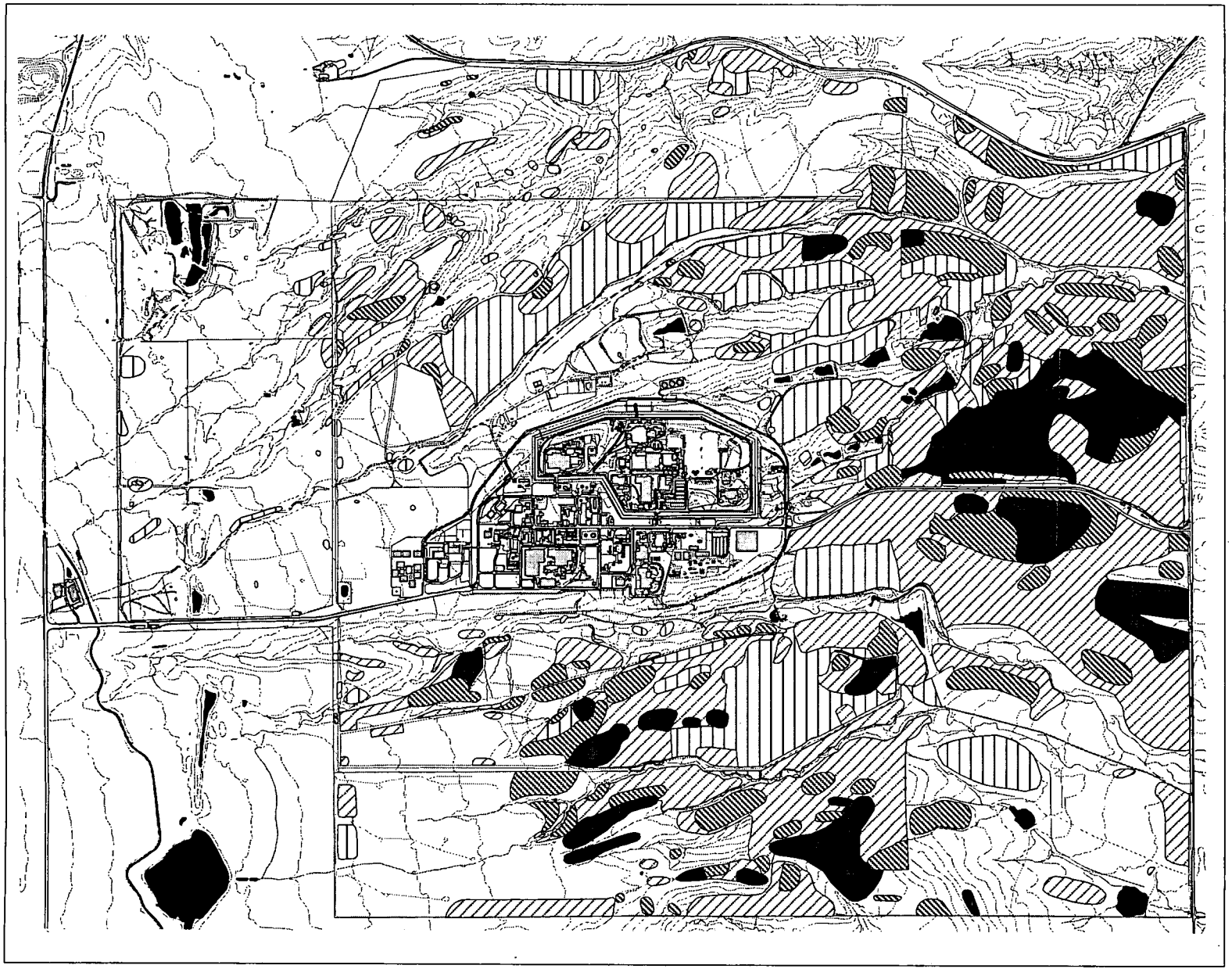
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

Exponent

MAP ID: /home/r619655/ March 23, 1999



1999 Dalmatian Toadflax (Linaria dalmatica) Distribution

Figure 23

MAP LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
1999 weed distributions provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. The DEM post-processing performed by MK, Winter 1997.

Note:

These locations approximate the boundaries of infestation areas. The boundaries are not exact and should not be treated as such. These areas may not represent all populations on Site.

N

1:23552

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

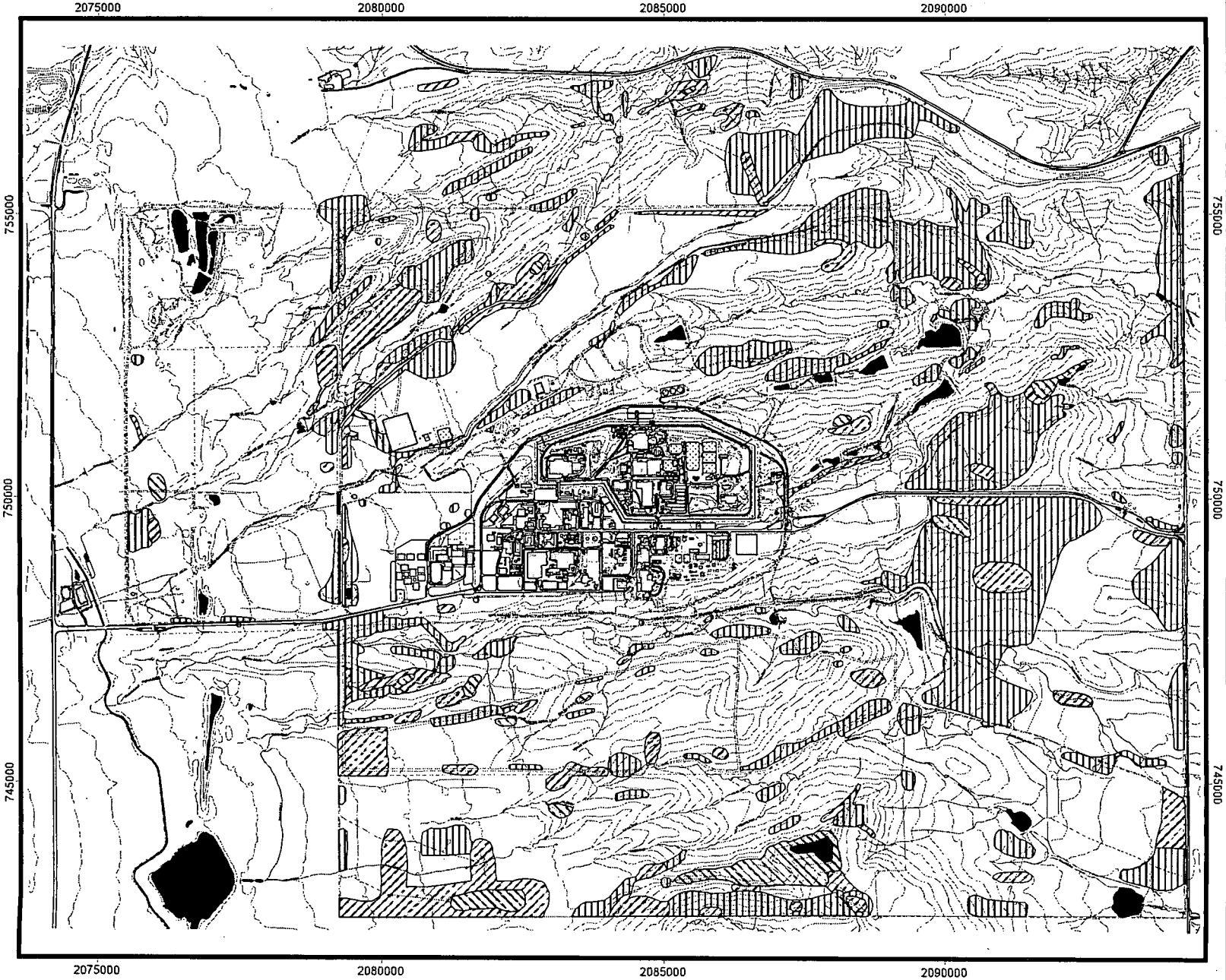
U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: K2-0018

March 14, 2000



2002 Dalmatian Toadflax (Linaria dalmatica) Distribution

Figure 4-3

LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

Standard Features

- Buildings
- Demolished Buildings
- Lakes & ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft. intervals)

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95.

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N

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: LABAT

For: Kaiser-Hill Company, LLC

RFETS GIS Dept. 303-966-7707

MAP ID: 02-0018

May 5, 2003

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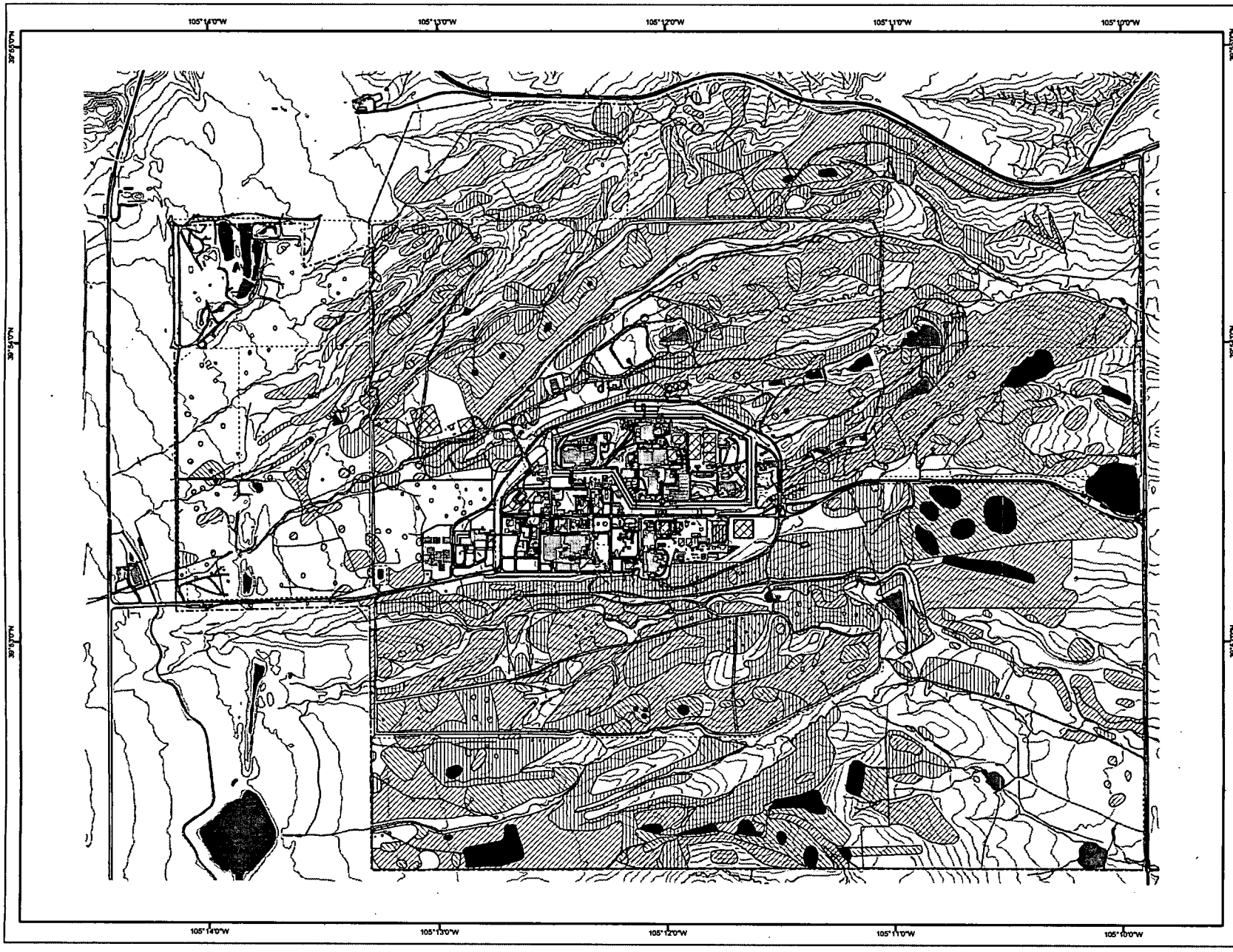

2003 Dalmatian Toadflax *(Linaria dalmatica)* Distribution

Figure 4-3

Legend

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

Standard Features

- Demolished Buildings
- Buildings
- Lakes
- Streams
- Boundary Fence
- Fences
- Trails
- Dirt Roads
- Paved Roads
- Contours (20 ft)

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs, 1/95.

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N

1,000 0 1,000 2,000
Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

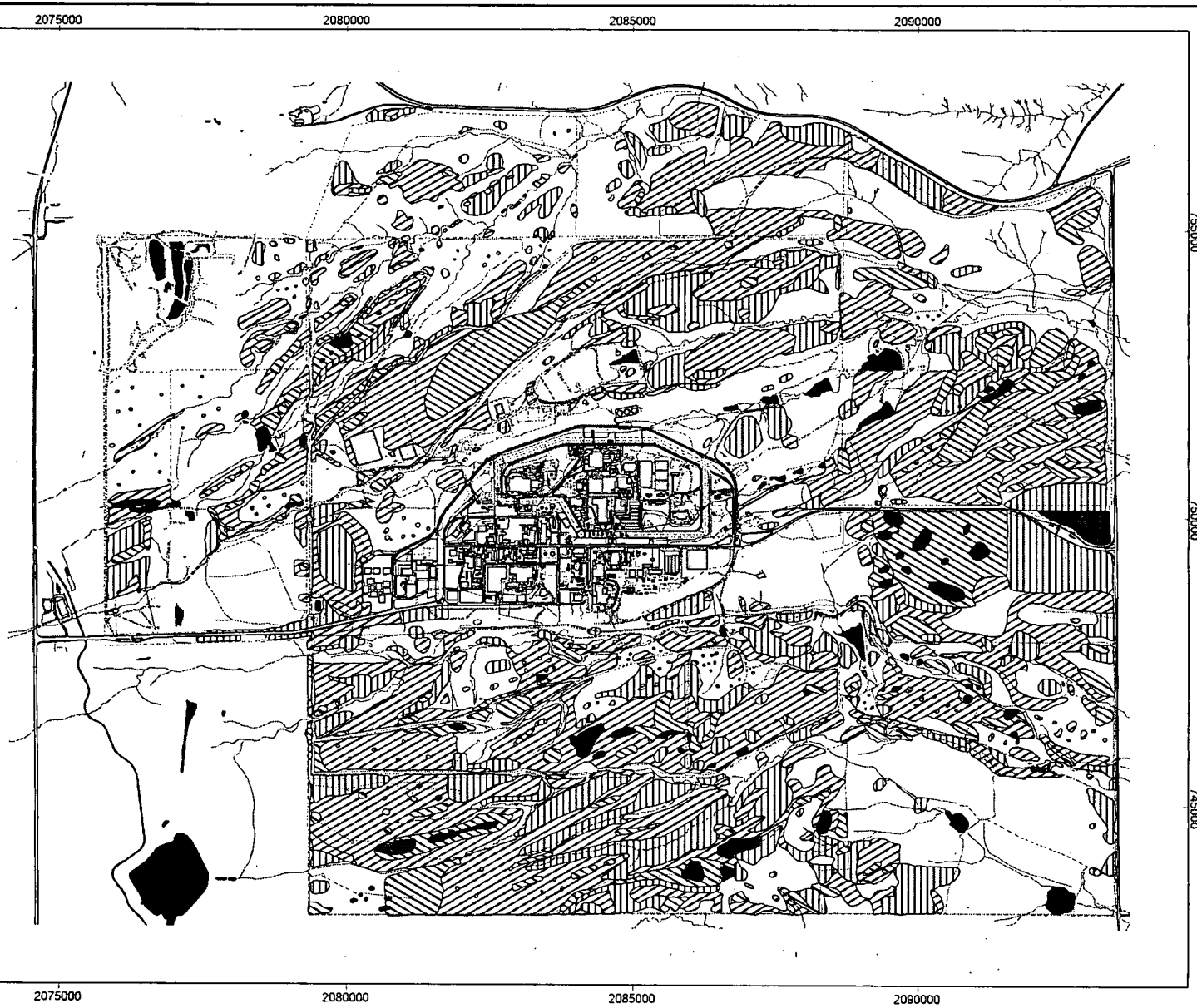
Prepared by: Professional Environmental Group, LLC

For: Kaiser-Hill Company, LLC

RFETS GIS Dept.
303-966-7707

MAP ID:04-0020

February 26, 2004



2004 Dalmatian Toadflax
(Linaria dalmatica) Distribution
at the Rocky Flats Environmental
Technology Site

Figure 4-4

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

Standard Features

- Buildings
- Demolished Buildings
- Lakes & ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft. intervals)

DATA SOURCE BASE FEATURES:
Wetlands data surveyed, compiled, and assembled by the U.S. Army Corps of Engineers, 1994.
Buildings, fences, hydrography, roads and other structures from 1994 aerial flyover data captured by EG&G RSL, Las Vegas
Digitized from the orthophotographs, 1993.

N

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
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May 11, 2005

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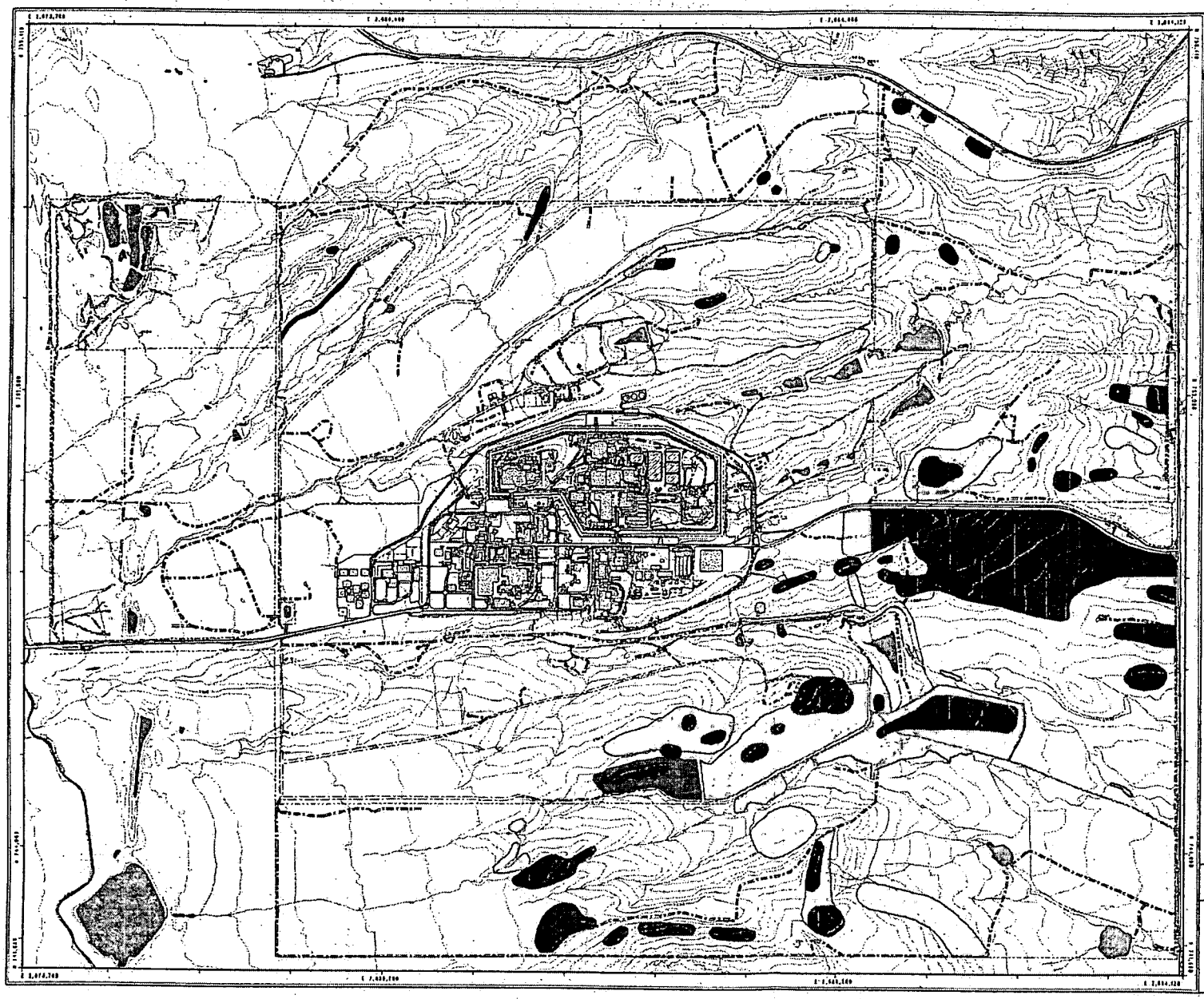


1997 Mullein (Verbascum thapsus) Distribution Figure 5-5

MAP LEGEND

Standard Map Features

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas
- Buildings and other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCES:

[illegible]

N

Scale = 1 : 21330
1 inch represents approximately 1778 feet

500 0 1000 2000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

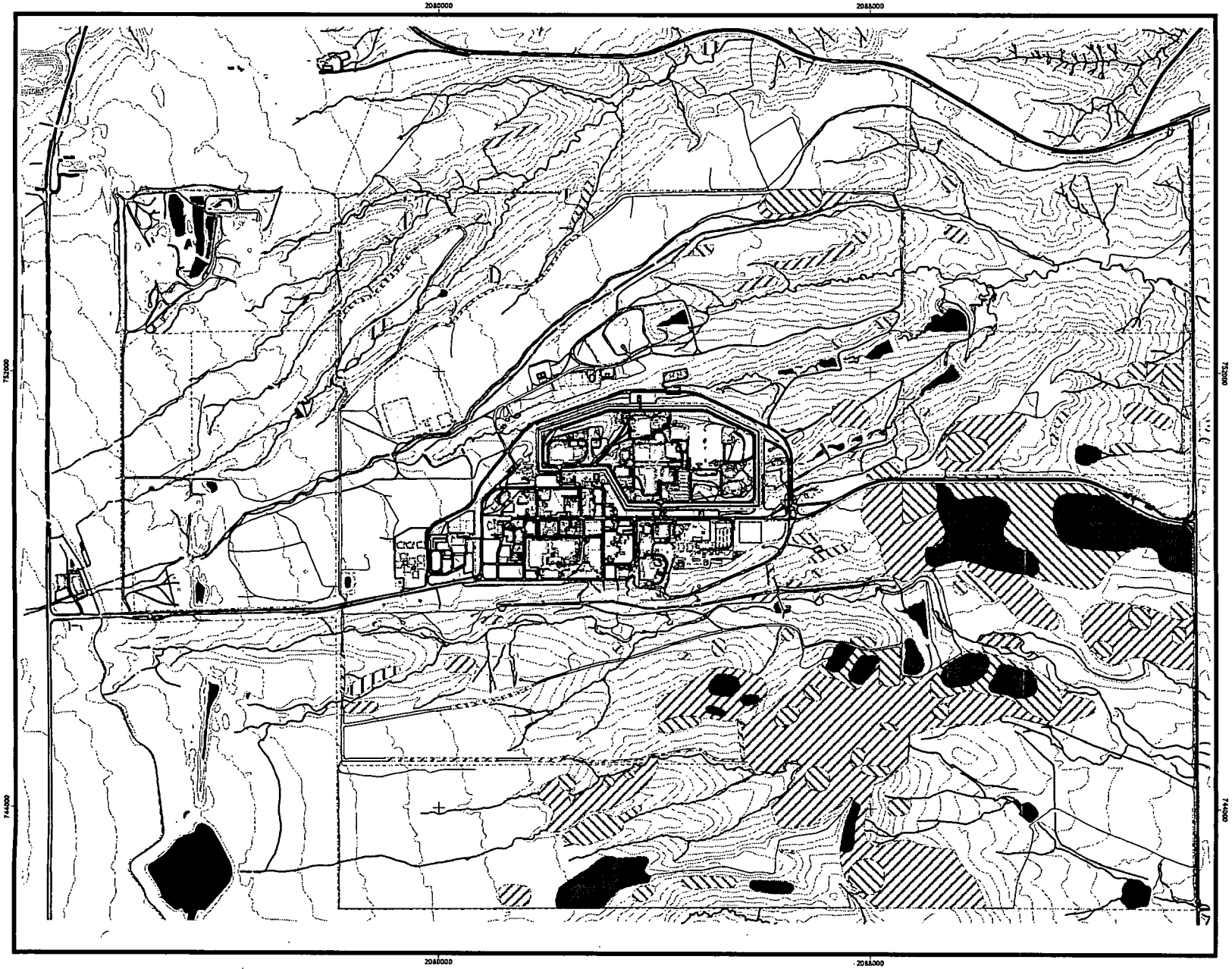
U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

Exponent™

MAP ID: /home/r519055/

April 28, 1998



1998 Common Mullein (Verbascum thapsus) Distribution

Figure 1-16

Legend

- High Density Areas
- Medium Density Areas
- Low High Density Areas
- Scattered Density Areas

Standard Legend

- Buildings
- Lakes and Ponds
- Landfill
- Streams and Ditches
- Fences
- Paved Roads
- Dirt Roads
- Contours (20 ft.)

Data Source Base Features:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95. Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~18 meter resolution. The DEM post-processing performed by MK. Winter 1997.

Data Source Ecology Features:
Location data provided by Exponent
K-H Ecology Group POC: Karen North 303-966-6576

N

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent®

For: Kaiser-Hill Company, L.L.C.

Map ID: 02-0072

March 21, 2002

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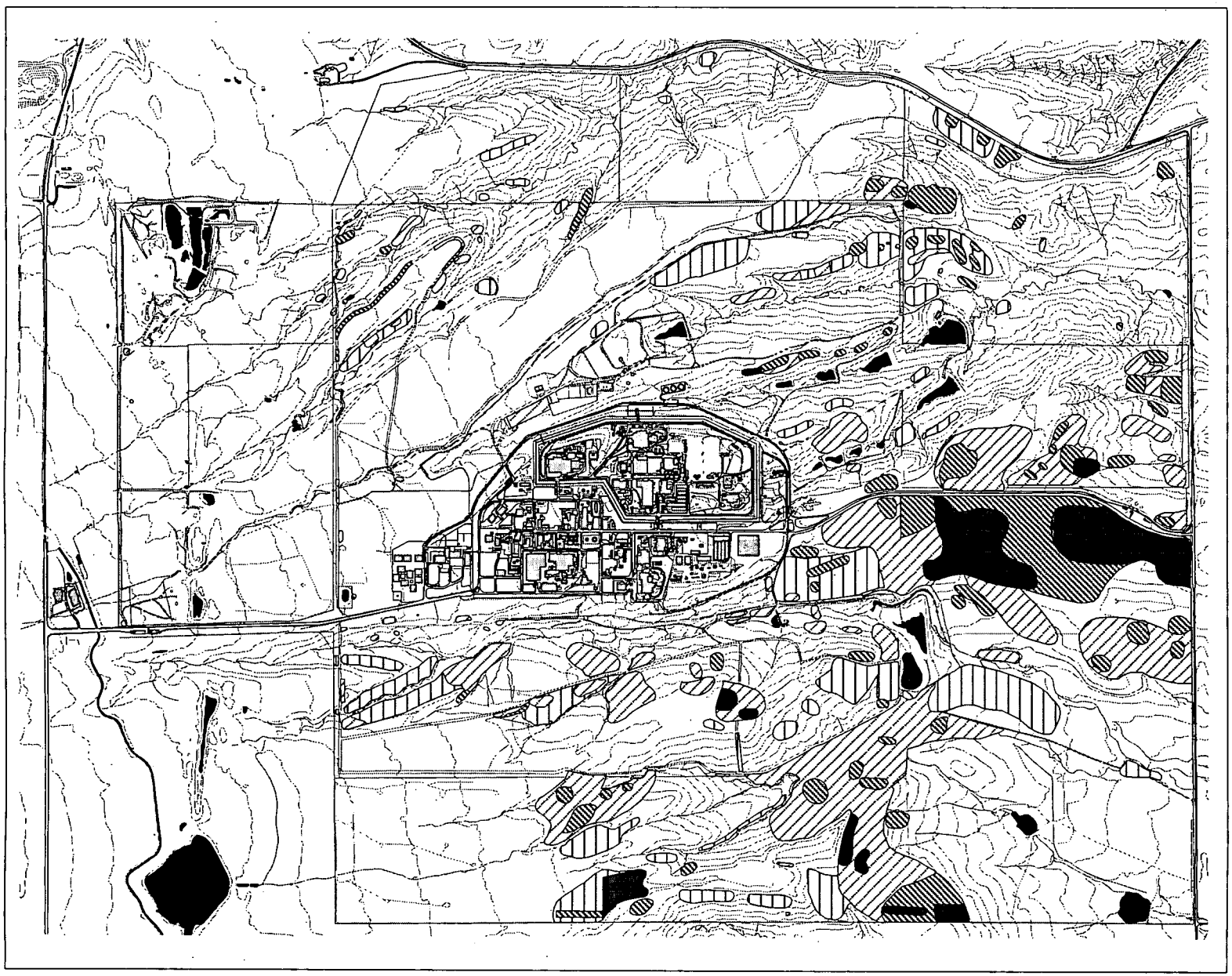


1999 Mullein (Verbascum thapsus) Distribution

Figure 24

MAP LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

Standard Map Features

- Buildings
- Lakes & Ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE:
1999 weed distributions provided by Exponent.
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

Note:

These locations approximate the boundaries of infestation areas. The boundaries are not exact and should not be treated as such. These areas may not represent all populations on Site.

N

1:23552

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

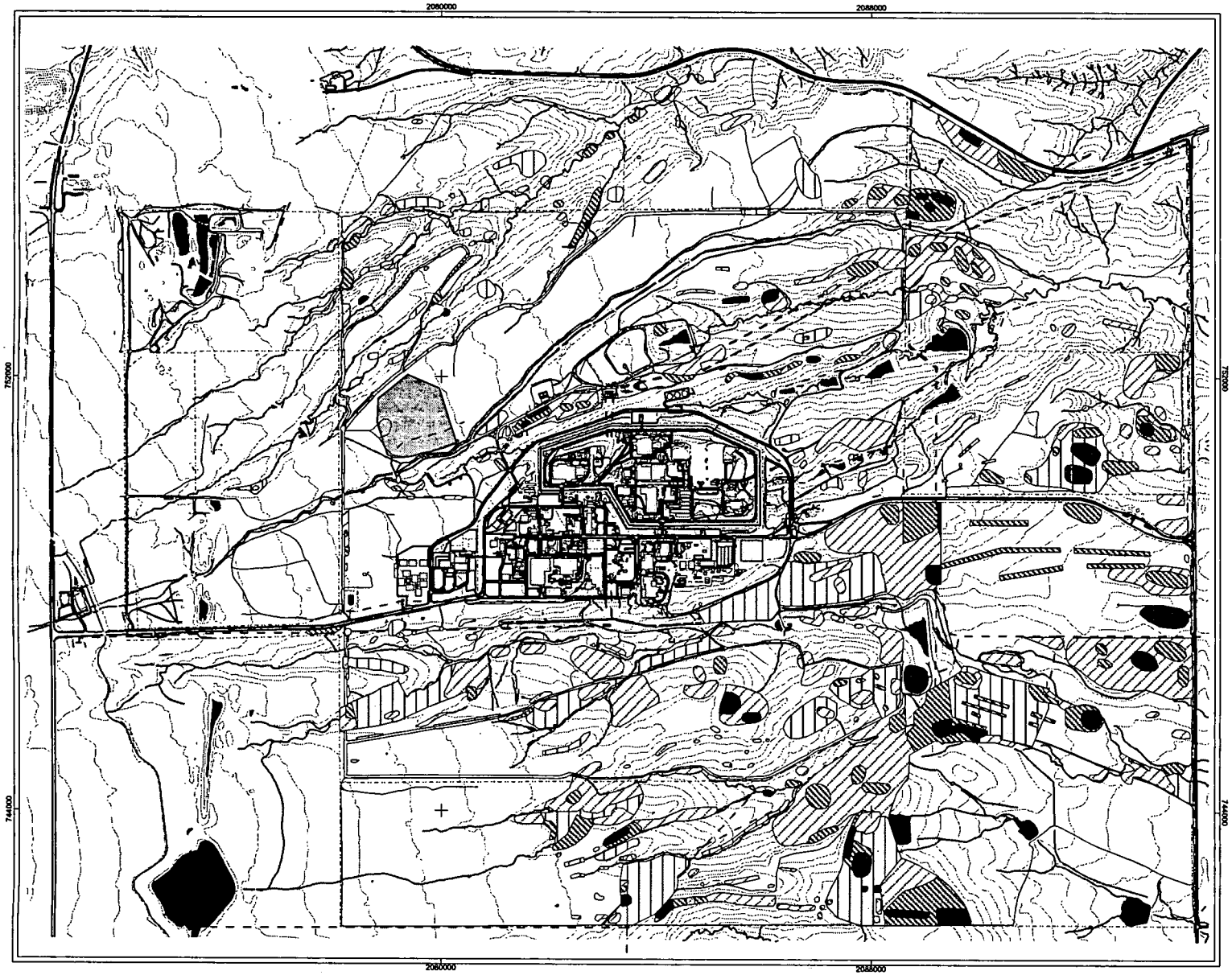
U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: K2-0020

March 14, 2000



2000 Mullein (Verbascum thapsus) Distribution

Figure 15

LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

Standard Features

- Buildings
- Lakes & ponds
- New Landfill
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)
- Power Lines

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypeography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

Data Source Ecology Features:
Weed distribution data provided by Exponent.
K-H Ecology Group POC; Karan North 303-966-9876.

N

1:23552

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent®

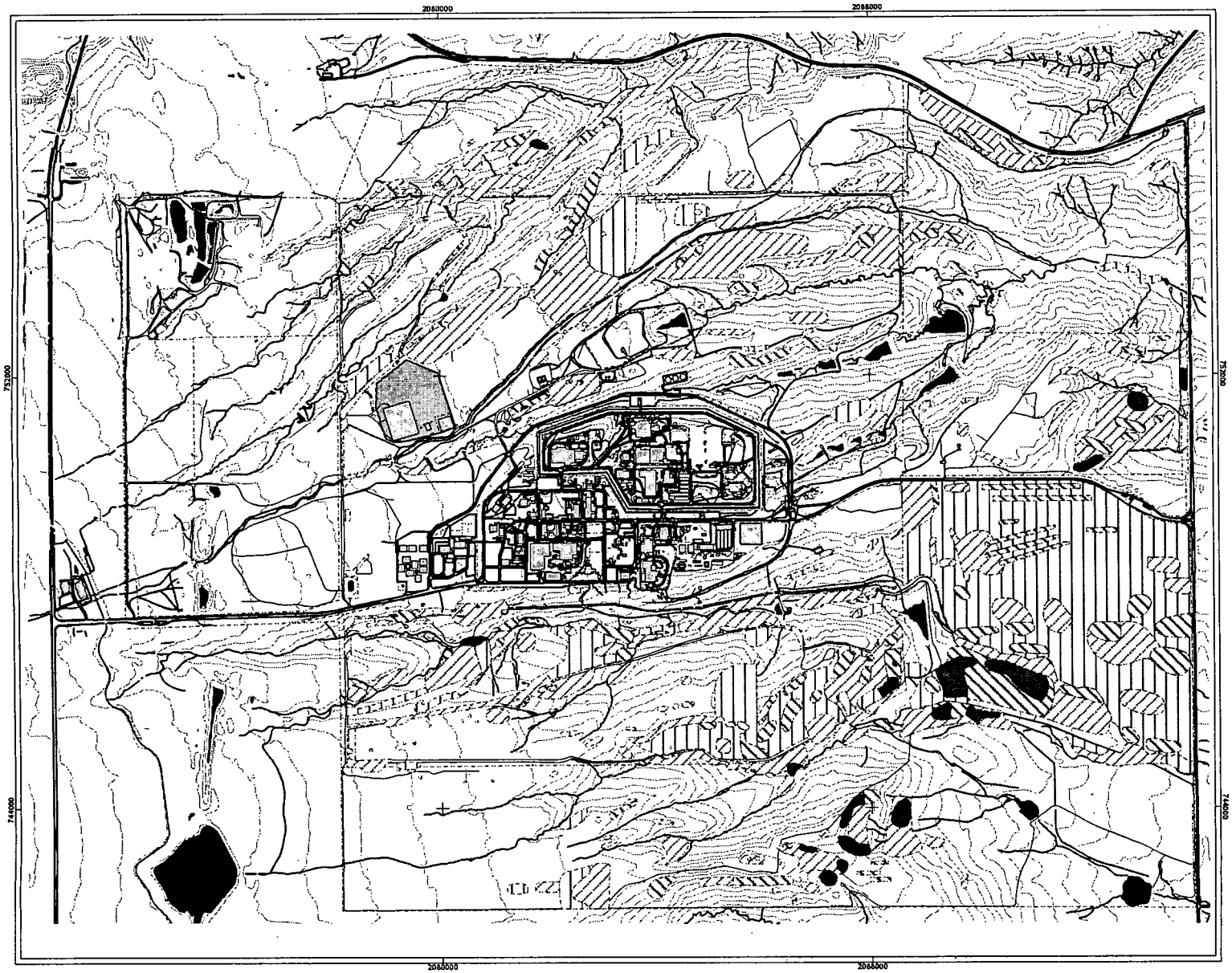
For: Kaiser-Hill Company, LLC

RFETS GIS Dept. 303-966-7707

MAP ID: 01-0081

May 3, 2001

\\Glasrv\GIS\ECO-projects\projects\01-0081\weh00.apr\ 2000 Mullein Distribution



2001 Common Mullein (Verbascum thapsus) Distribution

Figure 1-13

LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

Standard Features

- Buildings
- Lakes & ponds
- New Landfill
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft)

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

Data Source Ecology Features:
Location data provided by Exponent.
K-H Ecology Group POC; Karan North 303-966-9876.

N

1:23552

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

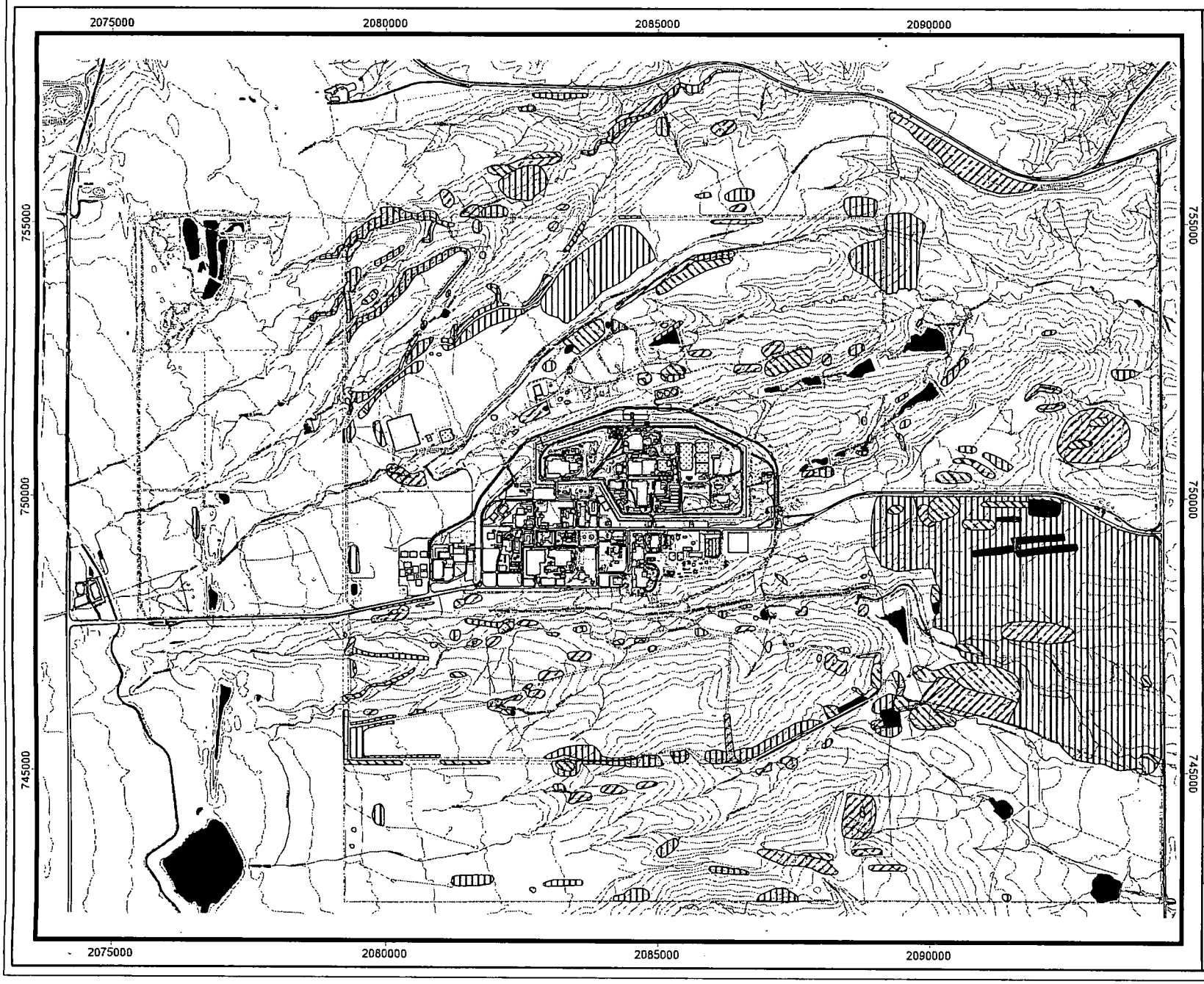
Prepared by: Exponent®

For: Kaiser-Hill Company, LLC

RFETS GIS Dept. 303-966-7707

MAP ID: 02-0072

February 14, 2002



2002 Common Mullein (Verbascum thapsus) Distribution

Figure 4-5

LEGEND

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

Standard Features

- Buildings
- Demolished Buildings
- Lakes & ponds
- Streams & ditches
- Fences
- Paved roads
- Dirt roads
- Contours (20 ft. intervals)

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1995.

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1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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Prepared by: LABAT

For: Kaiser-Hill Company, LLC

RFETS GIS Dept. 303-966-7707

MAP ID: 02-0019

May 5, 2003

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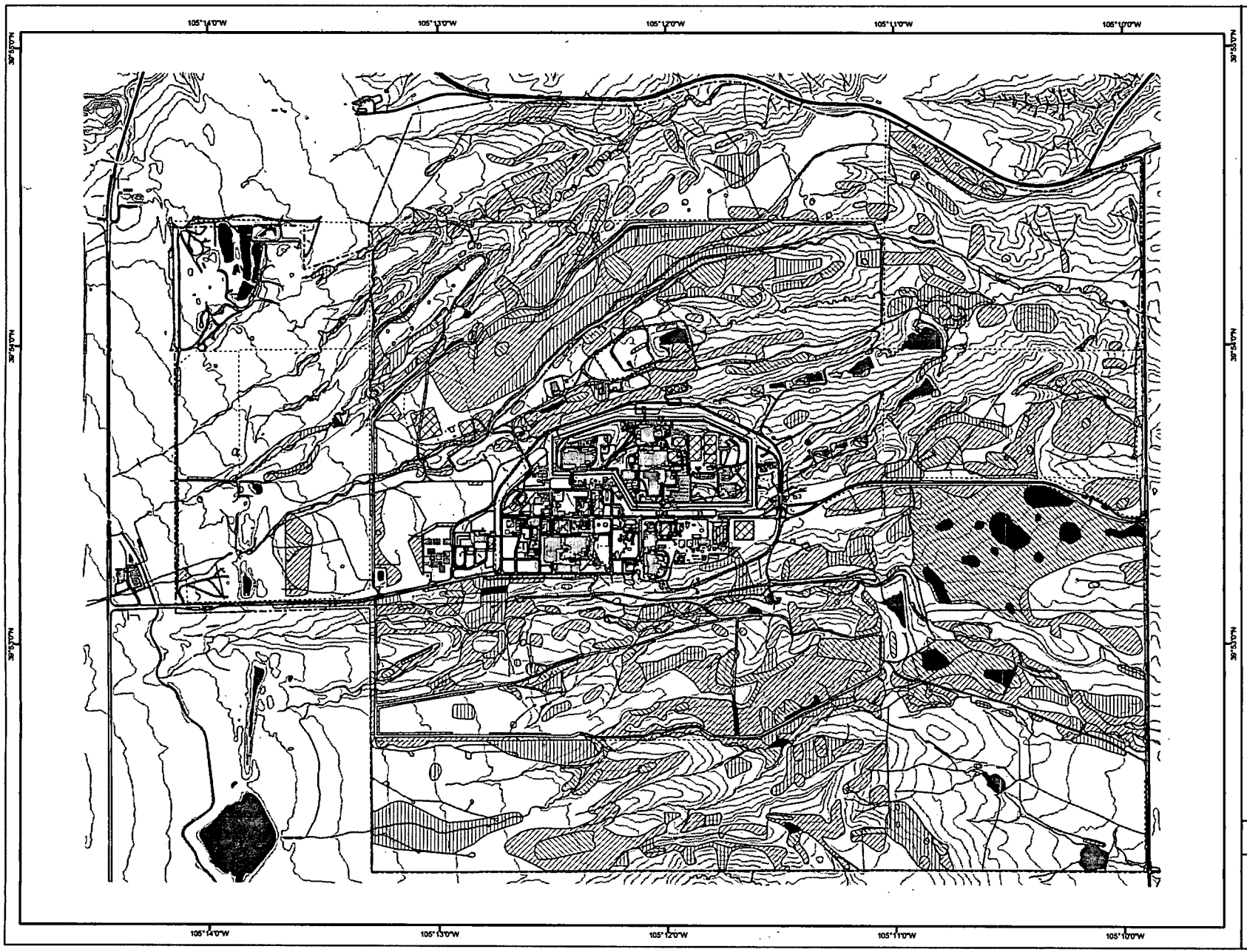

2003 Common Mullein *(Verbascum thapsus)* Distribution

Figure 4-5

Legend

- High Density Areas
- Medium Density Areas
- Low Density Areas
- Scattered Density Areas

Standard Features

- Demolished Buildings
- Buildings
- Lakes
- Streams
- Boundary Fence
- Fences
- Trails
- Dirt Roads
- Paved Roads
- Contours (20 ft)

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95.

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Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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303-966-7707

MAP ID:04-0017

February 26, 2004