Field Observations of the Recovery of Native Rangeland Plant Communities on Express Pipeline

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PREPARED FOR:

The Canadian Energy Pipeline Association

PREPARED BY:

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IN ASSOCIATION WITH:

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and

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Acknowledgements

The participants of the 2008 Express Pipeline tour would like to thank Kinder Morgan Canada Inc. and TransCanada Pipelines Ltd. for providing the funding necessary for the organization of the tour and for this report. Special thanks to Mike Droppo and Ryan Leier of Kinder Morgan Canada for all their help. We all agreed that the tour was very productive in terms of observing the long-term effects of the construction, reclamation and re-vegetation strategies implemented on Express in native prairie. What lively discussions we had at each site, learning from one another! We hope the key learnings and research questions we have compiled will be considered and addressed to further reduce the impact of large diameter pipelines in native prairie.

We would also like to thank the National Energy Board, Alberta Environment and Alberta Sustainable Resource Development for allowing key personnel to take the time to participate in the tour. It was very useful to engage in the field both provincial and federal agency participants.

Many thanks to Cheryl Bradley of the Alberta Native Plant Council and Cliff Wallis of the Alberta Wilderness Association, for taking time from their busy schedules to participate in the tour. Your participation has been very valuable and much appreciated. Thanks also for the great field notes.

Final thanks to Jane Lancaster and Frank Osterwoldt for their keen interest in the long term outcome of Express. Frank and Jane were responsible for taking the initiative forward to Kinder Morgan Canada. They helped me pull together the agenda of sites, based on our work together during the construction and monitoring of Express. Thanks Jane for your photos taken during the tour, and a great set of field notes. Thanks to Donna Kubian of CorPirate Services for the formatting and production of this report.

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Gramineae Services Ltd.
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Background

Express Pipeline (Express) is a 24 inch (610 mm) crude oil pipeline that extends from Kinder Morgan’s tank farm near Hardisty, Alberta, south 430 kilometers to cross the United States border at Wildhorse, Alberta, (see location map). The southern delivery terminal is located near Casper, Wyoming. As it crosses an international boundary it is regulated by the National Energy Board (NEB).

Express crosses large contiguous tracks of native prairie along its alignment. Portions of the right of way cross native prairie in the Central Parkland, Northern Fescue, Mixedgrass and Dry Mixedgrass Natural Subregions of Alberta. The long term impact of pipeline construction and reclamation on native prairie ecosystems was an issue identified by stakeholders early in the planning process in 1994. Native prairie issues continued to be a focal point of negotiations with the Alberta Wilderness Association (AWA), the Federation of Alberta Naturalists (FAN) and provincial agencies (Public Lands, Fish and Wildlife, Special Areas Board) throughout the NEB application process, public hearing and subsequent approval process. To resolve identified issues, an Environmental Advisory Committee was formed with representatives of Express, its environmental and construction consultants, provincial agencies, FAN and the AWA. The Committee met on a regular basis and reached consensus on improved pipeline construction, reclamation and re-vegetation practices designed to reduce the impact in native prairie. Natural recovery as a re-vegetation strategy was just starting to be used by industry in the mid 1990s. Also, research initiatives were in the process of being completed regarding the use of various types of native seed mixes in reclamation. As a result, numerous trial sites were established on Express including: natural recovery trial sites, no-strip trial sites, sod salvage trial sites and native cultivar seed trial sites. As well, a five year post-construction monitoring program was established with rigorous vegetation assessment methodology. The post construction monitoring program was conducted and data analysis completed. The annual reports filed with the NEB are available to the public at the NEB office in Calgary.

Recent research conducted at the Alberta Research Council (Woosaree, J. 2007b) indicates that a timeframe longer than 5 years is needed to evaluate performance trends of seeded native plant cultivars. Express could provide valuable data regarding the long term performance of the native cultivars used in the Express native seed mixes.

The idea for the Express Pipeline Tour 2008 was formed when members of the Express monitoring team came together at the Foothills Restoration Forum held at Maycroft in November of 2007. It was agreed that further monitoring of Express after ten years would provide a valuable contribution to reclamation science. It was agreed that important information sharing would occur if the original stakeholders in the Environmental Advisory Committee were invited to participate. The idea was explored, developed and agreed to with the assistance of Mike Droppo, Kinder Morgan Canada, TransCanada, and the Canadian Energy Pipeline Association. A three day field tour was organized based on representative sites and requests from tour participants.
Participants involved in the Express Pipeline Tour 2008 include:

Lorne Cole          SRD Public Lands, Land Use Branch
Barry Adams         SRD Provincial Rangeland Specialist Grasslands
Pat Porter          SRD Public Lands, Land Use Branch
Sandy Sissons      SRD Practicum Student, Lakeland College
Steve Demkiw       Regional Compliance Officer, Alberta Environment
Sandra Martindale  National Energy Board
Laura Randall      National Energy Board
Kevin Hill         National Energy Board
Laura Hickman      University of Calgary, MSc. Candidate
Cliff Wallis       Alberta Wilderness Association
Cheryl Bradley     Alberta Native Plant Council
Mike Droppo        Kinder Morgan Canada
Ryan Leier         Kinder Morgan Canada
Jane Lancaster     Kestrel Research Inc.
Marilyn Neville    Gramineae Services Ltd.

This report has been organized to capture the observations and key learnings from the tour as concisely as possible. The observations captured at each site have been compiled from field notes submitted by the participants. Locations of each site are accompanied by information recorded on Express post-construction alignment sheets. Photos were taken at each site and are included to provide a visual context with the recorded observations. All photos included in this report are courtesy of Jane Lancaster, Kestrel Research Inc. Copies of the native seed mixes used on Express are included as an appendix.

Questions regarding the content of this report should be directed to:

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Questions will be forwarded to Mike Droppo at Kinder Morgan Canada
Express Canada Pipeline

Legend
- Express Pipeline
- Control Point
- Valve
- Pump Station
- Reservation
- National Parks
- Provincial Park

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KINDER MORGAN
Summary of Key Learnings and Research Questions

The following summary has been compiled from the field observations made by the participants of the tour, from field notes compiled by Jane Lancaster of Kestrel Research and from written responses received from Cliff Wallis representing the Alberta Wilderness Association, Cheryl Bradley representing the Alberta Native Plant Council, Steve Demkiw of Alberta Environment, Sandra Martindale and Laura Randall of the National Energy Board.

The field tour of key sites in native prairie along the Express pipeline eleven years post-construction provided the opportunity to observe in the field the suite of reclamation and re-vegetation mitigation measures implemented on Express in native prairie. It allowed participants to discuss ongoing reclamation issues in native prairie, to identify key learnings from the observations made, and to identify research questions to assist industry, stakeholders and regulators in future planning and decision making.

Key Learnings

1. Express Pipeline offers rich opportunities for better understanding the long term efficacy of various native prairie reclamation techniques in the Dry Mixedgrass, Mixedgrass, Northern Fescue and Central Parkland Natural Subregions of Alberta. Additional monitoring is merited, given that there was monitoring data collected using a well defined methodology over the first five years post-construction. The results would inform future decisions about routing of large diameter pipelines in similar environments and appropriate reclamation/restoration requirements. Additional monitoring data from the Express Pipeline could contribute to our understanding about whether restoration of native vegetation communities is possible, and if so, in what situations and over what timeframe.

2. The primary mitigation still needs to be route selection to conserve the ever-increasingly fragmented native grasslands. Site selection and route planning with avoidance of the most ecologically sensitive sites is key to success.

3. Keep the area of total disturbance to an absolute minimum. Incorporate this into soil handling procedures and traffic control plans.

4. It was encouraging to see sage grouse fecal pallets on the Express pipeline right of way in Sage Creek in the natural recovery site. GPS co-ordinates were taken and have been submitted to ASRD.

5. The Grassland Vegetation Inventory, the Range Plant Community Guides and the Range Health Assessment protocol developed by the Rangeland Management Branch of Alberta Sustainable Resource Development are important tools that can be used for route selection and for construction and reclamation planning. Training courses for industrial application are important and are currently being planned.
6. The natural recovery site in the sandy soils of the Hemaruka Dunes most closely resembled adjacent off right of way native plant communities. The pipeline right of way visually disappeared. Natural recovery was also observed to be effective on the overflow range sites in Sage Creek. A criteria for the use of natural recovery is required. Natural recovery decisions need to consider the unique characteristics of each Natural Subregion, the soils, ecological range sites and site specific species composition. The Range Plant Community Guides provide important and useful information. Non-native invasive species of concern, present onsite or in close proximity (road ditches, tame pastures) prior to disturbance can influence the outcome of this re-vegetation strategy. The timing of construction and final cleanup is also important.

7. The timing of construction and reclamation can affect the outcome of revegetation strategies in native prairie. Two scenarios occurred on Express. Final cleanup occurred along the majority of the pipeline during the fall of 1996 when the native plants were dormant. However, final cleanup had to be abandoned as winter weather forced a voluntary shutdown of final cleanup activity. Final cleanup was resumed in late May and June of 1997. Additional monitoring data from Express would help to better understand the implications of stockpiling topsoil over winter with final cleanup occurring in the spring compared to monitoring data from sites where final cleanup was completed in the fall when the native plant communities were dormant. Other issues associated with spring final cleanup include: off set requirements for wildlife species of concern, and migratory birds nesting and rearing habitat. Construction concerns include waiting for the stockpiled soils to dry and the impact of construction equipment to unstripped native vegetation when it is actively growing. When seeding is required it most often is delayed beyond the optimal time period of early spring.

8. When constructing in solonetzic soils, some changes in the vertical and horizontal structure are bound to occur. Leaching of materials in the soil profile takes an extended period of time. It may be that disturbances on soils of the Solonetzic Order will take longer to return to native plant communities than other soils. Sandy soils are more homogeneous (fewer horizons). Plants respond to the disturbed soils and the released nitrogen and will be more vigorous. Visually the right of way will look different than the surrounding landscape for perhaps a very long time depending on the soils encountered and the re-vegetation strategy implemented.

9. The effect of temporary fencing of pipeline rights of way and the long term implications for native plant community re-establishment is an important issue. Fencing and the absence of grazing can affect native species diversity if the fencing remains in place for more than a few growing seasons. Fencing can result in excessive buildup of litter that can alter the moisture regime, affecting native plant diversity and subsequent successional pathways on the right of way.

10. Eliminate the use of sheep fescue (Festuca ovina) in native seed mixes. It is not native and remains persistent on Express after 10 years.
11. The green needlegrass and prairie sand reed native plant cultivars used on Express have remained persistent and are much larger plants than those found in native plant communities. Use more locally adapted and more recently developed native plant material, such as native plant cultivars produced from the Ducks Unlimited Ecovar program and native plant cultivars recently developed by the Alberta Research Council.

12. Consider the use of wild harvested plant material. The use of wild harvested native seed and wild harvested native hay as mulch is currently being researched at the University of Alberta. Wild harvested native seed has been used in native prairie restoration projects in Saskatchewan and Manitoba since the mid-1990s. More trial sites need to be established in Alberta.

13. Re-assessment of the sod salvage trial sites on Express could provide important information on native plant successional pathways, the impact on non-native invasive species on native plant succession over the long term and the efficacy of the sod salvage technique on large diameter pipelines. Data was only collected for the first two years in Wilf Petherbridge’s thesis report.

14. In the Central Parkland Natural Subregion there are more re-vegetation success stories in sandy soils than others. Natural recovery can work in small disturbances (< 3-4m wide) but on big sites it doesn’t. Natural recovery is hampered by competition from invasive species.

15. It is very important to control weeds for the first three years post-construction. Inspections and control should be done twice annually. Weed reports should be appended to the annual monitoring report. Suitable methods may include mowing, spot spraying, and wick application (good for selective control of early season or taller plants). For example, early spring (April) spraying of crested wheatgrass may be effective as it is the first species to start growing in the spring.

Operational practices for weed control tracking include:

- Documented pre-inspection
- Document decision making process for control
- Requirement to audit a certain % of controlled sites
- Important to train contractors on desired methods and outcomes.
**Research Questions**

Additional research is required to establish reliable methods of controlling non-native agronomic invasive species such as crested wheatgrass, smooth brome, Kentucky bluegrass and Timothy. Partnering with US agencies already looking into this would be worthwhile. Work with the genetic make-up of crested wheatgrass, smooth brome, timothy, Kentucky bluegrass, knapweed and Canada thistle to control them (genetic modification, viruses, or chemicals to alter DNA). Develop a technology for one species and then transfer it to another. Also, research is required to assess the efficacy of integrated pest management systems for the control of invasive non-native species on pipeline rights of way.

Research is needed to determine native plant successional pathways following industrial disturbance to determine the most appropriate re-vegetation strategy in native prairie soils of the Solonetzic Order. Consider additional soils and vegetation assessment at the strip vs. no strip trial sites established on Express that formed part of Wilf Petherbridge’s Masters Thesis. Additional monitoring sites established on Express could be included. There may be other trial sites established on other large diameter pipeline rights of way.

Research is required to determine the impact of fenced right of ways on the process of native plant succession. This is an important question and the results may vary by Natural Subregion. Information collected could provide important data on the role grazing has in controlling invasive non-native agronomic species on industrial disturbances. Results could provide important information regarding where fencing is appropriate and how long it should remain in place.

Research is needed to determine the effects spring final cleanup vs. fall final cleanup on native plant succession. The assessment should include both natural recovery sites and sites where native seed mixes were used. The study area should include all three zones of disturbance (spoil, ditch and workside).

**Foothills Restoration Forum Research Project Ideas**

- Delineation of the range extent of foothills rough fescue (*Festuca campestris*) and plains rough fescue (*Festuca hallii*) in the Cypress Hills. Genetic work is required on *Festuca campestris* and *Festuca hallii* on a transect in the Cypress Hills. Fescue on the top of the hills expresses itself as *campestris* but plants on the slopes look more like *hallii*.

- Re-assess the fescue sod salvage from the Grande Prairie highway transplant project.

- Re-assess the Express Pipeline sod salvage sites. Only two years worth of results were collected with Wilf Petherbridge’s thesis.
The influence of invasive non-native plants from the road crossing was very evident. Sweet clover, crested wheatgrass and Canada thistle were prominent on the borehole location. A criteria for natural recovery sites with setback distances from sources of non-native species invasion needs to be developed.

Lichen was observed on the unstripped travel lane
More vigorous growth of vegetation was noted over the trenchline. Trenching activities result in an alteration of soil structure in Solonetzic soils. Further research is required to determine the most effective revegetation strategy following pipeline construction in Solonetzic soils.

Western and slender wheatgrass are gone from seeded areas
Sheep fescue prominent on the right of way from the seed mix. Green needle grass and June grass are also present.
The disturbed and seeded ditchline is well vegetated but the native species composition is still not consistent with the unstripped portions of the right of way or adjacent off right of way.
Re-evaluation of the permanent monitoring sites established on Express would provide valuable data to determine if a positive sucessional trend is occurring over time.
Natural recovery more closely resembled the adjacent undisturbed native plant communities in terms of species composition than the seeded portions of the pipeline in Sage Creek. Encroachment of native species from the adjacent native plant community appears to be occurring on the seeded areas, however it appears to be occurring at a slower rate when compared to the natural recovery site. Reducing the area of soil disturbance is key to reducing the impact to native plant communities. This was very visually apparent. Laura Hickman, Masters Degree Candidate, University of Calgary, Department of Environmental Design gave an overview of her research in progress on Express Pipeline regarding sagebrush recovery on industrial disturbances. Initial results on Express Pipeline indicate that sage brush is re-establishing on the disturbed portions of the pipeline on overflow range sites where natural recovery has been implemented.

Cliff Wallis urges a re-inventory of the revegetation monitoring sites established on Express. Barry Adams indicates that the data acquired would improve the understanding of the process of recovery and the trends toward native plant community establishment on reclaimed native grasslands. The information could provide useful information for the Reclamation Criteria for Wellsites and Associated Facilities, currently under review. Data gathered could also assist the planning and application process for proposed future development.

Barry describes current rangeland assessment tools and publications developed by the SRD Rangeland Management Branch such as the Grassland Vegetation Inventory, the Range Plant Community Guides prepared by Natural Subregions and the Range Health Assessment protocol. All useful tools that can be applied to future development activity in native grassland.

Marilyn feels that 12 kg/ha is an adequate seeding rate in the dry mixed grass to allow erosion control and encroachment of native species.

A flush of fringed sage in the first year can be a good thing to keep cattle from grazing on the newly revegetation RoW. (MN and Clare Tannas)

There is always a risk of weeds with any seeding.

It is best to leave the cleaned up RoW rough and lumpy to create microsites for natural recovery.

To improve the likelihood of compliance with the environmental conditions of project construction it is very important that the construction contractors see the entire environmental commitment package before they bid.

It’s also important to train the contractor to get the results identified on the EPP.
Seeded rough fescue is evident on the disturbed portion of the right of way. The seeded rough fescue has done well however other cultivar components of the native seed mix are still persisting in the stand. An excellent site for further study. Where we have seen the best success when seeding rough fescue is on very dry sites. Wild harvesting hay much from adjacent off right of way native plant communities and eliminating all cultivars may have increased the species diversity on the seeded right of way.
### Fourth stop

<table>
<thead>
<tr>
<th>NE 9-8-5 W4, Rough fescue sod salvage site</th>
<th>Mixedgrass Natural Subregion, Chernozemic soils</th>
<th>Blade width stripping, Sod Salvage, no seed</th>
</tr>
</thead>
</table>

There is less diversity in the sod salvage site than off right of way. Adjacent seeded areas have greater species diversity. Re-evaluating the sod salvage site after 10 years could provide valuable information to determine if sod salvage is worthwhile in the long term. Sod salvage is very expensive, difficult to implement and has to be conducted ahead of all other pipeline activity.

- needs a site with good sod integrity (not too many rocks)
- needs dedicated care of the sod while stored, including wrapping, temperature monitoring.
- Timing of salvage needs to be when plants are relatively dormant or slow-growing and soils are reasonable dry (to prevent composting)
- The site needs to be a weed free community to start with
- Kentucky blue grass becomes one of the most prominent species and fescue cover has dimished at this site.
- The resulting round surface is very uneven.
- Sod salvage may have utility on smaller sites like well pads but the persistence of target species may not occur.

*Fourth Stop, Rough Fescue Sod Salvage*
This site is located in a field of abandoned cultivation from the 1920s. Native plant succession is still occurring after 90 years. Prairie sand reed grass is persisting on the RoW from the seed mix and is a taller cultivar than the local native plants. The most prominent species from the DMG Sandy soils seed mix are sheep fescue, green needle grass and prairie sand reed grass. The area stripped is still obvious based on visual vegetation differences from the undisturbed native vegetation. The reclaimed site lacks equivalent vegetation structure; little club moss, sedges and sagebrush have not re-established.

For Express, the multiple width stripping grade plan was measured out and the chainage and procedures to be implemented were recorded. This work started 2 months prior to construction and the grade plan was filed with the NEB prior to construction.

This site was seeded in late spring and spear grass seed did not survive in the topsoil piles stored over the winter. Less diversity on sites where spoil is stock-piled over winter.

Winter construction and early spring clean-up runs the risk of pushing seeding into June (late spring) when conditions are less favourable. Better to get the construction done early August and finish and seed before winter.

Research Question: What is the difference in recovery of native grasses in and under topsoil replaced in fall vs topsoil replaced after winter stock-piling. Need to compare equivalent sites as to range plant communities and underlying soils.

Perhaps assisted natural recovery would be more suitable at this site. Important to ensure fall final cleanup and replacement of topsoil.

Natural recovery decisions need to consider the species composition of the undisturbed area. If non-native grass species of concern are present then this can limit the choice of this method.

Other weedy species such as flaxweed, annual hawkweed and goat’s beard may be things we can live with since they are ubiquitous in many native prairie areas and don’t necessarily form solid stands on disturbances.
| Second stop | NW 31-21-9 W4M, Right of way south of Jenner Pump Station seeded spring 1997 | Dry Mixedgrass Natural Subregion, Solonetzic soils | Combination of stripping methods, blade width except where safety requirements dictate additional stripping, Seeded to Native seed mix 4 late June 1997 |

The seeded RoW is not a native plant community. It is a community of native cultivars in a seed mix. We need to be clear where the goal is “restoring” ecological integrity e.g. ecological reserves (if they absolutely can’t be avoided!) and where this is not the goal. What should the goal be in multiple use landscapes? Multiple use landscapes can still be significant ecologically.

Green needlegrass (Stipa viridula) is prominent on the right of way. The cultivar used in the native seed mix provides excellent erosion control, and is palatable but persists and is taller than the locally native green needle grass. Green needle is known to occur naturally and is observed on disturbances like gopher mounds, erosion, etc.

Discussion of cultivars – there are more recent native plant cultivars such as those produced by the Alberta Research Council and the Ducks Unlimited Ecovar program.

There is a need to re-assess native plant cultivars and their long term response in seed mixes.

Mowing 2nd year post-construction can knock back weeds and remove seed from plants like slender wheatgrass that have served their purpose (and you don’t want to persist).

It may take another 5-10 yrs for Stipa comata to move in. It likely did not survive over winter in the stored topsoil.

There is much more cumulative impact and fragmentation happening from the well infrastructure (wells, roads, tie-ins, smaller diameter pipe) than these big P/Ls. It would be better to apply our learning and improve what is going on with these developments by 10% and make a huge difference than to tweak what is already going pretty well for big pipelines.
| Third stop | NE 29-22-9 W4M, seeded fall 1996 | Dry Mixedgrass Natural Subregion, Solonetzic soils | Combination of stripping methods, blade width except where safety requirements dictate additional stripping | Seeded to Native seed mix #4 fall of 1996, reseeded bare areas and scalped areas spring of 2004 at landowners request |

Litter on RoW denser and coarser than off-RoW. Seeded plants still responding to released nitrogen (may affect ability of off-RoW species to recolonize on RoW but this can all change if grazing pressure changes).
Stipa comata present on site – natural recovery of this species from fall final clean-up.
Can see the effect of reseeding in 2004: lush growth, less encroachment from off right of way native species
Scalping occurred in this area when the contractor retrieved the topsoil and subsoil from the unstrpped sod. Environmental inspectors have to train operators and the first area can end up being “sacrificed” (so perhaps start on a not so critical piece of land).
If conditions permit, preferred method of topsoil stripping is with a grader.

Vegetation on the Express pipeline appears to differ from the native vegetation off of the pipeline. Sheep fescue, green needle grass and wheatgrasses are persistant on the cleared areas of the pipeline. However, the differences do not appear to be as great as at the previous site.
Again, there appears to be more litter/productivity on the pipeline compared to off right of way, due to disturbance of the solonetzic soil.
Additional monitoring data from this site may help to assess the difference in vegetation trend between fall seeding and spring seeding; as well as the merits of the modified construction technique. The effect of additional seeding in 2004 on the validity of the comparison should be assessed.
Poor range health need not limit the choice of natural recovery method if the remaining species are native. P/L ditchline now being used as access by other land users!

Natural recovery decisions on solonetz need to consider the range of solonetz (hardpan, solonetz, solod, solodic chernozem). Best seeding times late fall, after soil cools to <5 C, and early spring when soils warm to between 5-10C at 2” depth but only seed to ½” deep.

There are risks with fall seeding in foothills fescue due to winter Chinooks and seed loss. This site is more salinized and moister than Site 3. There is a seasonal wetland adjacent to the pipeline.
Fifth Stop, Natural Recovery in the Foreground

Portion seeded in fall 1996 with Mix 3 and portion with natural recovery, sand plain
In the natural recovery portion, there was single blade width stripping, fall final cleanup. The site was in good range condition, lightly grazed, which was one of the factors in deciding to use natural recovery.
In the seeded portion, some species from the seed mix not native to the site persist (e.g. green needle grass, wheat grasses), however the demarcation between vegetation on and off the pipeline is not visually obvious.
In the natural recovery portion, differences in vegetation on and off of the pipeline are imperceptible.
Dominant vegetation is a common wild rose – buckbrush/needle-and-thread grass – sand reed grass community
Plains rough fescue clumps have established on the pipeline.
Unfortunately, smooth brome and crested wheatgrass are invading the site from the road ditch and/or livestock feed.
Additional monitoring would provide useful information about success of natural recovery vs seeding on sandy sites.
Seeded fall using Mix 4 with plains rough fescue seed added, solonetzic blowout site
Plains rough fescue is present on the pipeline. Sheep fescue and green needle grass are persistent. Creeping thistle is present. Unlike site 4, this site has not been occupied by western wheatgrass even though there is a nearby wetland supporting that species.
Off RoW: Hard pan blowouts; Plains rough fescue plant community with increased productivity and diversity on ridges. Blowouts filled with Western wheatgrass.
Seeded species still persistent on blowouts, more so than on sandy soils. But Plains rough fescue present in large tussocks on RoW. Unknown whether the rough fescue is seeded or natural recovery.
Right of way is well vegetated, however it appears to be moderate to heavily grazed. Soil moisture conditions are the driest observed during the tour. Locals indicate there has been no moisture since early June and +30 degree weather. Species included in Native seed mix still obvious where seeded on right of way with the exception of rough fescue. Difficult to determine if rough fescue is present. It likely did not survive due to grazing pressure. Invasive non-native species including Kentucky bluegrass and smooth brome are present on right of way and in the adjacent off right of way in the riparian zone of Ribstone Creek.

First Stop, Seed Mix 1
<table>
<thead>
<tr>
<th>Second stop</th>
<th>W1/2 22-40-9 W4M, Plains rough fescue sod salvage site</th>
<th>Central Parkland Natural Subregion, Chernozemic soils</th>
<th>Blade width stripping</th>
<th>Sod salvage site</th>
</tr>
</thead>
</table>

Sods pre-cut with a concrete cutter. They broke naturally between the A and B horizons. Stored on pallets and covered with white morafee filter fabric. Stripped Sept. 6, 1996 and replaced as things were freezing up in late November. Now a fairly continuous, but not dense, cover of smooth brome. There was very little brome in the sod salvage in the first two years but there is plenty off RoW beneath the aspen stands. There is less brome higher on the slope in drier areas. Canada thistle and Poa pratensis are also present. There is still Plains rough fescue in the sods and there is good cover and diversity on the site. It's important to look at pre-construction site condition before deciding to do sod salvage. Invasive species off site will move onto sod salvage area. Important site to re-evaluate.
<table>
<thead>
<tr>
<th>Third stop</th>
<th>W1/2 22-40-9 W4M, Seeded area north of Sod salvage site</th>
<th>Central Parkland Natural Subregion, Chernozemic soils</th>
<th>Blade width stripping to full width where clearing and grading was required</th>
<th>Native seed mix #1, seeded spring of 1997</th>
</tr>
</thead>
</table>

Seeded areas to the north have lots of diversity, including shrubs, forbs and grasses. Poa pratensis and Bromus inermis are abundant. Plains rough fescue is present on the disturbance. Sheep fescue and green needle grass prominent, some June grass present. If we were to do it again: (Marilyn Neville, Lorne Cole, Pat Porter)

- bump up amounts of Festuca hallii in seed mix,
- keep Festuca ovina (sheep fescue) out of the mix,
- use local, more recently released cultivars of seeded grasses (ARC cultivars) and avoid the taller, more “wolffy” Manitoba raised cultivars.
- Other, more recent seed species to consider are nodding brome, bearded brome, sweet grass (for stream margins), DU Ecovar program “AC Mallard Stipa viridula”,

Other new species for other Natural Subregions to consider where they are naturally occurring:

- little bluestem on limy (basic pH), sandy and gravelly soils,
- Canada wild rye (Elymus canadensis), at 5-10% of mix, as a cover crop that will last 5-10 yrs in sandy soils.

If no sand reed grass on the site pre-disturbance then Lorne Cole wouldn’t put it in the mix, use Elymus canadensis instead.

*Third Stop, Seeded Area North of Sod Salvage*
End of Tour

*Pat Porter, ASRD, Explains Importance of Range Exclosure Reference Sites*
### Appendix A – Seed Mixes

#### Express Seed Mixtures Final Versions

<table>
<thead>
<tr>
<th>Mix 1</th>
<th>Aspen Parkland</th>
<th>Express Pipeline</th>
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</thead>
<tbody>
<tr>
<td>Species</td>
<td>seeds/g</td>
<td>PLS</td>
</tr>
<tr>
<td>streambank wheatgrass</td>
<td>344</td>
<td>92</td>
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<td>northern wheatgrass</td>
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<td>90</td>
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<td>sheep fescue</td>
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<td>88</td>
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</table>

**Assumptions**

1. Seed will be drill seeded (rate X 2 for broadcast, X 10 for hydroseeding)
2. Only recommended varieties or acceptable alternatives used
3. Avg 50-40% of seedlings (plt/m2) reach maturity in 3 yrs

**Key to Symbols**

- seed/g: number of seeds per unit weight (grams) for each species
- PLS: Pure Live Seed: percent purity times percent germination
- est%: estimated percent seedlings per number of seeds after 1 season
- plt/m2: total number of pure live seeds planted per square metre
- kg/ha: seeding rate by weight of seed in total and for each species
- %/wt: seed mixture calculated in proportion by weight
- total kg: weight of seed of each species and in total to seed indicated area
### Mix 3 Dry Mixed Grass Prairie Sandy Soils

<table>
<thead>
<tr>
<th>Species</th>
<th>seeds/g</th>
<th>PLS</th>
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<th>plt/m²</th>
<th>kg/ha</th>
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### Mix 4 Dry Mixed Grass Prairie Solonetzic Soils

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### Mix 5 Prairie Wetlands

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