

REVIEW OF:

COLORADO SPRINGS UTILITIES SOUTHERN DELIVERY SYSTEM

RESTORED VEGETATION COVER MONITORING - WORK SEGMENT S1

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INTRODUCTION

This review of the 2014 report addressing vegetation sampling by CSU-SDS along the S1 Segment of the Southern Delivery System water pipeline in Pueblo County focuses on the degree to which the revegetation requirements of the 1041 Permit issued by Pueblo County are being met. The overall goal of revegetation in the 1041 Permit is stated as:

“Applicant shall provide Pueblo County residents with replacement vegetation and property to match pre-construction conditions or better.”

This overall goal is clarified by describing that “matching pre-construction condition or better” will be based on evaluating vegetation cover by acceptable species, evaluating species diversity and assessing the abundance of noxious weeds (as defined by lists prepared by the State of Colorado). The requirements associated with these vegetation attributes are described in the following section.

REVEGETATION PERFORMANCE STANDARDS IDENTIFIED IN THE 1041 PERMIT

Vegetation Cover. The 1041 Permit states that successful vegetation establishment will consist of (in part) attaining cover values that are equal to (or greater than) 90 percent of the values that were present prior to construction of the water pipeline. Before construction of the pipeline, a vegetation study was conducted in October 2011 by CSU-SDS consultants to determine what the existing vegetation cover values were along the length of the water line right-of-way (ROW). The sampling program was stratified based on six different soil groups that had been identified along the water line route. Additionally, the ROW was divided into

three segments: S1, S2 and S3. Not all of the six soil groups occurred in each of the segments. Vegetation cover data were collected at 52 locations along the entire length of the ROW. After reviewing the data from the vegetation sampling transects, some of the results were dropped from the set of transects used to develop the base vegetation cover values. The reason for excluding some of the transects was that the excluded sites had low vegetation cover values that were not consistent with values measured at other sites within a particular soil group. The low values were related to impacts from grazing by livestock and prairie dogs. After excluding the data from 11 transects, base vegetation values were developed for each of the soil groups using the data from 41 transects. The vegetation cover standards were developed by multiplying the base values by 0.9 (90 percent). The transect locations for the 2011 study were distributed among the three ROW Segments as shown in the following table:

Soil Group	Number of Transects (2011 Study)					
	S1		S2		S3	
	Total Sampled	Used to develop standard	Total Sampled	Used to develop standard	Total Sampled	Used to develop standard
Type A (Penrose, Manvel and Minnequa Soils)	7	4	13	11		
Type B (Limon and Heldt Soils)	1	1	6	6	7	1
Type C (Stoneham and Cascajo Soils)					4	4
Type D (Midway Shale Complex - Shingle Series)			1	1	3	3
Type E (Razor Series)					7	7
Type F (Haverson Series and Ustic Torrfluvents)			2	2	1	1

Species Diversity. There is no specific standard for species diversity presented in the 1041 Permit revegetation requirements. There are however provisions for species diversity to be considered. The permit states that “*Vegetation cover will be of the same seasonal variety native to the area of disturbed land, or species that support the post-construction land use.*” Also, the permit states that the revegetated area will be considered acceptable if “*..the revegetated area cover is not less than 90 percent of the pre-construction vegetation cover with similar species diversity.*” The CSU-SDS report evaluates species diversity based on the number of acceptable species per square meter. Their target number for acceptable revegetation is a mean value of two species per square meter. Data for this type of evaluation were collected from the reclaimed areas following construction. There are no comparable pre-construction data, however the two species per square meter value is not an unreasonable target. It is also possible to evaluate species diversity by comparing the number of species per 100 square meters. The vegetation transect sampling approaches used in 2011 and in 2014 were conducted in the same manner so it is possible to make pre- and post-construction comparisons.

Noxious Weeds. No specific standard for noxious weed species is included in the 1041 Permit. However, the provision is included that “*Applicant shall control spread of noxious weeds resulting from project construction.*”

RESULTS OF 2014 CSU-SDS STUDY

The primary purpose of the CSU-SDS report was to present data that showed that the revegetation performance standards presented in the 1041 Permit had been met by the end of the 2014 growing season. Their interpretation of how to evaluate the success of revegetation relative to the 1041 Permit was presented in a Technical Memo submitted to Pueblo County in January 2014. While the approaches presented in this memo have been discussed with Pueblo County, there has been no specific agreement that the interpretation of the 1041 Permit requirements by CSU-SDS is completely consistent with what the intentions of Pueblo County were relative to the 1041 Permit. However, the results presented by CSU-SDS address in general the requirements of the Permit.

The evaluations conducted by CSU-SDS were based on comparisons of pre- and post-construction vegetation characteristics present with identified soil groups along the water pipeline ROW in Segment S1. There are three soil groups that were sampled in the S1 Section - Post Construction:

Soil Group Type A (Penrose, Manvel and Minnequa Soils)
Soil Group Type B (Limon and Heldt Soils)
Soil Group Type D (Midway Shale Complex; Shingle Series Soils)

In addition to these three evaluated types, a fourth type (Soil Group C - Stoneham and Cascajo) was identified as occurring at the extreme southern end of the S1 Segment. Apparently, this area was not disturbed during construction so post construction sampling was not required in this area. In the sections which follow, the results from each of the three soil groups are discussed separately.

Type A Soil Group (Penrose, Manvel and Minnequa Soils) Approximately 88.8 percent of the S1 Segment

Pre-Construction Sampling and Base Values for Performance Standards.

Seven transects were sampled in the Type A Soil Group in 2011, but only four of them were included in the set of transects used to develop the performance standard. The three transects that were not included were sampled in areas with high prairie dog use so the vegetation cover was limited (4, 3 and 10 percent). Cover for the four transects that were included in the performance standard was 24, 18, 8 and 12 percent. The mean cover for the seven sampled Type A soils in the S1 Section (pre-construction) was 11.3 percent compared with the base value of 17.2 percent for the cover performance standard for the Type A soil group (based on 15 transects: 4 from S1 and 11 from S2).

Post Construction Results

Vegetation Cover. In 2014, the vegetation consultants for CSU-SDS sampled 17 transects in the Type A Soil Group in the S1 Segment. The primary focus for success evaluation is the percent cover by acceptable species. For the Type A soils, the performance standard was established as 90 percent of 17.2 percent, or 15.5 percent (based on 2011 data). The mean total vegetation cover from the CSU-SDS study for the Type A Soil Group in 2014 was 51.2 percent of which 27.1 percent came from acceptable native species. Of this total, seeded species had a mean cover of 21.4 percent, which points to the overall success of the revegetation effort. Cover by introduced annual weedy species (mostly from two species of Russian thistle) was 24 percent. Based on these results, the conclusion is that the 90 percent cover standard was met.

For the 17 sampled transects, cover by acceptable species ranged between 12 and 42 percent which is above the range that was sampled with the seven pre-construction transects (3-24 percent) in the S1 Segment. Only four transects had less than the performance standard of 15.5 percent cover and the cover along those transects was 12, 14, 15 and 15 percent.

Species Diversity. The pre-construction data for the Type A Soil Group in the S1 Section showed that 34 species were encountered along the sampled transects. Of this total, 30 were native species and 4 were introduced. Following construction, 35 species were encountered with 26 native species and nine introduced species. While the total number of species was approximately the same, the CSU-SDS data show that the percent cover in the different life form groups was different from what was encountered prior to construction (Figure 1). The large increase in cover by introduced annual and biennial forbs is a common result on disturbed and revegetated areas. Most of the cover in this group was provided by two species of Russian thistle that are well-adapted to the growing conditions present on newly disturbed sites. In general, the abundance of these species should become less over time, especially on sites where perennial species have become well established. The other two groups that showed notable changes were the native perennial grasses (both cool and warm season). The increases in these two groups occurred because these were the species that were seeded.

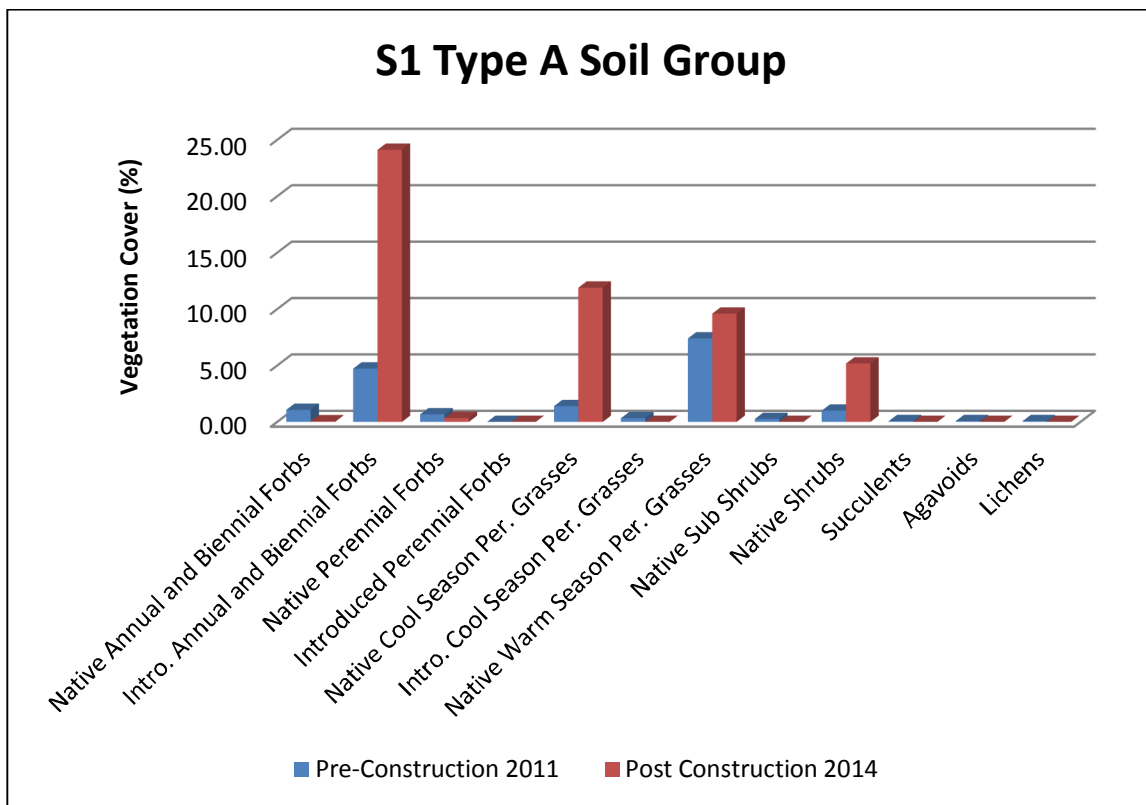


Figure 1. Pre- and Post-Construction vegetation cover by various life form groups in the Type A Soil Group (S1). Pre-construction data from October 2011; post construction data from late August 2014. The pre-construction data are based on all the transects that were used to establish the base value for the performance standard (Data from S1 and S2).

Prior to construction, mean species density per 100 square meters was 13.8 species based on transects sampled in the S1 and S1 Segments. Following construction, the mean species density was 11.5 species per 100 square meters (see the Table below). Native species decreased from 11.5 to 8.12 species per 100 square meter and introduced species increased from 2.3 to 3.4 species per 100 square meters. These changes are not unusual. The disturbances caused by the construction of the waterline tend to enhance the conditions required by introduced weedy species. Also, native species may require more time for re-establishment.

SOIL GROUP	Mean Number of Species per 100 m ²					
	Native Species - Pre Construction (Data from 15 Transects sampled in 2011: S1 and S2)	S1 Native Species Post Construction (17 Transects)	Introduced Species - Pre Construction (Data from 15 Transects sampled in 2011: S1 and S2)	S1 Introduced Species - Post Construction (17 Transects)	Total Species - Pre Construction (Data from 15 Transects sampled in 2011: S1 and S2)	S1 Total Species - Post Construction (17 Transects)
Type A (Penrose, Manvel and Minnequa)	11.5	8.12	2.3	3.35	13.8	11.47

Noxious Weeds. Only one noxious weed species (Canada thistle – a List B Species) was encountered in the 2014 CSU-SDS vegetation sampling in the Type A Soil Group. This species was found on only one transect and the cover was less than one percent.

**Type B Soil Group (Limon and Heldt Soils)
Approximately 3.8 percent of the S1 Segment**

Pre-Construction Sampling and Base Values for Performance Standards

One transect was sampled in the Type B Soil Group in 2011. Total vegetation cover for the transect was 34 percent compared with the base value of 26.5 percent for the cover performance standard for the Type B soil group (based on 8 transects: one from S1, six from S2 and one from S3).

Post Construction Results

Vegetation Cover. In 2014, the vegetation consultants for CSU-SDS sampled 10 transects in the Type B Soil Group in the S1 Segment. For the Type B soils, the performance standard was established as 90 percent of 26.5 percent, or 23.9 percent (based on 2011 data). The mean total vegetation cover from the CSU-SDS study for the Type B Soil Group in 2014 was 45.7 percent of which 40.3 percent came from acceptable native species. Of this total, seeded species had a mean cover of 36.8 percent, which points to the overall success of the revegetation effort. Cover by introduced annual weedy species [mostly from summer cypress (*Bassia sieversiana*) and Russian thistle] was 5.1 percent. Based on these results, the conclusion is that the 90 percent cover standard was met. For the 10 sampled transects, cover by acceptable species ranged between 28 and 54 percent. All of the transects had cover values greater than the performance standard of 23.9 percent cover.

Species Diversity. The pre-construction data for the Type B Soil Group in the S1 Section showed that 26 species were encountered along the sampled transect. Of this total, 20 were native species and 6 were introduced. Following construction, 41 species were encountered with 29 native species and 12 introduced species. While the total number of species was

somewhat higher following construction, the difference is likely related to the difference between the number of sampled transects (one in 2011 and ten in 2014). The CSU-SDS data show that the percent cover in the different life form groups was different from what was encountered prior to construction (Figure 2). The largest increases in cover occurred in the native perennial grasses (both cool and warm season). The increases in these two groups occurred because these were the species that were seeded.

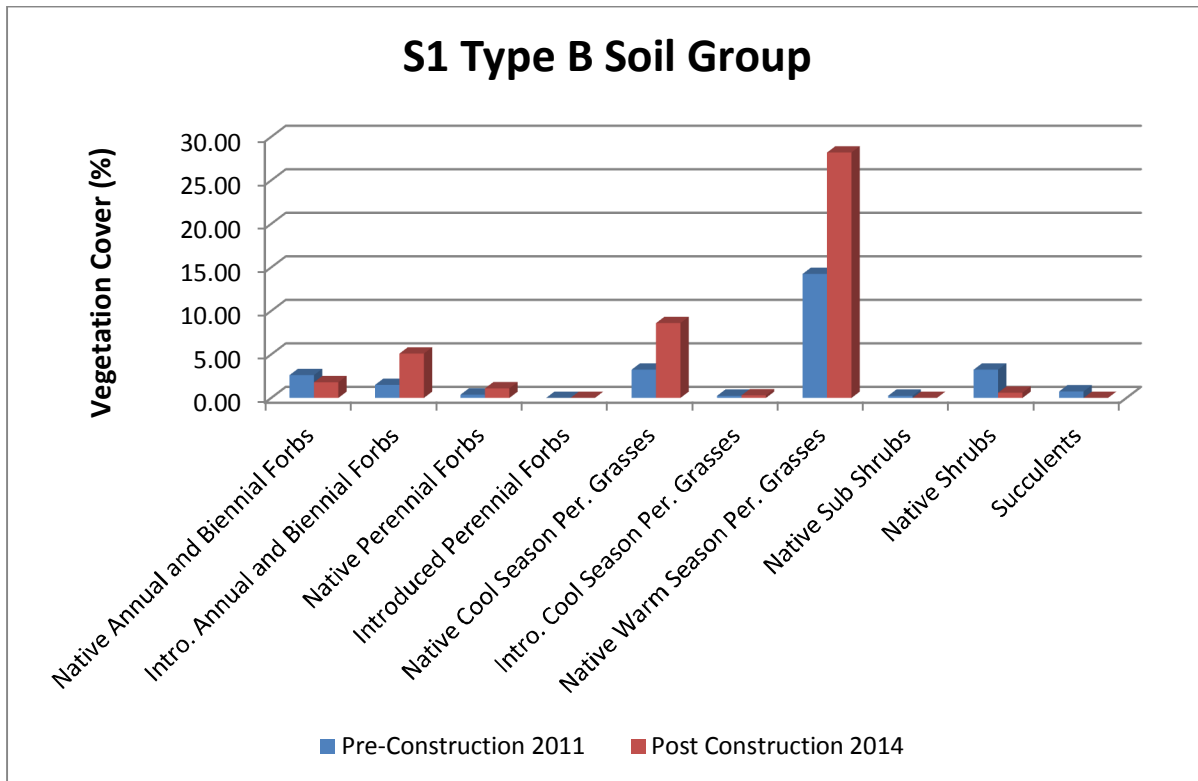


Figure 2. Pre- and Post-Construction vegetation cover by various life form groups in the Type B Soil Group (S1). Pre-construction data from October 2011; post construction data from late August 2014. The pre-construction data are based on all transects that were used to establish the base value for the performance standard (Data from S1, S2 and S3).

Changes were also noted in the number of species per 100 m². Overall, there was an increase in the total number of species per 100 m². This occurred as a result of an increase in the number of introduced species. There was a slight decrease in the number of native species. (See the Table below.)

SOIL GROUP	Mean Number of Species per 100 m ²					
	Native Species - Pre Construction (Data from 8 Transects sampled in 2011: S1, S2 and S3)	S1 Native Species Post Construction (10 Transects)	Introduced Species - Pre Construction (Data from 8 Transects sampled in 2011: S1, S2 and S3)	S1 Introduced Species - Post Construction (10 Transects)	Total Species - Pre Construction (Data from 8 Transects sampled in 2011: S1, S2 and S3)	S1 Total Species - Post Construction (10 Transects)
Type B (Limon and Heldt)	13.6	12.1	2.0	5.2	15.6	17.3

Noxious Weeds. Two noxious weed species (Halogeton and Cheatgrass – Both List C Species) were encountered in the 2014 CSU-SDS vegetation sampling in the Type B Soil Group. Halogeton and cheatgrass were each found on three transects. Where they were encountered, the cover was less than one percent.

Type D Soil Group (Midway-Shale Complex; Shingle Series Soils)
Approximately 7.4 percent of the S1 Segment

Pre-Construction Sampling and Base Values for Performance Standards.

The base vegetation cover values used to develop the performance standard for the Type D Soil Group were derived from four transects sampled in October 2011. Three transects were sampled in the S3 Segment and one transect was sampled in the S2 Segment. None of the transects were sampled in the S1 Segment. The mean cover for the four sampled Type D soils in the S2 and S3 Sections was 17.0 percent with a range of 12 to 24 percent. The 90 percent performance standard for this soil group is 15.3 percent cover by acceptable species.

Post Construction Results

Vegetation Cover. In 2014, the vegetation consultants for CSU-SDS sampled 10 transects in the Type D Soil Group in the S1 Segment. The mean total vegetation cover for this soil group in 2014 was 46.6 percent of which 35.5 percent came from acceptable native species. Of this total, seeded species had a mean cover of 33.4 percent, which points to the overall success of the revegetation effort. Cover by introduced annual weedy species (mostly from two species of Russian thistle and summer cypress) was 11.1 percent. Based on these results, the conclusion is that the 90 percent cover standard was met. For the 10 sampled transects cover by acceptable species ranged between 19 and 56 percent which is above the range that was sampled with the four pre-construction transects (12-24 percent). All of sampled transects exceeded the performance standard for the Type D Soil Group (15.3 percent cover by acceptable species).

Species Diversity. The pre-construction data for the Type D Soil Group showed that 32 species were encountered along the four sampled transects. Of this total, 27 were native species and 5 were introduced. Following construction, 30 species were encountered with 20 native species and 10 introduced species. While the total number of species was somewhat higher following construction, part of the difference is likely related to the difference between the number of sampled transects (four in 2011 and 10 in 2014). The CSU-SDS data show that the percent cover in the different life form groups was different from what was encountered prior to construction (Figure 3). The large increase in cover by introduced annual and biennial forbs is a common result on disturbed and revegetated areas. Most of the cover in this group was provided by two species of Russian thistle and summer cypress. These species are well-adapted to the growing conditions present on newly disturbed sites. Large increases were also noted for native perennial grasses (both cool and warm season). The increases in these two groups occurred because these were the species that were seeded.

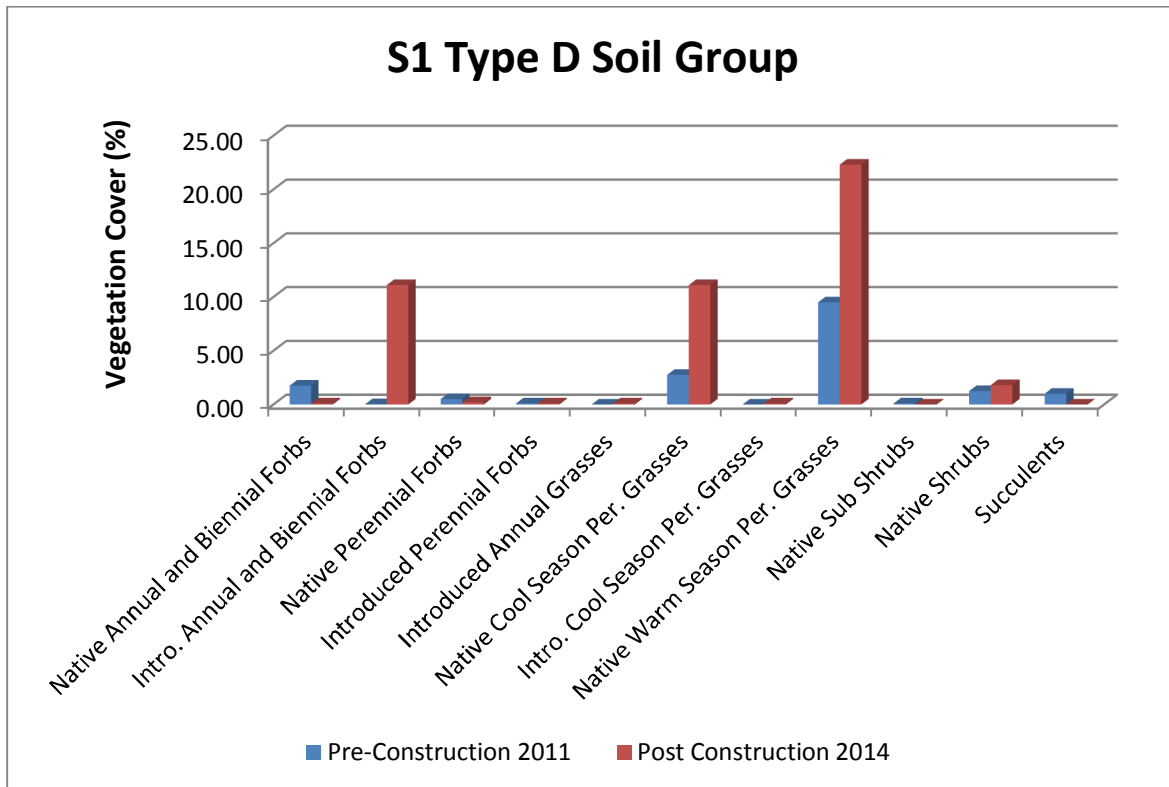


Figure 3. Pre- and Post-Construction vegetation cover by various life form groups in the Type D Soil Group (S1). Pre-construction data from October 2011; post construction data from late August 2014. The pre-construction data are based on the four transects that were used to establish the base value for the performance standard (Data from S2 and S3).

Changes were also noted in the number of species per 100 m². Overall, there was an increase in the total number of species per 100 m². This occurred as a result of an increase in the number of introduced species. There was a slight decrease in the number of native species. (See the Table below.)

SOIL GROUP	Mean Number of Species per 100 m ²					
	Native Species - Pre Construction (Data from 4 Transects sampled in 2011: S2 and S3)	S1 Native Species Post Construction (10 Transects)	Introduced Species - Pre Construction (Data from 4 Transects sampled in 2011: S2 and S3)	S1 Introduced Species - Post Construction (10 Transects)	Total Species - Pre Construction (Data from 4 Transects sampled in 2011: S2 and S3)	S1 Total Species - Post Construction (10 Transects)
Type D (Midway- Shale Complex; Shingle Series)	11.75	10.8	1.75	3.8	13.5	14.6

Noxious Weeds. Two noxious weed species (Halogeton and Cheatgrass - Both List C Species) were encountered in the 2014 CSU-SDS vegetation sampling in the Type D Soil Group. Halogeton was observed along one transect and cheatgrass was found on three transects. Vegetation cover by each of these species was less than one percent.

SUMMARY

- All of the Soil Groups that were sampled in the S1 Section met the mean cover performance standard (attaining at least 90 percent of the mean cover values that were present before construction).
- All of the sampled transects in Soil Group B and Soil Group D exceeded the cover standard for their soil group. All but four of the transects in Soil Group A exceeded the cover standard. The four transects that did not exceed the standard were only slightly below the standard.
- While changes in species diversity have occurred, numerous species were encountered on all of the sampled transects. Adequate levels of species diversity have been accomplished in the reclaimed areas.
- Some changes in cover by different life form groups have occurred. Introduced annual and biennial forbs have increased in the amount of cover compared to pre-conditions. Also, cover by native cool and warm season grasses has increased. This should be viewed as a positive result since these species have the potential for providing long-term vegetation stability on the reclaimed areas. These grass species were included in the seed mix used to reclaim the areas.
- While several noxious weed species were noted in the reclaimed areas, they had low cover values and never occurred at mean amounts greater than one percent cover.
- Based on the information presented in the CSU-SDS report, the conclusion should be made that the revegetation requirements of the 1041 Permit have been met.