

\*\*\*FINAL REPORT\*\*\*

REVIEW OF:

COLORADO SPRINGS UTILITIES SOUTHERN DELIVERY SYSTEM

**RESTORED VEGETATION COVER MONITORING - WORK SEGMENT S2****September, 2014**

Report prepared by:  
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**INTRODUCTION**

This review of the 2014 report addressing vegetation sampling by CSU-SDS along the S2 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 Torrifluvents)			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 within the identified soil groups along the water pipeline ROW in Segment S2. There are four soil groups that were sampled in the S2 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)  
Soil Group Type F (Haverson Series Soils; Ustic Torrifluvents)

In the sections which follow, the results from each of the four soil groups are discussed separately.

### **Type A Soil Group    (Penrose, Manvel and Minnequa Soils) Approximately 67.2 percent of the S2 Segment**

Pre-Construction Sampling and Base Values for Performance Standards.

Thirteen transects were sampled in the Type A Soil Group in the S2 segment in 2011. Data from eleven of these transects were included in the set of transects used to develop the performance standard for the Type A Soil Group. The two transects that were not included were sampled in areas with high prairie dog use so the vegetation cover was limited (2 and 6 percent). Mean total vegetation cover for the 11 transects that were included in the performance standard was 16 percent. The mean cover for all 13 sampled transects in the Type A soils in the S2 Section (pre-construction) was 15.7 percent compared with the base vegetation cover value of 17.2 percent used to derive the cover performance standard for the Type A soil group (based on 15 transects: 4 from S1 and 11 from S2). In general, these results show that if all the sampled Type A transects in the S2 Section are included in the pre-construction evaluation, the mean total vegetation cover value is somewhat less than the base value developed for the Type A soils in the S1 and S2 sections combined. Also, the range of cover values was greater (2-39% in S2 and 8-39% for S1 and S2 combined).

## Post Construction Results

Vegetation Cover. In 2014, the vegetation consultants for CSU-SDS sampled 15 transects in the Type A Soil Group in the S2 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 43.2 percent of which 19.5 percent came from acceptable native species. Of this total, seeded species had a mean cover of 16.9 percent, which points to the overall success of the revegetation effort. Cover by introduced annual weedy species (mostly from Russian thistle and summer cypress) was 23.7 percent. Based on these results, the conclusion is that the 90 percent cover standard was met. For the 15 sampled transects, cover by acceptable species ranged between <1 and 36 percent which is somewhat outside the range that was sampled with the 13 pre-construction transects (2-39 percent) in the S2 Segment. Five of the transects had less cover than the performance standard of 15.5 percent cover, and the cover along those transects was <1, 3, 6, 11 and 15 percent. These results suggest that some sparse areas still occur along the S2 Segment. In places where the cover by acceptable species was low (Transects with <1, 3 and 6 percent cover), the cover by introduced annual and biennial forbs (Russian thistle and summer cypress, mostly) was 30, 35 and 43 percent, respectively. It is important to note that sparse areas were also encountered during the pre-construction study in 2011. However, the CSU-SDS report does not include any evaluation of whether the sparse areas noted in 2011 coincide with the sparse areas noted in 2014.

Species Diversity. The pre-construction data for the Type A Soil Group in the S2 Section showed that 67 species were encountered along the sampled transects. Of this total, 55 were native species and 12 were introduced. Following construction, 65 species were encountered with 49 native species and 16 introduced species. While the total number of species was approximately the same (pre- and post-construction), 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 Russian thistle and summer cypress (*Bassia sieversiana*). These species 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. The changes in abundance of the different species groups in the S2 Segment were similar to what was observed in the S1 Segment for this Soil Group.

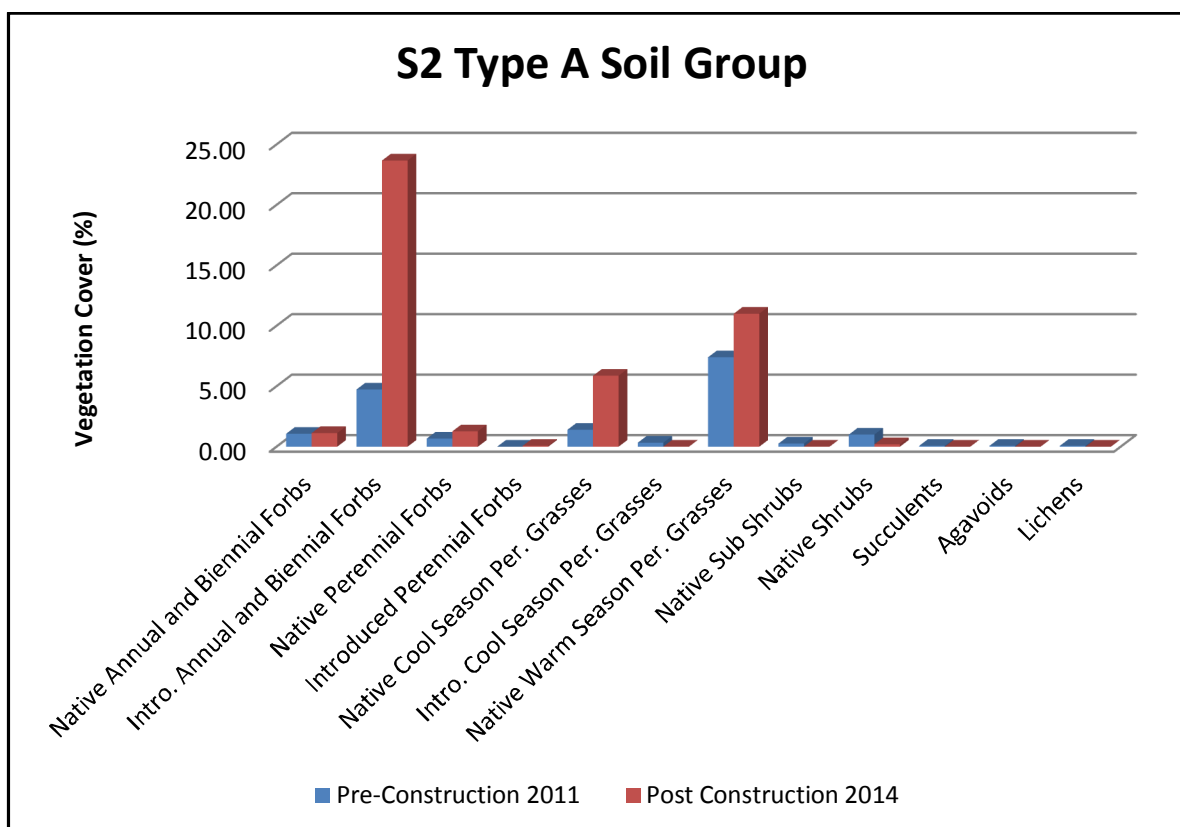


Figure 1. Pre- and Post-Construction vegetation cover by various life form groups in the Type A Soil Group (S2). Pre-construction data from October 2011; post construction data from late August 2014. The pre-construction data are based on all the transects that were used to establish the base value for 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 S2 Segments. Following construction, the mean species density was 21.9 species per 100 square meters (see the Table below). Native species increased from 11.5 to 16.5 species per 100 square meters and introduced species increased from 2.3 to 5.3 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. The increase in native species was related to the increased abundance of the seeded species.

SOIL GROUP	Mean Number of Species per 100 m <sup>2</sup>					
	Native Species - Pre Construction (Data from 15 Transects sampled in 2011: S1 and S2)	S2 Native Species Post Construction (15 Transects)	Introduced Species - Pre Construction (Data from 15 Transects sampled in 2011: S1 and S2)	S2 Introduced Species - Post Construction (15 Transects)	Total Species - Pre Construction (Data from 15 Transects sampled in 2011: S1 and S2)	S2 Total Species - Post Construction (15 Transects)
Type A (Penrose, Manvel and Minnequa)	11.5	16.5	2.3	5.3	13.8	21.9

Noxious Weeds. Two noxious weed species (cheatgrass and halogeton – both List C Species) were encountered in the 2014 CSU-SDS vegetation sampling in the Type A Soil Group in the S2 Segment. These species were encountered infrequently, and the mean cover for each of the species was less than one percent.

**Type B Soil Group (Limon and Heldt Soils)**  
**Approximately 23.1 percent of the S2 Segment**

**Pre-Construction Sampling and Base Values for Performance Standards**

In 2011 prior to construction, six transects were sampled in the Type B Soil Group in the S2 Segment. Total vegetation cover for these six transect was 27.3 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). In the S2 Segment, cover values ranged between 15 and 44 percent. Four of the transects had cover values that were less than mean S2 value of 27.3 percent (15, 16, 20 and 26).

**Post Construction Results**

Vegetation Cover. In 2014, the vegetation consultants for CSU-SDS sampled 15 transects in the Type B Soil Group in the S2 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 45.3 percent of which 38.7 percent came from acceptable native species. Of this total, seeded species had a mean cover of 31.2 percent, which points to the overall success of the revegetation effort. Cover by introduced annual weedy species (from a variety of species) was 6.6 percent. Based on these results, the conclusion is that the 90 percent cover standard was met. For the 15 sampled transects, cover by acceptable species ranged between 19 and 61 percent. Only one transect had a cover value by native species that was less than the performance standard of 23.9 percent cover.

Species Diversity. The pre-construction data for the Type B Soil Group in the S2 Section showed that 49 species were encountered along the sampled transects. Of this total, 37 were native species and 12 were introduced. Following construction, 72 species were encountered with 52 native species and 20 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 (six in 2011 and 15 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.

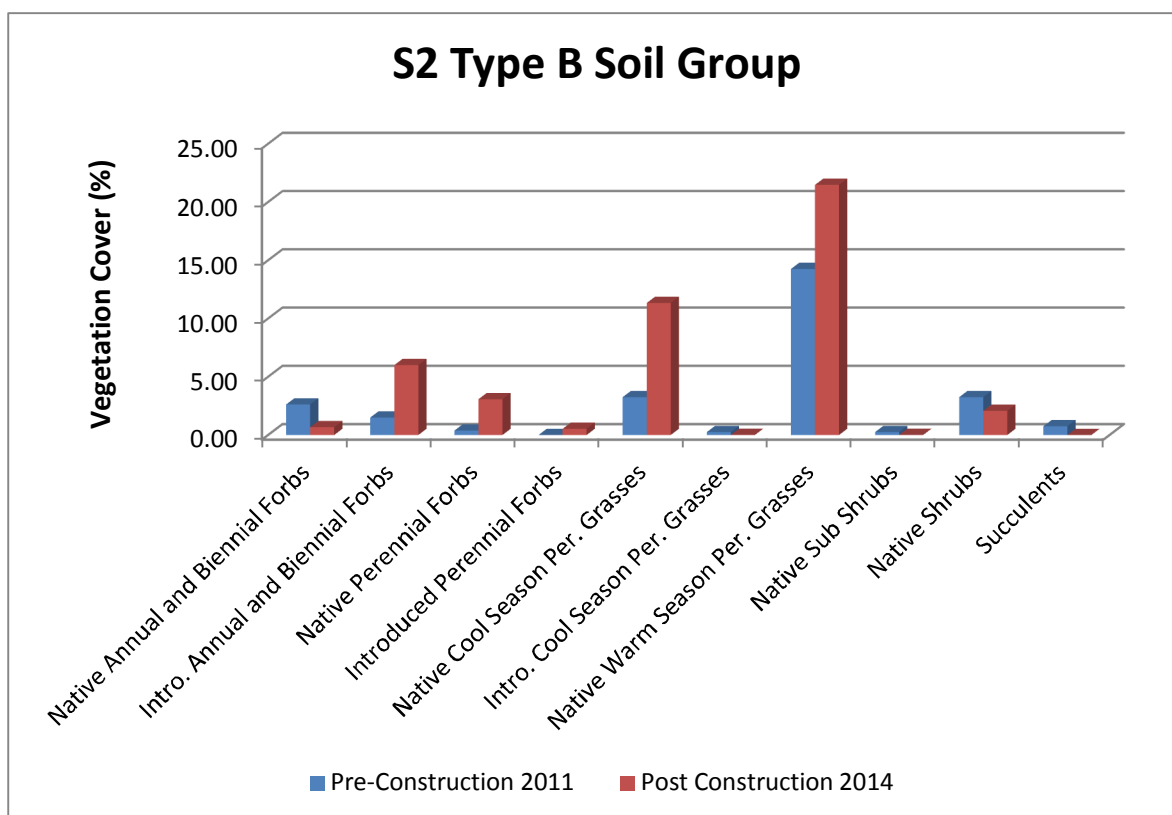


Figure 2. Pre- and Post-Construction vegetation cover by various life form groups in the Type B Soil Group (S2). Pre-construction data from October 2011; post construction data from late August 2014. The pre-construction data are based on all transects that were used to establish the base value for the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

Changes were also noted in the number of species per 100 m<sup>2</sup>. Overall, there was an increase in the total number of species per 100 m<sup>2</sup>. This occurred as a result of an increase in the number of introduced species. The increase in the number of native species mostly results from the widespread abundance of the seeded species (See the Table below.)

SOIL GROUP	Mean Number of Species per 100 m <sup>2</sup>					
	Native Species - Pre Construction (Data from 8 Transects sampled in 2011: S1, S2 and S3)	S2 Native Species Post Construction (15 Transects)	Introduced Species - Pre Construction (Data from 8 Transects sampled in 2011: S1, S2 and S3)	S2 Introduced Species - Post Construction (15 Transects)	Total Species - Pre Construction (Data from 8 Transects sampled in 2011: S1, S2 and S3)	S2 Total Species - Post Construction (15 Transects)
Type B (Limon and Heldt)	13.6	17.1	2.0	5.6	15.6	22.7

Noxious Weeds. One B List noxious weed species (Canada thistle – *Cirsium arvense*) was encountered in the Type B Soil Group in the S2 Segment. Cover by this species was less than one percent. Three C List noxious weed species [*Halogeton* (*Halogeton glomeratus*), Cheatgrass (*Bromus tectorum*) and field bindweed (*Convolvulus arvensis*)] were encountered in the S2 Segment Type B Soil Group. Cheatgrass was encountered along six of the 15 transects and had a mean cover of less than one percent. Field bindweed was encountered along one transect and had a mean cover of less than one percent. Halogeton was encountered on 11 of the 15 transects and had a mean cover of 1.6 percent. The abundance of halogeton was variable. Mostly the

cover values were less than one percent, but on one of the transects, cover by halogeton was 18 percent. Prior to construction, halogeton was encountered along only one of the six transects sampled in the S2 segment and the cover by halogeton along that transect was less than one percent. These results suggest that some additional weed control for this noxious weed species may be required.

**Type D Soil Group (Midway-Shale Complex; Shingle Series Soils)**  
**Approximately 5.6 percent of the S2 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. Total vegetation cover for the single transect in the S2 Segment was 12 percent. 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 S2 Segment. The mean total vegetation cover for this soil group in 2014 was 39.5 percent of which 27.3 percent came from acceptable native species. Of this total, seeded species had a mean cover of 22.7 percent compared to the performance standard of 15.3 percent, which points to the overall success of the revegetation effort. Cover by introduced annual weedy species (mostly from a species of Russian thistle) was 12.2 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 7 and 45 percent which was a higher range that was sampled with the four pre-construction transects (12-24 percent). Seven of the sampled transects exceeded the performance standard for the Type D Soil Group (15.3 percent cover by acceptable species). Cover values along transects that were less than the standard were 7, 12 and 14 percent. The single transect that was sampled in 2011 in Soil Group D along the S2 segment had a cover value of 12 percent.

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, 65 species were encountered with 51 native species and 14 introduced species. While the total number of species was 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 a species of Russian thistle. This species is 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.



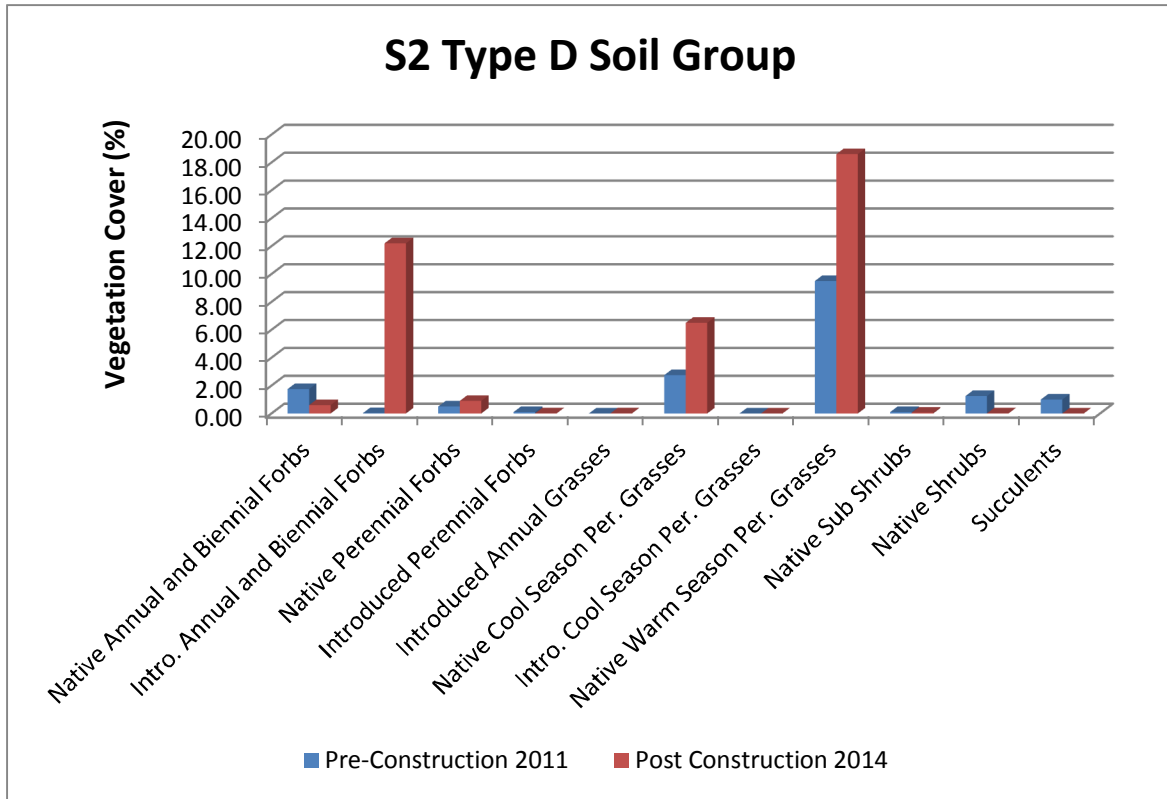


Figure 3. Pre- and Post-Construction vegetation cover by various life form groups in the Type D Soil Group (S2). Pre-construction data from October 2011; post construction data from late August 2014. The pre-construction data are based on the four transects that were used to establish the base value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

Changes were also noted in the number of species per 100 m<sup>2</sup>. Overall, there was an increase in the total number of species per 100 m<sup>2</sup>. This occurred as a result of an increase in the number of native species. There was also a slight increase in the number of introduced species. (See the Table below.)

SOIL GROUP	Mean Number of Species per 100 m <sup>2</sup>					
	Native Species - Pre Construction (Data from 4 Transects sampled in 2011: S2 and S3)	S2 Native Species Post Construction (10 Transects)	Introduced Species - Pre Construction (Data from 4 Transects sampled in 2011: S2 and S3)	S2 Introduced Species - Post Construction (10 Transects)	Total Species - Pre Construction (Data from 4 Transects sampled in 2011: S2 and S3)	S2 Total Species - Post Construction (10 Transects)
Type D (Midway- Shale Complex; Shingle Series)	11.75	17.3	1.75	3.9	13.5	21.2

Noxious Weeds. One noxious weed species (Halogeton - a List C Species) was encountered in the 2014 CSU-SDS vegetation sampling in the Type D Soil Group. Halogeton was observed along one transect and the cover was less than one percent.

**Type F Soil Group (Haverson Series and Ustic Torrifuvents)**  
**Approximately 4.1 percent of the S2 Segment**

**Pre-Construction Sampling and Base Values for Performance Standards.**

The base vegetation cover values used to develop the performance standard for the Type F Soil Group were derived from three transects sampled in October 2011. Two transects were sampled in the S2 Segment and one transect was sampled in the S3 Segment. Mean total vegetation cover for the transects in the S2 Segment was 30 percent. The mean cover for the three sampled Type F soils in the S2 and S3 Sections was 41.3 percent with a range of 15 to 64 percent. The 90 percent performance standard for this soil group is 37.2 percent cover by acceptable species.

**Post Construction Results**

Vegetation Cover. In 2014, the vegetation consultants for CSU-SDS sampled 10 transects in the Type F Soil Group in the S2 Segment. The mean total vegetation cover for this soil group in 2014 was 61.2 percent of which 45 percent came from acceptable native species. Of this total, seeded species had a mean cover of 33.1 percent compared to the performance standard of 37.2 percent. The remainder of the cover by acceptable species comes from native species which have re-grown on the disturbed areas. Cover by introduced annual weedy species (mostly from a species of Russian thistle and summer cypress) was 15.9 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 34 and 61 percent which was better than the range that was recorded with the three pre-construction transects (15-64 percent). Eight of the sampled transects exceeded the performance standard for the Type F Soil Group (37.2 percent cover by acceptable species). Cover values along transects that were less than the standard were 34 and 37 percent. The two transects that were sampled in 2011 in Soil Group F along the S2 segment had a mean cover value of 30 percent.

Species Diversity. The pre-construction data for the Type F Soil Group showed that 37 species were encountered along the three sampled transects. Of this total, 31 were native species and six were introduced. Following construction, 51 species were encountered with 41 native species and 10 introduced species. While the total number of species was higher following construction, part of the difference is likely related to the difference between the number of sampled transects (three 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 4). 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 a 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 (mostly warm season). The increases in these two groups occurred because these were the species that were seeded.

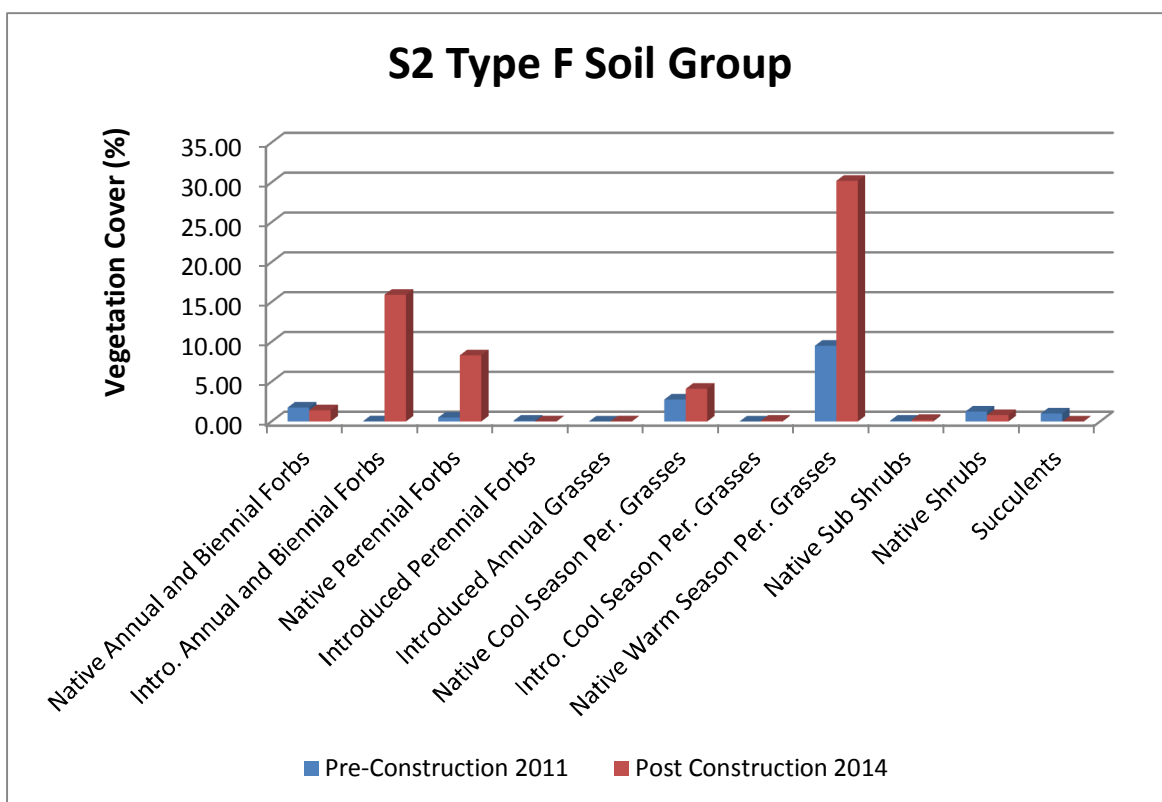


Figure 4. Pre- and Post-Construction vegetation cover by various life form groups in the Type F Soil Group (S2). Pre-construction data from October 2011; post construction data from late August 2014. The pre-construction data are based on the three transects that were used to establish the base value for the performance standard (Data from S2 and S3).

Changes were also noted in the number of species per 100 m<sup>2</sup>. Overall, there was an increase in the total number of species per 100 m<sup>2</sup>. This occurred as a result of an increase in the number of native species. There was also a slight increase in the number of introduced species. (See the Table below.)

SOIL GROUP	Mean Number of Species per 100 m <sup>2</sup>					
	Native Species - Pre Construction (Data from 3 Transects sampled in 2011: S2 and S3)	S2 Native Species Post Construction (10 Transects)	Introduced Species - Pre Construction (Data from 3 Transects sampled in 2011: S2 and S3)	S2 Introduced Species - Post Construction (10 Transects)	Total Species - Pre Construction (Data from 4 Transects sampled in 2011: S2 and S3)	S2 Total Species - Post Construction (10 Transects)
Type F (Haverson Series; Ustic Torrifluvents)	14.7	20.7	3.3	5.1	18.0	25.8

Noxious Weeds. No noxious weed species were encountered in Type F Soil Group along the S2 Segment.

## SUMMARY

- All of the Soil Groups that were sampled in the S2 Section met the mean cover performance standard (attaining at least 90 percent of the mean cover values that were present before construction).
- Cover by acceptable species along most of the sampled transects in the four Soil Groups exceeded the cover standard for their soil group. Several transects in Soil Group A had very low cover by seeded species.
- 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-construction conditions. Also, cover by native cool and warm season grasses has increased. The increase in cover by native grasses 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 mostly had mean cover values that were less than one percent. The only exception to this was halogeton which was commonly encountered in the Type B Soil Group where it occurred along 11 of 15 of the sampled transects and had a mean cover of 1.6 percent. (Note: On Transect 12 in the Type B Soil Group, halogeton had a cover value of 18 percent).
- Based on the information presented in the CSU-SDS report, the conclusion should be made that the revegetation requirements of the 1041 Permit have mostly been met, however some issues remain:
  1. It appears that some sites with very sparse cover by seeded species occur in the Type A Soil Group (Penrose, Manvel and Minnequa). One of the sampled transects had less than one percent cover by seeded species. Two other transects had only two and six percent cover by seeded species. These low values were offset by high values along other transects so that the mean cover standard was met. It would be useful to know the extent of the sparse areas, especially with regard to the potential for increasing cover by the seeded species.
  2. Halogeton (a List C noxious weed species) commonly occurs in the Type B Soil Group (Limon and Heldt). The transect data show that in one location the cover by this species was measured at 18 percent. The noxious weed provision in the 1041 permit states that *"Applicant shall control spread of noxious weeds resulting from project construction."* Prior to construction, cover by halogeton in the Type B Soil Group in the S2 Section was less than one percent.