

Hanford Site Revegetation Monitoring Report for Fiscal Year 2018



Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management
Contractor for the U.S. Department of Energy
under Contract DE-AC06-09RL14728



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February 2019

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TABLE OF CONTENTS

1.0 Introduction..... 1

2.0 Methods..... 4

3.0 Monitoring Results – 5-Year Monitoring Sites 6

 3.1 100 B/C Area Sites..... 6

 3.1.1 100-C-7:1 Site (183-C Water Treatment Facility Head House Foundation) 6

 3.1.2 Pit 24 Site (600-253, Gravel Pit #24)..... 10

 3.1.3 100-B-35 Site (Electrical Substation) 14

 3.2 100-K Area Sites 16

 3.3 100-N Area Sites 16

 3.3.1 130-N-1:1 Site (183-N Northeastern Backwash Discharge Pond) 17

 3.3.2 100-N-96 Site (Military Camp Disposal Pits) 20

 3.3.3 100-N-83 Site (Cleaned Contamination Area) 22

 3.3.4 100-N Container Transfer Area (CTA) Site 25

 3.3.5 100-N-61:1 (Underground Pipelines) 29

 3.4 100-D Area Sites 32

 3.4.1 100-D-30/104 Site (183-N Northeastern Backwash Discharge Pond) 32

 3.4.2 100-D-100 Site (Process Sewer, Unplanned Release 183-DR Railroad Tracks) ... 35

 3.4.3 100-D Trailer Village Site 38

 3.4.4 100-D-48:2 Site (Underground Pipelines) 39

 3.4.5 100-D-49:2 Site (Underground Pipelines) 41

 3.4.6 116-D-8 Site (Cask Storage Pad)..... 43

 3.5 100-H Area Sites 45

 3.5.1 100-H-28:2 Site (Process Sewer Area)..... 46

 3.5.2 600-385 Site (Dump Site) 48

 3.5.3 100-H-24 Site (Substation) 51

 3.5.4 116-H-1 Site (Liquid Waste Disposal Trench) 53

 3.6 100-F Area Sites..... 55

 3.6.1 100-F-47 Site (151-F Substation) 56

 3.6.2 100-F-48 Site (184-F Coal Pit Debris Dump Site) 58

 3.6.3 118-F-1 Site (Burial Ground)..... 60

 3.6.4 118-F-6 Site (Soil Staging Area) 62

3.6.5	100-F CTA Site (Container Transfer Area)	65
3.6.6	100-F Trailer Village Site	67
3.6.7	118-F-5 Site (Sawdust Pit).....	68
3.6.8	100-F-57 Site (190-F Water Pump House Debris)	71
3.6.9	100-F-26 Site (Water Treatment Facility Pipelines).....	73
3.6.10	118-F-3 Site (Burial Ground).....	75
3.6.11	Discussion: Revegetation Methods and Effectiveness of Additional Actions.....	77
3.7	100-IU-2 and 100-IU-6 Area Sites.....	79
3.7.1	600-301 Site (White Bluffs Sanitary Sewer Pipelines).....	80
3.7.2	600-369:3 Site (Dump Area)	82
3.7.3	600-370 Site (Dump Area).....	84
3.7.4	600-356 Site (Dump Area).....	86
3.7.5	600-379 Site (Burn Area).....	88
3.7.6	600-358 Site (Gable Mountain Fringe Dump Area).....	90
3.8	300 Area Sites	92
3.8.1	300-288:2 Container Transfer Area Site.....	92
3.8.2	300-North A-D Site (Various Facilities).....	95
3.8.3	618-2&3 Site (Solid Waste Burial Ground).....	97
3.9	200 Area Sites	99
3.9.1	200-West (L-840) Export Water Pipeline Site.....	100
3.9.2	200-East (L-525) Export Water Pipeline Site.....	103
3.9.3	200-East (L-419) Export Water Pipeline Site.....	106
4.0	Monitoring Results – Long Term Trend Monitoring Sites.....	108
4.1	100 B/C Area Sites.....	108
4.1.1	116-B/C Miscellaneous Site	108
4.1.2	100-C-9 Site (Underground Sewer Lines)	111
4.1.3	118-B-2/3 Site (Burial Ground).....	114
4.1.4	128-C-1 Site (Burn Pit).....	118
4.2	100 K Area Sites	121
4.2.1	116-K-1 Site (100-K Crib).....	121
4.2.2	116-K-2 Site (Mile Long Trench).....	123
4.3	100 N Area Sites	126
4.3.1	116-N-3 Site (1325-N Crib and Trench).....	126

4.3.2	120-N-1&2 (Percolation Pond).....	129
4.4	100 D Area Sites	133
4.4.1	116-D/DR-North.....	133
4.5	100 F Area Site.....	136
4.5.1	116-F-14 Site (107-F Retention Basin).....	136
4.6	300 Area Sites	139
4.6.1	618-4 Site (Burial Ground).....	139
4.6.2	316-1 Site / 300 RFBP Site (300 Area South Process Pond).....	143
5.0	Discussion.....	146
5.1	5-Year Monitoring Sites.....	146
5.2	Long-Term Trend Sites	152
6.0	References.....	155

APPENDIX

A	2018 REVEGETATION MONITORING TAXONOMY LIST.....	A-i
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FIGURES

Figure 1.	Map of Revegetation Sites Monitored in 2018.....	3
Figure 2.	The 100-C-7:1 Site in 2018. Top: Excavation Footprint Portion of the 100-C-7:1 Site in 2018. Bottom: Overview of Area 7 (outside of the excavation footprint) of the 100-C-7:1 Site in 2018.....	10
Figure 3.	Overview of the Pit 24 Site in 2018. Looking West from the East End of the Site. The White Arrows Show Areas Where Established Riparian Transects were Under Water.	11
Figure 4.	Overview of Western Pond in Pit 24, Photo Taken From Northwest Facing Southeast	14
Figure 5.	The 100-B-35 Site in 2018, From the Western End Looking East.	16
Figure 6.	The 130-N-1:1 Site in 2018. Top: Predominantly Loamy Area of Site. Bottom: Predominantly Cobbled Area of Site.....	20
Figure 7.	The 100-N-96 Site in 2018.....	22

Figure 8. The 100-N-83 Site in 2018. Top: Area 1 (lower portion) of the 100-N-83 Site in 2018. Bottom: Area 2 (upper portion) of the 100-N-83 Site in 2018.....	25
Figure 9. The 100-N Container Transfer Area Site in 2018. Top: Area 1 (lower portion) of the 100-N CTA Site in 2018. Bottom: Area 2 (upper portion) of the 100-N CTA Site in 2018.....	29
Figure 10. The Backfilled Portion of the 100-N-61:1 Site in 2018.	31
Figure 11. The 100-D-30/104 Site in 2018. Top: North Portion of the 100-D-30/104 Site in 2018. Bottom: South Portion of the 100-D-30/104 Site in 2018.	35
Figure 12. The 100-D-30/104 Site in 2018. Top: North Portion of the 100-D-100 Site in 2018. Bottom: South Portion of the 100-D-100 Site in 2018.....	37
Figure 13. The 100-D Trailer Village Site in 2018.....	39
Figure 14. The 100-D-48:2 Site in 2018.....	41
Figure 15. The 100-D-49:2 Site in 2018.....	43
Figure 16. The 116-D-8 Site in 2018.....	45
Figure 17. The 100-H-28:2 Site in 2018. Top: North Portion of the 100-H-28:2 Site in 2018. Bottom: South Portion of the 100-H-28:2 Site in 2018.....	48
Figure 18. The 600-385 Site in 2018.	50
Figure 19. The 100-H-24 Site in 2018.....	52
Figure 20. The 116-H-1 Site in 2018.....	55
Figure 21. The 100-F-47 Site in 2018.....	58
Figure 22. The 100-F-48 Site in 2018.....	60
Figure 23. The 118-F-1 Site in 2018, Viewed From East to West.	62
Figure 24. The 118-F-6 Soil Staging Area Site in 2018.	64
Figure 25. The 100-F CTA Site in 2018, Looking Towards the Southwest.....	66
Figure 26. The 100-F Trailer Village in 2018, View from South to North.	68
Figure 27. The 118-F-5 Site in 2018, Showing Heavier Cobble in the Northwestern Section.....	70
Figure 28. The 100-F-57 Site in 2018, View to the West.....	73
Figure 29. The 100-F-26 Site in 2018 Showing High Levels of Cheatgrass Cover, View Facing West.....	75
Figure 30. The 118-F-3 Site in 2018.....	77
Figure 31. Uniform Divets Left by the Imprinter at the 118-F-6 Area.....	77
Figure 32. The 600-301 Site in 2018.	82
Figure 33. The 600-369:3 Site in 2018.....	84
Figure 34. The 600-370 Site in 2018.	86

Figure 35. The 600-356 Site in 2018.	88
Figure 36. The 600-379 Site in 2018.	90
Figure 37. The 600-358 Site in 2018, Mainly Showing the Roadway Portion of the Site.	92
Figure 38. The 300-288:2 Site in 2018.	95
Figure 39. The 300-North A-D Site in 2018.	97
Figure 40. The 618-2&3 Site in 2018, Showing the 618-3 Portion of the Site.	99
Figure 41. The 200-West (L-840) Export Water Pipeline Site in 2018. Top: View to the Northeast from the Central Portion of the L-840 Export Water Pipeline Site in 2018. Bottom: Sagebrush Recruits at the L-840 Export Water Pipeline Site in 2018.	102
Figure 42. The 200-East (L-525) Export Water Pipeline Site in 2018. Top: View to the Southwest from the Central Portion of the 200-East Export Waterline Site in 2018. Bottom: View to the Southeast from the Central Portion of the 200-East Export Waterline Site in 2018.	105
Figure 43. The Export Water Pipeline Site (L-419) in 2018.	107
Figure 44. Overview of the 116-B/C Misc. Site in 2018, Looking North to South.	110
Figure 45. The 100-C-9 Site in 2009.	113
Figure 46. The 100-C-9 Site in 2018.	113
Figure 47. High Amounts of Cobble at the 118-B-2/3 Site in 2018.	116
Figure 48. Overview of the 118-B-2/3 Site in 2009, From East Side Facing West.	117
Figure 49. Overview of the 118-B-2/3 Site in 2018, From West Corner Facing Southeast.	117
Figure 50. The 128-C-1 Site in 2010.	120
Figure 51. The 128-C-1 Site in 2018.	120
Figure 52. The 116-K-1 Site in 2018.	123
Figure 53. The 116-K-2 Site in 2018.	126
Figure 54. Bluebunch Wheatgrass Growing at the 116-N-3 Site in 2009.	129
Figure 55. Overview of the 116-N-3 Site in 2018.	129
Figure 56. 120-N-1&2 Site in 2007.	132
Figure 57. 120-N-1&2 Site in 2018.	132
Figure 58. The 116-D/DR-North Site in 2006.	135
Figure 59. The 116-D/DR Site in 2018.	136
Figure 60. The 116-F-14 Site in 2008.	138
Figure 61. The 116-F-14 Site in 2018.	139
Figure 62. The 618-4 Burial Ground Site in 2010.	142

Figure 63. The 618-4 Burial Ground Site in 2018. 142
 Figure 64. Revegetated Process Ponds in the 300-FF-1 Operable Unit (2006). 145
 Figure 65. The 316-1 / 300 RFBP Site in 2018. 145
 Figure 66. Substrate at the 100-D-30/104 Site, Showing High Amounts of Cobble. 148

TABLES

Table 1. Percent Canopy Cover and Frequency of Occurrence at the 100-C-7:1 Site in 2018. (3 Pages) 7
 Table 2. Percent Canopy Cover and Frequency of Occurrence at Pit 24 Site (Upland Areas) in 2018. (2 Pages) 12
 Table 3. Percent Canopy Cover and Frequency of Occurrence at the 100-B-35 Site in 2018. 15
 Table 4. Percent Canopy Cover and Frequency of Occurrence at the 130-N-1:1 Site in 2018. (2 Pages) 18
 Table 5. Percent Canopy Cover and Frequency of Occurrence at the 100-N-96 Site in 2018. (2 Pages) 21
 Table 6. Percent Canopy Cover and Frequency of Occurrence at the 100-N-83 Site in 2018. (2 Pages) 23
 Table 7. Percent Canopy Cover and Frequency of Occurrence at the 100-N CTA Site in 2018. (2 Pages) 27
 Table 8. Percent Canopy Cover and Frequency of Occurrence at the 100-N-61:1 Site in 2018. 30
 Table 9. Percent Canopy Cover and Frequency of Occurrence at the 100-D-30/104 Site in 2018. (2 Pages) 33
 Table 10. Percent Canopy Cover and Frequency of Occurrence at the 100-D-100 Site in 2018. 36
 Table 11. Percent Canopy Cover and Frequency of Occurrence at the 100-D Trailer Village Site in 2018. (2 Pages) 38
 Table 12. Percent Canopy Cover and Frequency of Occurrence at the 100-D-48:2 Site in 2018. (2 Pages) 40
 Table 13. Percent Canopy Cover and Frequency of Occurrence at the 100-D-49:2 Site in 2018. (2 Pages) 42
 Table 14. Percent Canopy Cover and Frequency of Occurrence at the 116-D-8 Site in 2018. 44

Table 15. Percent Canopy Cover and Frequency of Occurrence at the 100-H-28:2 Site in 2018. (2 pages).	46
Table 16. Percent Canopy Cover and Frequency of Occurrence at the 600-385 Site in 2018. (2 Pages)	49
Table 17. Percent Canopy Cover and Frequency of Occurrence at the 100-H-24 Site in 2018. (2 Pages).	51
Table 18. Percent Canopy Cover and Frequency of Occurrence at the 116-H-1 Site in 2018. (2 Pages).	53
Table 19. Percent Canopy Cover and Frequency of Occurrence at the 100-F-47 Site in 2018. (2 Pages)	57
Table 20. Percent Canopy Cover and Frequency of Occurrence at the 100-F-48 Site in 2017. (2 Pages)	59
Table 21. Percent Canopy Cover and Frequency of Occurrence at the 118-F-1 Site in 2018.	61
Table 22. Percent Canopy Cover and Frequency of Occurrence at the 118-F-6 Soil Staging Area Site in 2018. (2 Pages)	63
Table 23. Percent Canopy Cover and Frequency of Occurrence at the 100 F CTA Site in 2018. (2 Pages)	65
Table 24. Percent Canopy Cover and Frequency of Occurrence at the 100-F Trailer Village Site in 2018. (2 Pages)	67
Table 25. Percent Canopy Cover and Frequency of Occurrence at the 118-K-5 Site in 2018. (2 Pages)	69
Table 26. Percent Canopy Cover and Frequency of Occurrence at the 100-F-57 Site in 2018. (2 Pages)	71
Table 27. Percent Canopy Cover and Frequency of Occurrence at the 100-F-26 Site in 2018.	74
Table 28. Percent Canopy Cover and Frequency of Occurrence at the 118-F-3 Site in 2018.	76
Table 29. Treatments and Results from 100-F Revegetation Actions in 2018.	78
Table 30. Summarized Results by Revegetation Treatment.	78
Table 31. Percent Canopy Cover and Frequency of Occurrence at the 600-301 Site in 2018. (2 Pages)	80
Table 32. Percent Canopy Cover and Frequency of Occurrence at the 600-369:3 Site in 2018.	83
Table 33. Percent Canopy Cover and Frequency of Occurrence at the 600-370 Site in 2018.	85
Table 34. Percent Canopy Cover and Frequency of Occurrence at the 600-356 Site in 2018.	87

Table 35. Percent Canopy Cover and Frequency of Occurrence at the 600-379 Site in 2018.	89
Table 36. Percent Canopy Cover and Frequency of Occurrence at the 600-358 Site in 2018.	91
Table 37. Percent Canopy Cover and Frequency of Occurrence at the 300-288:2 CTA Site in 2018. (2 Pages).....	93
Table 38. Percent Canopy Cover and Frequency of Occurrence at the 300-North A-D Site in 2018.....	96
Table 39. Percent Canopy Cover and Frequency of Occurrence at the 618-2&3 Site in 2018.	98
Table 40. Percent Canopy Cover and Frequency of Occurrence at the 200 West (L-840) Export Water Pipeline Site in 2018. (2 Pages).....	100
Table 41. Percent Canopy Cover and Frequency of Occurrence at the 200 West (L-525) Water Pipeline Site in 2018. (2 Pages).....	103
Table 42. Percent Canopy Cover and Frequency of Occurrence at the Export Water Pipeline Site (L-419) in 2018. (2 Pages)	106
Table 43. Percent Canopy Cover and Frequency of Occurrence at the 116-B/C Misc. Site in 2018.....	109
Table 44. Percent Canopy Cover Comparison at the 100-C-9 Site in 2010 and the 116-B/C Misc. Site in 2018.	110
Table 45. Percent Canopy Cover and Frequency of Occurrence at the 100-C-9 Site in 2018. (2 Pages)	112
Table 46. Percent Canopy Cover Comparison at the 100-C-9 Site in 2010 and 2018	112
Table 47. Percent Canopy Cover and Frequency of Occurrence at the 118-B-2/3 Site in 2018.	115
Table 48. Percent Canopy Cover Comparison at the 118-B-2/3 Site in 2009 and 2018. (2 Pages)	115
Table 49. Percent Canopy Cover and Frequency of Occurrence at the 128-C-1 Site in 2018. (2 Pages)	118
Table 50. Percent Canopy Cover Comparison at the 128-C-1 Site in 2010 and 2018	119
Table 51. Percent Canopy Cover and Frequency of Occurrence at the 116-K-1 Site in 2018.	122
Table 52. Percent Canopy Cover Comparison at the 116-K-2 Site (T1) in 2009 and the 116-K-1 Site in 2018	123
Table 53. Percent Canopy Cover and Frequency of Occurrence at the 116-K-2 Site in 2018. (2 Pages)	124
Table 54. Percent Canopy Cover Comparison at the 116-K-2 Site in 2009 and 2018.	125

Table 55. Percent Canopy Cover and Frequency of Occurrence at the 116-N-3 Site in 2018. (2 Pages) 127

Table 56. Percent Canopy Cover Comparison at the 116-N-3 Site in 2008 and 2018. 128

Table 57. Percent Canopy Cover and Frequency of Occurrence at the 120-N-1&2 Site in 2018. (2 Pages) 130

Table 58. Percent Canopy Cover Comparison at the 120-N-1&2 Site in 2007 and 2018. 131

Table 59. Percent Canopy Cover and Frequency of Occurrence at the 116-D/DR-North Site in 2018..... 134

Table 60. Percent Canopy Cover Comparison at the 116-D/DR-North Site in 2006 and 2018. 135

Table 61. Percent Canopy Cover and Frequency of Occurrence at the 116-F-14 Site in 2018. 137

Table 62. Percent Canopy Cover Comparison at the 116-F-14 Site in 2008 and 2018. 138

Table 63. Percent Canopy Cover and Frequency of Occurrence at the 618-4 Site in 2018. (2 Pages) 140

Table 64. Percent Canopy Cover Comparison at the 618-4 Site in 2006 and 2018. 141

Table 65. Percent Canopy Cover and Frequency of Occurrence at the 316-1 / 300-RFBP Site in 2018. (2 Pages)..... 143

Table 66. Percent Canopy Cover Comparison at the 316-1 / 300 RFBP Site in 2006 and 2018. 144

Table 67. The 2018 5-Year Revegetation Monitoring Summary (4 Pages) 148

Table 68. 2018 Long Term Trend Site Monitoring (2 Pages) 154

1.0 INTRODUCTION

This report describes the monitoring of areas revegetated by the River Corridor Closure Contractor (RCCC) and CH2M Hill Plateau Remediation Company (CHPRC) that were transitioned to and monitored by Mission Support Alliance (MSA) in 2018, along with sites revegetated by MSA. Site monitoring is a continuance of efforts performed by the RCCC from Fiscal Year (FY) 2012 through FY 2018. This report contains data collected in 2018 documenting the recovery of revegetation areas associated with the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* cleanup of National Priorities List waste sites and restoration of lands disturbed by ongoing site mission activities at the Hanford Site in Richland, Washington. It contains vegetation monitoring data for 40 sites selected to be representative sites for areas planted between the years of FY 2012 through FY 2018. Two revegetation site monitoring efforts occurred in 2018. The first effort was traditional revegetation monitoring, which analyzes the plant composition of representative revegetated sites for 5 years after they were planted. This monitoring is summarized in Section 3.0. The second effort evaluated the long-term trends of revegetated sites that were past their fifth year of growth. This monitoring is summarized in Section 4.0.

Five-year monitoring efforts analyze the structure and composition of native and non-native plant species on representative revegetated sites over a 5-year period. This provides a timeline over which to evaluate restoration success and provides insight into which planting methods are most effective. Revegetation sites are considered successful if after 5 years they have a native shrub density of 600 plants/ha (240 plants/ac) and total canopy cover of 25% or greater for native plants as specified in the *Hanford Site Revegetation Manual* (DOE/RL-2011-116, Rev. 1) and area specific revegetation plans (DOE/RL-96-17, Rev. 6, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Appendix H; DOE/RL-2005-93, Rev. 1, *Remedial Design Report/Remedial Action Work Plan for the 100-N Area*, Appendix G, and DOE/RL-2001-47, Rev. 3, *Remedial Design Report/Remedial Action Work Plan for the 300 Area*, Appendix C). If the structure and composition of a monitored revegetation site are determined to meet these success criteria by the fifth year, the site is considered “successful.” In addition to monitoring the representative sites, sites that were not originally monitored but are in the same area as unsuccessful representative sites may be monitored to evaluate the need for additional revegetation efforts. Each site monitored during 2018 is discussed in Section 3 of this report. For each site, Section 3 contains a brief summary of the revegetation activities, monitoring efforts, and tabulated species data.

This report provides fifth-year monitoring results for sites 100-C-7:1, 600-301, 600-370, and 600-369:3; fourth-year monitoring results for sites Pit 24, 130-N-1:1, 100-D-30/104, and 600-356; third-year monitoring results for sites 100-B-35, 100-N-96, 100-D-100, 100-H-28:2, 600-379, and 600-358; second-year monitoring for sites 100-N-83, 100-N-CTA, 100-D Trailer Village, 600-385, 600-288:2, the L-840 Export Water Pipeline, and the L-525 Export Water Pipeline; and first-year monitoring for sites 118-F-1, 118-F-6, 100-F-26, 118-F-3, 100-F-57, 100-F CTA, 100-F-Trailer Village, 118-F-5, and the L-419 Export Water Pipeline.

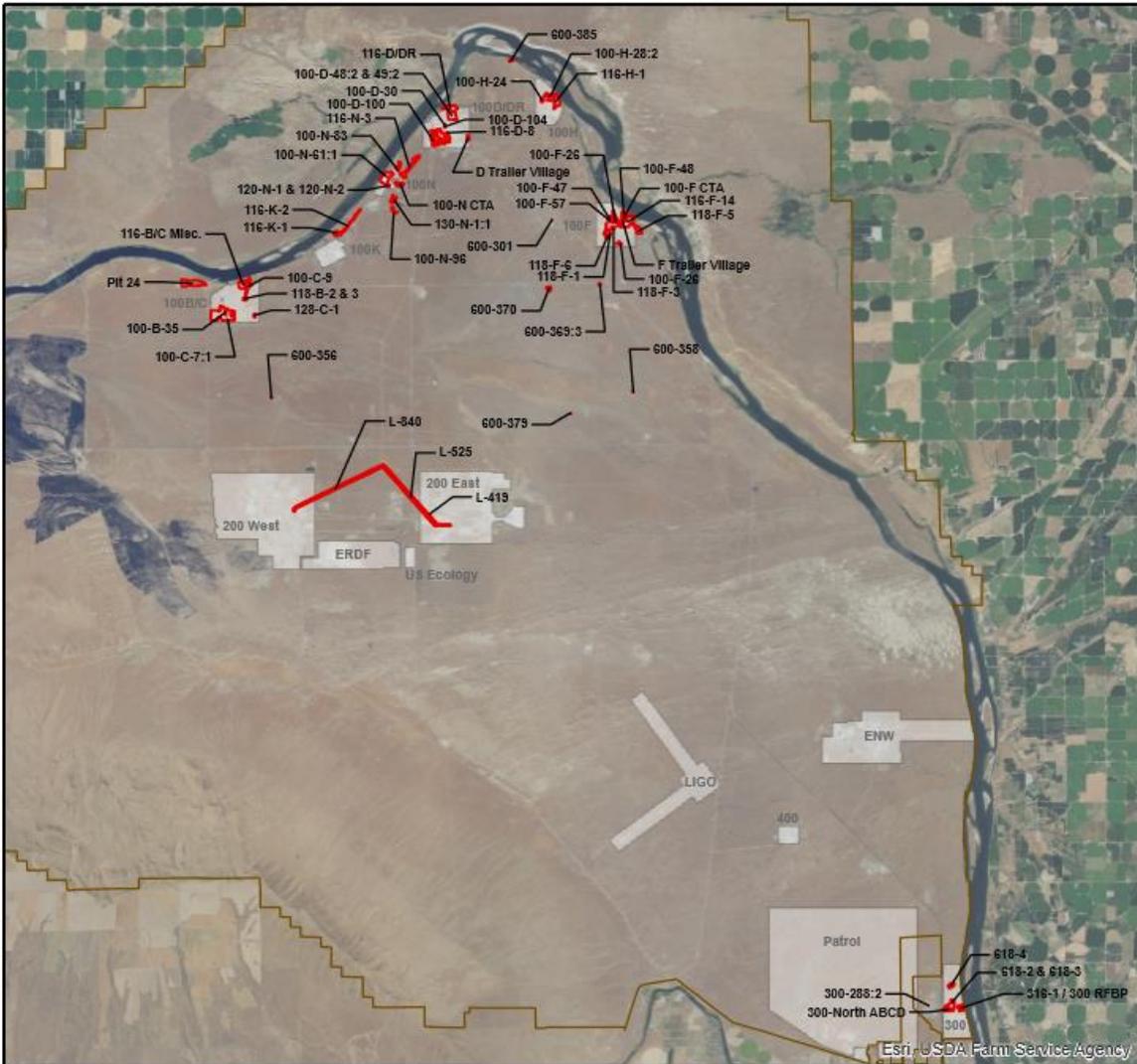
Two additional sites (100-F-47 and 100-F-48) that were originally planted in FY 2012 had supplemental shrub plantings in FY 2018 and were monitored for the first time in 2018. Eight additional sites (100-N-61:1, 100-D-48:2, 100-D-49:2, 116-D-8, 100-H-24, 116-H-1, 300-

North A-D, and 618-2 & 3) that were not initially monitored after planting were monitored in 2018. These sites were planted over 5 years ago and are located in an area where other representative sites that were monitored over the 5-year period failed to meet the prescribed success criteria. These sites were monitored to determine if they meet the success criteria noted above and, if not, to provide data that will be used to determine future revegetation strategies for the sites.

Additional monitoring efforts took place in 2018 to evaluate the long-term trends of revegetation sites past their fifth year of growth. Twelve revegetation sites planted from 2002 to 2007 were monitored to determine revegetation success after 10 to 16 years. Data collected from older revegetation sites may show that sites trend towards success in the long-term, or may indicate that without intervention unsuccessful sites will not improve in this time-period. These data will be used to inform future revegetation efforts, especially intervention efforts at unsuccessful sites. See Section 4.0 for the results from this monitoring effort.

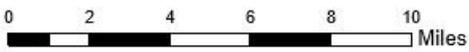
This report provides long-term trend data for the following sites, with the year planted in parentheses: 116-B/C Misc. (FY 2007), 100-C-9 (FY 2007), 118-B-2 & 3 (FY 2007), 128-C-1 (FY 2006), 116-K-1 and 116-K-2 (FY 2006), 116-N-3 (FY 2005), 120-N-1 & 2 (FY 2003), 116-D/DR North (FY 2002), 116-F-14 (FY 2005), 316-1/300 Retired Filter Backwash Pond (RFBP) (FY 2004), and 618-4 (FY 2004).

The locations of the 52 sites monitored in 2018 are shown in Figure 1.



- Legend**
- 2018 Revegetation Monitoring Sites
 - Management Areas
 - Hanford Site Boundary

NOTE: Aerial Imagery, 2015, NAIP.



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Revegetation Monitoring Sites, 2018

Hanford Site, Benton County, WA

Figure 1. Map of Revegetation Sites Monitored in 2018.

2.0 METHODS

The 2018 revegetation monitoring of 5-year monitoring sites consisted of two quantitative measurements taken at all sites. The first consisted of repeated measurements to estimate canopy cover and frequency of occurrence of all plant species observed within a series of plot frames. The second included the counting of transplanted shrubs/trees within an established transect area to estimate overstory density (plants/ ha) for the site. Shrub and tree species include big sagebrush (*Artemisia tridentata*), spiny hopsage (*Grayia spinosa*), antelope bitterbrush (*Purshia tridentata*), Wood's rose (*Rosa woodsii*), golden currant (*Ribes aureum*), black cottonwood (*Populus balsamifera*), narrowleaf willow (*Salix exigua*), peachleaf willow (*Salix amygdaloides*), and redosier dogwood (*Cornus sericea*). The data collected using these methods allows the analysis of relative seral stages, general site progression, as well as site trends, and provides a way to analyze the long-term achievement of management objectives.

Frequency of occurrence and canopy cover measurements were obtained using the methods described in *Steppe Vegetation of Washington* (Daubenmire 1970). Canopy coverage is defined in Daubenmire (1970) as “the percentage of ground surface included in the vertical projection of a polygon drawn around the extremities of undisturbed foliage of a plant.” The plot-frame encompasses a 0.5-m² (5.4 ft²) area. The name and relative amount of ground cover for each rooted species within the confines of the plot-frame is documented for each plot-frame measurement. The total vegetation can exceed 100% with this method due to species overlapping when plot measurements are taken in densely vegetated areas. Depending on the size of the restoration site, a number of plot-frame measurements were collected and analyzed to estimate canopy cover for each species present. Frequency was represented as the percentage of occurrences a species was observed within the given number of plot frames measured. For example, if a species was represented in 10 out of 25 plot frames, its frequency would be $10/25 \times 100 = 40\%$. The relative magnitude of a frequency rating in comparison to a canopy coverage rating provides an index of species distribution and its influence within a vegetation community. Species that were observed within a revegetated area but were not counted in a plot frame were recorded as occurrences and denoted as an “X” in the tables. Frequency of occurrence and canopy cover measurements were taken between April 19 and July 12, 2018. Listed Washington State noxious weed species identified within the monitoring areas are identified in the site monitoring result tables with their state class designation (e.g., A, B, or C). Washington State noxious weed classes are defined as:

“Noxious weed” is the traditional, legal term for invasive, non-native plants that are so aggressive they harm ecosystems or disrupt agricultural production. These plants crowd out the native species that fish and wildlife depend on. Washington State separates noxious weeds into three classifications. Class A noxious weeds are usually newcomers to Washington, and are generally rare. The goal is to completely eradicate them before they gain a foothold. Class B noxious weeds are widespread in some areas of the state, but limited or absent in other parts of the state. The goal is to prevent them from spreading into new areas, and to contain or reduce their population in already infested areas. Class C Noxious weeds are often widespread, or are of special interest to the agricultural industry. (NWCB 2017).

The evaluation of shrub density was determined through the establishment of stationary transect areas that are monitored annually over a 5-year period. In most cases, transects are 100 m (328 ft) in length with offsets to either side of up to 5-m (16.4 ft); shorter (25 to 75 m [82 to 246 ft]) transects have been established at sites too small to support a 100-m (328 ft) transect. The number of live shrubs within the established transect area [typically a 1,000-m² area (10,764 ft²)] was extrapolated to derive the shrub density for the site each year. For example, the 100-B-35 site in B Area has a 100-m (328 ft) transect with 5-m (16.4 ft) offsets that equates to a 1,000-m² (10,764 ft²) transect area. A total of 89 native shrubs were recorded within the transect area in 2018. Using the conversion factor of 1 acre = 4,047 m², we can derive that the shrub density for the site in 2018 was 889 plants/ha (360 plants/ac), meeting the shrub cover success criteria of 600 plants/ha (240 plants/ac). Shrub transect monitoring occurred between March and June 2018.

Long term trend monitoring sites were monitored only using frequency of occurrence and canopy cover measurements described in the report *Steppe Vegetation of Washington* (Daubenmire 1970). Shrub density transects were not established for these sites.

Plant identifications in the 2018 monitoring efforts use the current nomenclature from the United States Department of Agriculture (USDA) PLANTS Database (USDA 2018). Appendix A of this report lists the current scientific and common names from the USDA database along with synonyms possibly used in previous revegetation monitoring reports from *Flora of the Pacific Northwest* (Hitchcock and Cronquist 1973) and/or *Vascular Plants of the Hanford Site* (Sackschewsky and Downs 2001).

3.0 MONITORING RESULTS – 5-YEAR MONITORING SITES

This section describes the revegetation site data collected during the 2018 revegetation monitoring efforts. See Section 4.0 for long-term trend data.

3.1 100 B/C AREA SITES

Three sites were monitored in the 100 B/C Area: 100-C-7:1, Pit 24, and 100-B-35. The sites were revegetated in FY 2014, 2015, and 2016, respectively. These sites were remediated to meet the objectives for interim closure as established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (100 Area RDR/RAWP) (DOE/RL-96-17) and in the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 10-DR-2, 100-FR-1, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (Interim Action ROD) (EPA 1999). Revegetation efforts entailed broadcast seeding at approximately 16.8 kg/ha (15 lbs/ac) with a mixture of native grasses including Sandberg bluegrass (*Poa secunda*), Indian ricegrass (*Achnatherum hymenoides*), bluebunch wheatgrass (*Pseudoroegneria spicata*), squirreltail (*Elymus elymoides*), needle-and-thread grass (*Hesperostipa comata*), and prairie Junegrass (*Koeleria macrantha*) topped with a straw mulch that was crimped into the soil surface. Shrub species including big sagebrush (*Artemisia tridentata*), antelope bitterbrush (*Purshia tridentata*), and spiny hopsage (*Grayia spinosa*) were transplanted on the sites at approximately 1,235 to 1,600 plants/ha (500 to 650 plants/ac) with a mix of approximately 75% sagebrush, 15% bitterbrush, and 10% spiny hopsage.

3.1.1 100-C-7:1 Site (183-C Water Treatment Facility Head House Foundation)

The 100-C-7:1 site (Figure 2) was revegetated in FY 2014 and monitoring for the site was first conducted in 2014. Due to the large size of the site, it was divided into 10 areas with 1 stationary transect and 25 plot frames per area, totaling 10 stationary transects and 250 plot frames across the site. This is consistent with previous annual monitoring techniques. For the purposes of this report, the site was assessed based upon two treatment areas – areas within and directly adjacent to the excavation footprint (Areas 5, 6, and 9) and areas outside of the excavation footprint (Areas 1, 2, 3, 4, 7, 8, and 10). The site in general has a predominantly cobble substrate; however, areas within the excavation footprint have higher amounts of sand and loamy sand than the surrounding areas (outside of the excavation footprint), which have higher amounts of loam and sandy loam.

Ten shrub monitoring transects were established over the site in 2014. Shrub monitoring methods at the 100-C-7:1 site changed from fourth year to fifth year monitoring. Prior to fifth year monitoring, the 100-m (328 ft) shrub transects were monitored at an offset of approximately 2 m (6.6 ft) per side. This offset was increased to 5 m (16.4 ft) per side in fifth-year monitoring to better align with measurements taken at other revegetation sites. Fifth-year monitoring was conducted on May 14, 15, and 22, 2018; the results show a shrub density of 810 plants/ha (328 plants/ac) for the excavation footprint area, about 35% above the shrub density success criteria of 600 plants/ha (240 plants/ac). Shrub density outside of the excavation area was 600 plants/ha (243 plants/ac), exactly meeting the shrub density success criteria of 600 plants/ha (240 plants/ac). The shrub density rate for the entire site was 662 plants/ha (268 plants/ac), about 10% above the the shrub density success criteria of 600 plants/ha (240 plants/ac). Shrub

survival was about 99% of that observed in 2017. This site moved from an unsuccessful shrub density of 526 plants/ha in 2017 to a successful shrub density of 662 plants/ha in 2018, likely due to an increase in the area of the shrub monitoring transect.

Canopy cover data for the site was collected on May 22 and 23, 2018. Sitewide canopy cover averaged 31.7% with native cover representing 10.4% and invasive cover representing 21.3% (Table 1). This represents an increase of 1.1% in native cover and a decrease of 4.3% in invasive cover from 2017. Fifth-year monitoring at this site shows that the 100-C-7:1 Site does not meet the native cover success criteria of 25% native cover. Seeding of forbs and grasses is taking place at this site in November 2018 in an attempt to increase native cover. Native cover was comparable between the two areas of the site with 8.8% cover in the excavation footprint area and 11% outside of the excavation area. Invasive cover was substantially higher outside of the excavation area with 27% cover compared to 8% within the excavation. Cheatgrass (*Bromus tectorum*) was the dominant species with 16.7% canopy cover and occurrence in nearly 100% of the plot frames. The dominant native species was big sagebrush (*Artemisia tridentata*) with 2.8% canopy cover followed by Bluebunch wheatgrass (*Pseudoroegneria spicata*) with 2.2%.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was observed in both areas of the site with about 1.5% cover in each area and occurrence in about 27% of the plot frames. This is an increase of 13% occurrence from 2017. Dalmatian toadflax (*Linaria dalmatica*), a Washington State Class B noxious weed, was observed in the excavation footprint but did not occur in any plot frames. Noxious weed control is recommended to ensure the ecological integrity of this site.

Table 1. Percent Canopy Cover and Frequency of Occurrence at the 100-C-7:1 Site in 2018. (3 Pages)

Species	Inside Excavation		Outside Excavation		Entire Site	
	% Cover	% Frequency of Occurrence	% Cover	% Frequency of Occurrence	Average % Cover	Average % Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	-	-	X	X	X	X
<i>Achnatherum hymenoides</i> (Indian ricegrass)	2.8	57.3	1.1	20.7	1.5	29.6
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	X	X	0.1	4.0	0.0	0.4
<i>Artemisia tridentata</i> (big sagebrush)	1.6	13.3	3.3	13.7	2.8	13.6
<i>Astragalus purshii</i> (woollypod milkvetch)	-	-	X	X	X	X
<i>Astragalus succumbens</i> (Columbia milkvetch)	0.1	4.0	-	-	0.0	0.4
<i>Bromus tectorum</i> (cheatgrass)	5.5	100.0	21.5	99.4	16.7	99.6
<i>Centaurea diffusa</i> (diffuse knapweed) ^a (B)	1.5	32.0	1.6	24.6	1.6	26.8
<i>Elymus elymoides</i> (squirreltail)	-	-	0.5	13.0	0.2	5.2
<i>Epilobium brachycarpum</i> (tall annual willowherb)	-	-	0.1	4.0	0.0	1.2

**Table 1. Percent Canopy Cover and Frequency of Occurrence
at the 100-C-7:1 Site in 2018. (3 Pages)**

Species	Inside Excavation		Outside Excavation		Entire Site	
	% Cover	% Frequency of Occurrence	% Cover	% Frequency of Occurrence	Average % Cover	Average % Frequency of Occurrence
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	0.1	4.0	0.3	6.0	0.1	2.8
<i>Erigeron pumilus</i> (shaggy fleabane)	X	X	X	X	X	X
<i>Erodium cicutarium</i> (redstem stork's bill)	-	-	0.7	9.6	0.4	4.8
<i>Hesperostipa comata</i> (needle and thread grass)	X	X	0.1	5.6	0.1	2.8
<i>Holosteum umbellatum</i> (jagged chickweed) ^b	0.2	8.0	0.8	32.0	0.6	24.8
<i>Hordeum leporinum</i> (hare barley) ^b	-	-	0.1	4.0	0.0	0.8
<i>Lactuca serriola</i> (prickly lettuce) ^b	0.2	6.0	0.8	33.1	0.6	24.4
<i>Lamium amplexicaule</i> (henbit deadnettle) ^b	X	X	-	-	X	X
<i>Linaria dalmatica</i> (Dalmatian toadflax) ^a (B)	X	X	-	-	X	X
<i>Machaeranthera canescens</i> (hoary tansyaster)	-	-	0.1	4.0	0.0	0.4
<i>Melilotus officinalis</i> (sweetclover) ^b	0.1	4.0	0.3	7.0	0.1	3.2
<i>Penstemon acuminatus</i> (sharpleaf penstemon)	0.1	4.0	-	-	0.0	0.4
<i>Poa bulbosa</i> (bulbous bluegrass) ^b	X	X	0.2	6.7	0.1	2.0
<i>Poa secunda</i> (Sandberg bluegrass)	2.0	72.0	1.8	61.7	1.9	64.8
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	1.6	24.0	2.4	26.3	2.2	25.6
<i>Purshia tridentata</i> (antelope bitterbrush)	0.6	4.0	1.2	8.0	0.2	1.2
<i>Salsola kali</i> (Russian thistle) ^b	0.6	22.7	0.9	37.1	0.8	32.8
<i>Sisymbrium altissimum</i> (tall tumbled mustard) ^b	0.2	6.7	0.6	20.7	0.4	14.4
<i>Tragopogon dubius</i> (yellow salsify) ^b	X	X	0.1	4.0	0.0	0.8
<i>Triticum aestivum</i> (common wheat) ^b	X	X	X	X	X	X
<i>Vulpia microstachys</i> (desert fescue)	0.4	16.0	1.1	31.4	0.9	26.8
ARTR recruits ^c	0.2	8.0	1.5	20.0	0.5	7.6
Crust	0.1	4.0	10.4	60.6	7.3	43.6
Soil	85.0	100.0	57.0	100.0	65.4	100.0
Litter	14.7	100.0	37.7	100.0	30.8	100.0
Total canopy cover (excludes crust/soil/litter)	17.6		41.3		31.7	
Total Native % Cover	9.5		13.7		10.4	
Change in Native % Cover from 2017	-0.8		4.9		1.1	
Total Invasive % Cover	8.1		27.7		21.3	
Change in Invasive % Cover from 2017	-4.2		-3.6		-4.3	

Table 1. Percent Canopy Cover and Frequency of Occurrence at the 100-C-7:1 Site in 2018. (3 Pages)

Species	Inside Excavation		Outside Excavation		Entire Site	
	% Cover	% Frequency of Occurrence	% Cover	% Frequency of Occurrence	Average % Cover	Average % Frequency of Occurrence

^a Washington State Classified Noxious Weed (class)

^b Invasive species

^c ARTR recruits = *Artemisia tridentata* plants that are coming in naturally (were not planted)

X = present but not counted in plot frames

- = species not observed





Figure 2. The 100-C-7:1 Site in 2018. Top: Excavation Footprint Portion of the 100-C-7:1 Site in 2018. Bottom: Overview of Area 7 (outside of the excavation footprint) of the 100-C-7:1 Site in 2018.

3.1.2 Pit 24 Site (600-253, Gravel Pit #24)

The Pit 24 site (Figure 3) was revegetated in FY 2015 and monitoring for the site was first conducted in 2015. Remediation efforts at the site included revegetation of the upland areas and creation of wetland habitat with establishment of associated aquatic and riparian vegetation (Figure 4). This provided for three distinct ecological areas (upland, riparian, and wetland). Previous revegetation monitoring has included data collection from 4 upland transects and 10 riparian area transects; data has not been collected from the riparian areas due to seasonal water fluctuations and in-water hazards. High water levels were present on the site through July 2018, covering the established transects in the riparian area. Due to the persistent high water levels, no revegetation monitoring data were collected for the Pit 24 Riparian Area. In 2017, no revegetation monitoring data were collected for the riparian areas or Upland Transect 3 and Upland Area 3. In 2018, Upland Transect 3 and Upland Area 3 were monitored, and Upland Transect 3 saw significant dieoffs.



Figure 3. Overview of the Pit 24 Site in 2018. Looking West from the East End of the Site. The White Arrows Show Areas Where Established Riparian Transects were Under Water.

Upland shrub transects were established in 2015. Fourth-year monitoring of the transects was conducted on May 10 and 18, 2018; the results show an overall shrub density of 633 plants/ha (256 plants/ac) for Upland Transects 1, 2, and 4, currently meeting the shrub density success criteria of 600 plants/ha (240 plants/ac). Shrub survival for the upland areas was 96% of that observed in 2017. Upland Transect 3 was excluded from this calculation due to 80% of the shrubs dying, likely due to being under water the summer before.

Canopy cover data for the upland areas was collected on June 18, 2018. The upland canopy cover averaged 24.7% with native cover representing 12.5% and invasive cover representing 12.2% (Table 2). This represents an increase of 3.3% in native cover and a decrease of 4.9% in invasive cover from 2017. Cheatgrass (*Bromus tectorum*) was the dominant species with 8.2% canopy cover and occurrence in 99% of the plot frames. Native grasses including Sandberg bluegrass (*Poa secunda*) and bluebunch wheatgrass (*Pseudoroegneria spicata*) were the dominant native species with 2.8% and 3.2% canopy cover, respectively. Due to the large amount of cobble backfill used on this site, the 25% native cover within 5 years success criteria may not be a realistic benchmark.

Diffuse knapweed (*Centaurea diffusa*), common reed (*Phragmites australis*), burningbush (*Bassia scoparia*), and saltcedar (*Tamarix ramosissima*), all Washington State Class B noxious weeds, and reed canarygrass (*Phalaris arundinacea*), a Washington State Class C noxious weed, were present on the site. Diffuse knapweed was the most widespread with 1.4% cover and occurrence in 25% of the plot frames. Herbicidal treatment of diffuse knapweed, common reed, saltcedar, and reed canarygrass occurred in Summer 2018.

As in previous years, evidence of wildlife use of the area was observed. Waterfowl were noted on multiple occasions as were amphibians (frogs) and deer.

Table 2. Percent Canopy Cover and Frequency of Occurrence at Pit 24 Site (Upland Areas) in 2018. (2 Pages)

Species	Combined Upland Areas ^{a, b}	
	Average % Cover	Average % Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	0.2	5.0
<i>Achnatherum hymenoides</i> (Indian ricegrass)	0.7	10.7
<i>Artemisia tridentata</i> (big sagebrush)	1.3	11.0
<i>Bassia scoparia</i> (burning bush) ^c (B)	0.0	1.0
<i>Bromus tectorum</i> (cheatgrass) ^d	8.2	99.0
<i>Centaurea diffusa</i> (diffuse knapweed) ^e (B)	1.4	25.7
<i>Chaenactis douglasii</i> (Douglas' dustymaiden)	0.0	1.0
<i>Cornus sericea</i> (redosier dogwood)	X	X
<i>Dalea ornata</i> (Blue Mt. prairie clover)	0.2	1.0
<i>Descurcania pinnata</i> (western tansymustard)	0.0	1.7
<i>Elymus elymoides</i> (squirreltail)	0.1	2.0
<i>Epilobium brachycarpum</i> (tall annual willowherb) ^d	0.1	3.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	1.5	16.7
<i>Eriogonum niveum</i> (snow buckwheat)	0.1	0.0
<i>Eriogonum vimineum</i> (wickerstem buckwheat)	0.7	19.0
<i>Erodium cicutarium</i> (redstem stork's bill) ^d	0.2	0.0
<i>Hesperostipa comata</i> (needle and thread grass)	0.9	23.7
<i>Holosteum umbellatum</i> (jagged chickweed) ^d	0.0	1.0
<i>Lactuca serriola</i> (prickly lettuce) ^d	0.1	2.0
<i>Machaeranthera canescens</i> (hoary tansyaster)	0.1	2.0
<i>Melilotus officinalis</i> (sweetclover) ^d	0.4	2.0
<i>Mentzelia laevicaulis</i> (smoothstem blazingstar)	X	X
<i>Phalaris arundinacea</i> (reed canarygrass) ^e (C)	X	X
<i>Phragmites australis</i> (common reed) ^e (B)	X	X
<i>Poa bulbosa</i> (bulbous bluegrass) ^d	0.1	1.0
<i>Poa secunda</i> (Sandberg bluegrass)	2.8	64.7
<i>Populus baslamifera</i> (black cottonwood)	0.1	0.0

Table 2. Percent Canopy Cover and Frequency of Occurrence at Pit 24 Site (Upland Areas) in 2018. (2 Pages)

Species	Combined Upland Areas ^{a, b}	
	Average % Cover	Average % Frequency of Occurrence
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	3.2	44.0
<i>Purshia triedntata</i> (antelope bitterbrush)	0.0	1.0
<i>Rosa woodsii</i> (Woods' rose)	0.2	1.0
<i>Salix exigua</i> (narrowleaf willow)	X	X
<i>Salsola kali</i> (Russian thistle) ^d	1.5	44.7
<i>Sisymbrium altissimum</i> (tall tumbled mustard) ^d	0.3	9.3
<i>Sphaeralcea munroana</i> (Munro's globemallow)	0.0	0.0
<i>Sporobolus cryptandrus</i> (sand dropseed)	0.4	8.7
<i>Tamarix ramosissima</i> (saltcedar) ^e (B)	X	X
<i>Tragopogon dubius</i> (yellow salsify) ^d	0.0	1.0
<i>Verbascum thapsus</i> (common mullein) ^d	0.0	1.7
<i>Verbena bracteata</i> (bigbract verbena)	X	X
<i>Vulpia microstachys</i> (desert fescue)	0.1	5.0
ARTR recruits ^c	X	X
Crust	3.4	44.3
Soil	115.7	100.0
Litter	22.7	100.0
Total canopy cover (excludes crust/soil/litter)	24.7	
Total Native % Cover	12.5	
Change in Native % Cover from 2017	3.3	
Total Invasive % Cover	12.2	
Change in Invasive % Cover from 2017	-4.9	

^a No data was collected from Upland Area 3 in 2017 due to high water levels.

^b Cover level of 0.0 represents a cover of less than 0.1%

^c ARTR recruits = *Artemisia tridentata* plants that are coming in naturally (were not planted)

^d Invasive species

^e Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames



Figure 4. Overview of Western Pond in Pit 24, Photo Taken From Northwest Facing Southeast.

3.1.3 100-B-35 Site (Electrical Substation)

The 100-B-35 site (Figure 5) was revegetated in FY 2016 and monitoring for the site was first conducted in 2016. The substrate for the site consists predominantly of cobbles with varying amounts of sandy loam.

A shrub monitoring transect was established for the site in 2016. Third-year monitoring was conducted on May 10, 2018; the results show a shrub density of 889 plants/ha (360 plants/ac), well above the shrub density success criteria of 600 plants/ha (240 plants/ac). Shrub survival was 88.1% of that observed in 2017.

Canopy cover data for the site was collected on May 21, 2018. Canopy cover for the site was 19.9% with native cover representing 9.5% and invasive cover representing 10.4% (Table 3). This represents an increase of 2.9% in native cover and a decrease of 2.9% in invasive cover from 2017. Native grasses, dominated by bluebunch wheatgrass (*Pseudoroegneria spicata*) with 4.2% cover, represented 7.4% canopy cover, equating to over 37% of the total canopy cover present on the site. Cheatgrass (*Bromus tectorum*) was the dominant species at the site with a coverage of 4.9%. Due to the large amount of cobble backfill used on this site, the 25% native cover within 5 years criteria may not be a realistic benchmark.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was observed on the site and was recorded in 12% of the study plots.

Table 3. Percent Canopy Cover and Frequency of Occurrence at the 100-B-35 Site in 2018.

Species	% Cover	% Frequency of Occurrence
<i>Achnatherum hymenoides</i> (Indian ricegrass)	0.6	24.0
<i>Artemisia tridentata</i> (big sagebrush)	1.4	16.0
<i>Bromus tectorum</i> (cheatgrass) ^a	4.9	100.0
<i>Centaurea diffusa</i> (diffuse knapweed) ^b (B)	0.8	12.0
<i>Chrysothamnus viscidiflorus</i> (yellow rabbitbrush)	X	X
<i>Elymus elymoides</i> (squirreltail)	0.2	8.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	X	X
<i>Grayia spinosa</i> (spiny hopsage)	0.1	4.0
<i>Hesperostipa comata</i> (needle-and-thread grass)	0.1	4.0
<i>Holosteum umbellatum</i> (jagged chickweed) ^a	0.3	12.0
<i>Hordeum leporinum</i> (hare barley) ^a	X	X
<i>Lactuca serriola</i> (prickly lettuce) ^a	0.1	4.0
<i>Melilotus officinalis</i> (sweet clover) ^a	X	X
<i>Poa secunda</i> (Sandberg bluegrass)	2.9	96.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	4.2	88.0
<i>Purshia tridentata</i> (antelope bitterbrush)	X	X
<i>Salsola kali</i> (Russian thistle) ^a	2.0	60.0
<i>Sisymbrium altissimum</i> (tumble mustard) ^a	2.0	80.0
<i>Tragopogon dubius</i> (yellow salsify) ^a	X	X
<i>Triticum sp.</i> (wheat) ^a	0.3	12.0
Crust	0.0	0.0
Soil	74.6	100.0
Litter	22.0	100.0
Total canopy cover (excludes crust/soil/litter)	19.8	
Total Native % Cover	6.6	
Change in Native Cover from 2017	3.4	
Total Invasive % Cover	13.2	
Change in Invasive % Cover from 2017	8.8	

^a Invasive species^b Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames



Figure 5. The 100-B-35 Site in 2018, From the Western End Looking East.

3.2 100-K AREA SITES

The 100-K-95 and 100-K-CTA sites were scheduled for fourth-year and third-year monitoring in 2018, respectively. After the 2017 revegetation monitoring, these two sites were recommended for additional revegetation actions. These actions were scheduled for the fall/winter of 2018, so the 100-K-95 and 100-K-CTA site were not monitored in spring 2018. First year post-intervention monitoring results will be available in the 2019 Revegetation Monitoring Report.

3.3 100-N AREA SITES

Five sites were monitored in the 100-N Area: 130-N-1:1, 100-N-96, 100-N-83, 100-N CTA, and 100-N-61:1. The 130-N-1:1 and 100-N-61:1 sites were revegetated in FY 2015, the 100-N-96 site in FY 2016, and the 100-N-83 and 100-N CTA sites in FY 2017. These sites were remediated to meet the objectives for interim closure as established in the 100-N Area RDR/RAWP (DOE/RL-2005-93) and in the Interim Action ROD (EPA 2000a, 2000b). Site 100-N-96 had additional revegetation guidelines as stated in the *Memorandum of Agreement (MOA) Between the U.S. Department of Energy, Richland Operations Office and the Washington State Historic Office, and the Advisory Council on Historic Preservation Regarding the Remediation of the 100-N-96 Waste Site* (DOE-RL et al. 2014). Sites 100-N-83 and 100-N CTA had additional revegetation guidelines as stated in the *Memorandum of Agreement (MOA) Between the U.S. Department of Energy, Richland Operations Office and the Washington State Department of Archaeology and Historic Preservation Regarding Removal and Remedial Actions, Demobilization and Area Revegetation for the 100-N Area of the Hanford Site*

(DOE-RL et al. 2015a). Revegetation efforts entailed broadcast seeding at approximately 16.8 kg/ha (15 lbs/ac) with a mixture of native grasses including Sandberg's bluegrass (*Poa secunda*), Indian ricegrass (*Achnatherum hymenoides*), bluebunch wheatgrass (*Pseudoroegneria spicata*), squirreltail (*Elymus elymoides*), needle-and-thread grass (*Hesperostipa comata*), and prairie junegrass (*Koeleria macrantha*) topped with a straw mulch that was crimped into the soil surface. Shrub species including big sagebrush (*Artemisia tridentata*), antelope bitterbrush (*Purshia tridentata*), and spiny hopsage (*Grayia spinosa*) were transplanted on the sites at approximately 1,235 to 1,600 plants/ha (500 to 650 plants/ac) with a mix of approximately 75% sagebrush, 15% bitterbrush, and 10% spiny hopsage, with the exception of site 100-N-96. Site 100-N-96 received varying planting ratios ranging from 60 to 75% big sagebrush, 5 to 15% antelope bitterbrush, 10 to 30% spiny hopsage, and approximately 1% (cumulatively) of rubber rabbitbrush (*Ericameria nauseosa*) and yellow rabbitbrush (*Chrysothamnus viscidiflorus*).

3.3.1 130-N-1:1 Site (183-N Northeastern Backwash Discharge Pond)

The 130-N-1:1 site (Figure 6) was revegetated in FY 2015 and monitoring was first conducted for the site in 2015. The substrate for the site is characterized predominantly by cobbles with some loamy sand in the south area (Area 1) and predominantly sandy loam in the north area (Area 2) with increased amounts of cobbles in the south portion of this area.

Fourth-year shrub transect monitoring for the site was conducted on April 24, 2018. The results show a shrub density of 899 plants/ha (465 plants/ac) for Area 1 and 90 plants/ha (40 plants/ac) for Area 2; this equates to about 625 plants/ha (253 plants/ac) for the site overall. This is above the success criteria of 600 plants/ha (240 plants/ac). Over 90% of the transplanted shrubs in Area 2 were lost within the first year (2015 to 2016) and only 5 of the original 85 plants recorded along the transect remain.

Canopy cover data for the site was collected on June 11, 2018. Data was collected from 25 plot frames in each area. Canopy cover for the site overall was 32.4% with 9.7% native cover and 22.7% invasive cover (Table 4). This represents an increase of 1.1% in native cover and decrease of 2.2% in invasive cover from 2017. Total canopy cover for Area 1 was recorded at 20.9% with 12.2% native cover and 8.7% invasive cover. The dominant native species for Area 1 was Bluebunch wheatgrass (*Pseudoroegneria spicata*) with 4.9% cover followed by big sagebrush (*Artemisia tridentata*) with 2.9% cover; the dominant invasive species was cheatgrass (*Bromus tectorum*) with 5.9% cover. Cheatgrass in Area 1 increased by 1.9% and Sandberg's bluegrass (*Poa secunda*) decreased by 3.4% since 2017 monitoring. The dominant native species for Area 2 was tarweed fiddleneck (*Amsinckia lycopsoides*) with 3% cover. Cheatgrass (*Bromus tectorum*), with 26.8% cover, was the dominant invasive species for Area 2; however, cheatgrass coverage had decreased by nearly 10% from the year prior. Cheatgrass was also the dominant species for the site overall with average cover for the site at 16.4% and occurrence in every plot frame over both areas of the site. Additional revegetation efforts designed to increase native shrubs in Area 2 and grasses and forbs in both areas should be considered for this site, if the site can be seeded in a way that does not affect the established shrubs.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was recorded at 1% cover occurring in 10% of the plot frames. Coverage of this weed has increased since 2017.

Table 4. Percent Canopy Cover and Frequency of Occurrence at the 130-N-1:1 Site in 2018. (2 Pages)

Species	Area 1 (cobble)		Area 2 (loamy sand)		Entire Site	
	% Cover	% Frequency of Occurrence	% Cover	% Frequency of Occurrence	Average % Cover	Average % Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	X	X	0.1	4.0	0.1	2.0
<i>Achnatherum hymenoides</i> (Indian ricegrass)	1.4	16.0	0.2	8.0	0.8	12.0
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	0.1	4.0	3.0	24.0	1.6	14.0
<i>Artemisia tridentata</i> (big sagebrush)	2.9	20.0	X	X	1.5	10.0
<i>Bromus tectorum</i> (cheatgrass) ^a	5.9	100.0	26.8	100.0	16.4	100.0
<i>Centaurea diffusa</i> (diffuse knapweed) ^b (B)	0.2	8.0	1.7	12.0	1.0	10.0
<i>Draba verna</i> (spring draba) ^a	-	-	0.3	12.0	0.2	6.0
<i>Elymus elymoides</i> (bottlebrush squirreltail)	0.7	28.0	-	-	0.4	14.0
<i>Epilobium brachycarpum</i> (tall annual willowherb)	0.1	4.0	0.2	8.0	0.2	6.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	-	-	0.6	4.0	0.3	2.0
<i>Erigeron pumilus</i> (shaggy fleabane)	0.1	4.0	-	-	0.1	2.0
<i>Erodium cicutarium</i> (redstem stork's bill) ^a	-	-	1.2	8.0	0.6	4.0
<i>Hesperostipa comata</i> (needle and thread grass)	0.2	8.0	X	X	0.1	4.0
<i>Holosteum umbellatum</i> (jagged chickweed) ^a	0.7	28.0	0.4	16.0	0.6	22.0
<i>Hordeum leporinum</i> (hare barley) ^a	-	-	0.1	4.0	0.1	2.0
<i>Lactuca serriola</i> (prickly lettuce) ^a	0.2	8.0	1.6	24.0	0.9	16.0
<i>Machaeranthera canescens</i> (hoary tansyaster)	0.1	4.0	0.1	4.0	0.1	4.0
<i>Melilotus officinalis</i> (sweetclover) ^a	X	X	-	-	X	X
<i>Poa bulbosa</i> (bulbous bluegrass) ^a	-	-	0.1	4.0	0.1	2.0
<i>Poa secunda</i> (Sandberg's bluegrass)	1.6	64.0	1.2	48.0	1.4	56.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	4.9	56.0	0.6	4.0	2.8	30.0
<i>Purshia trieditata</i> (antelope bitterbrush)	X	X	-	-	X	X
<i>Salsola kali</i> (Russian thistle) ^a	1.4	56.0	2.5	60.0	2.0	58.0
<i>Sisymbrium altissimum</i> (tall tumbled mustard) ^a	0.3	12.0	2.0	60.0	1.2	36.0
<i>Sphaeralcea munroana</i> (Munro's globemallow)	-	-	0.6	4.0	0.3	2.0
<i>Tragopogon dubius</i> (yellow salsify) ^a	X	X	X	X	X	X
<i>Vulpia microstachys</i> (desert fescue)	0.1	4.0	0.6	24.0	0.4	14.0
Crust	0.0	0.0	0.9	36.0	0.5	18.0

Table 4. Percent Canopy Cover and Frequency of Occurrence at the 130-N-1:1 Site in 2018. (2 Pages)

Species	Area 1 (cobble)		Area 2 (loamy sand)		Entire Site	
	% Cover	% Frequency of Occurrence	% Cover	% Frequency of Occurrence	Average % Cover	Average % Frequency of Occurrence
Soil	72.0	100.0	53.7	100.0	62.9	100.0
Litter	27.0	100.0	40.0	100.0	33.5	100.0
Total canopy cover (excludes crust/soil/litter)	20.9		43.9		32.4	
Total Native % Cover	12.2		7.2		9.7	
Change in Native % Cover from 2017	0.9		1.4		1.1	
Total Invasive % Cover	8.7		36.7		22.7	
Change in Invasive % Cover from 2017	-0.7		-5.6		-2.2	

^a = Invasive species

^b Washington State Classified Noxious Weed (class)

- = species not observed in area

X = present but not counted in plots





Figure 6. The 130-N-1:1 Site in 2018. Top: Predominantly Loamy Area of Site. Bottom: Predominantly Cobbled Area of Site.

3.3.2 100-N-96 Site (Military Camp Disposal Pits)

The 100-N-96 site (Figure 7) was revegetated in FY 2016 and monitoring was first conducted for the site in 2016. The substrate for the site is characterized by loamy sand with varying amounts of gravel. In keeping with the *Memorandum of Agreement (MOA) Between the U.S. Department of Energy, Richland Operations Office and the Washington State Historic Office, and the Advisory Council on Historic Preservation Regarding the Remediation of the 100-N-96 Waste Site* (DOE-RL et al. 2014), seeds from several native forbs were collected from the Hanford Site and broadcast on the site along with the standard native grass seed mix. Rubber rabbitbrush (*Ericameria nauseosa*) and yellow rabbitbrush (*Chrysothamnus viscidiflorus*) were also planted on this site along with the standard mix of big sagebrush, antelope bitterbrush, and spiny hopsage.

A 75-m (246-ft) shrub monitoring transect with approximately 3-m (9.8-ft) offsets was established for the site in 2016. Third-year monitoring was conducted for the site on April 30, 2018; the results show a shrub density of 360 plants/ha (146 plants/ac), below the success criteria of 600 plants/ha (240 plants/ac).

Canopy cover data for the site was collected on June 11, 2018. Canopy cover for the site was 39.5% with native cover representing 9.5% and invasive cover representing 30% (Table 5). This represents an increase of 0.7% in native cover and an increase of 4.1% in invasive cover from 2017. The dominant native species was tarweed fiddleneck (*Amsinckia lycopsoides*) with 4% cover. Cheatgrass (*Bromus tectorum*) was the dominant species for the site overall with 23.1% cover. Additional revegetation efforts designed to increase native shrubs, grasses, and forbs should be considered for this site.

Diffuse knapweed (*Centaurea diffusa*) and rush skeletonweed (*Chondrilla juncea*), both Washington State Class B noxious weeds, were observed on the site but not captured in any of the plot frames.

**Table 5. Percent Canopy Cover and Frequency of Occurrence
at the 100-N-96 Site in 2018. (2 Pages)**

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	0.7	8.0
<i>Achnatherum hymenoides</i> (Indian ricegrass)	0.9	36.0
<i>Agropyron cristatum</i> ^a (crested wheatgrass)	X	X
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	4.0	28.0
<i>Artemisia tridentata</i> (big sagebrush)	1.3	12.0
<i>Bromus tectorum</i> ^a (cheatgrass)	23.1	100.0
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	X	X
<i>Chondrilla juncea</i> ^b (rush skeletonweed) (B)	X	X
<i>Chaenactis douglasii</i> (Douglas' dustymaiden)	0.1	4.0
<i>Draba verna</i> ^a (spring draba)	1.0	40.0
<i>Elymus elymoides</i> (squirreltail)	0.1	4.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	X	X
<i>Grayia spinosa</i> (spiny hopsage)	0.1	4.0
<i>Hesperostipa comata</i> (needle and thread grass)	0.3	12.0
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.9	36.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.6	24.0
<i>Machaeranthera canscens</i> (hoary tansymustard)	0.1	4.0
<i>Melilotus officinalis</i> ^a (sweetclover)	X	X
<i>Poa secunda</i> (Sandberg's bluegrass)	1.6	64.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	0.2	8.0
<i>Salsola kali</i> ^a (Russian thistle)	1.4	56.0
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	3.0	80.0
<i>Sphaeralcea munroana</i> (Munro's globemallow)	0.1	4.0
<i>Truticum sp.</i> ^a (wheat)	X	X
Crust	0.5	20.0
Soil	50.5	100.0
Litter	47.5	100.0
Total canopy cover (excludes crust/soil/litter)	39.5	
Total Native % Cover	9.5	
Change in Native % Cover from 2016	0.7	
Total Invasive % Cover	30.0	
Change in Invasive % Cover from 2016	4.1	

^a Invasive species

Table 5. Percent Canopy Cover and Frequency of Occurrence at the 100-N-96 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
^b Washington State Classified Noxious Weed (class) X = present but not counted in plot frames		



Figure 7. The 100-N-96 Site in 2018.

3.3.3 100-N-83 Site (Cleaned Contamination Area)

The 100-N-83 site (Figure 8) was revegetated in FY 2017 and monitoring was first conducted for the site in 2017. The substrate for the site is characterized by sandy loam with varying amounts of gravel and cobbles. In keeping with the *Memorandum of Agreement (MOA) Between the U.S. Department of Energy, Richland Operations Office and the Washington State Department of Archaeology and Historic Preservation Regarding Removal and Remedial Actions, Demobilization and Area Revegetation for the 100-N Area of the Hanford Site* (DOE-RL et al. 2015a), seeds from several native forbs were collected from the Hanford Site and broadcast on the site along with the standard native grass seed mix.

Forb species seeded at the 100-N-CTA included coyote tobacco (*Nicotiana attenuate*), Munro’s globemallow (*Schaeralecea munroana*), longleaf phlox (*Phlox longifolia*), slender phlox (*Microsteris gracilis*), Carey’s balsamorhiza (*Balsamorhiza careyana*), desert parsley (*Lomatium sp.*), common yarrow (*Achillea millefolium*), mariposa lily (*Calochortus macrocarpus*), upland larkspur (*Delphinium nuttallianum*), shaggy fleabane (*Erigeron pumilis*), white-stemmed blazingstar (*Mentzelia albicaulis*), woollypod milkvetch (*Astragalus purshii*), Douglas’

dustymaiden (*Chaenactis douglasii*), and yellowbell (*Fritillaria pudica*). Common yarrow and tarweed fiddleneck (*Amsinckia lycopsoides*, no record of seeding) were the only forbs recorded at this site in 2018. The rates at which these species were seeded and the viability of the seed planted is unknown. Native grass seed was broadcast seeded at an average of approximately 20.2 kg/ha (18 lb/ac) and was composed of Sandberg's bluegrass (*Poa secunda*), bluebunch wheatgrass (*Pseudoroegneria spicata*), needle-and-thread grass (*Hesperostipa comata*), Indian Ricegrass (*Achnatherum hymenoides*), bottlebrush squirreltail (*Elymus elymoides*), Idaho fescue (*Festuca idahoensis*), thickspike wheatgrass (*Elymus lanceolatus*), and sand dropseed (*Sporobolus cryptandrus*). All of these grasses, except thickspike wheatgrass and sand dropseed, were recorded at the site in 2018.

Two 100-m (328-ft) shrub monitoring transects were monitored for the site on April 23, 2018; Transect 1 in the lower (south) portion of the site and Transect 2 in the upper (north) portion of the site. Big sagebrush (*Artemisia tridentata*), spiny hopsage (*Grayia spinosa*), and antelope bitterbrush (*Purshia tridentata*) were recorded along both transects. The shrub density for the lower area was 800 plants/ha (324 plants/ac) and the density for the upper area was 620 plants/ha (251 plants/ac); this equates to about 684 plants/ha (277 plants/ac) for the site overall, above the success criteria of 600 plants/ha (240 plants/ac).

Canopy cover data for the site was collected on June 12, 2018. Canopy cover for the site was 35.5% (Table 6). Native cover for the site was 6.1%, an increase of 2.5% from the year previous. Invasive cover decreased by 4.7% since 2017 monitoring. Although native vegetation coverage is low, 12 different native species were recorded for the site. Tarweed fiddleneck (*Amsinckia lycopsoides*) was the dominant native species with 2.2% cover over the site. Cheatgrass (*Bromus tectorum*) was the dominant invasive species for the site overall with 23.3% cover, and increased by nearly 10% since 2017. Russian thistle (*Salsola kali*), one of the dominant species in 2017, decreased by about 12%. This site is not mature enough to recommend additional revegetation efforts.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, had a cover of less than 1% and occurred in 10% of the plot frames. Rush skeletonweed (*Chondrilla juncea*), a Washington State Class B noxious weed, was present on the site but not recorded in any plot frames.

Table 6. Percent Canopy Cover and Frequency of Occurrence at the 100-N-83 Site in 2018. (2 Pages)

Species	Lower Area		Upper Area		Entire Site	
	% Cover	% Frequency of Occurrence	% Cover	% Frequency of Occurrence	Average % Cover	Average % Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	X	X	1.3	12.0	0.7	0.0
<i>Achnatherum hymenoides</i> (Indian ricegrass)	-	-	0.1	4.0	0.1	0.0
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	0.7	8.0	3.6	44.0	2.2	26.0
<i>Artemisia tridentata</i> (big sagebrush)	1.3	12.0	0.3	12.0	0.8	12.0
<i>Bromus tectorum</i> ^a (cheatgrass)	16.0	100.0	30.6	96.0	23.3	98.0

Table 6. Percent Canopy Cover and Frequency of Occurrence at the 100-N-83 Site in 2018. (2 Pages)

Species	Lower Area		Upper Area		Entire Site	
	% Cover	% Frequency of Occurrence	% Cover	% Frequency of Occurrence	Average % Cover	Average % Frequency of Occurrence
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	0.9	16.0	0.1	4.0	0.5	10.0
<i>Chondrilla juncea</i> ^b (rush skeletonweed) (B)	X	X	-	-	X	X
<i>Draba verna</i> ^a (spring draba)	-	-	0.8	32.0	0.4	0.0
<i>Elymus elymoides</i> (squirreltail)	X	X	0.1	4.0	0.1	0.0
<i>Epilobium brachycarpum</i> (tall annual willowherb)	0.4	16.0	0.1	4.0	0.3	10.0
<i>Ericamerua nauseosa</i> (rubber rabbitbrush)	X	X	X	X	X	X
<i>Erodium cicutarium</i> ^a (redstem stork's bill)	0.3	12.0	0.1	4.0	0.2	8.0
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.3	12.0	0.8	32.0	0.6	22.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.1	4.0	0.6	24.0	0.4	14.0
<i>Lepidium perfoliatum</i> ^a (clasping pepperweed)	1.2	48.0	-	-	0.6	24.0
<i>Machaeranthera canescens</i> (hoary tansyaster)	-	-	X	X	X	X
<i>Matricaria recutita</i> ^a (German chamomile)	X	X	-	-	X	X
<i>Poa secunda</i> (Sandberg's bluegrass)	1.7	48.0	0.9	36.0	1.3	42.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	1.1	44.0	0.5	20.0	0.8	32.0
<i>Purshia trieditata</i> (antelope bitterbrush)	X	X	-	-	X	X
<i>Salsola kali</i> ^a (Russian thistle)	1.6	64.0	1.2	48.0	1.4	56.0
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	1.0	40.0	2.9	76.0	2.0	58.0
<i>Tragopogon dubius</i> ^a (yellow salsify)	X	X	-	-	X	X
<i>Triticum sp.</i> ^a (wheat)	0.1	4.0	0.2	8.0	0.2	6.0
<i>Vulpia microstachys</i> (small fescue)	-	-	0.1	4.0	0.1	0.0
Crust	0.0	0.0	0.0	0.0	0.0	0.0
Soil	52.2	100.0	51.8	100.0	52.0	100.0
Litter	43.8	100.0	47.2	100.0	45.5	100.0
Total canopy cover (excludes crust/soil/litter)	26.7		44.3		35.5	
Total Native % Cover	5.2		7.0		6.1	
Change in Native % Cover from 2017	0.6		4.4		2.5	
Total Invasive % Cover	21.5		37.3		29.4	
Change in Invasive % Cover from 2017	-11.1		1.8		-4.7	

^a Invasive species^b Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames

- = species not observed



Figure 8. The 100-N-83 Site in 2018. Top: Area 1 (lower portion) of the 100-N-83 Site in 2018. Bottom: Area 2 (upper portion) of the 100-N-83 Site in 2018.

3.3.4 100-N Container Transfer Area (CTA) Site

The 100-N CTA site (Figure 9) was revegetated in FY 2017 and monitoring was first conducted for the site in 2017. The substrate for the site is characterized by loamy sand with varying

amounts of cobbles and boulders. In keeping with the *Memorandum of Agreement (MOA) Between the U.S. Department of Energy, Richland Operations Office and the Washington State Department of Archaeology and Historic Preservation Regarding Removal and Remedial Actions, Demobilization and Area Revegetation for the 100-N Area of the Hanford Site* (DOE-RL et al. 2015a), seeds from several native forbs were collected from the Hanford Site and were hand seeded on the site.

Forb species seeded at the 100-N-CTA included coyote tobacco (*Nicotiana attenuate*), Munro's globemallow (*Schaeralecea munroana*), longleaf phlox (*Phlox longifolia*), slender phlox (*Microsteris gracilis*), Carey's balsamroot (*Balsamorhiza careyana*), desert parsley (*Lomatium sp.*), common yarrow (*Achillea millefolium*), mariposa lily (*Calochortus macrocarpus*), upland larkspur (*Delphinium nuttallianum*), shaggy fleabane (*Erigeron pumilis*), white-stemmed blazingstar (*Mentzelia albicaulis*), woollypod milkvetch (*Astragalus purshii*), Douglas' dustymaiden (*Chaenactis douglasii*), and yellowbell (*Fritillaria pudica*). Common yarrow, snow buckwheat (*Eriogonum niveum*, no record of seeding), and tarweed fiddleneck (*Amsinckia lycopsoides*, no record of seeding) were the only forbs recorded at this site in 2018. The rates at which these species were seeded and the viability of the seed planted is unknown. Native grass seed was broadcast seeded at an average of approximately 18 lb/ac and was composed of Sandberg's bluegrass (*Poa secunda*), bluebunch wheatgrass (*Pseudoroegneria spicata*), needle-and-thread grass (*Hesperostipa comata*), Indian ricegrass (*Achnatherum hymenoides*), bottlebrush squirreltail (*Elymus elymoides*), Idaho fescue (*Festuca idahoensis*), thickspike wheatgrass (*Elymus lanceolatus*), and sand dropseed (*Sporobolus cryptandrus*). All of these grasses except thickspike wheatgrass were recorded at the site in 2018.

Two 100-m (328-ft) shrub monitoring transects were monitored in 2018; Transect 1 in the lower (south) portion of the site and Transect 2 in the upper (north) portion of the site. Big sagebrush (*Artemisia tridentata*), spiny hopsage (*Grayia spinosa*), and antelope bitterbrush (*Purshia tridentata*) were recorded along both transects. The shrub density for the lower area was 820 plants/ha (332 plants/ac) and 59 plants/ha (24 plants/ac) for the upper area. Only 10% of the shrubs recorded in the upper area in 2017 survived to 2018. This equates to an overall shrub density of 439 plants/ha (178 plants/ac) for the site overall, not meeting the success criteria of 600 plants/ha (240 plants/ac).

Canopy cover data for the site was collected in June 2018. Canopy cover varied between the two areas (lower and upper) with 29.5% cover recorded for the lower area and 22.9% for the upper area; the average canopy cover for the site overall was 26.2% (Table 7). Native cover for the site averaged 11.5% with 14.3% recorded for the lower area and 8.7% recorded for the upper area. Native vegetation cover increased by 8.3% since 2017, and 13 different native species were recorded for the site. Bluebunch wheatgrass (*Pseudoroegneria spicata*) was the dominant native species with an average coverage of 3.9% for the site overall. Russian thistle (*Salsola kali*) was the dominant invasive species for the site overall with 8% average cover, decreased by 7% from the previous year.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was observed in 2% of the plots. Bull thistle (*Cirsium vulgare*), a Washington State Class C noxious weed, was observed on the site but not detected in any plot frames.

The 100-N-CTA site has high native species diversity and a relatively high native species cover that appears to be trending upward. The majority of these native species are grasses, as only one

of the 14 seeded forbs was recorded. Alternative methods of adding forbs to this site, like planting forb plugs, should be considered. High shrub die-off between 2017 and 2018 resulted in unsuccessful shrub cover. Supplemental shrub planting is recommended for this site, especially in the northern portion, to increase the number of shrubs per acre.

Table 7. Percent Canopy Cover and Frequency of Occurrence at the 100-N CTA Site in 2018. (2 Pages)

Species	Lower Area		Upper Area		Entire Site	
	% Cover	% Frequency of Occurrence	% Cover	% Frequency of Occurrence	Average % Cover	Average % Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	-	-	0.1	4.0	0.1	2.0
<i>Achnatherum hymenoides</i> (Indian ricegrass)	0.3	12.0	-	-	0.2	6.0
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	-	-	0.3	12.0	0.2	6.0
<i>Artemisia tridentata</i> (big sagebrush)	1.6	24.0	X	X	0.8	12.0
<i>Bromus tectorum</i> ^a (cheatgrass)	2.7	48.0	1.5	60.0	2.1	54.0
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	X	X	0.6	4.0	0.3	2.0
<i>Cirsium vulgare</i> ^b (bull thistle) (C)	X	X	-	-	X	X
<i>Draba verna</i> ^a (spring draba)	0.2	8.0	-	-	0.1	4.0
<i>Elymus elymoides</i> (squirreltail)	0.7	28.0	0.1	4.0	0.4	16.0
<i>Epilobium brachycarpum</i> (tall annual willowherb)	0.3	12.0	-	-	0.2	6.0
<i>Eriogonum niveum</i> (snow buckwheat)	X	X	-	-	X	X
<i>Grayia spinosa</i> (spiny hopsage)	X	X	-	-	X	X
<i>Hesperostipa comata</i> (needle and thread grass)	0.4	16.0	-	-	0.2	8.0
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	-	-	0.1	4.0	0.1	2.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.7	28.0	0.8	32.0	0.8	30.0
<i>Matricaria recutita</i> ^a (German chamomile)	-	-	0.2	8.0	0.1	4.0
<i>Poa secunda</i> (Sandberg bluegrass)	4.1	84.0	6.9	96.0	5.5	90.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	6.7	68.0	1.1	24.0	3.9	46.0
<i>Salsola kali</i> ^a (Russian thistle)	6.7	92.0	9.2	100.0	8.0	96.0
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	4.6	64.0	1.9	36.0	3.3	50.0
<i>Sporobolus cryptandrus</i> (sand dropseed)	0.2	8.0	-	-	0.1	4.0
<i>Triticum sp.</i> ^a (wheat)	0.3	12.0	-	-	0.2	6.0
<i>Vulpia microstachys</i> (desert fescue)	-	-	0.2	8.0	0.1	4.0
Crust	0.0	0.0	0.0	0.0	0.0	0.0

Table 7. Percent Canopy Cover and Frequency of Occurrence at the 100-N CTA Site in 2018. (2 Pages)

Species	Lower Area		Upper Area		Entire Site	
	% Cover	% Frequency of Occurrence	% Cover	% Frequency of Occurrence	Average % Cover	Average % Frequency of Occurrence
Soil	61.3	100.0	60.4	100.0	60.9	100.0
Litter	38.7	100.0	37.6	100.0	38.2	100.0
Total canopy cover (excludes crust/soil/litter)	29.5		22.9		26.2	
Total Native % Cover	14.3		8.7		11.5	
Total Invasive % Cover	15.2		14.3		14.8	

^a Invasive species

^b Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames

- = species not observed





Figure 9. The 100-N Container Transfer Area Site in 2018. Top: Area 1 (lower portion) of the 100-N CTA Site in 2018. Bottom: Area 2 (upper portion) of the 100-N CTA Site in 2018.

3.3.5 100-N-61:1 (Underground Pipelines)

The 100-N-61:1 site (Figure 10) was revegetated in FY 2015. Monitoring for this site was not conducted until June 2018, when the site was 3 years old. The substrate for the site is characterized predominantly by cobbles and backfill material.

No shrub transect was established for this site, as first-year monitoring did not occur until June 2018.

Canopy cover data for the site was collected in June 2018. Data was collected from 50 plot frames, 25 in the eastern area and 25 in the backfilled area to the northwest of N Reactor. Canopy cover data for the two areas were fairly similar. Canopy cover for the site overall was 19.0% with 9.4% native cover and 9.6% invasive cover (Table 8). The dominant native species for this site was bluebunch wheatgrass (*Pseudoroegneria spicata*) with 3.6% cover followed by big sagebrush (*Artemisia tridentata*) and Sandberg's bluegrass, both with 1.9% cover. The dominant invasive species was cheatgrass (*Bromus tectorum*) with 7.7% cover and occurrence in 100% of the plot frames.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was recorded at less than 1% cover and occurred in 10% of the plot frames.

Additional revegetation efforts designed to increase native cover that will not negatively impact the existing sagebrush should be considered for this site.

Table 8. Percent Canopy Cover and Frequency of Occurrence at the 100-N-61:1 Site in 2018.

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	0.1	2.0
<i>Achnatherum hymenoides</i> (Indian ricegrass)	0.9	16.0
<i>Artemisia tridentata</i> (big sagebrush)	1.9	18.0
<i>Bromus tectorum</i> ^a (cheatgrass)	7.7	100.0
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	0.5	10.0
<i>Draba verna</i> ^a (spring draba)	0.1	2.0
<i>Epilobium brachycarpum</i> (tall annual willowherb)	0.1	4.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	0.1	4.0
<i>Festuca sp.</i> (fescue)	0.7	18.0
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.3	10.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.8	22.0
<i>Laminum amplexicaule</i> ^a (henbit deadnettle)	0.1	4.0
<i>Melilotus officinalis</i> ^a (sweet clover)	X	X
<i>Poa secunda</i> (Sandberg bluegrass)	1.9	74.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	3.6	52.0
<i>Salsola kali</i> ^a (Russian thistle)	0.2	6.0
<i>Sisymbrium altissimum</i> ^a (tumble mustard)	0.1	2.0
<i>Sporobolus cryptandrus</i> (sand dropseed)	0.2	8.0
<i>Tragopogon dubius</i> ^a (yellow salsify)	X	X
Crust	2.1	8.0
Soil	77.9	100.0
Litter	22.1	100.0
Total canopy cover (excludes crust/soil/litter)	19.0	
Total Native % Cover	9.4	
Total Invasive % Cover	9.6	

^a Invasive species^b Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames



Figure 10. The Backfilled Portion of the 100-N-61:1 Site in 2018.

3.4 100-D AREA SITES

Six sites were monitored for post-revegetation five year monitoring in the 100-D Area: 100-D-30/104, 100-D-100, 100-D Trailer Village, 100-D-48:2, 100-D-49:2, and 116-D-8. The 100-D-30/104, 100-D-48:2 and 100-D-49:2 sites were revegetated in FY 2015, the 100-D-100 and 116-D-8 sites in FY 2016, and the 100-D Trailer Village site in FY 2017. These sites were remediated to meet the objectives for interim closure as established in the 100 Area RDR/RAWP (DOE/RL-96-17) and in the Interim Action ROD (EPA 1999). The 118-D-2 site would have had fifth-year monitoring in 2018 but was scheduled for further revegetation actions in winter 2018, therefore, postponing monitoring. These revegetation actions were halted when the new 100-D/H ROD was released, reclassifying parts of the 118-D-2 site. Further revegetation actions are postponed until FY 2020.

Revegetation efforts entailed broadcast seeding or hydroseeding with a mixture of native grasses including Sandberg's bluegrass (*Poa secunda*), Indian ricegrass (*Achnatherum hymenoides*), bluebunch wheatgrass (*Pseudoroegneria spicata*), squirreltail (*Elymus elymoides*), needle-and-thread grass (*Hesperostipa comata*), and prairie junegrass (*Koeleria macrantha*) at approximately 15 lbs/ac. Broadcast seeding areas were topped with a straw mulch that was crimped into the soil surface. Areas with steep slopes were seeded by hydroseeding vs. broadcast seeding followed by mulch application. Shrub species including big sagebrush (*Artemisia tridentata*), antelope bitterbrush (*Purshia tridentata*), and spiny hopsage (*Grayia spinosa*) were transplanted on the sites at approximately 1,235 to 1,600 plants/ha (500 to 650 plants/ac) with a mix of approximately 75% sagebrush, 15% bitterbrush, and 10% spiny hopsage (with the exception of site 100-D-100). Sites planted in FY 2016 (100-D-100) received varying planting ratios ranging from 60 to 75% big sagebrush, 5 to 15% antelope bitterbrush, 10 to 30% spiny hopsage, and approximately 1% (cumulatively) rubber rabbitbrush (*Ericameria nauseosa*) and yellow rabbitbrush (*Chrysothamnus viscidiflorus*).

3.4.1 100-D-30/104 Site (183-N Northeastern Backwash Discharge Pond)

The 100-D-30/104 site (Figure 11) was revegetated in FY 2015 and monitoring was first conducted for the site in 2015. This is a larger site that was divided into five areas (northwest-north, northeast, southwest-south, south central, and southeast) for monitoring purposes with 1 established transect in each area and data collected from 25 plot frames in each area. Substrates at the site are predominantly very cobbly loamy sands.

Five shrub monitoring transects were established for the site in 2015. Fourth-year monitoring for the site was conducted in May 2018. The results show a shrub density of 790 plants/ha (320 plants/ac), above the success criteria of 600 plants/ha (240 plants/ac). The transects for each area varied greatly, with Transect 2 showing 449 plants/ha (182 plants/ac) and Transect 5 showing 1,499 plants/ha (607 plants/ac). Inconsistency in plant spacing may have led to these varied results. This highlights the importance of establishing multiple transects in large revegetation sites for a more accurate measure of shrub cover.

Canopy cover data for the site was collected on May 31, 2018. Average canopy cover for the site was 26% with native cover representing 11.8% and invasive cover representing 14.3% (Table 9). This represents an increase of 2.8% in native cover from 2017 and an increase of 4.3% in invasive cover. The dominant species for the site overall was cheatgrass (*Bromus*

tectorum) with 6.8% cover followed by bluebunch wheatgrass (*Pseudoroegneria spicata*) with 3.6% cover. The continued trend towards increasing native cover is expected to continue at this site. The large amount of cobble present in the soil limits the available growing space for plants, because of this the success criteria of 25% native cover may not be realistic for this site.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was recorded on the site at less than 1% and occurring in 4% of the plot frames.

Table 9. Percent Canopy Cover and Frequency of Occurrence at the 100-D-30/104 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	0.3	3.2
<i>Achnatherum hymenoides</i> (Indian ricegrass)	1.1	20.8
<i>Artemisia tridentata</i> (big sagebrush)	1.4	14.4
<i>Bromus arvensis</i> ^a (field brome)	0.0	0.8
<i>Bromus tectorum</i> ^a (cheatgrass)	6.8	100.0
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	0.2	4.0
<i>Descurainia pinnata</i> (western tansymustard)	X	X
<i>Draba verna</i> ^a (spring draba)	0.2	7.2
<i>Elymus elymoides</i> (squirreltail)	0.1	4.8
<i>Epilobium brachycarpum</i> (tall annual willowherb)	0.3	13.6
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	0.7	21.6
<i>Grayia spinosa</i> (spiny hopsage)	X	X
<i>Hesperostipa comata</i> (needle and thread grass)	0.3	5.6
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	1.7	42.4
<i>Koeleria macrantha</i> (prairie Junegrass)	0.0	1.6
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.4	16.8
<i>Leymus cinereus</i> (basin wildrye)	0.1	0.8
<i>Machaeranthera canescens</i> (hoary tansyaster)	0.1	4.0
<i>Medicago sativa</i> ^a (alfalfa)	X	X
<i>Melilotus officinalis</i> ^a (sweetclover)	2.5	27.2
<i>Poa secunda</i> (Sandberg bluegrass)	2.0	75.2
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	3.6	45.6
<i>Purshia tridentata</i> (antelope bitterbrush)	0.9	7.2
<i>Salsola kali</i> ^a (Russian thistle)	1.7	67.2
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	0.7	24.0
<i>Tragopogon dubius</i> ^a (yellow salsify)	0.1	2.4
<i>Triticum aestivum</i> ^a (common wheat)	0.0	1.6
<i>Vulpia microstachys</i> (desert fescue)	0.8	28.0
Crust	0.0	0.0
Soil	58.3	100.0
Litter	39.3	100.0
Total canopy cover (excludes crust/soil/litter)	26.1	

Table 9. Percent Canopy Cover and Frequency of Occurrence at the 100-D-30/104 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
Total Native % Cover	11.8	
Change in Native % Cover from 2016	2.8	
Total Invasive % Cover	14.3	
Change in Invasive % Cover from 2016	4.3	

^a Invasive species

^b Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames





Figure 11. The 100-D-30/104 Site in 2018. Top: North Portion of the 100-D-30/104 Site in 2018. Bottom: South Portion of the 100-D-30/104 Site in 2018.

3.4.2 100-D-100 Site (Process Sewer, Unplanned Release 183-DR Railroad Tracks)

The 100-D-100 site (Figure 12) was revegetated in FY 2016 and monitoring was first conducted for the site in 2016. This is a larger site that was divided into three areas (north, central, and south) for monitoring purposes with one established transect in each area and data collected from 25 plot frames in each area. Substrates at the site are predominantly very cobbly loamy sands.

Three shrub monitoring transects were established for the site in 2016. Third-year monitoring was conducted on April 19, 2018. The results show a shrub density of 886 plants/ha (359 plants/ac) for the site overall, well above the success criteria of 600 plants/ha (240 plants/ac). A total of 97% of the planted shrubs have survived since the initial planting in 2016. Only one spiny hopsage (*Grayia spinosa*) was initially recorded in the transects, and that hopsage did not survive into 2018. These transects are not a good indicator of spiny hopsage health. Antelope bitterbrush (*Purshia tridentata*) has a survival rate of 99% at this site, which is impressive, as typically very few antelope bitterbrush survive through the first year of planting.

Canopy cover data for the site was collected in May 2018. Average canopy cover for the site was 15.4% with native cover representing 7.7% and invasive cover representing 7.7% (Table 10). This represents an increase of about 2% in native cover and of 0.1% in invasive cover from 2017. The dominant native species were bluebunch wheatgrass (*Pseudoroegneria spicata*), Sandberg bluegrass (*Poa secunda*), and squirreltail (*Elymus elymoides*) with 3.0%, 2.8%, and 0.8% cover, respectively. Cheatgrass (*Bromus tectorum*) was the dominant invasive species for the site with 3% cover. Columbia milkvetch (*Astragalus succumbens*) is a notable forb species that was observed at this site but not detected in any study plots. Considering the high shrub survival percentage of nearly 98% for the first year (which is typically when the most

substantial loss occurs), the lack of substantial cover by invasive species, and the amount of cobble backfill on the site, no additional revegetation efforts are suggested at this time.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was observed on the site but was not recorded in any of the plot frames.

Table 10. Percent Canopy Cover and Frequency of Occurrence at the 100-D-100 Site in 2018.

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	X	X
<i>Artemisia tridentata</i> (big sagebrush)	0.6	10.7
<i>Astragalus succumbens</i> (Columbia milkvetch)	X	X
<i>Bromus arvensis</i> ^a (field brome)	0.3	13.3
<i>Bromus tectorum</i> ^a (cheatgrass)	3.0	94.7
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	X	X
<i>Draba verna</i> ^a (spring draba)	0.2	9.3
<i>Elymus elymoides</i> (squirreltail)	0.8	24.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	X	X
<i>Grayia spinosa</i> (spiny hopsage)	X	X
<i>Hesperostipa comata</i> (needle and thread grass)	0.0	1.3
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.1	4.0
<i>Hordeum leporinum</i> ^a (hare barley)	0.0	1.3
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.4	8.0
<i>Melilotus officinalis</i> ^a (sweetclover)	0.0	1.3
<i>Poa secunda</i> (Sandberg bluegrass)	2.8	92.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	3.0	53.3
<i>Purshia triedntata</i> (antelope bitterbrush)	0.4	2.7
<i>Salsola kali</i> ^a (Russian thistle)	2.1	82.7
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	1.4	57.3
<i>Tragopogon dubius</i> ^a (yellow salsify)	0.1	2.7
<i>Triticum aestivum</i> ^a (common wheat)	X	X
<i>Vulpia microstachys</i> (desert fescue)	0.1	5.3
Crust	1.3	1.3
Soil	72.4	100.0
Litter	26.3	100.0
Total canopy cover (excludes crust/soil/litter)	15.4	
Total Native % Cover	7.7	
Change in Native % Cover from 2017	2.2	
Total Invasive % Cover	7.7	
Change in Invasive % Cover from 2017	0.1	

^a Invasive species

^b Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames



Figure 12. The 100-D-30/104 Site in 2018. Top: North Portion of the 100-D-100 Site in 2018. Bottom: South Portion of the 100-D-100 Site in 2018.

3.4.3 100-D Trailer Village Site

The 100-D Trailer Village site (Figure 13) was revegetated in FY 2017 and monitoring was first conducted for the site in 2017. The substrate for the site is characterized predominantly by loamy sand with some scattered patches of gravel.

A 100-m (328-ft) shrub monitoring transect was established in 2017 and second-year monitoring occurred in April 2018. The results show a shrub density of 340 plants/ha (138 plants/ac), which falls well below the success criteria of 600 plants/ha (240 plants/ac). None of the spiny hopsage (*Grayia spinosa*) or antelope bitterbrush (*Purshia tridentata*) plants recorded in 2017 survived into 2018. Only 30% of the big sagebrush (*Artemisia tridentata*) recorded in 2017 survived to 2018.

Canopy cover data for the site was collected in May 2018. Total canopy cover for the site was 24% with 3.9% native cover and 20.1% invasive cover (Table 11). Total invasive cover decreased by 16.7% since 2017, and total native cover did not significantly change. Sandberg's bluegrass was the most abundant native species with 2.1% cover and occurrence in 64% of the plot frames. Russian thistle (*Salsola kali*) was the dominant invasive species for the site with 12.1% cover, decreasing from 31.8% cover the previous year.

Though this site has high invasive cover, Russian thistle cover is expected to continue to decrease as the site matures. Additional revegetation efforts designed to increase shrub cover are recommended at this site. Additional revegetation efforts designed to increase native grasses and forbs may need to be considered for this site if native cover does not increase in the future.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was recorded on the site with less than 1% cover occurring in 20% of the plot frames.

Table 11. Percent Canopy Cover and Frequency of Occurrence at the 100-D Trailer Village Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	0.3	12.0
<i>Achnatherum hymenoides</i> (Indian ricegrass)	X	X
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	0.8	8.0
<i>Artemisia tridentata</i> (big sagebrush)	0.1	8.0
<i>Bromus tectorum</i> ^a (cheatgrass)	2.4	76.0
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	0.5	20.0
<i>Elymus elymoides</i> (squirreltail)	X	X
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.9	32.0
<i>Machaeranthera canescens</i> (hoary tansymustard)	0.4	12.0
<i>Poa secunda</i> (Sandberg bluegrass)	2.1	64.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	0.3	8.0
<i>Salsola kali</i> ^a (Russian thistle)	12.1	92.0
<i>Sisymbrium altissimum</i> ^a (tall tumbledustard)	4.1	72.0
<i>Tragopogon dubius</i> ^a (yellow salsify)	0.1	4.0
Crust	0.0	0.0
Soil	80.1	100.0
Litter	19.9	100.0

Table 11. Percent Canopy Cover and Frequency of Occurrence at the 100-D Trailer Village Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
Total canopy cover (excludes crust/soil/litter)	24.0	0.0
Total Native % Cover	3.9	
Change in Native % Cover from 2017	0.1	
Total Invasive % Cover	20.1	
Change in Invasive % Cover from 2017	-16.7	

^a Invasive species

^b Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames



Figure 13. The 100-D Trailer Village Site in 2018.

3.4.4 100-D-48:2 Site (Underground Pipelines)

The 100-D-48:2 site (Figure 14) was revegetated in FY 2015. Monitoring for this site was not conducted until June 2018 when the site was 3 years old. This site is directly west of the 100-D-49:2 site.

No shrub transect was established for this site.

Canopy cover data for the site was collected in June 2018. Data was collected from 25 plot frames. Canopy cover for the entire site was 33.1%, made up of 20.2% native cover and 12.9% invasive cover (Table 12). The dominant native species at this site was bluebunch wheatgrass (*Pseudoroegneria spicata*) with 7.5% cover followed by rubber rabbitbrush (*Ericameria*

nauseosa) with 3.2% cover. The dominant invasive species was cheatgrass (*Bromus tectorum*) with 7.5% cover and occurrence in 100% of the plot frames. Sagebrush (*Artemisia tridentata*) had a cover of 2.1% at this site. Eighteen native species were recorded in 2018.

Burningbush (*Bassia scoparia*), a Washington State Class B noxious weed, was recorded at this site but did not occur in any plot frames. Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was recorded at this site with a cover of 0.3%.

Both the native canopy cover and species diversity at this site are relatively high for a 3-year old site. No additional actions are recommended at this site apart from continued monitoring.

Table 12. Percent Canopy Cover and Frequency of Occurrence at the 100-D-48:2 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	X	X
<i>Achnatherum hymenoides</i> (Indian ricegrass)	1.3	12.0
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	X	X
<i>Artemisia tridentata</i> (big sagebrush)	2.1	8.0
<i>Astragalus purshii</i> (woollypod milkvetch)	X	X
<i>Bassia scoparia</i> ^a (burningbush) (B)	X	X
<i>Bromus tectorum</i> ^b (cheatgrass)	7.5	100.0
<i>Centaurea diffusa</i> ^a (diffuse knapweed) (B)	0.3	12.0
<i>Dalea sp.</i> (prairie clover)	X	X
<i>Draba verna</i> ^b (spring draba)	0.2	8.0
<i>Elymus elymoides</i> (squirreltail)	0.1	4.0
<i>Epilobium brachycarpum</i> (tall annual willowherb)	0.3	12.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	3.2	28.0
<i>Erodium cicutarium</i> ^b (redstem stork's bill)	1.9	56.0
<i>Festuca sp.</i> (fescue)	0.2	8.0
<i>Hesperostipa comata</i> (needle and thread grass)	2.2	28.0
<i>Holosteum umbellatum</i> ^b (jagged chickweed)	0.7	28.0
<i>Lactuca serriola</i> ^b (prickly lettuce)	X	X
<i>Machaeranthera canscens</i> (hoary tansyaster)	0.2	8.0
<i>Melilotus officinalis</i> ^b (sweet clover)	0.1	4.0
<i>Poa secunda</i> (Sandberg bluegrass)	2.8	92.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	7.5	48.0
<i>Purshia tridentata</i> (antelope bitterbrush)	X	X
<i>Salsola kali</i> ^b (Russian thistle)	1.9	76.0
<i>Sisymbrium altissimum</i> ^b (tumble mustard)	0.3	12.0
<i>Sphaeralcea munroana</i> (Munro's globemallow)	X	X
<i>Sporobolus cryptandrus</i> (sand dropseed)	0.1	4.0
<i>Vulpia microstachys</i> (desert fescue)	0.2	8.0
Crust	0.0	0.0
Soil	58.4	100.0
Litter	40.6	100.0
Total canopy cover (excludes crust/soil/litter)	33.1	

Table 12. Percent Canopy Cover and Frequency of Occurrence at the 100-D-48:2 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
Total Native % Cover	20.2	
Total Invasive % Cover	12.9	

^a Washington State Classified Noxious Weed (class)

^b Invasive species

X = present but not counted in plot frames



Figure 14. The 100-D-48:2 Site in 2018.

3.4.5 100-D-49:2 Site (Underground Pipelines)

The 100-D-49:2 site (Figure 15) was revegetated in FY 2015. Monitoring for this site was not conducted until June 2018 when the site was 3 years old. This site is directly east of the 100-D-48:2 site.

No shrub transect was established for this site.

Canopy cover data for the site was collected in June 2018. Data was collected from 25 plot frames. Canopy cover for the entire site was 35.6%, made up of 14.3% native cover and 21.3% invasive cover (Table 13). The dominant native species at this site was bluebunch wheatgrass (*Pseudoroegneria spicata*) with 6.8% cover followed by needle-and-thread grass (*Hesperostipa comata*) with 2.3% cover. The dominant invasive species was cheatgrass (*Bromus tectorum*) with 10.0% cover and occurrence in 100% of the plot frames. Sagebrush (*Artemisia tridentata*) had a cover of 0.6% at this site. Fifteen native species were recorded in 2018.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was recorded at this site and had a cover of 3.1%, occurring in 44.0% of plot frames. Burningbush (*Bassia scoparia*), a Washington State Class B noxious weed, was recorded at this site with a cover of less than 1%.

Treatment of diffuse knapweed is highly recommended at this site. This site is not as successful as the neighboring 100-D-48:2 site, but still has a relatively high native species diversity. Continued monitoring is recommended.

Table 13. Percent Canopy Cover and Frequency of Occurrence at the 100-D-49:2 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	X	X
<i>Achnatherum hymenoides</i> (Indian ricegrass)	0.7	8.0
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	X	X
<i>Artemisia tridentata</i> (big sagebrush)	0.6	4.0
<i>Astragalus succumbens</i> (Columbia milkvetch)	X	X
<i>Bassia scoparia</i> ^a (burningbush) (B)	0.9	16.0
<i>Bromus tectorum</i> ^b (cheatgrass)	10.0	100.0
<i>Centaurea diffusa</i> ^a (diffuse knapweed) (B)	3.1	44.0
<i>Dalea sp.</i> (prairie clover)	X	X
<i>Draba verna</i> ^b (spring draba)	0.1	4.0
<i>Epilobium brachycarpum</i> (tall annual willowherb)	0.7	28.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	0.8	12.0
<i>Erodium cicutarium</i> ^b (redstem stork's bill)	2.2	48.0
<i>Hesperostipa comata</i> (needle and thread grass)	2.3	32.0
<i>Holosteum umbellatum</i> ^b (jagged chickweed)	1.3	52.0
<i>Hordeum murinum</i> ^b (hare barley)	0.2	8.0
<i>Lactuca serriola</i> ^b (prickly lettuce)	0.6	24.0
<i>Machaeranthera canscens</i> (hoary tansyaster)	0.3	12.0
<i>Melilotus officinalis</i> ^b (sweet clover)	X	X
<i>Poa secunda</i> (Sandberg bluegrass)	1.8	72.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	6.8	52.0
<i>Purshia tridentata</i> (antelope bitterbrush)	X	X
<i>Salsola kali</i> ^b (Russian thistle)	2.3	92.0
<i>Sisymbrium altissimum</i> ^b (tumble mustard)	0.5	20.0
<i>Sphaeralcea munroana</i> (Munro's globemallow)	0.1	4.0
<i>Tragopogon dubius</i> ^b (yellow salsify)	0.1	4.0
<i>Vulpia microstachys</i> (desert fescue)	0.2	8.0
Crust	0.0	0.0
Soil	67.1	100.0
Litter	32.9	100.0
Total canopy cover (excludes crust/soil/litter)	35.6	
Total Native % Cover	14.3	
Total Invasive % Cover	21.3	

Table 13. Percent Canopy Cover and Frequency of Occurrence at the 100-D-49:2 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
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^a Washington State Classified Noxious Weed (class)

^b Invasive species

X = present but not counted in plot frames



Figure 15. The 100-D-49:2 Site in 2018.

3.4.6 116-D-8 Site (Cask Storage Pad)

The 116-D-8 site (Figure 16) was revegetated in FY 2012. Monitoring for this site was not conducted until June 2018 when the site was 6 years old. This site is directly east of the D Reactor and is a relatively small area.

No shrub transect was established for this site.

Canopy cover data for the site was collected in May 2018. Data was collected from five plot frames. Canopy cover for the entire site was 22.0%, made up of 12.0% native cover and 10.0% invasive cover (Table 14). The dominant native species at this site was Sandberg’s bluegrass (*Poa secunda*) with 7.5% cover followed by rubber rabbitbrush (*Ericameria nauseosa*) with 4.5% cover. The dominant invasive species was cheatgrass (*Bromus tectorum*) with 8.0% cover. Sagebrush (*Artemisia tridentata*) was present on the site but not recorded in any plot frames. Four native species were recorded in 2018.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was recorded at this site and had a cover of less than 1%.

Given the small size of this site, it is not the best choice of a representative site for the 2012 planting year. It is recommended that other FY 2012 planting sites be monitored to determine success in the area.

Table 14. Percent Canopy Cover and Frequency of Occurrence at the 116-D-8 Site in 2018.

Species	% Cover	% Frequency of Occurrence
<i>Artemisia tridentata</i> (big sagebrush)	X	X
<i>Bromus tectorum</i> ^a (cheatgrass)	8.0	40.0
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	0.5	20.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	4.5	80.0
<i>Machaeranthera canescens</i> (hoary tansyaster)	X	X
<i>Poa secunda</i> (Sandberg bluegrass)	7.5	100.0
<i>Salsola kali</i> ^a (Russian thistle)	1.5	60.0
<i>Sisymbrium altissimum</i> ^a (tumble mustard)	X	X
Crust	0.5	20.0
Soil	85.5	100.0
Litter	14.5	100.0
Total canopy cover (excludes crust/soil/litter)	22.0	
Total Native % Cover	12.0	
Total Invasive % Cover	10.0	

^a Invasive species

^b Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames



Figure 16. The 116-D-8 Site in 2018.

3.5 100-H AREA SITES

Four sites were monitored in the 100-H Area: 100-H-28:2, 600-385, 100-H-24, and 116-H-1. The 100-H-24 site was revegetated in FY 2015, the 100-H-28:2 and 116-H-1 sites were revegetated in FY 2016, and the 600-385 site in FY 2017. These sites were remediated to meet the objectives for interim closure as established in the 100 Area RDR/RAWP (DOE/RL-96-17) and in the Interim Action ROD (EPA 1999). Site 600-385 had additional revegetation guidelines as stated in the *Memorandum of Agreement (MOA) Between the U.S. Department of Energy, Richland Operations Office, the Washington Department of Archaeology and Historic Preservation, and the Advisory Council on Historic Preservation Regarding the Remediation of Waste Site 600-385, and Removal of Miscellaneous Restoration Items SG4DH-169 and SG4DH-207 in the 100-D and 100-H Intermediary Area of the Hanford Site, Benton County, Washington (HCR#2011-100-083)* (DOE-RL et al. 2015b).

Revegetation efforts entailed broadcast seeding with a mixture of native grasses including Sandberg's bluegrass (*Poa secunda*), Indian ricegrass (*Achnatherum hymenoides*), bluebunch wheatgrass (*Pseudoroegneria spicata*), squirreltail (*Elymus elymoides*), needle-and-thread grass (*Hesperostipa comata*), and prairie junegrass (*Koeleria macrantha*) at approximately 16.8 kg/ha (15 lbs/ac). Broadcast seeding areas were topped with a straw mulch that was crimped into the soil surface. Shrub species including big sagebrush (*Artemisia tridentata*), antelope bitterbrush (*Purshia tridentata*), and spiny hopsage (*Grayia spinosa*) were transplanted on the sites at approximately 1,235 to 1,600 plants/ha (500 to 650 plants/ac) with a mix of approximately 75% sagebrush, 15% bitterbrush, and 10% spiny hopsage. Sites planted in FY 2016 (100-H-28:2) received varying planting ratios ranging from 60 to 75% big sagebrush, 5 to

15% antelope bitterbrush, 10 to 30% spiny hopsage, and approximately 1% (cumulatively) of rubber rabbitbrush (*Ericameria nauseosa*) and yellow rabbitbrush (*Chrysothamnus viscidiflorus*).

3.5.1 100-H-28:2 Site (Process Sewer Area)

The 100-H-28:2 site (Figure 17) was revegetated in FY 2016 and monitoring was first conducted for the site in 2016. This is a larger site that was divided into two areas (north and south) for monitoring purposes with 1 established transect in each area and data collected from 25 plot frames in each area. Substrates at the site are predominantly gravel and cobbles with varying amounts of loamy sand.

Two shrub monitoring transects were established for the site in 2016. In 2016 and 2017, these transects were monitored by recording plants only 3 m (9.8 ft) on either side of the tape. Third-year monitoring for the site was conducted on June 12, 2017; the results show a shrub density of 528 plants/ha (214 plants/ac), below the success criteria of 600 plants/ha (240 plants/ac). Big sagebrush (*Artemisia tridentata*) is the most abundant with a total of 110 live plants recorded for the site.

Canopy cover data for the site was collected on May 29, 2018. Average canopy cover for the site was 20.2% with native cover representing 12.5% and invasive cover representing 7.8% (Table 15). This represents an increase of 2% in native cover and an increase of 0.3% in invasive cover from 2017. The dominant native species was bluebunch wheatgrass (*Pseudoroegneria spicata*) with 5.6% cover followed by Sandberg's bluegrass (*Poa secunda*) with 2.2% cover. Russian thistle (*Salsola kali*) and cheatgrass (*Bromus tectorum*) were the dominant invasive species for the site with 2.2% and 2.8% cover, respectively. Though this site has high survival since the initial planting (~95%), it appears the site was not planted at the usual rate of about 1400 plants per ha (600 plants per ac). Expanding the transect to cover more area revealed that this site has unsuccessful shrub cover. Though this site lacks substantial cover by invasive species and shows a positively trending cover of native species, additional revegetation actions in the form of supplemental shrub plantings are recommended for this site.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was recorded on the site with less than 1% cover occurring in 10% of the plot frames. Dalmatian toadflax (*Linaria dalmatica*), a Washington State Class B noxious weed, was seen on the site but not recorded in any plot frames.

Table 15. Percent Canopy Cover and Frequency of Occurrence at the 100-H-28:2 Site in 2018. (2 pages).

Species	% Cover	% Frequency of Occurrence
<i>Artemisia tridentata</i> (big sagebrush)	1.0	10.00
<i>Agropyron cristatum</i> ^a (crested wheatgrass)	X	X
<i>Bromus arvensis</i> ^a (field brome)	0.1	4.0
<i>Bromus tectorum</i> ^a (cheatgrass)	2.8	100.0
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	0.5	10.0
<i>Chrysothamnus viscidiflorus</i> (yellow rabbitbrush)	X	X
<i>Draba verna</i> ^a (spring draba)	0.3	10.0

Table 15. Percent Canopy Cover and Frequency of Occurrence at the 100-H-28:2 Site in 2018. (2 pages).

Species	% Cover	% Frequency of Occurrence
<i>Elymus elymoides</i> (squirreltail)	1.7	48.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	0.2	6.0
<i>Grayia spinosa</i> (spiny hopsage)	0.1	2.0
<i>Hesperostipa comata</i> (needle and thread grass)	0.8	22.0
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.1	2.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.2	6.0
<i>Linaria dalmatica</i> ^b (Dalmation toadflax) (B)	X	X
<i>Machaeranthera canescens</i> (hoary tansyaster)	X	X
<i>Melilotus officinalis</i> ^a (sweetclover)	1.4	6.0
<i>Poa secunda</i> (Sandberg bluegrass)	2.2	88.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	5.6	84.0
<i>Purshia trieditata</i> (antelope bitterbrush)	0.1	2.0
<i>Salsola kali</i> ^a (Russian thistle)	2.2	88.0
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	0.4	14.0
<i>Sphaeralcea munroana</i> (Munro's globemallow)	0.3	2.0
<i>Sporobolus cryptandrus</i> (sand dropseed)	0.1	2.0
<i>Tragopogon dubius</i> ^a (yellow salsify)	0.1	2.0
<i>Verbascum thapsus</i> ^a (common mullein)	X	X
<i>Vulpia microstachys</i> (desert fescue)	0.6	12.0
Crust	0.2	8.0
Soil	67.0	100.0
Litter	30.3	100.0
Total canopy cover (excludes crust/soil/litter)	20.2	
Total Native % Cover	12.5	
Change in Native % Cover from 2017	2.0	
Total Invasive % Cover	7.8	
Change in Invasive % Cover from 2017	0.3	

^a Invasive species^b Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames



Figure 17. The 100-H-28:2 Site in 2018. Top: North Portion of the 100-H-28:2 Site in 2018. Bottom: South Portion of the 100-H-28:2 Site in 2018.

3.5.2 600-385 Site (Dump Site)

The 600-385 site (Figure 18) was revegetated in FY 2017 and monitoring was first conducted for the site in 2017. The substrate for the site is characterized by loamy sand with varying amounts

of gravel. In keeping with the *Memorandum of Agreement (MOA) Between the U.S. Department of Energy, Richland Operations Office, the Washington Department of Archaeology and Historic Preservation, and the Advisory Council on Historic Preservation Regarding the Remediation of Waste Site 600-385, and Removal of Miscellaneous Restoration Items SG4DH-169 and SG4DH-207 in the 100-D and 100-H Intermediary Area of the Hanford Site, Benton County, Washington (HCR#2011-100-083)* (DOE-RL et al. 2015b), seeds from several native forbs were collected from the Hanford Site and broadcast on the site along with the standard native grass seed mix.

One 100-m (328-ft) shrub monitoring transect was established in 2017 and monitored for the site in June 2018. The results show a density of 350 plants/ha (142 plants/ac). This does not meet the success criteria of 600 plants/ha (240 plants/ac). Shrub survival was 48% of those recorded in 2017. Standing water at this site in the late summer of 2017 may have caused this decrease in shrub survival.

Canopy cover data for the site was collected on May 29, 2018. Data was collected from 25 plot frames. Canopy cover for the site overall was 37.9% with 19.2% native cover and 18.7% invasive cover (Table 16). Native cover increased by 11.5% since 2017 and invasive cover decreased by 22.3% from 2017. The dominant native species was bluebunch wheatgrass (*Pseudoroegneria spicata*) with 7.7% cover, a 2% increase from 2017. Tall tumbled mustard (*Sisymbrium altissimum*) was the dominant invasive species for the site with 9.5% cover, and Russian thistle (*Salsola kali*) cover decreased by 30% since the first year of monitoring. Additional revegetation efforts designed to increase native shrubs should be considered for this site.

Burning bush (*Bassia scoparia*) and diffuse knapweed (*Centaurea diffusa*), both Washington State Class B noxious weeds, were recorded at this site at levels less than 1% coverage.

Table 16. Percent Canopy Cover and Frequency of Occurrence at the 600-385 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	0.2	8.0
<i>Achnatherum hymenoides</i> (Indian ricegrass)	0.7	28.0
<i>Artemisia tridentata</i> (big sagebrush)	1.3	12.0
<i>Bassia scoparia</i> ^a (burning bush) (B)	0.4	16.0
<i>Bromus tectorum</i> ^b (cheatgrass)	5.7	92.0
<i>Centaurea diffusa</i> ^a (diffuse knapweed) (B)	X	X
<i>Chenopodium album</i> (lambsquarters)	X	X
<i>Chorispora tenella</i> ^b (crossflower)	0.1	4.0
<i>Draba verna</i> ^b (spring draba)	0.1	4.0
<i>Erodium cicutarium</i> ^b (redstem stork's bill)	0.1	4.0
<i>Hesperostipa comata</i> (needle and thread)	1.3	12.0
<i>Hordeum leporinum</i> ^b (hare barley)	0.3	12.0
<i>Lactuca serriola</i> ^b (prickly lettuce)	0.1	4.0
<i>Lepidium perfoliatum</i> ^b (clasping pepperweed)	0.2	8.0
<i>Leymus cinereus</i> (basin wildrye)	2.5	44.0
<i>Melilotus officinalis</i> ^b (sweetclover)	X	X

Table 16. Percent Canopy Cover and Frequency of Occurrence at the 600-385 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Poa secunda</i> (Sandberg bluegrass)	5.5	84.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	7.7	72.0
<i>Raphanus raphanistrum</i> ^b (wild radish)	0.1	4.0
<i>Salsola kali</i> ^a (Russian thistle)	2.1	44.0
<i>Sisymbrium altissimum</i> ^b (tall tumbled mustard)	9.5	72.0
<i>Sphaeralcea munroana</i> (Munro's globemallow)	X	X
Crust	0.1	4.0
Soil	59.9	100.0
Litter	38.2	100.0
Total canopy cover (excludes crust/soil/litter)	37.9	
Total Native % Cover	19.2	
Change in Native % Cover from 2017	11.5	
Total Invasive % Cover	18.7	
Change in Invasive % Cover from 2017	-22.3	

^a Washington State Classified Noxious Weed (class)

^b Invasive species

X = present but not counted in plot frames



Figure 18. The 600-385 Site in 2018.

3.5.3 100-H-24 Site (Substation)

The entire 100-H-24 site was revegetated multiple times, most recently in FY 2015 (Figure 19). These multiple iterations of revegetation activities were most likely due to repeated industrial use of the 100-H-24 site. Monitoring for this site was not conducted until June 2018 when the site was 3 years old.

No shrub transect was established for this site.

Canopy cover data for the site was collected in May 2018. Data was collected from 25 plot frames. Canopy cover for the entire site was 27.0%, made up of 14.8% native cover and 12.2% invasive cover (Table 17). The dominant native species at this site was bluebunch wheatgrass (*Pseudoroegneria spicata*) with 9.0% cover followed by sagebrush (*Artemisia tridentata*) with 1.9% cover. The dominant invasive species was cheatgrass (*Bromus tectorum*) with 7.9% cover and occurrence in 100% of the plot frames followed by Russian thistle (*Salsola kali*) with 2.1% cover. Ten native species were recorded in 2018.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was recorded at this site and had a cover of less than 1%.

As this is the first year canopy cover data was collected at this site, continued monitoring is recommended before any additional revegetation actions are taken.

Table 17. Percent Canopy Cover and Frequency of Occurrence at the 100-H-24 Site in 2018. (2 Pages).

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	X	X
<i>Artemisia tridentata</i> (big sagebrush)	1.9	16.0
<i>Bromus tectorum</i> ^a (cheatgrass)	7.9	100.0
Bunchgrasses ^c	X	X
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	0.9	16.0
<i>Draba verna</i> ^a (spring draba)	0.1	4.0
<i>Epilobium brachycarpum</i> (tall annual willowherb)	0.2	8.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	0.7	8.0
<i>Erodium cicutarium</i> ^a (redstem stork's bill)	0.2	8.0
<i>Hesperostipa comata</i> (needle and thread grass)	X	X
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.4	16.0
<i>Hordeum leporinum</i> ^a (hare barley)	X	X
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.1	4.0
<i>Melilotus officinalis</i> ^a (sweet clover)	0.2	8.0
<i>Poa bulbosa</i> ^a (bulbous bluegrass)	0.1	4.0
<i>Poa secunda</i> (Sandberg bluegrass)	1.6	64.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	9.0	80.0
<i>Purshia tridentata</i> (antelope bitterbrush)	0.1	4.0
<i>Salsola kali</i> ^a (Russian thistle)	2.1	84.0
<i>Sisymbrium altissimum</i> ^a (tumble mustard)	0.1	4.0

Table 17. Percent Canopy Cover and Frequency of Occurrence at the 100-H-24 Site in 2018. (2 Pages).

Species	% Cover	% Frequency of Occurrence
<i>Sphaeralcea munroana</i> (Munro's globemallow)	0.6	4.0
<i>Tragopogon dubius</i> ^a (yellow salsify)	0.1	4.0
<i>Vulpia microstachys</i> (desert fescue)	0.7	28.0
Crust	0.2	8.0
Soil	67.4	100.0
Litter	32.6	100.0
Total canopy cover (excludes crust/soil/litter)	27.0	
Total Native % Cover	14.8	
Total Invasive % Cover	12.2	

^a Invasive species

^b Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames



Figure 19. The 100-H-24 Site in 2018.

3.5.4 116-H-1 Site (Liquid Waste Disposal Trench)

The 116-H-1 site was revegetated multiple times, most recently in FY 2016. These multiple iterations of revegetation activities were most likely due to repeated industrial use of the 116-H-1 site. Monitoring for this site was not conducted until June 2018 when the site was 3 years old (Figure 20).

No shrub transect was established for this site.

Canopy cover data for the site was collected in May 2018. Data was collected from 50 plot frames, 25 in the northern portion and 25 in the southern portion of the site. Canopy cover did not differ significantly between the two areas. Canopy cover for the entire site was 21.8%, made up of 8.6% native cover and 13.2% invasive cover (Table 18). The dominant native species at this site was bluebunch wheatgrass (*Pseudoroegneria spicata*) with 3.4% cover followed by Sandberg's bluegrass (*Poa secunda*) with 2.3% cover. Sagebrush (*Artemisia tridentata*) has a coverage of 0.8% at this site. The dominant invasive species was cheatgrass (*Bromus tectorum*) with 9.1% cover and occurrence in 100% of the plot frames followed by Russian thistle (*Salsola kali*) with 1.8% cover. Seventeen native species were recorded in 2018.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was recorded at this site and had a cover of 1%, occurring in 32% of the plot frames.

As this is the first year canopy cover data was collected at this site, continued monitoring is recommended before any additional revegetation actions are taken. Native species diversity at this site is high. This may be due to previous revegetation efforts increasing native species abundance in the seed bank.

Table 18. Percent Canopy Cover and Frequency of Occurrence at the 116-H-1 Site in 2018. (2 Pages).

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	X	X
<i>Achnatherum hymenoides</i> (Indian ricegrass)	X	X
<i>Artemisia tridentata</i> (big sagebrush)	0.8	10.0
<i>Astragalus succumbens</i> (Columbia milkvetch)	X	X
<i>Bromus arvensis</i> ^a (field brome)	0.1	2.0
<i>Bromus tectorum</i> ^a (cheatgrass)	9.1	100.0
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	1.0	32.0
<i>Chrysothamnus viscidiflorus</i> (yellow rabbitbrush)	X	X
<i>Draba verna</i> ^a (spring draba)	0.1	2.0
<i>Elymus elymoides</i> (squirreltail)	0.5	20.0
<i>Epilobium brachycarpum</i> (tall annual willowherb)	0.1	2.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	0.2	6.0
<i>Erodium cicutarium</i> ^a (redstem stork's bill)	0.1	2.0
<i>Grayia spinosa</i> (spiny hopsage)	0.1	2.0
<i>Hesperostipa comata</i> (needle and thread)	1.0	28.0
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.6	22.0

**Table 18. Percent Canopy Cover and Frequency of Occurrence
at the 116-H-1 Site in 2018. (2 Pages).**

Species	% Cover	% Frequency of Occurrence
<i>Hordeum leporinum</i> ^a (hare barley)	X	X
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.1	4.0
<i>Melilotus officinalis</i> ^a (sweet clover)	X	X
<i>Plantago patagonica</i> (woolly plantain)	X	X
<i>Poa secunda</i> (Sandberg bluegrass)	2.3	84.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	3.4	56.0
<i>Purshia tridentata</i> (antelope bitterbrush)	0.1	2.0
<i>Salsola kali</i> ^a (Russian thistle)	1.8	74.0
<i>Salvia dorrii</i> (purple sage)	X	X
<i>Sisymbrium altissimum</i> ^a (tumble mustard)	0.4	16.0
<i>Sphaeralcea munroana</i> (Munro's globemallow)	X	X
<i>Tragopogon dubius</i> ^a (yellow salsify)	X	X
<i>Vulpia microstachys</i> (desert fescue)	0.2	10.0
Crust	0.0	0.0
Soil	67.2	100.0
Litter	33.3	100.0
Total canopy cover (excludes crust/soil/litter)	21.8	
Total Native % Cover	8.6	
Total Invasive % Cover	13.2	

^a Invasive species

^b Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames



Figure 20. The 116-H-1 Site in 2018.

3.6 100-F AREA SITES

Ten sites were monitored in the 100-F Area: 118-F-6 SSA, 100-F-47, 100-F-48, 100-F CTA, 100-F-57, 100-F-26, 118-F-1, 118-F-3, 118-F-5, and the 100-F Trailer Village. The 100-F-47 and 100-F-48 sites were revegetated in FY 2012 and monitoring was first conducted in FY 2016. The 100-F-47 and 100-F-48 sites had additional shrubs planted in FY 2018 in order to increase the shrub coverage. The eight other sites were determined to need additional revegetative actions due to failing shrub and/or native plant coverage, and were all completely re-done in FY 2018. The original planting of the 118-F-6 SSA took place in FY 2009 and the original planting of 100-F-47, 100-F-48, and 100-F CTA occurred in FY 2012. Initial revegetation efforts at all these sites entailed broadcast seeding at approximately 16.8 kg/ha (15 lbs/ac) with a mixture of native grasses including Sandberg's bluegrass (*Poa secunda*), Indian ricegrass (*Achnatherum hymenoides*), bluebunch wheatgrass (*Pseudoroegneria spicata*), squirreltail (*Elymus elymoides*), needle-and-thread grass (*Hesperostipa comata*), and prairie junegrass (*Koeleria macrantha*) topped with a straw mulch that was crimped into the soil surface. Shrub species including big sagebrush (*Artemisia tridentata*), antelope bitterbrush (*Purshia tridentata*), and spiny hopsage (*Grayia spinosa*) were transplanted on the sites at approximately 1,235 to 1,600 plants/ha (500 to 650 plants/ac) with a mix of approximately 75% sagebrush, 15% bitterbrush, and 10% spiny hopsage. The 2017 monitoring of these sites showed higher invasive cover than native cover and low shrub coverage.

In FY 2018, additional revegetation actions at the 100-F Area involved both supplemental plantings of shrubs and the complete re-working of failing revegetation sites. All of the sites monitored and included in this report were completely re-done. Revegetation efforts at these

sites included seeding approximately 16.8 kg/ha (15 lbs/ac) pure live seed of a mixture of native grasses including Sandberg bluegrass, Indian ricegrass, bluebunch wheatgrass, squirreltail, and needle-and-thread grass. Gray rabbitbrush (*Ericameria nauseosa*), snow buckwheat (*Eriogonum niveum*), Blue Mountain buckwheat (*Eriogonum strictum*), Munro's globemallow (*Sphaeralcea munroana*), Douglas' dustymaiden (*Chaenactis douglasii*), Carey's balsamroot (*Balsamorhiza careyana*), and sharpleaf penstemon (*Penstemon acuminatus*) were seeded as a mix at a rate of 1.1 lb/ac. Big sagebrush, antelope bitterbrush, and spiny hopsage were planted at a rate of 1,480 plants/ha (600 plants/ac), at a mix of 67%, 16%, and 16%, respectively.

Three different revegetation treatments were used on the sites that were completely redone. The 118-F-1 and 118-F-6 seeding used an imprinter rather than a broadcast seeder, and these sites were not covered with straw mulch. The 100-F CTA, the 100-F-Trailer Village, and 118-F-5 were imprinted and covered with straw mulch. The 100-F-57, 100-F-26, and 118-F-3 used the traditional method of broadcast seeding and covered with straw mulch.

3.6.1 100-F-47 Site (151-F Substation)

The 100-F-47 site (Figure 21) was revegetated in FY 2012 and monitoring was first conducted for the site in 2016. In 2018, sagebrush, bitterbrush, and hopsage were planted at this site at a rate of approximately 864 plants/ha (350 plants/ac), 247 plants/ha (100 plants/ac), and 247 plants/ha (100 plants/ac), respectively. The substrate for the site is primarily gravel and cobble backfill with varying amounts of loamy sand.

A shrub monitoring transect was established for the site in 2016 and was monitored on June 27, 2017; the results show a shrub density of 979 plants/ha (396 plants/ac) above the success criteria of 600 plants/ha (240 plants/ac). Shrub survival was 97.0% of that observed in 2016. A new transect was established for the site after supplemental planting in 2018 and was monitored in May 2018. This transect recorded existing shrubs, existing recruits, and newly planted shrubs. The results show a shrub density of 2,618 plants/ha (1,060 plants/ac), with about half of those shrubs being newly planted. This is well above the success criteria of 600 plants/ha (240 plants/ac).

Canopy cover data was not collected for this site in 2018. See information below for 2017 data.

Canopy cover data for the site was collected on June 27, 2017. Data was collected from a total of 25 plot frames. Canopy cover for the site was 22.9% with native cover representing 10.8% and invasive cover representing 12.1% (Table 19). This represents a decrease of 2.0% in native cover and of 42.7% in invasive cover from 2016. The dominant native species was bluebunch wheatgrass (*Pseudoroegneria spicata*) with 3.5% cover followed by Sandberg bluegrass (*Poa secunda*) and rubber rabbitbrush (*Ericameria nauseosa*) with 2.4% cover each. Cheatgrass (*Bromus tectorum*) was the dominant invasive species with 6.8% cover. The 10.8% native cover does not meet the success criteria of 25% native cover within 5 years. With less than 25% total canopy cover for the site after 5 years, it is unlikely that 25% native canopy cover is an achievable goal for this site due to the makeup of the substrate or other unknown factors; however, additional revegetation efforts designed to increase native grasses and forbs should be considered for this site.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was present on the site with 1.5% cover and occurrence in 20% of the plot frames.

Table 19. Percent Canopy Cover and Frequency of Occurrence at the 100-F-47 Site in 2018.

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	X	X
<i>Achnatherum hymenoides</i> (Indian ricegrass)	X	X
<i>Artemisia tridentata</i> (big sagebrush)	2.1	20.0
<i>Bromus tectorum</i> ^a (cheatgrass)	6.8	100.0
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	1.5	48.0
<i>Descurcania pinnata</i> (western tansymustard)	X	X
<i>Epilobium brachycarpum</i> (tall annual willowherb)	0.1	4.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	2.4	20.0
<i>Grayia spinosa</i> (spiny hopsage)	X	X
<i>Hesperostipa comata</i> (needle and thread grass)	0.1	4.0
<i>Holodiscus discolor</i> (oceanspray)	X	X
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.4	12.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.6	20.0
<i>Machaeranthera canescens</i> (hoary tansyaster)	0.1	4.0
<i>Melilotus officinalis</i> ^a (sweetclover)	X	X
<i>Poa bulbosa</i> ^a (bulbous bluegrass)	0.3	16.0
<i>Poa secunda</i> (Sandberg bluegrass)	2.4	88.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	3.5	60.0
<i>Salsola kali</i> ^a (Russian thistle)	2.1	84.0
<i>Sanguisorba minor</i> ^a (small burnet)	X	X
<i>Sisymbrium altissimum</i> ^a (tall tumbledustard)	0.4	12.0
<i>Sphaeralcea munroana</i> (Munro's globemallow)	X	X
<i>Triticum aestivum</i> ^a (common wheat)	0.1	4.0
ARTR recruits ^c	X	X
Crust	0.0	4.0
Soil	68.1	100.0
Litter	31.9	100.0
Total canopy cover (excludes crust/soil/litter)	22.9	
Total Native % Cover	10.8	
Change in Native % Cover from 2017	-2.0	
Total Invasive % Cover	12.1	
Change in Invasive % Cover from 2017	-42.7	

^a Invasive species^b Washington State Classified Noxious Weed (class)^c ARTR recruits = *Artemisia tridentata* plants that are coming in naturally (were not planted)

X = present but not counted in plot frames



Figure 21. The 100-F-47 Site in 2018.

3.6.2 100-F-48 Site (184-F Coal Pit Debris Dump Site)

The 100-F-48 site (Figure 22) was revegetated in FY 2012 and monitoring was first conducted for the site in 2016. Similar to the 100-F-47 site, this site had supplemental shrub plantings in FY 2018. Sagebrush, bitterbrush, and hopsage were planted at this site at a rate of approximately 988 plants/ha (400 plants/ac), 247 plants/ha (100 plants/ac), and 247 plants/ha (100 plants/ac), respectively. The substrate for the site is primarily loamy sand with varying amounts of gravel and cobbles.

A shrub monitoring transect was established for the site in 2016 and was monitored on June 21, 2017; the results show a shrub density of 479 plants/ha (194 plants/ac), well below the success criteria of 600 plants/ha (240 plants/ac). A new transect was established in 2018 to measure density after supplemental planting. The 83 supplemental plants and 65 established plants were counted on this transect, leading to a measurement of 2,114 shrubs/ha (856 shrubs/ac). Supplemental plantings at this site resulted in successful shrub coverage.

Canopy cover data was not collected for this site in 2018. See below for 2017 results.

Canopy cover data for the site was collected on June 21, 2017. Data was collected from a total of 25 plot frames. Canopy cover for the site was 36.3% with native cover representing 13.3% and invasive cover representing 23.0% (Table 20). This represents an increase of 9.1% in native cover and decrease of 26.7% in invasive cover from 2016. The dominant native species was Sandberg bluegrass (*Poa secunda*) with 7.0% cover followed by big sagebrush (*Artemisia tridentata*) with 4.0% cover. Cheatgrass (*Bromus tectorum*) was the dominant invasive species with 15.6% cover. The 13.3% native cover does not meet the success criteria of 25% native cover within 5 years. Additional revegetation efforts designed to increase native shrubs, grasses, and forbs should be considered for this site.

Diffuse knapweed (*Centaurea diffusa*) and broadleaved pepperweed (*Lepidium latifolium*), Washington State Class B noxious weeds, were present on the site. Diffuse knapweed had 1.3% cover and occurrence in 24% of the plot frames; broadleaved pepperweed was observed at one location on the site but was not recorded in any of the plot frames.

Table 20. Percent Canopy Cover and Frequency of Occurrence at the 100-F-48 Site in 2017. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	0.0	4.0
<i>Achnatherum hymenoides</i> (Indian ricegrass)	0.3	8.0
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	0.1	4.0
<i>Artemisia tridentata</i> (big sagebrush)	4.0	20.0
<i>Bromus tectorum</i> ^a (cheatgrass)	15.6	100.0
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	1.3	24.0
<i>Descurcania pinnata</i> (western tansymustard)	0.8	4.0
<i>Draba verna</i> ^a (spring draba)	0.4	20.0
<i>Elymus elymoides</i> (squirreltail)	X	X
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	X	X
<i>Erodium cicutarium</i> ^a (redstem stork's bill)	X	X
<i>Hesperostipa comata</i> (needle and thread grass)	0.0	4.0
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.9	36.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	X	X
<i>Lepidium latifolium</i> ^a (broadleaved pepperweed)	X	X
<i>Lepidium perfoliatum</i> ^a (clasping pepperweed)	X	X
<i>Machaeranthera canescens</i> (hoary tansyaster)	X	X
<i>Poa secunda</i> (Sandberg bluegrass)	7.0	76.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	1.1	16.0
<i>Salsola kali</i> ^a (Russian thistle)	2.1	88.0
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	2.8	12.0
<i>Vulpia microstachys</i> (desert fescue)	0.0	4.0
ARTR recruits ^c	X	X
Crust	2.9	44.0
Soil	59.3	100.0
Litter	38.3	100.0
Total canopy cover (excludes crust/soil/litter)	36.3	
Total Native % Cover	13.3	

Table 20. Percent Canopy Cover and Frequency of Occurrence at the 100-F-48 Site in 2017. (2 Pages)

Species	% Cover	% Frequency of Occurrence
Change in Native % Cover from 2016	9.1	
Total Invasive % Cover	23.0	
Change in Invasive % Cover from 2016	-26.7	

^a Invasive species

^b Washington State Classified Noxious Weed (class)

^c ARTR recruits = *Artemisia tridentata* plants that are coming in naturally (were not planted)

X = present but not counted in plot frames



Figure 22. The 100-F-48 Site in 2018.

3.6.3 118-F-1 Site (Burial Ground)

The 118-F-1 and 118-F-6 sites were revegetated in FY 2018 using an imprinter seeder and no straw mulch (Figure 23). The 118-F-1 site was originally revegetated in FY 2009 and was not monitored; however, 118-F-6 acts as a representative site, suggesting 118-F-1 also failed to meet success criteria. The substrate for this site is predominantly sand with some gravel and cobbles.

One transect was established on this site in May 2018. First-year monitoring results show a shrub density of 1,499 plants/ha (607 plants/ac), putting this site well above the success criteria of 600 plants/ha (240 plants/ac). Second-year monitoring will be more informative regarding the success of this site, as first-year monitoring occurred only 4 months after planting.

Canopy cover at this site was measured with 25 plots in May 2018 (Table 21). Canopy cover totaled 26.1% with 8.1% native cover and 18.0% invasive cover. The dominant native species was “Bunchgrasses” with a coverage totaling 2.4%. Squirreltail (*Elymus elymoides*), Indian ricegrass (*Achnatherum hymenoides*), bluebunch wheatgrass (*Pseudoroegneria spicata*), and needle-and-thread grass (*Hesperostipa comata*) were categorized as “Bunchgrasses,” as they were too immature to determine species. The dominant invasive plant was Russian thistle (*Salsola kali*) with a coverage totaling 9.4%. It is common for Russian thistle to be the most abundant species in first-year revegetation sites. Twelve native grass and forb species were observed at this site. Three of the six forbs that were seeded at 118-F-1 were detected: Douglas’ dustymaiden (*Chaenactis douglasii*), snow buckwheat (*Eriogonum niveum*), and sharpleaf penstemon (*Penstemon acuminatus*).

More time is needed to determine the success of this site but the high diversity of native plants observed is a positive indicator.

No Washington State Noxious Weeds were identified at this site.

Table 21. Percent Canopy Cover and Frequency of Occurrence at the 118-F-1 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Achnatherum hymenoides</i> (Indian ricegrass)	X	X
<i>Artemisia tridentata</i> (big sagebrush)	0.3	12.0
<i>Bromus tectorum</i> ^a (cheatgrass)	5.8	72.0
Bunchgrasses ^c	2.4	96.0
<i>Chaenactis douglasii</i> (Douglas' dusty maiden)	0.3	12.0
<i>Draba verna</i> ^a (spring draba)	0.1	4.0
<i>Elymus elymoides</i> (squirreltail)	2.1	84.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	0.8	32.0
<i>Eriogonum niveum</i> (snow buckwheat)	0.4	16.0
<i>Erodium cicutarium</i> ^a (redstem stork's bill)	0.1	4.0
<i>Grayia spinosa</i> (spiny hopsage)	X	X
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.4	16.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.8	12.0
<i>Machaeranthera canescens</i> (hoary tansyaster)	0.1	4.0
<i>Penstemon sp.</i> (beardtongue)	0.1	4.0
<i>Phacelia sp.</i> (phacelia)	0.1	4.0
<i>Poa secunda</i> (Sandberg bluegrass)	1.5	60.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	X	X
<i>Purshia tridentata</i> (antelope bitterbrush)	X	X
<i>Salsola kali</i> ^a (Russian thistle)	9.4	100.0
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	1.4	36.0
<i>Tragopogon dubius</i> ^a (yellow salsify)	X	X
Crust	0.0	0.0
Soil	91.6	100.0
Litter	8.4	100.0

Table 21. Percent Canopy Cover and Frequency of Occurrence at the 118-F-1 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
Total canopy cover (excludes crust/soil/litter)	26.1	
Total Native % Cover	8.1	
Total Invasive % Cover	18.0	

^a Invasive species

^b Washington State Classified Noxious Weed (class)

^c ARTR recruits = *Artemisia tridentata* plants that are coming in naturally (were not planted)

X = present but not counted in plot frames



Figure 23. The 118-F-1 Site in 2018, Viewed From East to West.

3.6.4 118-F-6 Site (Soil Staging Area)

The 118-F-6 Soil Staging Area (SSA) site (Figure 24) was revegetated in FY 2009 and monitoring was first conducted for the site in 2016. The substrate for the site is a loamy sand with varying amounts of gravel and cobbles. No shrub transect was established for the site in 2016 due to the scarcity of shrubs observed on the site. In 2018 this site was revegetated with an imprint seeder and no straw mulch.

In 2017, 7 years after this site was originally planted, it had little to no shrub cover and a canopy cover of 18.7% with 14.2% invasive and 4.5% native. In May 2018, after this site was redone,

one transect was set up to measure shrub cover. The results show a shrub cover of 1,489 plants/ha (603 plants/ac), well above the success criteria of 600 plants/ha (240 plant/ac).

Canopy cover data for this site was collected in June 2018 (Table 22). Data was collected from a total of 25 plot frames. Canopy cover for the site was 33.4% with 6.4% native cover and 27.0% invasive cover. The high invasive cover is mainly made up of Russian thistle (*Salsola kali*, 10.3% cover) and cheatgrass (*Bromus tectorum*, 11.1% cover). The highest native coverage was from unidentified bunchgrass species with 1.7% cover. Sixteen native grasses and forbs were identified at this site. Two of the six seeded forb species were found at this site. Prior to additional revegetation action, five native grass and forb species were identified at this site. Though this site had high invasive cover, this is not unusual in the first year after planting.

The 118-F-6 site, after being redone, had successful shrub cover and had a higher native cover and more native species than it had after the original revegetation effort. More monitoring data is needed before the success of this site can be determined.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was observed in 4% of the plot frames at this site.

Table 22. Percent Canopy Cover and Frequency of Occurrence at the 118-F-6 Soil Staging Area Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	X	X
<i>Achnatherum lymenoides</i> (Indian ricegrass)	0.1	4.0
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	0.1	4.0
<i>Artemisia tridentata</i> (big sagebrush)	0.2	8.0
<i>Bromus tectorum</i> ^a (cheatgrass)	11.1	92.0
<i>Bunchgrasses</i> ^b	1.7	68.0
<i>Centaurea diffusa</i> ^c (diffuse knapweed) (B)	0.1	4.0
<i>Chaenactis douglasii</i> (Douglas' dusty maiden)	0.4	16.0
<i>Chenopodium sp.</i> (goosefoot)	X	X
<i>Cryptantha circumscissa</i> (cushion cryptantha)	X	X
<i>Draba verna</i> ^a (spring draba)	0.5	20.0
<i>Elymus elymoides</i> (squirreltail)	1.1	44.0
<i>Epilobium brachycarpum</i> (tall annual willowherb)	0.3	12.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	0.3	12.0
<i>Erigeron sp.</i> (fleabane)	0.2	8.0
<i>Eriogonum niveum</i> (snow buckwheat)	0.3	12.0
<i>Erodium cicutarium</i> ^a (redstem stork's bill)	0.2	8.0
<i>Grayia spinosa</i> (spiny hopsage)	X	X
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.2	8.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.7	8.0
<i>Lepidium perfoliatum</i> ^a (clasping pepperweed)	0.6	4.0
<i>Machaeranthera canescens</i> (hoary tansyaster)	0.1	4.0

Table 22. Percent Canopy Cover and Frequency of Occurrence at the 118-F-6 Soil Staging Area Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Poa secunda</i> (Sandberg bluegrass)	0.7	28.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	0.6	4.0
<i>Salsola kali</i> ^a (Russian thistle)	10.3	100.0
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	3.3	52.0
<i>Stephanomeria paniculata</i> (tufted wirelettuce)	0.2	8.0
<i>Tragopogon dubius</i> ^a (yellow salsify)	X	X
<i>Vulpia microstachys</i> (desert fescue)	0.1	4.0
Crust	0.0	0.0
Soil	93.5	100.0
Litter	6.5	100.0
Total canopy cover (excludes crust/soil/litter)	33.4	
Total Native % Cover	6.4	
Total Invasive % Cover	27.0	

^a Invasive species

^b Bunchgrasses include *Pseudoroegneria spicata*, *Achnatherum hymenoides*, *Elymus elymoides*, *Poa secunda*, *Sporobolus cryptandrus*, and *Hesperostipa comata*

^c Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames



Figure 24. The 118-F-6 Soil Staging Area Site in 2018.

3.6.5 100-F CTA Site (Container Transfer Area)

The 100-F Container Transfer Area (100-F CTA) site (Figure 25) was revegetated in FY 2012 and monitoring was first conducted for the site in 2016. This site met success criteria in 2017 monitoring with 640 plants/ha (259 plants/ac). Native canopy cover at this site was not successful in 2017 with 9.6% native cover and 12.3% invasive cover. Due to the low native cover and patchy shrub cover at this site, it was redone in FY 2018. This site was imprinted and covered with a straw mulch, care was taken to avoid running machinery over existing patches of shrubs. The substrate for the site is primarily gravel and cobble backfill with varying amounts of loamy sand.

A shrub monitoring transect was established for the site after the completion of revegetation activities in 2018; this transect was monitored immediately after planting and in May. The May results show a shrub density of 760 plants/ha (308 plants/ac), meeting the success criteria of 600 plants/ha (240 plants/ac). Shrub survival was 97.4% of that observed immediately post planting.

Canopy cover data for the site was collected in June 2018. Data was collected from a total of 25 plot frames. Canopy cover for the site was 20.4% with native cover representing 7.3% and invasive cover representing 13.1% (Table 23). The dominant native species was bluebunch wheatgrass (*Pseudoroegneria spicata*) with 2.4% cover. Two of the six forb species seeded at this site were detected during canopy cover monitoring. Eleven native grass and forb species were identified at this site; prior to the additional revegetation actions only six native grass and forb species were found at this site. Russian thistle (*Salsola kali*) was the dominant invasive species with 7.2% cover followed by cheatgrass (*Bromus tectorum*) with a cover of 3.9%.

Though invasive cover is higher at this site than it was pre-redo, high invasive cover caused by Russian thistle is common in the first year of a revegetation site. Though native cover was less after additional revegetation actions, the number of native species on the site nearly doubled. More monitoring years are required to determine if this site is successful.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was present on the site with less than 1% cover and occurrence in 12% of the plot frames.

Table 23. Percent Canopy Cover and Frequency of Occurrence at the 100 F CTA Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Artemisia tridentata</i> (big sagebrush)	0.5	20.0
<i>Bromus tectorum</i> ^a (cheatgrass)	3.9	96.0
<i>Bunchgrasses</i> ^b	1.9	76.0
<i>Centaurea diffusa</i> ^c (diffuse knapweed) (B)	0.3	12.0
<i>Chaenactis douglasii</i> (Douglas' dusty maiden)	0.2	8.0
<i>Chenopodium sp.</i> (goosefoot)	X	X
<i>Dalea ornata</i> (Bluie Mountain prairie clover)	X	X
<i>Draba verna</i> ^a (spring draba)	X	X
<i>Elymus elymoides</i> (squirreltail)	1.4	56.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	0.1	4.0
<i>Eriogonum nievum</i> (snow buckwheat)	0.1	4.0
<i>Festuca sp.</i> (fescue)	0.3	12.0

Table 23. Percent Canopy Cover and Frequency of Occurrence at the 100 F CTA Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Grayia spinosa</i> (spiny hopsage)	X	X
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.5	20.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.1	4.0
<i>Lepidium perfoliatum</i> ^a (clasping pepperweed)	0.1	4.0
<i>Poa secunda</i> (Sandberg bluegrass)	0.3	12.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	2.4	36.0
<i>Purshia tridentata</i> (antelope bitterbrush)	X	X
<i>Salsola kali</i> ^a (Russian thistle)	7.2	88.0
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	0.4	16.0
<i>Triticum sp.</i> ^a (wheat)	0.6	24.0
<i>Vulpia microstachys</i> (desert fescue)	0.1	4.0
Crust	0.0	0.0
Soil	34.3	100.0
Litter	63.7	100.0
Total canopy cover (excludes crust/soil/litter)	20.4	
Total Native % Cover	7.3	
Total Invasive % Cover	13.1	

^a Invasive species

^b Bunchgrasses include *Pseudoroegneria spicata*, *Achnatherum hymenoides*, *Elymus elymoides*, *Poa secunda*, *Sporobolus cryptandrus*, and *Hesperostipa comata*

^c Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames



Figure 25. The 100-F CTA Site in 2018, Looking Towards the Southwest.

3.6.6 100-F Trailer Village Site

The 100-F Trailer Village site was revegetated in FY 2018 using an imprinter seeder and straw mulch (Figure 26). The 100-F Trailer Village site was originally revegetated in FY 2013 and was not monitored but the 100-F CTA site acts as a representative site, suggesting the 100-F Trailer Village would also benefit from additional revegetation activities. The substrate for this site is predominantly loamy sand with gravel.

One transect was established on this site and monitored immediately after planting and in May 2018. May monitoring results show a shrub density of 1,559 plants/ha (631 plants/ac), putting this site well above the success criteria of 600 plants/ha (240 plants/ac). Shrubs had a 96.9% survival rate post-planting. Second-year monitoring will be more informative regarding the success of this site, as first-year monitoring occurred only 4 months after planting.

Canopy cover at this site was measured with 25 plots in June 2018 (Table 24). Canopy cover totaled 21.2% with 4.8% native cover and 16.4% invasive cover. The dominant native species was “Bunchgrasses” with a coverage totaling 2.0%. The dominant invasive plant was Russian thistle (*Salsola kali*) with a coverage totaling 11.7%. It is common for Russian thistle to be the most abundant species in first-year revegetation sites. Only one of the six forbs that were seeded at 100-F CTA were detected. Ten species of native forbs and grasses were identified at this site. More time is needed to determine the success of this site.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was present on the site but did not occur in any of the plot frames.

Table 24. Percent Canopy Cover and Frequency of Occurrence at the 100-F Trailer Village Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	X	X
<i>Artemisia tridentata</i> (big sagebrush)	0.5	20.0
<i>Bromus tectorum</i> ^a (cheatgrass)	3.6	84.0
<i>Bunchgrasses</i> ^b	2.0	80.0
<i>Centaurea diffusa</i> ^c (diffuse knapweed) (B)	X	X
<i>Chaenactis douglasii</i> (Douglas' dusty maiden)	X	X
<i>Elymus elymoides</i> (squirreltail)	0.7	28.0
<i>Epilobium brachycarpum</i> (tall annual willowherb)	0.2	8.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	0.5	20.0
<i>Festuca</i> sp. (fescue)	0.5	20.0
<i>Grayia spinosa</i> (spiny hopsage)	X	X
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.2	8.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	X	X
<i>Poa secunda</i> (Sandberg bluegrass)	0.1	4.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	0.2	8.0
<i>Purshia tridentata</i> (antelope bitterbrush)	0.1	4.0
<i>Salsola kali</i> ^a (Russian thistle)	11.7	100

Table 24. Percent Canopy Cover and Frequency of Occurrence at the 100-F Trailer Village Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	0.6	24
<i>Stephanomeria paniculata</i> (tufted wirelettuce)	X	X
<i>Tragopogon dubius</i> ^a (yellow salsify)	0.1	4
<i>Triticum sp.</i> ^a (wheat)	0.2	8
Crust	0.0	0.0
Soil	42.4	100.0
Litter	56.6	100.0
Total canopy cover (excludes crust/soil/litter)	21.2	
Total Native % Cover	4.8	
Total Invasive % Cover	16.4	

^a Invasive species

^b Bunchgrasses include *Pseudoroegneria spicata*, *Achnatherum hymenoides*, *Elymus elymoides*, *Poa secunda*, *Sporobolus cryptandrus*, and *Hesperostipa comata*

^c Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames



Figure 26. The 100-F Trailer Village in 2018, View from South to North.

3.6.7 118-F-5 Site (Sawdust Pit)

The 118-F-5 site was revegetated in FY 2018 using an imprinter seeder and straw mulch (Figure 27). The 118-F-5 site was originally revegetated in FY 2008 and was not monitored. The 2017 evaluations recommended additional revegetation actions to increase shrubs and native

plant cover at this site. The substrate for this site is predominantly sandy loam with heavy cobble changing to sandy loam with some gravel. The northwestern third of the site had especially high rates of cobble.

Two transects were established on this site and monitored immediately after planting and in May 2018. May monitoring results show an average shrub density of 830 plants/ha (336 plants/ac), putting this site above the success criteria of 600 plants/ha (240 plants/ac). Shrubs had a 93.5% survival rate post-planting. Second-year monitoring will be more informative regarding the success of this site as first-year monitoring occurred only 4 months after planting.

Canopy cover at this site was measured with 50 plots in June 2018 (Table 25). Canopy cover totaled 13.1% with 4.0% native cover and 9.1% invasive cover. The dominant native species was “Bunchgrasses” with a coverage totaling 1.2%. The dominant invasive plant was cheatgrass (*Bromus tectorum*) with a coverage totaling 4.6% followed by Russian thistle (*Salsola kali*) with a coverage of 2.8%. Two of the six forbs that were seeded at 118-K-5 were detected. Sixteen species of native forbs and grasses were identified at this site. More time is needed to determine the success of this site but the large number of native plant species suggests this site’s native plant cover will increase significantly.

Diffuse knapweed (*Centaurea diffusa*) and rush skeleton weed (*Chondrilla juncea*), both Washington State Class B noxious weeds, were present on the site and have less than 1% cover.

Table 25. Percent Canopy Cover and Frequency of Occurrence at the 118-K-5 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	0.4	6.0
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	0.1	2.0
<i>Artemisia tridentata</i> (big sagebrush)	0.1	5.0
<i>Bromus tectorum</i> ^a (cheatgrass)	4.6	50.0
Bunchgrasses ^b	1.2	48.0
<i>Centaurea diffusa</i> ^c (diffuse knapweed) (B)	0.1	4.0
<i>Chaenactis douglasii</i> (Douglas' dusty maiden)	0.3	10.0
<i>Chenopodium sp.</i> (goosefoot)	X	X
<i>Chondrilla juncea</i> ^c (rush skeletonweed) (B)	X	X
<i>Draba verna</i> ^a (spring draba)	0.7	22.0
<i>Elymus elymoides</i> (squirreltail)	0.8	27.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	0.2	6.0
<i>Erigeron sp.</i> (fleabane)	0.1	2.0
<i>Eriogonum niveum</i> (snow buckwheat)	0.1	4.0
<i>Eriogonum vimineum</i> (wickerstem buckwheat)	0.1	4.0
<i>Erodium cicutarium</i> ^a (redstem stork's bill)	0.1	2.0
<i>Grayia spinosa</i> (spiny hopsage)	0.1	2.0
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.2	8.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	X	X

Table 25. Percent Canopy Cover and Frequency of Occurrence at the 118-K-5 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Machaeranthera canescens</i> (hoary tansyaster)	0.1	2.0
<i>Microsteris gracillis</i> (slender phlox)	X	X
<i>Plantago patagonica</i> (woolly plantain)	0.1	4.0
<i>Poa bulbosa</i> ^a (bulbous bluegrass)	0.1	2.0
<i>Poa secunda</i> (Sandberg bluegrass)	0.2	9.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	X	X
<i>Purshia tridentata</i> (antelope bitterbrush)	X	X
<i>Salsola kali</i> ^a (Russian thistle)	2.8	50.0
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	0.2	7.0
<i>Stephanomeria paniculata</i> (tufted wirelettuce)	X	X
<i>Tragopogon dubius</i> ^a (yellow salsify)	X	X
<i>Triticum sp.</i> ^a (wheat)	0.5	13.0
<i>Vulpia microstachys</i> (desert fescue)	0.4	10.0
Crust	0.0	0.0
Soil	26.2	50.0
Litter	23.6	50.0
Total canopy cover (excludes crust/soil/litter)	13.1	
Total Native % Cover	4.0	
Total Invasive % Cover	9.1	

^a Invasive species

^b Bunchgrasses include *Pseudoroegneria spicata*, *Achnatherum hymenoides*, *Elymus elymoides*, *Poa secunda*, *Sporobolus cryptandrus*, and *Hesperostipa comata*

^c Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames



Figure 27. The 118-F-5 Site in 2018, Showing Heavier Cobble in the Northwestern Section.

3.6.8 100-F-57 Site (190-F Water Pump House Debris)

The 100-F-57 site was revegetated in FY 2018 using a broadcast seeder and straw mulch (Figure 28). The 100-F-57 site was originally revegetated in FY 2009 and was not monitored. The 2017 evaluations recommended additional revegetation actions to increase shrubs and native plant cover at this site. The substrate for this site is predominantly loamy sand with high amounts of cobble, scattered asphalt patches, and some debris.

One transect was established on this site and monitored immediately after planting and in May 2018. May monitoring results show an average shrub density of 2919 plants/ha (1182 plants/ac), putting this site far above the success criteria of 600 plants/ha (240 plants/ac). Shrubs had a 95.7% survival rate post-planting. This transect was located in an especially dense area of planted shrubs, and typically a density this high is not recommended due to increased competition among the shrubs and with other plants. Second-year monitoring will be more informative regarding the density of this site, as first-year monitoring occurred only four months after planting.

Canopy cover at this site was measured with 25 plots in June 2018 (Table 26). Canopy cover totaled 26.8% with 10.6% native cover and 16.2% invasive cover. The dominant native species was “Bunchgrasses” with a coverage totaling 3.3%. The dominant invasive plant was cheatgrass (*Bromus tectorum*), with a coverage totaling 9.2%, followed by Russian thistle (*Salsola kali*) with a coverage of 5.4%. Three of the six forbs that were seeded at 118-K-5 were detected. Seventeen species of native forbs and grasses were identified at this site.

More time is needed to determine the success of this site but the large number of native plant species suggests this site’s native plant cover will increase significantly. A total of 10.6% native cover in the first year is relatively high compared to most revegetation sites; this number tends to trend upward in the years following revegetation.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was present on the site and had less than 1% cover.

Table 26. Percent Canopy Cover and Frequency of Occurrence at the 100-F-57 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	X	X
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	0.2	8.0
<i>Artemisia tridentata</i> (big sagebrush)	0.6	24.0
<i>Astragalus succumbens</i> (Columbia milkvetch)	X	X
<i>Bromus arvensis</i> ^a (field brome)	X	X
<i>Bromus tectorum</i> ^a (cheatgrass)	9.2	96.0
Bunchgrasses ^b	3.3	92.0
<i>Centaurea diffusa</i> ^c (diffuse knapweed) (B)	0.1	4.0
<i>Chaenactis douglasii</i> (Douglas' dustymaiden)	0.2	8.0
<i>Crepis sp.</i> (hawksbeard)	0.1	4.0
<i>Draba verna</i> ^a (spring draba)	0.2	8.0
<i>Elymus elymoides</i> (squirreltail)	3.1	84.0

**Table 26. Percent Canopy Cover and Frequency of Occurrence
at the 100-F-57 Site in 2018. (2 Pages)**

Species	% Cover	% Frequency of Occurrence
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	0.3	12.0
<i>Eriogonum niveum</i> (snow buckwheat)	0.3	12.0
<i>Eriogonum vimineum</i> (wickerstem buckwheat)	0.1	4.0
<i>Festuca sp.</i> (fescue)	0.7	8.0
<i>Grayia spinosa</i> (spiny hopsage)	X	X
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.3	12.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	X	X
<i>Machaeranthera canescens</i> (hoary tansyaster)	0.1	4.0
<i>Penstemon acuminatus</i> (sharpleaf penstemon)	X	X
<i>Poa secunda</i> (Sandberg bluegrass)	0.2	8.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	0.9	16.0
<i>Purshia tridentata</i> (antelope bitterbrush)	0.1	4.0
<i>Salsola kali</i> ^a (Russian thistle)	5.4	100.0
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	0.4	16.0
<i>Sporobolus cryptandrus</i> (sand dropseed)	X	X
<i>Stephanomeria paniculata</i> (tufted wirelettuce)	X	X
<i>Tragopogon dubius</i> ^a (yellow salsify)	X	X
<i>Triticum sp.</i> ^a (wheat)	0.6	24.0
<i>Vulpia microstachys</i> (desert fescue)	0.4	16.0
Crust	0.0	0.0
Soil	47.6	100.0
Litter	52.4	100.0
Total canopy cover (excludes crust/soil/litter)	26.8	
Total Native % Cover	10.6	
Total Invasive % Cover	16.2	

^a Invasive species^b Bunchgrasses include *Pseudoroegneria spicata*, *Achnatherum hymenoides*, *Elymus elymoides*, *Poa secunda*, *Sporobolus cryptandrus*, and *Hesperostipa comata*^c Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames



Figure 28. The 100-F-57 Site in 2018, View to the West.

3.6.9 100-F-26 Site (Water Treatment Facility Pipelines)

The 100-F-26 site was revegetated in FY 2018 using a broadcast seeder and straw mulch (Figure 29). The 100-F-26 site was originally revegetated in FY 2009 and was not monitored. The 2017 evaluations recommended additional revegetation actions to increase shrubs and native plant cover at this site. The substrate for this site is predominantly loamy sand with some gravel and cobbles.

One transect was established on this site and monitored immediately after planting and in May 2018. May monitoring results show an average shrub density of 959 plants/ha (388 plants/ac), putting this site above the success criteria of 600 plants/ha (240 plants/ac). Shrubs had a 91.0% survival rate post-planting. Second-year monitoring will be more informative regarding the density of this site, as first-year monitoring occurred only 4 months after planting.

This site is relatively small, and canopy cover was measured with 12 plots in June 2018 (Table 27). Canopy cover totaled 47.7% with 4.0% native cover and 43.8% invasive cover. The dominant native species was “Bunchgrasses” with a coverage totaling 1.5%. The dominant invasive plant was cheatgrass (*Bromus tectorum*) with a coverage totaling 34.4% followed by Russian thistle (*Salsola kali*) with a coverage of 6.5%. Two of the six forbs that were seeded at 118-K-5 were detected. Ten species of native forbs and grasses were identified at this site.

More time is needed to determine the success of this site. Cheatgrass coverage at this site is extremely high and may limit the ability of native plants to establish and grow. This site is smaller than the other sites and its small surface area to boundary ratio may have enabled cheatgrass to invade with relative ease. Second-year monitoring will help identify the trend in native species cover.

No Washington State Noxious Weeds were identified at this site.

Table 27. Percent Canopy Cover and Frequency of Occurrence at the 100-F-26 Site in 2018.

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	X	X
<i>Artemisia tridentata</i> (big sagebrush)	0.2	8.3
<i>Bromus tectorum</i> ^a (cheatgrass)	34.4	100.0
Bunchgrasses ^b	1.5	58.3
<i>Chaenactis douglasii</i> (Douglas' dusty maiden)	0.2	8.3
<i>Draba verna</i> ^a (spring draba)	1.7	66.7
<i>Elymus elymoides</i> (squirreltail)	0.6	25.0
<i>Eriogonum niveum</i> (snow buckwheat)	0.4	16.7
<i>Festuca sp.</i> (fescue)	X	X
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.2	8.3
<i>Lactuca serriola</i> ^a (prickly lettuce)	X	X
<i>Plantago patagonica</i> (woolly plantain)	X	X
<i>Poa secunda</i> (Sandberg bluegrass)	0.4	16.7
<i>Purshia tridentata</i> (antelope bitterbrush)	X	X
<i>Salsola kali</i> ^a (Russian thistle)	6.5	91.7
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	1.0	41.7
<i>Stephanomeria paniculata</i> (tufted wirelettuce)	X	X
<i>Triticum sp.</i> ^a (wheat)	X	X
<i>Vulpia microstachys</i> (desert fescue)	0.6	25.0
Crust	0.0	0.0
Soil	56.0	100.0
Litter	44.0	100.0
Total canopy cover (excludes crust/soil/litter)	47.7	
Total Native % Cover	4.0	
Total Invasive % Cover	43.8	

^a Invasive species

^b Bunchgrasses include *Pseudoroegneria spicata*, *Achnatherum hymenoides*, *Elymus elymoides*, *Poa secunda*, *Sporobolus cryptandrus*, and *Hesperostipa comata*

X = present but not counted in plot frames



Figure 29. The 100-F-26 Site in 2018 Showing High Levels of Cheatgrass Cover, View Facing West.

3.6.10 118-F-3 Site (Burial Ground)

The 118-F-3 site was revegetated in FY 2018 using a broadcast seeder and straw mulch (Figure 30). The 100-F-57 site was originally revegetated in FY 2008 and was not monitored. The 2017 evaluations recommended additional revegetation actions to increase shrubs and native plant cover at this site. The substrate for this site is predominantly sandy with areas of cobbles and boulders.

One transect was established on this site and monitored immediately after planting and in May 2018. May monitoring results show an average shrub density of 1,170 plants/ha (473 plants/ac), putting this site well above the success criteria of 600 plants/ha (240 plants/ac). Shrubs had a 93.6% survival rate post-planting. Spiny hopsage (*Grayia spinosa*) had a relatively low survival rate of 66.7% from the initial planting. Second-year monitoring will be more informative regarding the density of this site as first-year monitoring occurred only 4 months after planting.

Canopy cover at this site was measured with 25 plots in June 2018 (Table 28). Canopy cover totaled 25.4%, with 5.9% native cover and 19.5% invasive cover. The dominant native species was bottlebrush squirreltail (*Elymus elymoides*) with a coverage totaling 1.9%. The dominant invasive plant was Russian thistle (*Salsola kali*) with a coverage totaling 10.1% followed by cheatgrass (*Bromus tectorum*) with a coverage of 6.9%. Two of the six forbs that were seeded at 118-F-3 were detected. Eleven species of native forbs and grasses were identified at this site.

More time is needed to determine the success of this site.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was present on the site and had 1% cover and occurred in 20% of the plot frames.

Table 28. Percent Canopy Cover and Frequency of Occurrence at the 118-F-3 Site in 2018.

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	0.2	8.0
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	X	X
<i>Artemisia tridentata</i> (big sagebrush)	0.5	20.0
<i>Bromus tectorum</i> ^a (cheatgrass)	6.9	76.0
<i>Bunchgrasses</i> ^b	1.8	72.0
<i>Centaurea diffusa</i> ^c (diffuse knapweed) (B)	1.0	20.0
<i>Chaenactis douglasii</i> (Douglas' dustymaiden)	0.1	4.0
<i>Draba verna</i> ^a (spring draba)	0.2	8.0
<i>Elymus elymoides</i> (squirreltail)	1.9	56.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	0.3	12.0
<i>Eriogonum niveum</i> (snow buckwheat)	X	X
<i>Grayia spinosa</i> (spiny hopsage)	X	X
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.4	16.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.2	8.0
<i>Machaeranthera canescens</i> (hoary tansyaster)	0.1	4.0
<i>Poa secunda</i> (Sandberg bluegrass)	0.3	12.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	0.4	16.0
<i>Purshia tridentata</i> (antelope bitterbrush)	X	X
<i>Salsola kali</i> ^a (Russian thistle)	10.1	96.0
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	0.3	12.0
<i>Sporobolus cryptandrus</i> (sand dropseed)	X	X
<i>Triticum sp.</i> ^a (wheat)	0.4	16.0
<i>Vulpia microstachys</i> (desert fescue)	0.2	8.0
Artr recruits	0.1	4.0
Crust	0.0	0.0
Soil	64.5	100.0
Litter	35.5	100.0
Total canopy cover (excludes crust/soil/litter)	25.4	
Total Native % Cover	5.9	
Total Invasive % Cover	19.5	

^a Invasive species

^b Bunchgrasses include *Pseudoroegneria spicata*, *Achnatherum hymenoides*, *Elymus elymoides*, *Poa secunda*, *Sporobolus cryptandrus*, and *Hesperostipa comata*

^c Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames



Figure 30. The 118-F-3 Site in 2018.

3.6.11 Discussion: Revegetation Methods and Effectiveness of Additional Actions

Three different revegetation treatments were used at revegetation sites that were redone in the 100-F Area in 2018. The goal of this method was to compare results from different revegetation treatments and to determine if any revegetation treatment yielded greater success over the 5-year post-restoration monitoring period.

Two of the three methods included using an imprinting seeder rather than a broadcast seeder. The imprinter uses a roller with angular teeth that creates even divets in the soil (Figure 31). These divets create microhabitats within the revegetation site where moisture will accumulate and may provide a more favorable environment for seed germination.



Figure 31. Uniform Divets Left by the Imprinter at the 118-F-6 Area.

The three methods used at 100-F revegetation sites were: imprinting without straw mulch, imprinting with straw mulch, and broadcast seeding with straw mulch. First-year monitoring identified native and invasive cover results varied greatly for all three treatments (Table 29). Sites with mulch had an average native cover of 6.1% while sites without mulch had an average native cover of 7.3%. Imprinted sites had an average native cover of 6.1% while broadcast seeded sites had an average native cover of 6.8%.

More monitoring trend data is needed to determine if one method of treatment results in more successful revegetation sites (Table 30). From 2018 monitoring data, variations in native cover between treatments are small and could also be due to variation in site conditions. Invasive cover in the “Imprint with mulch” treatment is about 10% less than the other two treatments.

Table 29. Treatments and Results from 100-F Revegetation Actions in 2018.				
Site	Treatment	Native Cover (%)	Invasive Cover (%)	Native Grass/Forb Species
118-F-1	Imprint only	8.1	18	12
118-F-6	Imprint only	6.4	27	16
100-F Container Transfer Area	Imprint with mulch	7.3	13.1	11
100-F-Trailer Village	Imprint with mulch	4.8	16.4	10
118-F-5	Imprint with mulch	4	9.1	16
100-F-57	Broadcast with mulch	10.6	16.2	17
100-F-26	Broadcast with mulch	4	43.8	10
118-F-3	Broadcast with mulch	5.9	19.5	11

Table 30. Summarized Results by Revegetation Treatment.		
Treatment	Native Cover (%)	Invasive Cover (%)
Imprint only	7.3	22.5
Imprint with mulch	5.4	12.9
Broadcast with mulch	6.8	26.5

Though the different treatments were all used in a similar geographic area, the soil types at each site varied from sandy soils (118-F-3) to primarily gravel and cobble substrates (100-F CTA). The soil type likely plays a significant role in the success of the revegetation site. Future

monitoring may show correlation between certain revegetation treatments and success; however, causation cannot be inferred from this data alone.

Shrub cover was successful at all 100-F revegetation sites; this measurement was taken only 4 months after the sites were planted. Second-year monitoring results will better describe shrub success at these sites.

In addition to shrub plantings, the sites that were completely redone in 2018 were seeded with six grasses, six forbs, and one shrub. This mix significantly increased native plant diversity at both of the previously monitored sites (118-F-6 and 100-F CTA) from 5 species to 16 species and from 6 species to 11 species, respectively. All of the redone sites had between 10 and 17 native plant species identified during first-year monitoring. This is a relatively high number and suggests that redoing these sites may have greatly increased native plant diversity. The additional revegetation actions were successful at increasing native plant diversity at these previously failing revegetation sites.

Native cover before additional revegetation actions had only been measured at the 118-F-6 and 100-F CTA sites, which were the representative sites for the 100-F Area. Native cover at 118-F-6 site increased by 2% after 2018 additional revegetation actions. Native cover at the 100-F CTA site decreased by 2% after 2018 additional revegetation actions. Considering that these sites were less than 4 months old at the time of 2018 monitoring, more monitoring years of data are needed before determining if additional revegetation actions at 100-F increased native plant cover. Typically native plant cover at revegetation sites trends positively and increases year after year, especially after the initial invasion of Russian thistle subsides. At the representative 100-F sites, native plant cover had been trending negatively in 2016 and 2017. By not intervening at these sites, native plant cover there likely would have continued to decline.

Supplemental shrub plantings, or planting additional shrub plugs on sites that had previously been revegetated, took place at the 100-F-47 and 100-F-48 sites in FY 2018. At both of these sites, native cover was relatively high in 2017 monitoring, but shrubs per acre was close to or below success levels. Post supplemental planting, both of these sites have successful shrub cover. Second-year monitoring will give a more accurate picture of shrub survival post-planting.

3.7 100-IU-2 AND 100-IU-6 AREA SITES

Six sites were monitored in the 100-IU-2/100-IU-6 Area: 600-301, 600-369:3, 600-370, 600-356, 600-379, and 600-358. The 600-301, 600-369:3, and 600-370 sites were revegetated in FY 2014; the 600-356 and 600-379 sites in FY 2015; and the 600-358 site in FY 2016. These sites were remediated to meet the objectives for interim closure as established in the 100 Area RDR/RAWP (DOE/RL-96-17) and in the Interim Action ROD (EPA 1999).

Revegetation efforts entailed broadcast seeding with a mixture of native grasses including Sandberg bluegrass (*Poa secunda*), Indian ricegrass (*Achnatherum hymenoides*), bluebunch wheatgrass (*Pseudoroegneria spicata*), squirreltail (*Elymus elymoides*), needle-and-thread grass (*Hesperostipa comata*), and prairie junegrass (*Koeleria macrantha*) at approximately 16.8 kg/ha (15 lbs/ac). Broadcast seeding areas were topped with a straw mulch that was crimped into the soil surface. Shrub species including big sagebrush (*Artemisia tridentata*), antelope bitterbrush (*Purshia tridentata*), and spiny hopsage (*Grayia spinosa*) were transplanted on the sites at

approximately 1,235 to 1,600 plants/ha (500 to 650 plants/ac) with a mix of approximately 75% sagebrush, 15% bitterbrush, and 10% spiny hopsage. Site 600-358 had a varied ratio of transplanted shrubs with 60 to 70% big sagebrush, 5 to 15% antelope bitterbrush, 10 to 30% spiny hopsage, and approximately 1% (cumulatively) rubber rabbitbrush (*Ericameria nauseosa*) and yellow rabbitbrush (*Chrysothamnus viscidiflorus*).

Additional revegetation actions designed to increase cover of native shrubs and forbs are recommended at 600-301, 600-356, 600-358, and 600-370.

3.7.1 600-301 Site (White Bluffs Sanitary Sewer Pipelines)

The 600-301 site (Figure 32) was revegetated in FY 2014 and monitoring was first conducted for the site in 2014. The substrate for the site is characterized by sand and loamy sand with a small amount of intermixed cobbles.

Fifth-year shrub transect monitoring for the site was conducted in April 2018. The results show a shrub density of only 20 plants/ha (8 plants/ac), well below the success criteria of 600 plants/ha (240 plants/ac). Over 97% of the transplanted shrubs were lost within the first year (2014 to 2015) when only 1 of 103 recorded big sagebrush and 3 of 45 recorded spiny hopsage remained.

Canopy cover data for the site was collected in May 2018. Data was collected from 25 plot frames. Canopy cover for the site was 45.9% with 13.2% native cover and 32.7% invasive cover (Table 31). This represents an increase of 4.2% in native cover and decrease of 11.5% in invasive cover from 2017. The dominant native species were Indian ricegrass (*Achnatherum hymenoides*) and desert fescue (*Vulpia microstachys*), both with 2.1% cover. Cheatgrass (*Bromus tectorum*) was the dominant species for the site overall with 21.1% cover.

After 5 years of monitoring, this site has failed to meet revegetation success criteria, most notably in the shrub cover aspect. Additional actions designed to increase native shrub, forb, and grass cover are needed at this site.

No Washington State Class B noxious weeds were recorded at this site.

Table 31. Percent Canopy Cover and Frequency of Occurrence at the 600-301 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	0.6	4.0
<i>Achnatherum hymenoides</i> (Indian ricegrass)	2.1	24.0
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	1.6	8.0
<i>Bromus tectorum</i> ^a (cheatgrass)	21.1	100.0
<i>Descurcania pinnata</i> (western tansymustard)	X	X
<i>Draba verna</i> ^a (spring draba)	0.6	24.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	1.3	12.0
<i>Erodium cicutarium</i> ^a (redstem stork's bill)	0.3	12.0
<i>Grayia spinosa</i> (spiny hopsage)	1.5	4.0
<i>Hesperostipa comata</i> (needle and thread grass)	X	X
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	1.0	40.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.5	20.0

**Table 31. Percent Canopy Cover and Frequency of Occurrence
at the 600-301 Site in 2018. (2 Pages)**

Species	% Cover	% Frequency of Occurrence
<i>Lepidium perfoliatum</i> ^a (clasping pepperweed)	X	X
<i>Machaeranthera canescens</i> (hoary tansyaster)	0.7	8.0
<i>Plantago patagonica</i> (woolly plantain)	1.0	20.0
<i>Poa bulbosa</i> ^a (bulbous bluegrass)	0.6	4.0
<i>Poa secunda</i> (Sandberg bluegrass)	1.4	36.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	0.6	4.0
<i>Salsola kali</i> ^a (Russian thistle)	2.1	64.0
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	6.5	48.0
<i>Sphaeralcea munroana</i> (Munro's globemallow)	X	X
<i>Sporobolus cryptandrus</i> (sand dropseed)	0.3	12.0
<i>Tragopogon dubius</i> ^a (yellow salsify)	X	X
<i>Vulpia microstachys</i> (desert fescue)	2.1	24.0
Crust	1.3	52.0
Soil	48.1	100.0
Litter	48.3	100.0
Total canopy cover (excludes crust/soil/litter)	45.9	
Total Native % Cover	13.2	
Change in Native % Cover from 2017	4.2	
Total Invasive % Cover	32.7	
Change in Invasive % Cover from 2017	-11.5	

^a Invasive species

X = present but not counted in plot frames



Figure 32. The 600-301 Site in 2018.

3.7.2 600-369:3 Site (Dump Area)

The 600-369:3 site (Figure 33) was revegetated in FY 2014 and monitoring was first conducted for the site in 2014. The substrate for the site is characterized by an inner area of predominantly cobbles with varied amounts of loamy sand and an outer area of predominantly sandy loam with few cobbles.

Fifth-year shrub transect monitoring for the site was conducted in April 2018. The results show a shrub density of 920 plants/ha (372 plants/ac), meeting the success criteria of 600 plants/ha (240 plants/ac). Nearly half (45%) of the shrubs were lost in the first year but the site appears to have stabilized since that time.

Canopy cover data for the site was collected in May 2018. Data was collected from 15 plot frames in the inner area and 15 plot frames in the outer area. Average canopy cover for the site overall was 37.9% with 4.8% native cover and 33.1% invasive cover (Table 32). This represents a decrease of 2.2% in native cover and of 1.2% in invasive cover from 2017. The dominant native species was Sandberg bluegrass (*Poa secunda*) with 1.7% cover and occurrence in 80% of the inner area plots and 53% of the outer area plots. Cheatgrass (*Bromus tectorum*) was the dominant species for the site overall with 30.1% cover; it occurred in 96% of the plot frames but had substantially higher cover in the outer area than in the inner (54.7% cover in outer vs. 5.5% cover in the inner). Cheatgrass levels have increased at this site since 2017. Native plant diversity at this site totals 3 grasses and 2 shrubs.

Upon the completion of fifth-year monitoring activities, this site meets success criteria for shrub cover but does not meet success criteria for native plant cover. Considering the low native plant diversity and decreasing trend of native plant cover, it is not expected this site will reach

successful native plant cover independently. Additional revegetation actions designed to increase native grasses and forbs are recommended for this site.

Rush skeletonweed (*Chondrilla juncea*), Washington State Class B noxious weeds, was observed on this site but was not recorded in any of the plot frames.

Table 32. Percent Canopy Cover and Frequency of Occurrence at the 600-369:3 Site in 2018.

Species	Area 1 (Inner)		Area 2 (Outer)		Entire Site	
	% Cover	% Frequency of Occurrence	% Cover	% Frequency of Occurrence	Average % Cover	Average % Frequency of Occurrence
<i>Artemisia tridentata</i> (big sagebrush)	4.0	26.7	2.0	13.3	3.0	20.0
<i>Bromus tectorum</i> ^a (cheatgrass)	5.5	93.3	54.7	100.0	30.1	96.7
<i>Chondrilla juncea</i> ^b (rush skeletonweed) (B)	X	X	X	X	X	X
<i>Draba verna</i> ^a (spring draba)	0.2	6.7	2.0	80.0	1.1	43.3
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	X	X	-	-	X	X
<i>Hesperostipa comata</i> (needle and thread grass)	0.2	6.7	-	-	0.1	3.3
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	1.0	40.0	0.8	33.3	0.9	36.7
<i>Lycium barbarum</i> ^a (matrimony vine)	-	-	1.0	6.7	0.5	3.3
<i>Poa secunda</i> (Sandberg bluegrass)	2.0	80.0	1.3	53.3	1.7	66.7
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	X	X	-	-	X	X
<i>Salsola kali</i> ^a (Russian thistle)	0.2	6.7	-	-	0.1	3.3
<i>Sisymbrium altissimum</i> ^a (tumble mustard)	0.3	13.3	0.7	26.7	0.5	20.0
Crust	0.0	0.0	0.8	33.3	0.4	16.7
Soil	85.5	100.0	44.3	100.0	64.9	100.0
Litter	14.5	100.0	52.3	100.0	33.4	100.0
Total canopy cover (excludes crust/soil/litter)	13.3		62.5		37.9	
Total Native % Cover	6.2		3.3		4.8	-
Change in Native % Cover from 2017	-0.8		-0.9		-0.9	
Total Invasive % Cover	7.0		59.2		33.1	
Change in Invasive % Cover from 2017	-5.7		3.2		-1.2	

^a Invasive species

^b Washington State Classified Noxious Weed (class)

-- = species not observed on site

X = present but not counted in plot frames



Figure 33. The 600-369:3 Site in 2018.

3.7.3 600-370 Site (Dump Area)

The 600-370 site (Figure 34) was revegetated in FY 2014 and monitoring was first conducted for the site in 2014. The substrate for the site is characterized by sand with varied amounts of cobbles and small boulders. Black sand is common in the western portion of the site.

Fifth-year shrub transect monitoring for the site was conducted in May 2018. The results show a shrub density of 770 plants/ha (312 plants/ac), meeting the success criteria of 600 plants/ha (240 plants/ac). Over half (55%) of the shrubs were lost in the first year but the site appears to have stabilized since that time, current shrub survival was 98.7% of that observed in 2017.

Canopy cover data for the site was collected in May 2018. Data was collected from 25 plot frames. Canopy cover for the site was 31.1% with 11.2% native cover and 19.9% invasive cover (Table 33). This represents an increase of 5.6% in native cover and a decrease of 13.3% in invasive cover from 2017. The dominant native species was big sagebrush (*Artemisia tridentata*) with 4.6% cover. Cheatgrass (*Bromus tectorum*) was the dominant species for the site overall with 16.8% cover, which had decreased by 6% since 2017.

At fifth-year monitoring, this site had met success criteria for shrub density but had not met success criteria for native cover. Native cover had increased at this site over the last 2 years and invasive cover had decreased significantly, suggesting native plants may continue to establish and increase. Additional revegetation actions meant to increase native plants should be considered for this site in order for it to meet success criteria for native cover.

No listed Washington State Class B noxious weeds were observed on the site.

Table 33. Percent Canopy Cover and Frequency of Occurrence at the 600-370 Site in 2018.

Species	% Cover	% Frequency of Occurrence
<i>Artemisia tridentata</i> (big sagebrush)	4.6	28.0
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	X	X
<i>Brassica sp.^a</i> (mustard)	0.8	12.0
<i>Bromus tectorum^a</i> (cheatgrass)	16.8	100.0
<i>Chorispora tenella^a</i> (crossflower)	X	X
<i>Chrysothamnus viscidiflorus</i> (yellow rabbitbrush)	0.1	4.0
<i>Cryptantha circumscissa</i> (cushion cryptantha)	X	X
<i>Draba verna^a</i> (spring draba)	0.1	4.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	0.2	8.0
<i>Eriogonum niveum</i> (snow buckwheat)	1.2	28.0
<i>Hesperostipa comata</i> (needle and thread grass)	0.6	4.0
<i>Holosteum umbellatum^a</i> (jagged chickweed)	1.7	68.0
<i>Machaeranthera canescens</i> (hoary tansyaster)	0.1	4.0
<i>Oenothera pallida</i> (pale evening primrose)	0.6	4.0
<i>Poa secunda</i> (Sandberg bluegrass)	1.7	68.0
<i>Psoraleidum lanceolatum</i> (lemon scurfpea)	1.3	12.0
<i>Salsola kali^a</i> (Russian thistle)	0.1	4.0
<i>Sisymbrium altissimum^a</i> (tall tumbled mustard)	0.4	16.0
<i>Vulpia microstachys</i> (desert fescue)	0.8	32.0
ARTR recruits	X	X
Crust	0.0	0.0
Soil	79.6	100.0
Litter	18.4	100.0
Total canopy cover (excludes crust/soil/litter)	31.1	
Total Native % Cover	11.2	
Change in Native % Cover from 2017	5.6	
Total Invasive % Cover	19.9	
Change in Invasive % Cover from 2017	-13.3	

^a Invasive species

X = present but not counted in plot frames



Figure 34. The 600-370 Site in 2018.

3.7.4 600-356 Site (Dump Area)

The 600-356 site (Figure 35) was revegetated in FY 2015 and monitoring was first conducted for the site in 2015. The substrate for the site is predominantly cobbly sandy loam.

All transplanted shrubs within the transect for the 600-356 site died between the 2015 and 2016 monitoring years. A total of 78 transplanted shrubs (68 big sagebrush [*Artemisia tridentate*], 8 antelope bitterbrush [*Purshia tridentate*], and 2 spiny hopsage [*Grayia spinosa*]) were documented along the transect when it was first installed in 2015; no live shrubs have been documented in the transect area since then.

Canopy cover data for the site was collected in May 2018. Data was collected from 25 plot frames. Canopy cover for the site was 53.2% with 7.5% native cover and 45.7% invasive cover (Table 34). This represents an increase of 0.1% in native cover and increase of 3.1% in invasive cover from 2016. The dominant native species was bluebunch wheatgrass (*Pseudoroegneria spicata*) with 1.9% cover. Cheatgrass (*Bromus tectorum*) was the dominant species for the site overall with 36.8% cover, increasing by 2% since 2017 monitoring.

Though this site is not yet in its fifth year of monitoring, the successful establishment of 25% native cover is unlikely within the next year and additional revegetation efforts designed to increase native shrubs, grasses, and forbs should be considered for this site. Additionally, replanting this site with shrub plugs is highly recommended.

No Washington State Class B noxious weeds were recorded at this site.

Table 34. Percent Canopy Cover and Frequency of Occurrence at the 600-356 Site in 2018.

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	X	X
<i>Achnatherum hymenoides</i> (Indian ricegrass)	0.5	20.0
<i>Artemisia tridentata</i> (big sagebrush)	1.8	12.0
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	X	X
<i>Bromus tectorum</i> ^a (cheatgrass)	36.8	100.0
<i>Elymus elymoides</i> (squirreltail)	0.1	4.0
<i>Epilobium brachycarpum</i> (tall annual willowherb)	0.1	4.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	0.8	12.0
<i>Erigeron pumilus</i> (shaggy fleabane)	0.2	8.0
<i>Erodium cicutarium</i> ^a (redstem stork's bill)	6.4	44.0
<i>Grayia spinosa</i> (spiny hopsage)	X	X
<i>Hesperostipa comata</i> (needle and thread grass)	0.3	12.0
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.1	4.0
<i>Hordeum leporinum</i> ^a (hare barley)	0.2	8.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.3	12.0
<i>Poa bulbosa</i> ^a (bulbous bluegrass)	X	X
<i>Poa secunda</i> (Sandberg bluegrass)	1.2	48.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	1.9	36.0
<i>Purshia tridentata</i> (antelope bitterbrush)	0.6	4.0
<i>Salsola kali</i> ^a (Russian thistle)	0.2	8.0
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	1.7	68.0
<i>Tragopogon dubius</i> ^a (yellow salsify)	X	X
Crust	0.0	0.0
Soil	58.9	100.0
Litter	37.7	100.0
Total canopy cover (excludes crust/soil/litter)	53.2	
Total Native % Cover	7.5	
Change in Native % Cover from 2017	0.1	
Total Invasive % Cover	45.7	
Change in Invasive % Cover from 2017	3.1	

^a Invasive species

X = present but not counted in plot frames



Figure 35. The 600-356 Site in 2018.

3.7.5 600-379 Site (Burn Area)

The 600-379 site (Figure 36) was revegetated in FY 2015 and monitoring was first conducted for the site in 2015. The substrate for the site is predominantly sandy loam with varying amounts of small cobbles.

No shrub transect has been established for the site due to its small size.

Canopy cover data for the site was collected in May 2018. Data was collected from 10 plot frames. Canopy cover for the site was 69.0% with 5.0% native cover and 64.0% invasive cover (Table 35). This represents an increase of 2.9% in native cover and a decrease of 19.1% in invasive cover from 2017. The dominant native species was needle and thread grass (*Hesperostipa comata*) with 2.3% cover. Cheatgrass (*Bromus tectorum*) was the dominant species for the site overall with 59.8% cover.

Though this site is not yet in its fifth year of monitoring, the successful establishment of 25% native cover is unlikely within the next year and additional revegetation efforts designed to increase native shrubs, grasses, and forbs should be considered for this site.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was present on the site and had less than 1% cover.

Table 35. Percent Canopy Cover and Frequency of Occurrence at the 600-379 Site in 2018.

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	0.3	10.0
<i>Artemisia tridentata</i> (big sagebrush)	1.5	10.0
<i>Bromus tectorum</i> ^a (cheatgrass)	59.8	100.0
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	0.3	10.0
<i>Chrysothamnus viscidiflorus</i> (yellow rabbitbrush)	X	X
<i>Draba verna</i> ^a (spring draba)	0.3	10.0
<i>Epilobium brachycarpum</i> (tall annual willowherb)	X	X
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	X	X
<i>Hesperostipa comata</i> (needle and thread grass)	2.3	40.0
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	1.3	50.0
<i>Machaeranthera canescens</i> (hoary tansyaster)	0.3	10.0
<i>Phlox longifolia</i> (longleaf phlox)	X	X
<i>Poa secunda</i> (Sandberg bluegrass)	0.8	30.0
<i>Salsola kali</i> ^a (Russian thistle)	2.5	50.0
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	X	X
Artr recruit	X	X
Crust	0.0	0.0
Soil	36.5	100.0
Litter	58.5	100.0
Total canopy cover (excludes crust/soil/litter)	69.0	
Total Native % Cover	5.0	
Change in Native % Cover from 2017	2.9	
Total Invasive % Cover	64.0	
Change in Invasive % Cover from 2017	-19.1	

^a Invasive species^b Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames



Figure 36. The 600-379 Site in 2018.

3.7.6 600-358 Site (Gable Mountain Fringe Dump Area)

The 600-358 site (Figure 36) was revegetated in FY 2016 and monitoring was first conducted for the site in 2016. The substrate for the site is characterized by loamy sand with some gravel through the revegetated roadway and predominantly gravel with varying amounts of loamy sand in the dump area at the north end of the roadway. In addition to the standard native grass seed mix that was broadcast over the site, seeds from several native forbs were collected from the Hanford Site and hand seeded on the site. This site is surrounded by mature native vegetation that should promote natural recovery of the site.

Two 100-m (328-ft) shrub monitoring transects were established at this site in 2016, one on the southern and one on the northern portion of the site. Third-year shrub monitoring was conducted at this site in April 2018. The southern transect had a shrub density of 267 plants/ha (108 plants/ac) and the northern transect had a shrub density of 538 plants/ha (218 plants/ac) for a combined density of 402 plants/ha (163 plants/ac), all below the success criteria of 600 plants/ha (240 plants/ac). Over half of the shrubs recorded initially in the transect area were lost in this first year.

Canopy cover data for the site was collected in May 2018. Data was collected from 25 plot frames. Canopy cover for the site overall was 13.0% with 9.0% native cover and 4.0% invasive cover (Table 35). Native cover decreased by 3.7% since 2017 and invasive cover had decreased by 8.8% since 2017. The dominant native species was Sandberg's bluegrass (*Poa secunda*) with 4.5% cover followed by bluebunch wheatgrass (*Pseudoroegneria spicata*) with 3.2% cover. Cheatgrass (*Bromus tectorum*) was the dominant invasive species for the site with 1.2% cover, decreasing by about 7% since 2017.

Additional revegetation efforts designed to increase native shrubs should be considered for this site. If native cover continues to decrease, additional revegetation efforts designed to increase native grass and forb cover should be considered for this site.

No listed Washington State Class B noxious weeds were observed on the site.

Table 36. Percent Canopy Cover and Frequency of Occurrence at the 600-358 Site in 2018.

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	0.1	4.0
<i>Artemisia tridentata</i> (big sagebrush)	X	X
<i>Bromus tectorum</i> ^a (cheatgrass)	1.2	8.0
<i>Chrysothamnus viscidiflorus</i> (yellow rabbitbrush)	0.1	4.0
<i>Draba verna</i> ^a (spring draba)	1.1	44.0
<i>Elymus elymoides</i> (squirreltail)	0.1	4.0
<i>Epilobium brachycarpum</i> (tall annual willowherb)	0.1	4.0
<i>Erigeron pumilus</i> (shaggy fleabane)	0.1	4.0
<i>Grayia spinosa</i> (spiny hopsage)	X	X
<i>Hesperostipa comata</i> (needle and thread grass)	0.5	20.0
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.6	24.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.4	16.0
<i>Machaeranthera canescens</i> (hoary tansyaster)	X	X
<i>Melilotus officinalis</i> ^a (sweet clover)	X	X
<i>Poa secunda</i> (Sandberg bluegrass)	4.5	100.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	3.2	48.0
<i>Purshia trieditata</i> (antelope bitterbrush)	0.1	4.0
<i>Salsola kali</i> ^a (Russian thistle)	X	X
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	0.6	4.0
<i>Tragopogon dubius</i> ^a (yellow salsify)	0.1	4.0
<i>Vulpia microstachys</i> (desert fescue)	0.2	8.0
Crust	0.0	0.0
Soil	67.4	100.0
Litter	31.6	100.0
Total canopy cover (excludes crust/soil/litter)	13.0	
Total Native % Cover	9.0	
Change in Native % Cover from 2017	-3.7	
Total Invasive % Cover	4.0	
Change in Invasive % Cover from 2017	-8.8	

^a Invasive species

X = present but not counted in plot frames



Figure 37. The 600-358 Site in 2018, Mainly Showing the Roadway Portion of the Site.

3.8 300 AREA SITES

Three sites in the 300 Area were monitored for routine 5-year monitoring in 2018; 300-288:2, 300-North A-D, and 618-2&3. The 300-North A-D site was revegetated in FY 2013; the 618-2&3 site was revegetated in FY 2015, and the 300-288:2 site was revegetated in FY 2017. These sites were remediated to meet the objectives for interim closure as established in the 300 Area RDR/RAWP (DOE/RL-2001-47, Rev. 3 and DOE/RL-2014-13-ADD1) and in the Interim Action ROD (EPA 1999).

Revegetation efforts entailed broadcast seeding with a mixture of native grasses including Sandberg bluegrass (*Poa secunda*), Indian ricegrass (*Achnatherum hymenoides*), bluebunch wheatgrass (*Pseudoroegneria spicata*), squirreltail (*Elymus elymoides*), needle-and-thread grass (*Hesperostipa comata*), and prairie Junegrass (*Koeleria macrantha*) at approximately 20.2 kg/ha (18 lbs/ac). Broadcast seeding areas were topped with a straw mulch that was crimped into the soil surface. Shrub species including big sagebrush (*Artemisia tridentata*), antelope bitterbrush (*Purshia tridentata*), and spiny hopsage (*Grayia spinosa*) were transplanted on the site at approximately 1,730 plants/ha (700 plants/ac) with a mix of approximately 75% sagebrush, 15% bitterbrush, and 10% spiny hopsage.

3.8.1 300-288:2 Container Transfer Area Site

The 300-288:2 CTA site (Figure 38) was revegetated in FY 2017 and monitoring was first conducted for the site in 2017. This is a larger site that was divided into two areas (east and west) for monitoring purposes with one established transect in each area and data collected from

25 plot frames in each area. Substrates at the site are predominantly sandy loam with varying amounts of cobbles.

Two 100-m (328-ft) shrub monitoring transects with 5-m (16.4-ft) offsets to each side were established for the site in 2017, one in the west portion of the site and another in the east. Second-year monitoring of the transect area was conducted in April 2018. A total of 138 shrubs were recorded along the west transect and 150 shrubs were recorded along the east transect. The west transect data shows 600 plants/ha (243 plants/ac) with a total shrub survival of 39.6% since the initial planting in FY 2017. The east transect data shows 780 plants/ha (316 plants/ac) with a total shrub survival of 48.8% since the initial planting in FY 2017. This equates to an overall shrub density of 690 plants/ha (279 plants/ac) for the site, meeting the success criteria of 600 plants/ha (240 plants/ac).

Canopy cover data for the site was collected in June 2018. Average canopy cover for the site was 22.9% with native cover representing 14.4% and invasive cover representing 8.5% (Table 37). Native cover had increased by 9.9% and invasive cover had decreased by 4.6% since 2017 monitoring. Native bunchgrasses (*Pseudoroegneria spicata*, *Achnatherum hymenoides*, *Elymus elymoides*, *Sporobolus cryptandrus*, and *Hesperostipa comata*) accounted for 4.2% of the native cover. Russian thistle (*Salsola kali*) was the dominant invasive species for the site with 3.2% cover, decreasing by 7.2% since first-year monitoring. Cheatgrass (*Bromus tectorum*) cover had increased by 1.6% since first-year monitoring but cover is still relatively low at 2.6%.

Diffuse knapweed (*Centaurea diffusa*) and burning bush (*Bassia scoparia*), both Washington State Class B noxious weeds, and Canada thistle (*Cirsium arvense*), a Washington State Class C noxious weed, were recorded on the site. Diffuse knapweed was observed in the plot frames and had less than 1% cover and occurrence in 6% of the plot frames, burning bush had less than 1% cover and was recorded in 8% of the plot frames, the Canada thistle was observed on the site but was not recorded in any of the plot frames.

Table 37. Percent Canopy Cover and Frequency of Occurrence at the 300-288:2 CTA Site in 2018. (2 Pages)

Species	Area 1 (east)		Area 2 (west)		Entire Site	
	% Cover	% Frequency of Occurrence	% Cover	% Frequency of Occurrence	Average % Cover	Average % Frequency of Occurrence
<i>Achnatherum hymenoides</i> (Indian ricegrass)	2.1	24.0	0.4	16.0	1.3	20.0
<i>Artemisia tridentata</i> (big sagebrush)	2.7	28.0	0.8	12.0	1.8	20.0
<i>Bassia scoparia</i> ^a (burning bush) (B)	X	X	0.2	8.0	0.2	8.0
<i>Bromus tectorum</i> ^b (cheatgrass)	1.6	64.0	3.6	64.0	2.6	64.0
<i>Bunchgrasses</i> ^c	4.1	84.0	4.2	88.0	4.2	86.0
<i>Centaurea diffusa</i> ^a (diffuse knapweed) (B)	0.1	4.0	0.7	8.0	0.4	6.0
<i>Cirsium arvense</i> ^a (Canada thistle)(C)	X	X	X	X	X	X
<i>Draba verna</i> ^b (spring draba)	0.1	4.0	-	-	0.1	4.0
<i>Elymus elymoides</i> (squirreltail)	0.7	28.0	0.2	8.0	0.5	18.0

Table 37. Percent Canopy Cover and Frequency of Occurrence at the 300-288:2 CTA Site in 2018. (2 Pages)

Species	Area 1 (east)		Area 2 (west)		Entire Site	
	% Cover	% Frequency of Occurrence	% Cover	% Frequency of Occurrence	Average % Cover	Average % Frequency of Occurrence
<i>Epilobium brachycarpum</i> (tall annual willowherb)	0.1	4.0	0.2	8.0	0.2	6.0
<i>Erodium cicutarium</i> ^b (redstem stork's bill)	0.1	4.0	0.9	16.0	0.5	10.0
<i>Festuca sp.</i> (fescue)	0.1	4.0	0.1	4.0	0.1	4.0
<i>Grayia spinosa</i> (spiny hopsage)	0.1	4.0	X	X	0.1	4.0
<i>Hesperostipa comata</i> (needle and thread grass)	-	-	0.2	8.0	0.2	8.0
<i>Holosteum umbellatum</i> ^b (jagged chickweed)	0.1	4.0	0.1	4.0	0.1	4.0
<i>Lactuca serriola</i> ^b (prickly lettuce)	0.2	8.0	0.4	16.0	0.3	12.0
<i>Melilotus officinalis</i> ^b (sweet clover)	X	X	-	-	X	X
<i>Poa secunda</i> (Sandberg bluegrass)	4.0	100.0	2.4	96.0	3.2	98.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	2.6	44.0	3.3	36.0	3.0	40.0
<i>Purshia tridentata</i> (antelope bitterbrush)	X	X	X	X	X	X
<i>Salsola kali</i> ^b (Russian thistle)	2.7	88.0	3.6	84.0	3.2	86.0
<i>Sisymbrium altissimum</i> ^b (tall tumbled mustard)	0.7	28.0	1.4	36.0	1.1	32.0
<i>Sporobolus cryptandrus</i> (sand dropseed)	-	-	0.1	4.0	0.1	4.0
<i>Tragopogon dubius</i> ^b (yellow salsify)	-	-	0.1	4.0	0.1	4.0
Crust	0.0	0.0	0.0	0.0	0.0	0.0
Soil	57.0	100.0	63.1	100.0	60.1	100.0
Litter	41.0	100.0	36.9	100.0	39.0	100.0
Total canopy cover (excludes crust/soil/litter)	22.1		22.9		22.9	
Total Native % Cover	16.5		11.9		14.4	
Change in Native Cover from 2017	12.2		7.2		9.9	
Total Invasive % Cover	5.6		11.0		8.5	
Change in Invasive % Cover from 2017	-10.7		1.2		-4.6	

^a Washington State Classified Noxious Weed (class)

^b Invasive species

^c Bunchgrasses include *Pseudoroegneria spicata*, *Achnatherum hymenoides*, *Elymus elymoides*, *Poa secunda*, *Sporobolus cryptandrus*, and *Hesperostipa comata*

-- = species not observed on site

X = present but not counted in plot frames



Figure 38. The 300-288:2 Site in 2018.

3.8.2 300-North A-D Site (Various Facilities)

The 300-North A-D site encompasses the 300 North A, 300 North B, 300 North C, and 300 North D sites. These sites were revegetated in FY 2013 but were not monitored after planting. The first year the 300-North A-D site was monitored was in 2018, making the site 5 years old (Figure 39).

No shrub transect was established for this site.

Canopy cover data for the site was collected in June 2018. Data was collected from 50 plot frames, 25 in the northern D area of the site and 25 in the southern A, B, and C areas of the site. Canopy cover did not differ significantly between the northern and southern areas. Canopy cover for the entire site was 25.8%, made up of 12.3% native cover and 13.5% invasive cover (Table 38). The dominant native species at this site was bluebunch wheatgrass (*Pseudoroegneria spicata*) with 5.7% cover followed by Sandberg's bluegrass (*Poa secunda*) with 3.0% cover. Sagebrush (*Artemisia tridentata*) was not observed at this site. The dominant invasive species was cheatgrass (*Bromus tectorum*) with 8.3% cover and occurrence in 100% of the plot frames followed by Russian thistle (*Salsola kali*) with 1.8% cover. Twelve native species were recorded in 2018.

Diffuse knapweed (*Centaurea diffusa*), burningbush (*Bassia scoparia*), and rush skeletonweed (*Chondrilla juncea*), all Washington State Class B noxious weeds, were recorded at this site. Diffuse knapweed had a cover of 1.5% and occurred in 20% of the plot frames.

As this is the first year canopy cover data was collected at this site, continued monitoring is recommended before any additional revegetation actions are taken. This site is lacking a sagebrush component, and sagebrush could be added in to increase native cover in the future.

Table 38. Percent Canopy Cover and Frequency of Occurrence at the 300-North A-D Site in 2018.

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	0.1	4.0
<i>Achnatherum hymenoides</i> (Indian ricegrass)	0.1	4.0
<i>Astragalus sp.</i> (milkvetch)	X	X
<i>Bassia scoparia</i> ^a (burning bush) (B)	X	X
<i>Bromus tectorum</i> ^b (cheatgrass)	8.3	100.0
<i>Centaurea diffusa</i> ^a (diffuse knapweed) (B)	1.5	20.0
<i>Chondrilla juncea</i> ^a (rush skeletonweed) (B)	0.2	6.0
<i>Elymus elymoides</i> (squirreltail)	0.4	16.0
<i>Epilobium brachycarpum</i> (tall annual willowherb)	0.6	22.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	0.7	16.0
<i>Erodium cicutarium</i> ^b (redstem stork's bill)	0.7	8.0
<i>Eriogonum niveum</i> (snow buckwheat)	X	X
<i>Festuca sp.</i> (fescue)	1.2	18.0
<i>Hesperostipa comata</i> (needle and thread grass)	0.1	4.0
<i>Holosteum umbellatum</i> ^b (jagged chickweed)	0.7	28.0
<i>Lactuca serriola</i> ^b (prickly lettuce)	0.3	10.0
<i>Machaeranthera canescens</i> (hoary tansyaster)	0.5	10.0
<i>Melilotus officinalis</i> ^b (sweet clover)	0.7	6.0
<i>Poa secunda</i> (Sandberg bluegrass)	3.0	90.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	5.7	58.0
<i>Salsola kali</i> ^b (Russian thistle)	1.0	38.0
<i>Sisymbrium altissimum</i> ^b (tall tumbled mustard)	0.2	6.0
<i>Tragopogon dubius</i> ^b (yellow salsify)	0.2	6.0
<i>Triticum sp.</i> ^b (wheat)	X	X
Crust	1.0	20.0
Soil	76.9	100.0
Litter	22.4	100.0
Total canopy cover (excludes crust/soil/litter)	25.8	
Total Native % Cover	12.3	
Total Invasive % Cover	13.5	

^a Washington State Classified Noxious Weed (class)

^b Invasive species

X = present but not counted in plot frames



Figure 39. The 300-North A-D Site in 2018.

3.8.3 618-2&3 Site (Solid Waste Burial Ground)

The 618-2&3 site was revegetated in FY 2015 but never monitored. The 618-2&3 site is a combination of the 618-2 and 618-3 sites. Since revegetation in FY 2015, it appears the 618-2 area of this site was converted to a gravel laydown yard. The substrate at this site is cobble backfill. This site was 3 years old at the time of monitoring (Figure 40).

No shrub transect was established for this site.

Canopy cover data for the site was collected in June 2018. Data was collected from 25 plot frames. Canopy cover for the entire site was 11.9%, made up of 7.3% native cover and 4.6% invasive cover (Table 39). The dominant native species at this site was bluebunch wheatgrass (*Pseudoroegneria spicata*) with 2.9% cover followed by Sandberg's bluegrass (*Poa secunda*) and rubber rabbitbrush (*Ericameria nauseosa*), both with 1.8% cover. Sagebrush (*Artemisia tridentata*) was not observed at this site. The dominant invasive species was cheatgrass (*Bromus tectorum*) with 2.4% cover and occurrence in 96% of the plot frames. Eight native species were recorded in 2018.

Burningbush (*Bassia scoparia*) and rush skeletonweed (*Chondrilla juncea*), both Washington State Class B noxious weeds, were recorded at this site with covers less than 1%.

As this is the first year canopy cover data was collected at this site, continued monitoring is recommended before any additional revegetation actions are taken. This site is lacking a sagebrush component, and sagebrush could be added in to increase native cover in the future. Considering the high cobble cover at this site, establishing 25% native cover may not be possible without adding topsoil.

Table 39. Percent Canopy Cover and Frequency of Occurrence at the 618-2&3 Site in 2018.

Species	% Cover	% Frequency of Occurrence
<i>Achnatherum hymenoides</i> (Indian ricegrass)	X	X
<i>Bassia scoparia</i> ^a (burning bush) (B)	0.1	4.0
<i>Bromus tectorum</i> ^b (cheatgrass)	2.4	96.0
<i>Chondrilla juncea</i> ^a (rush skeletonweed) (B)	X	X
<i>Epilobium brachycarpum</i> (tall annual willowherb)	0.5	20.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	1.8	32.0
<i>Festuca sp.</i> (fescue)	0.1	4.0
<i>Holosteum umbellatum</i> ^b (jagged chickweed)	0.5	20.0
<i>Lactuca serriola</i> ^b (prickly lettuce)	0.1	4.0
<i>Machaeranthera canescens</i> (hoary tansyaster)	0.1	4.0
<i>Poa secunda</i> (Sandberg bluegrass)	1.8	52.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	2.9	36.0
<i>Salsola kali</i> ^b (Russian thistle)	1.3	52.0
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	0.2	8.0
<i>Vulpia microstachys</i> (desert fescue)	0.1	4.0
Crust	0.0	0.0
Soil	76.2	100.0
Litter	23.8	100.0
Total canopy cover (excludes crust/soil/litter)	11.9	
Total Native % Cover	7.3	
Total Invasive % Cover	4.6	

^a Washington State Classified Noxious Weed (class)^b Invasive species

X = present but not counted in plot frames



Figure 40. The 618-2&3 Site in 2018, Showing the 618-3 Portion of the Site.

3.9 200 AREA SITES

In FY 2017, an export water line was installed and the disturbed areas revegetated. For revegetation and monitoring purposes the area was divided into two sites, the 200-West (L-840) Export Water Pipeline site and the 200-East (L-525) Export Water Pipeline site. Per the *Site-Specific Revegetation Plan for the Export Water Pipeline (L-840)* and the *Site-Specific Revegetation Plan for the Export Water Pipeline (L-525)* (MSA 2016 and MSA 2017a), revegetation efforts entailed broadcast seeding with a mixture of native grasses including Sandberg bluegrass (*Poa secunda*), Indian ricegrass (*Achnatherum hymenoides*), and needle-and-thread grass (*Hesperostipa comata*) at approximately 10.9 kg/ha (9.75 lbs/ac) combined with a native forb mix of a minimum of four species at approximately 0.45kg/ha (0.4 lbs/ac). Broadcast seeding areas were topped with a straw mulch that was crimped into the soil surface. Shrub species including big sagebrush (*Artemisia tridentata*), antelope bitterbrush (*Purshia tridentata*), and spiny hopsage (*Grayia spinosa*) were transplanted on the sites at approximately 1,482 plants/ha (600 plants/ac) with a mix of approximately 66% sagebrush, 17% bitterbrush, and 17% spiny hopsage.

In FY 2018, an export water line was installed between the 2901-Y Valve House and the 282-E Inlet Valve House in the 200-East Area. The pipeline is approximately 3.73 km (2.37 miles) in length and is close and parallel to the L-525 Export Water Pipeline. Per the *Site-Specific Revegetation Plan for the Export Water Pipeline (L-419)* (MSA 2017b), revegetation efforts entailed broadcast seeding with a mixture of native grasses including Sandberg bluegrass (*Poa secunda*), Indian ricegrass (*Achnatherum hymenoides*), and needle-and-thread grass (*Hesperostipa comata*) at approximately 17.4 kg/ha (15.5 lbs/ac). Native forb seed was also

broadcasted across the site including Munro's Globemallow (*Sphaeralcea munroana*), Carey's balsamorhiza (*Balsamorhiza careyana*), shaggy fleabane (*Erigeron pumilis*), slender hawksbeard (*Crepis atribarba*), snow buckwheat (*Eriogonum niveum*), and Douglas' Dustymaiden (*Chaenactis douglasii*) at a rate of 2.1 kg/ha (1.88 lbs/ac). Shrub species including big sagebrush (*Artemisia tridentata*), antelope bitterbrush (*Purshia tridentata*), and spiny hopsage (*Grayia spinosa*) were transplanted on the sites at approximately 1,482 plants/ha (600 plants/ac) with a mix of approximately 66% sagebrush, 17% bitterbrush, and 17% spiny hopsage, respectively.

3.9.1 200-West (L-840) Export Water Pipeline Site

The 200-West (L-840) Export Water Pipeline site (Figure 41) was revegetated in FY 2017 and monitoring was first conducted for the site in 2017. This is a larger site that was divided into 5 areas for monitoring purposes with data collected from 20 plot frames in each area and 1 transect at the southwest end of the site. Substrates for the site are sandy loams to loamy sands with varied amounts of gravel and cobble.

The transect for L-840 that was established in 2017 measured 889 plants/ha (360 plants/ac). This transect was converted to an industrial use area post-2017 monitoring and was not monitored in 2018. It is recommended that a new transect be established in 2019 to track shrub density per acre.

Canopy cover data for the site was collected in June 2018. Average canopy cover for the site overall was 39.9% with native cover representing 10.6% and invasive cover representing 29.4% (Table 40). Native cover increased by 5.4% since 2017 and invasive cover decreased by 8% since 2017. Sandberg's bluegrass (*Poa secunda*) was the dominant native species for the site with 4.0% cover. Cheatgrass (*Bromus tectorum*) was the dominant invasive species for the site with 18.6% cover. Since 2017 monitoring, Russian thistle (*Salsola kali*) cover had decreased from 32.3% to 8.2%; however, cheatgrass cover had increased from 4.3% to 18.6%. Sections of the site had notably high levels of sagebrush recruits (Figure 31).

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was observed at this site but not recorded in any plot frames.

Table 40. Percent Canopy Cover and Frequency of Occurrence at the 200 West (L-840) Export Water Pipeline Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Achnatherum hymenoides</i> (Indian ricegrass)	1.7	24.0
<i>Agropyron cristatum</i> ^a (crested wheatgrass)	0.1	2.0
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	0.1	2.0
<i>Artemisia tridentata</i> (big sagebrush)	0.7	13.0
<i>Astragalus purshii</i> (woollypod milkvetch)	0.0	1.0
<i>Astragalus succumbens</i> (Columbia milkvetch)	0.1	2.0
<i>Balsamorhiza careyana</i> (Carey's balsamorhiza)	X	X
<i>Bromus tectorum</i> ^a (cheatgrass)	18.6	94.0
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	X	X
<i>Draba verna</i> ^a (spring draba)	0.1	5.0

Table 40. Percent Canopy Cover and Frequency of Occurrence at the 200 West (L-840) Export Water Pipeline Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	X	X
<i>Eriogonum niveum</i> (snow buckwheat)	0.9	17.0
<i>Grayia spinosa</i> (spiny hopsage)	X	X
<i>Hesperostipa comata</i> (needle and thread grass)	0.2	7.0
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.1	4.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.8	20.0
<i>Lepidium latifolium</i> ^b (broadleaved pepperweed) (B)	0.3	12.0
<i>Machaeranthera canescens</i> (hoary tansyaster)	X	X
<i>Matricaria recutita</i> ^a (German chamomile)	0.0	1.0
<i>Poa secunda</i> (Sandberg bluegrass)	4.0	85.0
<i>Plantago patagonica</i> (woolly plantain)	0.0	1.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	0.5	15.0
<i>Salsola kali</i> ^a (Russian thistle)	8.2	92.0
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	1.3	24.0
<i>Sphaeralcea munroana</i> (Munro's globemallow)	X	X
<i>Sporobolus cryptandrus</i> (sand dropseed)	0.4	4.0
<i>Tragopogon dubius</i> ^a (yellow salsify)	0.0	1.0
<i>Vulpia microstachys</i> (desert fescue)	0.3	12.0
Artr recruits ^c	1.8	21.0
Crust	0.0	0.0
Soil	62.2	100.0
Litter	35.8	100.0
Total canopy cover (excludes crust/soil/litter)	39.9	
Total Native % Cover	10.6	
Change in Native Cover from 2017	5.4	
Total Invasive % Cover	29.4	
Change in Invasive % Cover from 2017	-8.0	

^a Invasive species^b Washington State Classified Noxious Weed (class)^c ARTR recruits = *Artemisia tridentata* plants that are coming in naturally (were not planted)

X = present but not counted in plot frames



Figure 41. The 200-West (L-840) Export Water Pipeline Site in 2018. Top: View to the Northeast from the Central Portion of the L-840 Export Water Pipeline Site in 2018. Bottom: Sagebrush Recruits at the L-840 Export Water Pipeline Site in 2018.

3.9.2 200-East (L-525) Export Water Pipeline Site

The 200-East (L-525) Export Water Pipeline site (Figure 42) was revegetated in FY 2017 and monitoring was first conducted for the site in 2017. This is a larger site that was divided into 5 areas for monitoring purposes with data collected from 20 plot frames in each area and 1 transect at the northwest end of the site. Substrates for the site are sandy loams to loamy sands with varied amounts of gravel and cobbles.

A 100-m (328-ft) shrub monitoring transect with 5-m (16.4-ft) offsets to each side was established for the site in 2017. Second-year monitoring of the transect area was conducted in April 2018. A total of 94 shrubs were recorded along the transect in 2017; in 2018, only 1 shrub was recorded on this transect. Only 1.1% of the shrubs survived into year two. This equates to shrub density of 10 plants/ha (4 plants/ac), well below the success criteria of 600 plants/ha (240 plants/ac).

Canopy cover data for the site was collected in June 2018. Average canopy cover for the site overall was 21.1% with native cover representing 8.8% and invasive cover representing 12.3% (Table 41). Native cover had increased by 5.1% and invasive cover had decreased by 6.1% at this site since first-year monitoring in 2017. Sandberg's bluegrass (*Poa secunda*) accounted for 3.2% of the native cover. Forbs (including Columbia milkvetch [*Astragalus succumbens*], snow buckwheat [*Eriogonum niveum*], and Munro's globemallow [*Sphaeralcea munroana*] were recorded at this site. Cheatgrass (*Bromus tectorum*) was the dominant invasive species for the site with 4.4% cover. Since first-year monitoring, Russian thistle (*Salsola kali*) levels have decreased from 16.0% to 4.0%, and cheatgrass levels have increased by 1.3% to 4.4%.

Notably, big sagebrush (*Artemisia tridentata*) coverage was measured at 1.5% cover and sagebrush was detected in 20% of the plot frames. This suggests that the low shrub survival at the original monitoring transect may be unique to that area. It is recommended that a new transect is established to measure shrub density at this site. If this new transect also shows shrub density levels that do not meet success criteria, additional revegetation actions must be considered for this site.

Broadleaf pepperweed (*Lepidium latifolium*), a Washington State Class B noxious weed, was observed on this site.

Table 41. Percent Canopy Cover and Frequency of Occurrence at the 200 West (L-525) Water Pipeline Site in 2018. (2 Pages)

Species	% Cover ^a	% Frequency of Occurrence
<i>Achnatherum hymenoides</i> (Indian ricegrass)	0.6	12.0
<i>Agropyron cristatum</i> ^b (crested wheatgrass)	X	X
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	0.2	3.0
<i>Artemisia tridentata</i> (big sagebrush)	1.5	20.0
<i>Astragalus succumbens</i> (Columbia milkvetch)	0.2	2.0
<i>Bromus tectorum</i> ^b (cheatgrass)	4.4	62.0
<i>Bunchgrasses</i> ^c	0.5	14.0
<i>Descurainia pinnata</i> (western tansymustard)	0.0	1.0

Table 41. Percent Canopy Cover and Frequency of Occurrence at the 200 West (L-525) Water Pipeline Site in 2018. (2 Pages)

Species	% Cover ^a	% Frequency of Occurrence
<i>Draba verna</i> ^b (spring draba)	0.0	1.0
<i>Eriogonum niveum</i> (snow buckwheat)	0.8	12.0
<i>Grayia spinosa</i> (spiny hopsage)	0.0	1.0
<i>Hesperostipa comata</i> (needle and thread grass)	0.3	12.0
<i>Holosteum umbellatum</i> ^b (jagged chickweed)	0.0	1.0
<i>Lactuca serriola</i> ^b (prickly lettuce)	0.5	15.0
<i>Lepidium latifolium</i> ^d (broadleaved pepperweed) (B)	0.0	1.0
<i>Machaeranthera canescens</i> (hoary tansyaster)	0.2	3.0
<i>Poa secunda</i> (Sandberg bluegrass)	3.2	86.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	0.2	9.0
<i>Purshia tridentata</i> (antelope bitterbrush)	0.2	3.0
<i>Salsola kali</i> ^b (Russian thistle)	4.0	74.0
<i>Sisymbrium altissimum</i> ^b (tall tumbled mustard)	2.8	56.0
<i>Sphaeralcea munroana</i> (Munro's globemallow)	0.6	7.0
<i>Tragopogon dubius</i> ^b (yellow salsify)	0.5	9.0
<i>Triticum sp.</i> ^b (wheat)	0.2	7.0
<i>Vulpia microstachys</i> (desert fescue)	0.0	1.0
Artr recruits ^e	0.4	5.0
Crust	0.0	0.0
Soil	65.3	100.0
Litter	33.0	100.0
Total canopy cover (excludes crust/soil/litter)	21.1	
Total Native % Cover	8.8	
Change in Native Cover from 2017	5.1	
Total Invasive % Cover	12.3	
Change in Invasive % Cover from 2017	-6.1	

^a % Cover measurements of "0.0" represent an average cover of less than 0.1

^b Invasive species

^c Bunchgrasses include *Pseudoroegneria spicata*, *Achnatherum hymenoides*, *Elymus elymoides*, *Sporobolus cryptandrus*, *Poa secunda*, and *Hesperostipa comata*

^d Washington State Classified Noxious Weed (class)

^e ARTR recruits = *Artemisia tridentata* plants that are coming in naturally (were not planted)

X = present but not counted in plot frames



Figure 42. The 200-East (L-525) Export Water Pipeline Site in 2018. Top: View to the Southwest from the Central Portion of the 200-East Export Waterline Site in 2018. Bottom: View to the Southeast from the Central Portion of the 200-East Export Waterline Site in 2018.

3.9.3 200-East (L-419) Export Water Pipeline Site

The 200-East (L-419) Export Water Pipeline site (Figure 43) was revegetated in FY 2018 and monitoring was first conducted for the site in 2018. This is a larger site that was divided into 5 areas for monitoring purposes with data collected from 20 plot frames in each area and 3 transects spaced along the site. Loamy sand is the predominant substrate at this site.

Three 100-m (328-ft) shrub monitoring transects with 5-m (16.4-ft) offsets to each side were established for the site in 2018. These transects were established immediately post-revegetation and monitored again in May 2018. Using data from these three transects, an overall shrub density of 1,579 plants/ha (639 plants/ac) was recorded for the site in May 2018. This equates to an overall shrub survival of 93.8% since the initial planting is near the targeted planting rate of 1482 plants/ha (600 plants/ac).

Canopy cover data for the site was collected in June 2018. Average canopy cover for the site overall was 25.7% with native cover representing 2.8% and invasive cover representing 22.9% (Table 42). Russian thistle (*Salsola kali*) was the main component of the invasive cover with a coverage of 19.5%. This is not unusual for first year revegetation sites. Bunchgrasses had the highest native cover with 0.8%. Twelve species of native grasses and forbs were recorded at this site. Four of the six forbs that were seeded at this site were detected in first-year monitoring: Douglas' Dustymaiden (*Chaenactis douglasii*), snow buckwheat (*Eriogonum niveum*), shaggy fleabane (*Erigeron pumilus*), and Munro's Globemallow (*Sphaeralcea munroana*).

Though this site has only 2.8% native cover, high species diversity and the success of multiple species of forbs is an indication that this site will be successful in the future. No additional revegetation actions are recommended at this site at this time.

No listed Washington State Class B noxious weeds were observed on the site.

Table 42. Percent Canopy Cover and Frequency of Occurrence at the Export Water Pipeline Site (L-419) in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Achnatherum hymenoides</i> (Indian ricegrass)	0.0	1.0
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	0.0	1.0
<i>Artemisia tridentata</i> (big sagebrush)	0.2	8.0
<i>Bromus tectorum</i> ^a (cheatgrass)	1.4	52.0
Bunchgrasses ^b	0.8	30.0
<i>Chaenactis douglasii</i> (Douglas' dustymaiden)	0.4	15.0
<i>Draba verna</i> ^a (spring draba)	0.0	1.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	0.0	1.0
<i>Erigeron pumilus</i> (shaggy fleabane)	0.1	2.0
<i>Eriogonum niveum</i> (snow buckwheat)	0.6	22.0
<i>Grayia spinosa</i> (spiny hopsage)	X	X
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.3	12.0
<i>Machaeranthera canescens</i> (hoary tansyaster)	0.0	1.0
<i>Poa secunda</i> (Sandberg bluegrass)	0.0	1.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	0.6	23.0
<i>Purshia tridentata</i> (antelope bitterbrush)	0.1	2.0

Table 42. Percent Canopy Cover and Frequency of Occurrence at the Export Water Pipeline Site (L-419) in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Salsola kali</i> ^a (Russian thistle)	19.5	93.0
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	1.5	36.0
<i>Sphaeralcea munroana</i> (Munro's globemallow)	0.0	1.0
<i>Triticum sp.</i> ^a (wheat)	0.2	6.0
<i>Vulpia microstachys</i> (desert fescue)	0.0	1.0
ARTR recruits ^c	0.1	3.0
Crust	0.0	0.0
Soil	57.0	100.0
Litter	41.5	100.0
Total canopy cover (excludes crust/soil/litter)	25.7	
Total Native % Cover	2.8	
Total Invasive % Cover	22.9	

^a Invasive species

^b Bunchgrasses include *Pseudoroegneria spicata*, *Achnatherum hymenoides*, *Elymus elymoides*, *Sporobolus cryptandrus*, *Poa secunda*, and *Hesperostipa comata*

^cARTR recruits = *Artemisia tridentata* plants that are coming in naturally (were not planted)

X = present but not counted in plot frames



Figure 43. The Export Water Pipeline Site (L-419) in 2018.

4.0 MONITORING RESULTS – LONG TERM TREND MONITORING SITES

This section describes the revegetation site data for sites planted between 2002 and 2007. This is the first monitoring attempt of sites that have been planted over 10 years ago. The goal of this monitoring effort is to establish long-term trends in site success. Twelve sites were monitored across the Hanford Site.

4.1 100 B/C AREA SITES

Four sites were monitored for long-term trend in the 100-B/C Area (116-B/C Misc, 100-C-9, 118-B-2/3, 128-C-1). These sites were planted from 2006 to 2007. Additional revegetation actions with the goal of increasing sagebrush abundance are scheduled for the 116-B/C Misc. and 100-C-9 areas in FY 2019.

4.1.1 116-B/C Miscellaneous Site

This site encompasses multiple Waste Information Data System (WIDS) sites in the northern 100-B/C Area. WIDS sites included in the 116-B/C Miscellaneous (116-B/C Misc.) site included the 116-B-11 site, the 116-C-5 site, the 100-C-6 site, the 100-B-8 site, and the 100-B-7 site. The majority of this area was revegetated in FY 2007, with a small section of the northern portion revegetated in FY 2000. The substrate at this site is a high amount of cobble and rock mixed with loam (Figure 44).

No initial monitoring data is available for these sites after they were planted in 2007. The representative site for this area and planting year is the 100-C-9 Site. The 100-C-9 had native cover of 18.4% and invasive cover of 21.4% in 2010 monitoring.

Canopy cover data for the site was collected in May 2018. Data was collected from 25 plot frames. Canopy cover for the site was 27.5% with 20.6% native cover and 6.9% invasive cover (Table 43). The dominant native species was snow buckwheat (*Eriogonum niveum*) with 9.7% cover followed by rubber rabbitbrush (*Ericameria nauseosa*) at 7.3% cover. Cheatgrass (*Bromus tectorum*) was the dominant invasive species for the site with 5.0% cover. Sagebrush (*Artemisia tridentata*) was not a dominant species on this site and had 0.6% cover and occurred in 4% of plot frames. Two native forbs occurred on this site, Carey's balsamroot (*Balsamorhiza careyana*) and snow buckwheat. Though there is no revegetation plan available for this site, given the other 100-B/C Area revegetation actions at the time, it is highly unlikely that this site was seeded with forb species. These forbs likely colonized the site from surrounding areas post-remediation. Sandberg's bluegrass (*Poa secunda*) was the only native grass detected at this site. Native species diversity at this site was not high (six species) compared to sites revegetated in more recent years. This could be due to the number of species included during the initial revegetation. This site was revegetated before DOE/RL-2011-116, *Hanford Site Revegetation Manual*, was published, identifying best practices for revegetation actions.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was observed at this site at less than 1% cover and was detected in 12% of plot frames.

Compared to 2010 data for 100-C-9, the representative revegetation site for FY 2007 plantings in the B/C Area, the 116-B/C Misc. site had improved over the last 8 years (Table 44). Native

cover had increased to 20.6%, invasive cover had decreased to 6.9%, and biotic crust had increased to 13.3%. The ratio of native cover to invasive cover had increased from about 6:7 to 6:2. These are all indicators of a healthy shrub-steppe ecosystem. It is expected this site will continue to improve. Sagebrush cover at this site had not improved since 2010 monitoring. Additional sagebrush plantings are recommended in this area.

Table 43. Percent Canopy Cover and Frequency of Occurrence at the 116-B/C Misc. Site in 2018.

Species	% Cover	% Frequency of Occurrence
<i>Artemisia tridentata</i> (big sagebrush)	0.6	4.0
<i>Bromus tectorum</i> ^a (cheatgrass)	5.0	100.0
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	0.9	16.0
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	0.3	12.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	7.3	44.0
<i>Eriogonum niveum</i> (snow buckwheat)	9.7	76.0
<i>Grayia spinosa</i> (spiny hopsage)	X	X
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	1.0	40.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.1	4.0
<i>Melilotus officinalis</i> ^a (sweet clover)	X	X
<i>Poa secunda</i> (Sandberg bluegrass)	2.1	84.0
<i>Salsola kali</i> ^a (Russian thistle)	0.4	16.0
<i>Sisymbrium altissimum</i> ^a (tumble mustard)	0.1	4.0
Crust	13.3	88.0
Soil	80.2	100.0
Litter	17.9	100.0
Total canopy cover (excludes crust/soil/litter)	27.5	
Total Native % Cover	20.6	
Total Invasive % Cover	6.9	

^a Invasive species

^b Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames

Table 44. Percent Canopy Cover Comparison at the 100-C-9 Site in 2010 and the 116-B/C Misc. Site in 2018.

	Canopy Cover (%)	
	100-C-9	116-B/C Misc.
	2010	2018
Native Cover	18.4	20.6
Big sagebrush	0.7	0.6
Rubber rabbitbrush	0.8	7.3
Snow buckwheat	0	9.7
Sandberg's bluegrass	14.6	2.1
Biotic crust	0	13.3
Invasive Cover	21.4	6.9
Cheatgrass	17.8	5.0
Russian thistle	2.2	0.4
Diffuse knapweed	0	0.3



Figure 44. Overview of the 116-B/C Misc. Site in 2018, Looking North to South.

4.1.2 100-C-9 Site (Underground Sewer Lines)

The 100-C-9 site is located east of the 116-B/C-Misc. site and is about 1,300 m (0.85 mi) long. This area was revegetated in FY 2007 (Figure 45). The substrate at this site is a high amount of cobble and rock mixed with loam (Figure 46).

This site was broadcast seeded with a native grass seed mix that included Sandberg's bluegrass (*Poa secunda*), needle-and-thread grass (*Hesperostipa comata*), Indian Ricegrass (*Achnatherum hymenoides*), bluebunch wheatgrass (*Pseudoroegneria spicata*), squirreltail (*Elymus elymoides*), and prairie junegrass (*Koeleria macrantha*). Triple-16 fertilizer and polyacrylamide was applied with the grass seed along with 4.5 metric tons/ha (4,015 lb/ac) straw mulch. This site was planted with approximately 1300 sagebrush (*Artemisia tridentata*) plants/ha (530 plants/ac).

The 2010 monitoring recorded 82.3% shrub survival at this site, which would result in about 1,066 plants/ha (434 plants/ac). Sagebrush was recorded at 0.67% cover. Sandberg's bluegrass (*Poa secunda*) had the highest native cover at 14.6%, followed by Indian Ricegrass (*Oryzopsis hymenoides*) at 1.1% and rubber rabbitbrush (*Ericameria nauseosa*) at 0.8%. Total native cover equaled 18.4%. The dominant invasive species and dominant species at the site overall was cheatgrass (*Bromus tectorum*) with a cover of 17.8%, followed by Russian thistle (*Salsola kali*) with a cover of 2.2%. Total invasive cover equaled 21.4%. Biotic crust cover was non-existent at this site. Twelve native species were observed in 2010.

Canopy cover data for the site was collected again in May 2018. Data was collected from 25 plot frames. Canopy cover for the site was 35.3% with 15.4% native cover and 19.9% invasive cover (Table 45). The dominant native species was big sagebrush with 6.0% cover followed by rubber rabbitbrush (*Ericameria nauseosa*) at 5.2% cover. Cheatgrass (*Bromus tectorum*) was the dominant invasive species for the site with 14.5% cover. Three native forbs occurred on this site: Carey's balsamroot (*Balsamorhiza careyana*), common yarrow (*Achillea millefolium*), and snow buckwheat (*Eriogonum niveum*). These forbs likely colonized the site from surrounding areas post-remediation. Biotic crust cover measured 6.5% at this site. Eight native species were recorded in 2018.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was observed at this site at 4.7% cover and was detected in 48% of plot frames. Treatment of diffuse knapweed is highly recommended at this site. Burningbush (*Bassia scoparia*), a Washington State Class B noxious weed, was observed at this site but not detected in any of the plot frames.

At the time of 2018 monitoring, this site was 11 years old. Decreases in both native and invasive cover were measured at this site (Table 46). The native species recorded decreased from 12 to 8. The ratio of native cover to invasive cover had not changed significantly. Increases in shrub cover (in the form of big sagebrush, rubber rabbitbrush, and snow buckwheat) were recorded. Notably, biotic crust, an indicator of a healthy shrub steppe ecosystem, had increased over the past 11 years. This increase in crust may explain the decrease in both native and invasive cover as it reduces growing space for plants. This site had high amounts of cobble and rock and may never reach 25% native cover. Additional monitoring considering the cobble/rock levels is recommended.

Table 45. Percent Canopy Cover and Frequency of Occurrence at the 100-C-9 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	X	X
<i>Artemisia tridentata</i> (big sagebrush)	6.0	32.0
<i>Balsamorhiza careyana</i> (Carey's balsamroot)	X	X
<i>Bassia scoparia</i> ^a (burningbush) (B)	X	X
<i>Bromus tectorum</i> ^b (cheatgrass)	14.5	100.0
<i>Centaurea diffusa</i> ^a (diffuse knapweed) (B)	4.7	48.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	5.2	16.0
<i>Eriogonum niveum</i> (snow buckwheat)	1.3	12.0
<i>Erodium cicutarium</i> ^b (redstem stork's bill)	0.1	4.0
<i>Grayia spinosa</i> (spiny hopsage)	X	X
<i>Holosteum umbellatum</i> ^b (jagged chickweed)	0.4	16.0
<i>Melilotus officinalis</i> ^b (sweet clover)	X	X
<i>Poa secunda</i> (Sandberg bluegrass)	2.8	92.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	0.1	4.0
<i>Salsola kali</i> ^b (Russian thistle)	0.1	4.0
<i>Sisymbrium altissimum</i> ^a (tumble mustard)	0.1	4.0
Crust	6.5	84.0
Soil	71.1	100.0
Litter	23.0	100.0
Total canopy cover (excludes crust/soil/litter)	35.3	
Total Native % Cover	15.4	
Total Invasive % Cover	19.9	

^a Washington State Classified Noxious Weed (class)

^b Invasive species

X = present but not counted in plot frames

Table 46. Percent Canopy Cover Comparison at the 100-C-9 Site in 2010 and 2018

	Canopy Cover (%)	
	2010	2018
Native Cover	18.4	15.4
Big sagebrush	0.7	6
Rubber rabbitbrush	0.8	5.2
Indian ricegrass	1.1	0
Sandberg's bluegrass	14.6	2.8
Biotic crust	0	6.5
Invasive Cover	21.4	19.9
Cheatgrass	17.8	14.5
Russian thistle	2.2	0.1
Diffuse knapweed	0	4.7



Figure 45. The 100-C-9 Site in 2009.



Figure 46. The 100-C-9 Site in 2018.

4.1.3 118-B-2/3 Site (Burial Ground)

The 118-B-2 and 118-B-3 sites are located east of the B Reactor and south of B Avenue. These sites overlap each other and will be referred to as 118-B-2/3. This site was revegetated in FY 2007, the same winter as the 116-B/C Misc. and 100-C-9 sites. The substrate at this site is a high amount of cobble and rock mixed with loam (Figure 47).

This site was broadcast seeded with a native grass seed mix that included Sandberg's bluegrass (*Poa secunda*), needle-and-thread grass (*Hesperostipa comata*), Indian Ricegrass (*Achnatherum hymenoides*), bluebunch wheatgrass (*Pseudoroegneria spicata*), squirreltail (*Elymus elymoides*), and prairie junegrass (*Koeleria macrantha*). Triple-16 fertilizer and polyacrylamide was applied with the grass seed along with 4.5 metric tons/ha straw mulch. This site was planted with approximately 1,300 sagebrush (*Artemisia tridentata*) plants/ha (530 plants/ac).

Canopy cover monitoring was performed at the 118-B-2/3 site in 2009, 2 years after planting (Figure 48). Shrub survival data is not available for this area. At the time of 2009 monitoring, total canopy cover was 64.5%, made up of 52.5% invasive and 12.2% native species. Sandberg's bluegrass was the most abundant native species with 10.0% cover followed by bluebunch wheatgrass at 0.8% cover. The most abundant invasive species was cheatgrass (*Bromus tectorum*) with a cover of 43.2%. Biotic crust had a cover of 0.5%. Nine native species were recorded in 2009.

Canopy cover data for the site was collected again in May 2018 (Figure 49). Data was collected from 25 plot frames. Canopy cover for the site was 35.8% with 23.5% native cover and 12.3% invasive cover (Table 47). The dominant native species was rubber rabbitbrush (*Ericameria nauseosa*) with 19.6% cover followed by Sandberg's bluegrass at 1.9% cover. Cheatgrass (*Bromus tectorum*) was the dominant invasive species for the site with 9.7% cover. Two native forbs, common yarrow (*Achillea millefolium*) and hoary tansyaster (*Machaeranthera canescens*), occurred on this site. Biotic crust cover measured 7.1%. Nine native species were recorded in 2018.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was observed at this site at less than 1% cover and was detected in 16% of plot frames.

At the time of 2018 monitoring, this site was 11 years old. Native cover at this site had increased to near-success levels and invasive cover had significantly decreased since 2009 monitoring (Table 48). The ratio of native cover to invasive cover had increased from about 6:26 to 6:3. Native species diversity had not changed. The native cover is made up of a significant amount of rubber rabbitbrush; a few sagebrush plants seem to have established there. Notably, biotic crust, an indicator of a healthy shrub steppe ecosystem, had increased over the past 11 years. Given this site's high amounts of cobble and rock, it is impressive that it had reached 23.5% native cover. It is expected this site will continue to trend positively in the future.

Table 47. Percent Canopy Cover and Frequency of Occurrence at the 118-B-2/3 Site in 2018.

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	X	X
<i>Achnatherum hymenoides</i> (Indian ricegrass)	0.1	4.0
<i>Artemisia tridentata</i> (big sagebrush)	X	X
<i>Bromus tectorum</i> ^a (cheatgrass)	9.7	100.0
Bunchgrasses ^b	X	X
<i>Centaurea diffusa</i> ^c (diffuse knapweed) (B)	0.9	16.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	19.6	60.0
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.7	28.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.3	12.0
<i>Machaeranthera canescens</i> (hoary tansyaster)	X	X
<i>Poa secunda</i> (Sandberg bluegrass)	1.9	76.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	1.3	12.0
<i>Salsola kali</i> ^a (Russian thistle)	0.5	20.0
<i>Sisymbrium altissimum</i> ^a (tumble mustard)	0.2	8.0
<i>Sporobolus cryptandrus</i> (sand dropseed)	0.6	4.0
<i>Tragopogon dubius</i> ^a (yellow salsify)	X	X
Crust	7.1	88.0
Soil	74.6	100.0
Litter	25.4	100.0
Total canopy cover (excludes crust/soil/litter)	35.8	
Total Native % Cover	23.5	
Total Invasive % Cover	12.3	

^a Invasive species

^b Bunchgrasses include *Pseudoroegneria spicata*, *Achnatherum hymenoides*, *Elymus elymoides*, *Sporobolus cryptandrus*, *Poa secunda*, and *Hesperostipa comata*

^c Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames

Table 48. Percent Canopy Cover Comparison at the 118-B-2/3 Site in 2009 and 2018. (2 Pages)

	Canopy Cover (%)	
	2009	2018
Native Cover	12.2	23.5
Big sagebrush	0.2	X
Rubber rabbitbrush	0.2	19.6
Bluebunch wheatgrass	0.8	1.3
Sandberg's bluegrass	10.0	1.9
Biotic crust	0.5	7.1
Invasive Cover	52.5	12.3
Cheatgrass	43.2	9.7

Table 48. Percent Canopy Cover Comparison at the 118-B-2/3 Site in 2009 and 2018. (2 Pages)

	Canopy Cover (%)	
	2009	2018
Russian thistle	3.3	0.5
Diffuse knapweed	0	0.9

X = present but not counted in plot frames



Figure 47. High Amounts of Cobble at the 118-B-2/3 Site in 2018.



Figure 48. Overview of the 118-B-2/3 Site in 2009, From East Side Facing West.



Figure 49. Overview of the 118-B-2/3 Site in 2018, From West Corner Facing Southeast.

4.1.4 128-C-1 Site (Burn Pit)

The 128-C-1 site was revegetated in FY 2006. The 128-C-1 site was backfilled to grade with pit-run cobble and broadcast seeded with a native grass seed mix that included Sandberg's bluegrass (*Poa secunda*), needle-and-thread grass (*Hesperostipa comata*), Indian Ricegrass (*Achnatherum hymenoides*), bluebunch wheatgrass (*Pseudoroegneria spicata*), thickspike wheatgrass (*Elymus lanceolatus*), and prairie junegrass (*Koeleria macrantha*). Triple-16 fertilizer and polyacrylamide was applied with the grass seed along with 4.5 metric tons/ha straw mulch. The site was planted with sagebrush (*Artemisia tridentata*) and spiny hopsage (*Grayia spinosa*) seedlings at a rate of 96% and 4%. The substrate at this site is pit-run cobble backfill.

Canopy cover monitoring was performed at the 128-C-1 site in 2010, 5 years after planting (Figure 50). At the time of 2010 monitoring, total canopy cover was 41.0%, made up of 19.7% invasive and 21.3% native species. Sagebrush had a cover of 0.8%. Sandberg's bluegrass was the most abundant native species with 17.7% cover followed by bluebunch wheatgrass at 1.2% cover. The most abundant invasive species was cheatgrass (*Bromus tectorum*) with a cover of 15.5%. Biotic crust had a cover of 0.7%. Twelve native species were recorded in 2010.

Canopy cover data for the site was collected again in May 2018 (Figure 51). Data was collected from 25 plot frames. Canopy cover for the site was 27.6% with 16.0% native cover and 11.6% invasive cover (Table 49). The dominant native species was rubber rabbitbrush (*Ericameria nauseosa*) with 7.4% cover followed by sagebrush at 4.9% cover. Cheatgrass (*Bromus tectorum*) was the dominant invasive species for the site with 9.0% cover. Biotic crust cover measured 1.8%. Eight native species were recorded in 2018.

Diffuse knapweed (*Centaurea diffusa*) and rush skeletonweed (*Chondrilla juncea*), both Washington State Class B noxious weeds, were observed at this site at less than 1% cover.

At the time of 2018 monitoring, this site was 12 years old. Native cover and invasive cover had both decreased since 2010 monitoring (Table 50). The overall composition at this site changed from being dominated by grasses to being dominated by shrubs; native species recorded decreased from 12 to 8. Cheatgrass had decreased significantly at this site. Though total native cover had decreased, the ratio of native cover to invasive cover had increased favorably from nearly 1:1 to about 4:3. Biotic crust cover has increased by about 1% in the past 8 years.

Table 49. Percent Canopy Cover and Frequency of Occurrence at the 128-C-1 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	0.1	5.0
<i>Artemisia tridentata</i> (big sagebrush)	4.9	25.0
<i>Bromus tectorum</i> ^a (cheatgrass)	9.0	95.0
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	0.9	10.0
<i>Chondrilla juncea</i> ^b (rush skeletonweed) (B)	0.8	5.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	7.4	35.0
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.3	10.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.4	15.0
<i>Machaeranthera canescens</i> (hoary tansyaster)	X	X

Table 49. Percent Canopy Cover and Frequency of Occurrence at the 128-C-1 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Poa secunda</i> (Sandberg bluegrass)	2.4	95.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	0.8	5.0
<i>Salsola kali</i> ^a (Russian thistle)	X	X
<i>Sisymbrium altissimum</i> ^a (tumble mustard)	0.4	15.0
<i>Sporobolus cryptandrus</i> (sand dropseed)	0.3	10.0
<i>Vulpia microstachys</i> (desert fescue)	0.1	5.0
Artr recruits	0.1	5.0
Crust	1.8	45.0
Soil	79.5	100.0
Litter	18.0	100.0
Total canopy cover (excludes crust/soil/litter)	27.6	
Total Native % Cover	16.0	
Total Invasive % Cover	11.6	

^a Invasive species

^b Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames

Table 50. Percent Canopy Cover Comparison at the 128-C-1 Site in 2010 and 2018

	Canopy Cover (%)	
	2010	2018
Native Cover	21.3	16.0
Big sagebrush	0.8	4.9
Rubber rabbitbrush	0.5	7.4
Bluebunch wheatgrass	1.2	0.8
Sandberg's bluegrass	17.7	2.4
Biotic crust	0.7	1.8
Invasive Cover	19.7	11.6
Cheatgrass	15.5	9.0
Russian thistle	2.3	X
Diffuse knapweed	X	0.9

X = present but not counted in plot frames



Figure 50. The 128-C-1 Site in 2010.



Figure 51. The 128-C-1 Site in 2018.

4.2 100 K AREA SITES

Two sites were surveyed in the 100-K Area: 116-K-1 and 116-K-2. These sites border each other. Both of these sites were planted in February and March 2006, notably late in the planting season. The sites were broadcast seeded with a native grass seed mix that included Sandberg's bluegrass (*Poa secunda*), needle-and-thread grass (*Hesperostipa comata*), Indian ricegrass (*Achnatherum hymenoides*), bluebunch wheatgrass (*Pseudoroegneria spicata*), thickspike wheatgrass (*Elymus lanceolatus*), and prairie junegrass (*Koeleria macrantha*). Triple-16 fertilizer and polyacrylamide was applied with the grass seed along with 4.5 metric tons/ha (4,015 lb/ac) straw mulch. The site was planted with sagebrush (*Artemisia tridentata*) and spiny hopsage (*Grayia spinosa*) seedlings at a rate of 98.5% and 1.5%. The substrate at these sites is pit-run cobble backfill. The 116-K-2 site was monitored for 4 years and is the representative site for this area and planting year.

4.2.1 116-K-1 Site (100-K Crib)

The 116-K-2 site is the representative site for the adjacent 116-K-1 site, which was not monitored. Both were revegetated in FY 2006. The 116-K-1 site is located on the northwestern end of the 116-K-2 site. The 116-K-2 site is about a mile long and was segmented into four areas for monitoring. The most representative area of 116-K-2 to 116-K-1 is Transect 1 (T1) of the monitoring area; this is what the 116-K-1 2018 data was compared to.

Canopy cover monitoring was performed at the 116-K-2 site in 2009, 4 years after planting. At the time of 2009 monitoring, total canopy cover was 61.5%, made up of 19.7% invasive and 41.8% native species. Bluebunch wheatgrass (*Pseudoroegneria spicata*) was the most abundant native species with 32.5% cover followed by Sandberg's bluegrass (*Poa secunda*) at 6.5% cover. The most abundant invasive species was cheatgrass (*Bromus tectorum*) with a cover of 12.8%. Biotic crust had a cover of 8.3%. Nine native species were recorded in 2009. Shrubs recorded at T1 had a 68% survival rate; however, the total number of shrubs planted at this site is not known so density cannot be calculated.

Canopy cover data for the site was collected again in May 2018 (Figure 52). Data was collected from 25 plot frames. Canopy cover for the site was 36.3% with 16.8% native cover and 19.5% invasive cover (Table 51). The dominant native species was rubber rabbitbrush (*Ericameria nauseosa*) with 9.0% cover followed by Sandberg's bluegrass at 3.9% cover. Cheatgrass (*Bromus tectorum*) was the dominant invasive species for the site with 9.9% cover. Four native forbs occurred on this site. Biotic crust cover measured 15.8%. Twelve native species were recorded in 2018.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was observed at this site at 4.9% cover and was detected in 70% of plot frames. Treatment of diffuse knapweed is highly recommended at this site. Rush skeleton weed (*Chondrilla diffusa*), a Washington State Class B noxious weed, was observed at this site at less than 1% cover.

At the time of 2018 monitoring, this site was 12 years old. Native cover at this site had decreased significantly since 2009 monitoring (Table 52). Invasive cover had remained around 19%. The ratio of native cover to invasive cover had decreased from about 2:1 to 1:1. Native species diversity has increased since 2009 monitoring. The native cover is made up of a significant amount of rubber rabbitbrush; few sagebrush plants seem to have established. Biotic

crust levels are high at this site and have increased since 2009. High native species diversity and biotic crust levels both suggest this site will have resistance to further invasion by weeds like cheatgrass but continued monitoring is still needed at this site.

Table 51. Percent Canopy Cover and Frequency of Occurrence at the 116-K-1 Site in 2018.

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	X	X
<i>Achnatherum hymenoides</i> (Indian ricegrass)	0.8	5.0
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	X	X
<i>Artemisia tridentata</i> (big sagebrush)	X	X
<i>Bromus arvensis</i> ^a (field brome)	0.8	30.0
<i>Bromus tectorum</i> ^a (cheatgrass)	9.9	100.0
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	4.9	70.0
<i>Chondrilla juncea</i> ^b (rush skeletonweed) (B)	0.8	5.0
<i>Draba verna</i> ^a (spring draba)	0.8	30.0
<i>Epilobium brachycarpum</i> (tall annual willowherb)	0.1	5.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	9.0	70.0
<i>Erigeron pumilus</i> (shaggy fleabane)	0.1	5.0
<i>Erodium cicutarium</i> ^a (redstem stork's bill)	0.3	10.0
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.4	15.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	X	X
<i>Leymus cinereus</i> (basin wildrye)	X	X
<i>Machaeranthera canescens</i> (hoary tansyaster)	0.3	10.0
<i>Poa secunda</i> (Sandberg bluegrass)	3.9	80.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	2.5	25.0
<i>Salsola kali</i> ^a (Russian thistle)	1.6	65.0
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	0.3	10.0
<i>Vulpia microstachys</i> (desert fescue)	0.1	5.0
Artr recruits	X	X
Crust	15.8	95.0
Soil	70.8	100.0
Litter	27.5	100.0
Total canopy cover (excludes crust/soil/litter)	36.3	
Total Native % Cover	16.8	
Total Invasive % Cover	19.5	

^a Invasive species

^b Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames

Table 52. Percent Canopy Cover Comparison at the 116-K-2 Site (T1) in 2009 and the 116-K-1 Site in 2018

	Canopy Cover (%)	
	116-K-2 (T1)	116-K-1
	2009	2018
Native Cover	41.8	16.8
Big sagebrush	1.7	X
Rubber rabbitbrush	-	9.0
Bluebunch wheatgrass	32.5	2.5
Sandberg's bluegrass	6.5	3.9
Biotic crust	8.3	15.8
Invasive Cover	19.7	19.5
Cheatgrass	12.8	9.9
Russian thistle	1.7	1.6
Diffuse knapweed	1.7	4.9

X = present but not counted in plot frames



Figure 52. The 116-K-1 Site in 2018.

4.2.2 116-K-2 Site (Mile Long Trench)

The 116-K-2 site was planted in FY 2006 and monitored from 2006 until 2009. It is approximately a mile long and is rectangular, so it was split into four transects for monitoring.

Canopy cover monitoring was performed at the 116-K-2 site in 2009, 4 years after planting. At the time of 2009 monitoring, total canopy cover was 80.9%, made up of 29.1% invasive and 51.8% native species. Sandberg's bluegrass (*Poa secunda*) was the most abundant native species with 28.3% cover, followed by bluebunch wheatgrass (*Pseudoroegneria spicata*) at 18.9% cover. The most abundant invasive species was cheatgrass (*Bromus tectorum*) with a cover of 19.0%. Biotic crust had a cover of 9.6%. Seventeen native species were recorded in 2009. Shrubs recorded during transect monitoring had a 53% survival rate, but the total number of shrubs planted at this site is not know so density cannot be calculated.

Canopy cover data for the site was collected again in May 2018 (Figure 53). Data was collected from 25 plot frames. Canopy cover for the site was 44.5% with 28.6% native cover and 16.1% invasive cover (Table 53). The dominant native species was big sagebrush (*Artemisia tridentata*) with 19.3% cover, followed by bluebunch wheatgrass at 8.7% cover. Cheatgrass (*Bromus tectorum*) was the dominant invasive species for the site with 9.2% cover. Biotic crust cover measured 7.7%. Ten native species were recorded in 2018.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was observed at this site at 3.0% cover and was detected in 80.0% of plot frames. Treatment of diffuse knapweed is highly recommended at this site. Rush skeleton weed (*Chondrilla diffusa*), a Washington State Class B noxious weed, was observed at this site but not recorded in any plot frames.

At the time of 2018 monitoring, this site was 12 years old. Native cover at this site had decreased significantly since 2009 monitoring (Table 54). Extreme decreases in native coverage may be tied more to differences in monitoring styles than actual species coverage. See Section 5.2 for more details. Invasive cover also decreased significantly from 2009 to 2018. Despite this, ratio of native cover to invasive cover had remained relatively similar. Native species diversity had decreased since 2009 monitoring, but this might be attributed to a more extensive monitoring effort in 2009 detecting more species. The 2018 monitoring only used 25 transects, while 2009 monitoring used 100. Biotic crust levels at this site have decreased since 2009. The native cover at this site is made up mainly of sagebrush and bluebunch wheatgrass, which is a sign of a healthy sagebrush habitat. This site meets all success criteria and is expected to continue to be successful into the future.

Table 53. Percent Canopy Cover and Frequency of Occurrence at the 116-K-2 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	X	X
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	X	X
<i>Artemisia tridentata</i> (big sagebrush)	15.0	44.0
<i>Astragalus sclerocarpus</i> (woodypod milkvetch)	0.1	4.0
<i>Bromus arvensis</i> ^a (field brome)	0.1	4.0
<i>Bromus tectorum</i> ^a (cheatgrass)	9.2	100.0
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	3.0	80.0
<i>Chaenactis douglasii</i> (Douglas' dustymaiden)	X	X
<i>Chondrilla juncea</i> ^b (rush skeletonweed) (B)	X	X
<i>Draba verna</i> ^a (spring draba)	1.5	60.0

Table 53. Percent Canopy Cover and Frequency of Occurrence at the 116-K-2 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	0.3	12.0
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	1.0	40.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.1	4.0
<i>Lupinus wyethii</i> (Wyeth's lupine)	X	X
<i>Poa secunda</i> (Sandberg bluegrass)	X	X
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	8.7	84.0
<i>Salsola kali</i> ^a (Russian thistle)	0.7	28.0
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	0.1	4.0
<i>Tragopogon dubius</i> ^a (yellow salsify)	0.4	16.0
<i>Vulpia microstachys</i> (desert fescue)	X	X
Artr recruits	4.3	36.0
Crust	7.7	88.0
Soil	59.5	100.0
Litter	38.0	100.0
Total canopy cover (excludes crust/soil/litter)	44.5	
Total Native % Cover	28.4	
Total Invasive % Cover	16.1	

^a Invasive species^b Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames

Table 54. Percent Canopy Cover Comparison at the 116-K-2 Site in 2009 and 2018.

	Canopy Cover (%)	
	116-K-2 2009	116-K-2 2018
Native Cover	51.8	28.4
Big sagebrush	3.2	19.3
Rubber rabbitbrush	0.1	0.3
Bluebunch wheatgrass	18.9	8.7
Sandberg's bluegrass	28.3	X
Biotic crust	9.6	7.7
Invasive Cover	29.1	16.1
Cheatgrass	19.0	9.2
Russian thistle	4.3	0.7
Diffuse knapweed	1.2	3.0

X = present but not counted in plot frames



Figure 53. The 116-K-2 Site in 2018.

4.3 100 N AREA SITES

Two sites were monitored in the 100-N Area for long term trends; 116-N-3 and 120-N-1&2; these sites were planted in FY 2005 and FY 2003, respectively.

4.3.1 116-N-3 Site (1325-N Crib and Trench)

The 116-N-3 Site stretches through an area known as the *Mooli Mooli* to local Native American Tribes and is a significant area to religion, traditions, and cultural heritage. When the 116-N-3 trench was ready for remediation, it was backfilled and recontoured to restore the removed portions of *Mooli Mooli*. Revegetation activities took place in FY 2005.

The site was broadcast seeded with a native grass seed mix that included Sandberg's bluegrass (*Poa secunda*), needle-and-thread grass (*Hesperostipa comata*), Indian ricegrass (*Achnatherum hymenoides*), bluebunch wheatgrass (*Pseudoroegneria spicata*), thickspike wheatgrass (*Elymus lanceolatus*), and prairie junegrass (*Koeleria macrantha*). Triple-16 fertilizer was applied with the grass seed, along with 4.5 metric tons/ha (4,015 lb/ac) straw mulch. The site was planted with sagebrush (*Artemisia tridentata*) and spiny hopsage (*Grayia spinosa*) seedlings. There were 13,050 shrubs (i.e., 11,500 sagebrush and 1,550 spiny hopsage).

Shrub survival information is not included in the available reports. Canopy cover monitoring in 2008 showed 44.7% native and 27.8% invasive species coverage (Figure 54). Sandberg's bluegrass (*Poa secunda*) made up the majority of the native coverage at 33.0% cover followed by bluebunch wheatgrass (*Pseudoroegneria spicata*) with 9.9% cover. Cheatgrass (*Bromus*

tectorum) was the dominant invasive species with 20.3% cover followed by Russian thistle (*Salsola kali*) with 4.2% cover. Sagebrush (*Artemisia tridentata*) was seen on the site but not recorded in any of the plot frames. Biotic crust cover measured 0%. Nine native species were recorded at this site in 2009.

Canopy cover data for this site was collected again in May 2018 (Figure 55). Data was collected from 25 plot frames. Canopy cover for the site was 37.5% with 11.6% native cover and 25.9% invasive cover (Table 55). The dominant native species was bluebunch wheatgrass (*Pseudoroegneria spicata*) with 5.1% cover, followed by rubber rabbitbrush (*Ericameria nauseosa*) with 3.9% cover. Cheatgrass (*Bromus tectorum*) was the dominant invasive species for the site with 15.1% cover. Biotic crust cover measured 5.9%. Eleven native species were recorded in 2018.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was observed at this site at 2.6% cover and was detected in 24.0% of plot frames. Rush skeleton weed (*Chondrilla diffusa*), a Washington State Class B noxious weed, was observed at this site at less than 1% cover.

At the time of 2018 monitoring, this site was 13 years old. Native cover at this site had decreased significantly since 2008 monitoring (Table 56). The decrease in native cover could be attributed to simply the decrease in Sandberg's bluegrass, which was measured at 33.0% cover in 2008 and at 0.7% cover in 2018. Invasive cover had decreased slightly. Native species diversity and biotic crust cover have increased since 2008 monitoring, both positive signs of growth. The steep drop in native species coverage at this site in the last 10 years suggests the 116-N-3 site may be trending downwards and require intervention. Continued monitoring is recommended at this site.

Table 55. Percent Canopy Cover and Frequency of Occurrence at the 116-N-3 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	X	X
<i>Achnatherum hymenoides</i> (Indian ricegrass)	X	X
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	0.6	4.0
<i>Artemisia tridentata</i> (big sagebrush)	0.6	4.0
<i>Bromus tectorum</i> ^a (cheatgrass)	15.1	100.0
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	2.6	24.0
<i>Chondrilla juncea</i> ^b (rush skeletonweed) (B)	0.8	12.0
<i>Draba verna</i> ^a (spring draba)	0.5	20.0
<i>Elymus elymoides</i> (squirreltail)	0.6	4.0
<i>Epilobium brachycarpum</i> (tall annual willowherb)	X	X
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	3.9	20.0
<i>Erodium cicutarium</i> ^a (redstem stork's bill)	X	X
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.4	16.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	1.8	52.0
<i>Machaeranthera canescens</i> (hoary tansymustard)	0.1	4.0
<i>Melilotus officinalis</i> ^a (sweet clover)	0.1	4.0
<i>Poa secunda</i> (Sandberg bluegrass)	0.7	28.0

Table 55. Percent Canopy Cover and Frequency of Occurrence at the 116-N-3 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	5.1	32.0
<i>Salsola kali</i> ^a (Russian thistle)	1.4	36.0
<i>Sisymbrium altissimum</i> ^a (tumble mustard)	3.1	8.0
<i>Sporobolus cryptandrus</i> (sand dropseed)	X	X
<i>Tragopogon dubius</i> ^a (yellow salsify)	0.1	4.0
Crust	5.9	76.0
Soil	67.9	100.0
Litter	35.4	100.0
Total canopy cover (excludes crust/soil/litter)	37.5	
Total Native % Cover	11.6	
Total Invasive % Cover	25.9	

^a Invasive species

^b Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames

Table 56. Percent Canopy Cover Comparison at the 116-N-3 Site in 2008 and 2018.

	Canopy Cover (%)	
	2008	2018
Native Cover	44.7	11.6
Big sagebrush	X	0.6
Rubber rabbitbrush	X	3.9
Bluebunch wheatgrass	9.9	5.1
Sandberg's bluegrass	33.0	0.7
Biotic crust	0	5.9
Invasive Cover	27.8	25.9
Cheatgrass	20.3	15.1
Russian thistle	4.2	1.4
Diffuse knapweed	0.3	2.6

X = present but not counted in plot frames



Figure 54. Bluebunch Wheatgrass Growing at the 116-N-3 Site in 2009.



Figure 55. Overview of the 116-N-3 Site in 2018.

4.3.2 120-N-1&2 (Percolation Pond)

The 120-N-1 and 120-N-2 sites were revegetated as one unit in FY 2003. The areas were broadcast seeded with a mix of Sandberg's bluegrass (*Poa secunda*), needle-and-thread grass

(*Hesperostipa comata*), Indian ricegrass (*Achnatherum hymenoides*), bluebunch wheatgrass (*Pseudoroegneria spicata*), thickspike wheatgrass (*Elymus lanceolatus*), sagebrush (*Artemisia tridentata*), common yarrow (*Achillea millefolium*), and small amounts of cushion fleabane (*Erigeron poliospermus*), false yarrow (*Chaenactis douglasii*), phlox (*Phlox longifolium*), wallflower (*Erysimum asperum*), and rubber rabbitbrush (*Ericameria nauseosa*). The site was split into four treatment areas and treated with various fertilizers and mulches.

Canopy cover monitoring was performed at the 116-K-2 site in 2007, 5 years after planting (Figure 56). At the time of 2007 monitoring, total canopy cover was 86.3%, made up of 54.6% invasive and 31.7% native species. Sandberg's bluegrass was the most abundant native species with 16.4% cover followed by bluebunch wheatgrass at 11.2% cover. The most abundant invasive species was cheatgrass (*Bromus tectorum*) with a cover of 51.4%. Biotic crust had a cover of 1.3%. Twelve native species were recorded in 2007. Shrubs were not transplanted during this monitoring effort, only seeded. Sagebrush had an estimated coverage of 0.05%.

Canopy cover data for the site was collected again in May 2018 (Figure 57). Data was collected from 25 plot frames. Canopy cover for the site was 32.2% with 20.3% native cover and 11.9% invasive cover (Table 57). The dominant native species was rubber rabbitbrush (*Ericameria nauseosa*) with 14.5% cover followed by Sandberg's bluegrass at 3.1% cover. Cheatgrass was the dominant invasive species for the site with 10.8% cover. Biotic crust cover measured 7.0%. Seven native species were recorded in 2018.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was observed at this site at less than 1% cover and occurred in 12.5% of plot frames.

At the time of 2018 monitoring, this site was 15 years old. Native cover and native species diversity at this site had decreased since 2007 monitoring, but the site still had a native cover of over 20% (Table 58). Invasive cover decreased by over 40% from 2007 to 2018. Though native cover had declined, the ratio of native to invasive species cover had improved from about 1:2 to 2:1. Sagebrush did not have significant cover at this site and it is recommended this site be planted with sagebrush plugs in order to increase cover. Biotic crust, an indicator of site health, had increased at this site. Given the high ratio of native to invasive cover and the increase in biotic crust, it is expected this site will continue to improve.

Table 57. Percent Canopy Cover and Frequency of Occurrence at the 120-N-1&2 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	X	X
<i>Artemisia tridentata</i> (big sagebrush)	1.1	12.5
<i>Bromus tectorum</i> ^a (cheatgrass)	10.8	100.0
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	0.3	12.5
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	14.7	50.0
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.2	6.3
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.3	12.5
<i>Lomatium sp.</i> (desertparsley)	X	X
<i>Poa secunda</i> (Sandberg bluegrass)	3.1	62.5
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	1.3	18.8

Table 57. Percent Canopy Cover and Frequency of Occurrence at the 120-N-1&2 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Salsola kali</i> ^a (Russian thistle)	0.3	12.5
<i>Sisymbrium altissimum</i> ^a (tumble mustard)	X	X
<i>Vulpia microstachys</i> (desert fescue)	0.2	6.3
Crust	7.0	68.8
Soil	63.1	100.0
Litter	36.9	100.0
Total canopy cover (excludes crust/soil/litter)	32.2	
Total Native % Cover	20.3	
Total Invasive % Cover	11.9	

^a Invasive species

^b Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames

Table 58. Percent Canopy Cover Comparison at the 120-N-1&2 Site in 2007 and 2018.

	Canopy Cover (%)	
	2007	2018
Native Cover	31.7	20.3
Big sagebrush	0.05	1.1
Rubber rabbitbrush	1.16	14.7
Bluebunch wheatgrass	11.2	1.3
Sandberg's bluegrass	16.4	3.1
Biotic crust	1.3	7.0
Invasive Cover	54.6	11.9
Cheatgrass	51.4	10.8
Russian thistle	1.5	0.3
Diffuse knapweed	0.7	0.3



Figure 56. 120-N-1&2 Site in 2007.



Figure 57. 120-N-1&2 Site in 2018.

4.4 100 D AREA SITES

One site was monitored for long-term trend in the 100-D Area, 116-D/DR North. This site is a combination of a number of liquid waste sites in the 100-D Area that were revegetated in FY 2002.

4.4.1 116-D/DR-North

The 116-D/DR Site was revegetated in FY 2002. This site was broadcast seeded with Sandberg's bluegrass (*Poa secunda*); needle-and-thread grass (*Hesperostipa comata*); and small amounts of yarrow (*Achillea millefolium*), prairie clover (*Dalea ornata*), sagebrush (*Artemisia tridentata*), rabbitbrush (*Ericameria nauseosa*), Indian ricegrass (*Achnatherum hymenoides*), Carey's balsamroot (*Balsamorhiza careyana*), snow buckwheat (*Eriogonum niveum*), milkvetch (*Astragalus caricinus*, *A. sclerocarpus*, and *A. purshii*), mariposa lily (*Calochortus macrocarpus*), grayball sage (*Salvia dorrii*), false yarrow (*Chaenactis douglasii*), slender hawksbeard (*Crepis atrabarba*), sanddrop seed (*Sporobolus cryptandrus*), fleabane (*Erigeron sp.*), wallflower (*Erysimum occidentale*), blazingstar (*Mentzelia laevicaulis*), spring parsley (*Cymopterus terebinthinus*), sand beardtongue (*Penstemon acuminatus*), and long leaf phlox (*Phlox longifolia*). Triple-16 fertilizer was applied at a rate of 112 kg/ha during seeding, and straw mulch was spread across the seeded area at a rate of 4.5 metric tons/ha (4,015 lb/ac). Sagebrush seedlings were planted at this site.

Canopy cover monitoring was performed at the 116-K-2 site in 2006, 5 years after planting (Figure 59). At the time of 2006 monitoring, total canopy cover was 47.8%, made up of 14.3% invasive and 33.5% native species. Sandberg's bluegrass was the most abundant native species at 20.8% cover followed by bluebunch wheatgrass (*Pseudoroegneria spicata*) at 4.9% cover. The most abundant invasive species was cheatgrass (*Bromus tectorum*) with a cover of 10.7%. Biotic crust had a cover of 24.4%. Twenty-eight native species were recorded at this site in 2006. Sagebrush planted at this site had 78.2% survival, but the density of sagebrush is unknown.

Canopy cover data for the site was collected again in May 2018 (Figure 60). Data was collected from 50 plot frames. Canopy cover for the site was 42.7% with 25.1% native cover and 17.6% invasive cover (Table 58). The dominant native species was rubber rabbitbrush (*Ericameria nauseosa*) with 9.0% cover followed by prairie clover (*Dalea ornata*) at 6.2% cover. Cheatgrass (*Bromus tectorum*) was the dominant invasive species for the site with 10.4% cover. Biotic crust cover measured 31.9%. Eighteen native species were recorded in 2018.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was observed at this site at 2.3% cover and was detected in 40% of plot frames. Puncturevine (*Tribulus terrestris*), a Washington State Class B noxious weed, was observed at this site at 1% cover and occurred in 8% of plot frames.

At the time of 2018 monitoring, this site was 16 years old. Native cover at this site had decreased slightly since 2006 monitoring (Table 59). Invasive cover had increased slightly. Native species diversity had decreased since 2006 monitoring however, due to the large size of the site it is possible that species were missed during 2018 monitoring. The 116-D/DR site remains one of the most diverse sites monitored in 2018. Biotic crust levels have remained extremely high at this site and have increased since 2006. High native species diversity and

biotic crust levels both suggest this site will have resistance to further invasion by weeds like cheatgrass. No further actions are recommended at this site.

Table 59. Percent Canopy Cover and Frequency of Occurrence at the 116-D/DR-North Site in 2018.

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	1.2	8.0
<i>Achnatherum hymenoides</i> (Indian ricegrass)	X	X
<i>Artemisia tridentata</i> (big sagebrush)	2.6	8.0
<i>Astragalus purshii</i> (woollypod milkvetch)	X	X
<i>Astragalus sclerocarpus</i> (stalked-pod milkvetch)	X	X
<i>Astragalus succumbens</i> (Columbia milkvetch)	0.4	4.0
<i>Bromus tectorum</i> ^a (cheatgrass)	10.4	98.0
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	2.3	40.0
<i>Chaenactis douglasii</i> (Douglas' dustymaiden)	X	X
<i>Dalea ornata</i> (prairie clover)	6.2	8.0
<i>Draba verna</i> ^a (spring draba)	0.8	30.0
<i>Elymus elymoides</i> (squirreltail)	0.1	4.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	9.0	54.0
<i>Erodium cicutarium</i> ^a (redstem stork's bill)	0.2	6.0
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.8	30.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.1	4.0
<i>Machaeranthera canscens</i> (hoary tansyaster)	0.2	8.0
<i>Plantago patagonica</i> (woolly plantain)	X	X
<i>Poa bulbosa</i> ^a (bulbous bluegrass)	0.1	2.0
<i>Poa secunda</i> (Sandberg bluegrass)	3.4	86.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	1.8	6.0
<i>Purshia tridentata</i> (antelope bitterbrush)	X	X
<i>Salsola kali</i> ^a (Russian thistle)	2.2	86.0
<i>Sphaeralcea munroana</i> (Munro's globemallow)	X	X
<i>Sporobolus cryptandrus</i> (sand dropseed)	0.1	2.0
<i>Tribulus terrestris</i> ^b (puncturevine) (B)	1.0	8.0
<i>Vulpia microstachys</i> (desert fescue)	0.1	2.0
Artr recruits	0.3	10.0
Crust	31.9	88.0
Soil	79.8	100.0
Litter	18.6	100.0
Total canopy cover (excludes crust/soil/litter)	42.6	
Total Native % Cover	25.1	
Total Invasive % Cover	17.6	

^a Invasive species

^b Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames

Table 60. Percent Canopy Cover Comparison at the 116-D/DR-North Site in 2006 and 2018.

	Canopy Cover (%)	
	2006	2018
Native Cover	33.5	25.1
Big sagebrush	X	2.6
Prairie clover	-	6.2
Rubber rabbitbrush	2.5	9.0
Bluebunch wheatgrass	4.9	1.8
Sandberg's bluegrass	20.8	3.4
Biotic crust	24.4	31.9
Invasive Cover	14.3	17.6
Cheatgrass	10.7	10.4
Russian thistle	0.3	2.2
Diffuse knapweed	X	2.3

X = present but not counted in plot frames



Figure 58. The 116-D/DR-North Site in 2006.



Figure 59. The 116-D/DR Site in 2018.

4.5 100 F AREA SITE

One site was monitored for long-term trend in the 100-F Area, the 116-F-14 site. This site is monitored in past documents as part of the 100-FR-1 Operable Unit and was revegetated in FY 2005.

4.5.1 116-F-14 Site (107-F Retention Basin)

The 116-F-14 site was revegetated in FY 2005. The site was hydroseeded with a native grass seed mix that included Sandberg's bluegrass (*Poa secunda*), needle-and-thread grass (*Hesperostipa comata*), Indian ricegrass (*Achnatherum hymenoides*), bluebunch wheatgrass (*Pseudoroegneria spicata*), thickspike wheatgrass (*Elymus lanceolatus*), and prairie junegrass (*Koeleria macrantha*). Triple-16 fertilizer was applied with the grass seed along with 4.5 metric tons/ha (4,015 lb/ac) straw mulch. The entire 100-FR-1 Operable Unit was planted with 55,000 sagebrush (*Artemisia tridentata*) seedlings.

Canopy cover monitoring was performed at the 116-F-14 site in 2008 (Figure 60). At the time of 2008 monitoring, total canopy cover was 104.3%, made up of 57.4% invasive and 46.6% native species. Sandberg's bluegrass was the most abundant native species at 28.9% cover followed by bluebunch wheatgrass (*Pseudoroegneria spicata*) at 11.8% cover. The most abundant invasive species was cheatgrass (*Bromus tectorum*) with a cover of 53.9%. Biotic crust had a cover of 1.4%. Twenty-eight native species were recorded at this site in 2006. Sagebrush density at this site was 0.5%.

Canopy cover data for the site was collected again in May 2018 (Figure 61). Data was collected from 50 plot frames. Canopy cover for the site was 27.3% with 20.6% native cover and 6.7% invasive cover (Table 61). The dominant native species was rubber rabbitbrush (*Ericameria nauseosa*) with 13.2% cover followed by Sandberg's bluegrass at 3.5% cover. Cheatgrass

(*Bromus tectorum*) was the dominant invasive species for the site with 4.3% cover. Biotic crust cover measured 8.4%. Seven native species were recorded in 2018.

Diffuse knapweed (*Centaurea diffusa*), a Washington State Class B noxious weed, was observed at this site at less than 1% cover and was detected in 16% of plot frames. Rush skeletonweed (*Chondrilla juncea*), a Washington State Class B noxious weed, was observed at this site but not recorded in any plot frames.

At the time of 2018 monitoring, this site was 13 years old. Native cover at this site had decreased since 2008 monitoring (Table 62). Invasive cover had decreased about 50% since 2008. Native species diversity had decreased since 2006 monitoring, but due to the large size of the site it is possible that species were missed during 2018 monitoring. Though native cover had decreased, the ration of native to invasive species cover had improved significantly, from about 3:4 in 2008 to 3:1 in 2018. Biotic crust levels had also increased since 2008. Native species' ability to outcompete invasive species, along with increased biotic crust levels, are clear indicators of site health. No further actions are recommended at this site.

Table 61. Percent Canopy Cover and Frequency of Occurrence at the 116-F-14 Site in 2018.

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	X	X
<i>Achnatherum hymenoides</i> (Indian ricegrass)	0.6	4.0
<i>Artemisia tridentata</i> (big sagebrush)	2.1	8.0
<i>Bromus tectorum</i> ^a (cheatgrass)	4.3	100.0
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	0.9	16.0
<i>Chondrilla juncea</i> ^b (rush skeletonweed) (B)	X	X
<i>Draba verna</i> ^a (spring draba)	0.1	4.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	13.2	66.0
<i>Erodium cicutarium</i> ^a (redstem stork's bill)	0.5	20.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.1	4.0
<i>Poa secunda</i> (Sandberg bluegrass)	3.5	90.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	1.0	8.0
<i>Salsola kali</i> ^a (Russian thistle)	0.9	34.0
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	X	X
<i>Sporobolus cryptandrus</i> (sand dropseed)	0.3	10.0
Crust	8.4	88.0
Soil	83.8	100.0
Litter	16.3	100.0
Total canopy cover (excludes crust/soil/litter)	27.3	
Total Native % Cover	20.6	
Total Invasive % Cover	6.7	

^a Invasive species

^b Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames

Table 62. Percent Canopy Cover Comparison at the 116-F-14 Site in 2008 and 2018.

	Canopy Cover (%)	
	2008	2018
Native Cover	46.6	20.6
Big sagebrush	0.5	2.1
Rubber rabbitbrush	1.1	13.2
Bluebunch wheatgrass	11.8	1.0
Sandberg's bluegrass	28.9	3.5
Biotic crust	1.4	8.4
Invasive Cover	57.4	6.7
Cheatgrass	53.9	4.3
Russian thistle	2.4	0.9
Diffuse knapweed	X	0.9

X = present but not counted in plot frames



Figure 60. The 116-F-14 Site in 2008.



Figure 61. The 116-F-14 Site in 2018.

4.6 300 AREA SITES

The 618-4 and 316-1/300 RFBP sites were both revegetated in FY 2004 as part of the 300-FF-1 Operational Unit. The sites were broadcast seeded with a grass seed mix that included crested wheatgrass (*Agropyron cristatum*), Regreen (*Agropyron* hybrid), needle-and-thread grass (*Hesperostipa comata*), Indian ricegrass (*Achnatherum hymenoides*), bluebunch wheatgrass (*Pseudoroegneria spicata*), and thickspike wheatgrass (*Elymus lanceolatus*). Terra Bond (water retaining crystals) were applied during seeding at a rate of 16.8 kg/ha (15 lb/ac), and straw mulch was spread over the seed to prevent wind erosion.

4.6.1 618-4 Site (Burial Ground)

The 618-4 site was revegetated with shrub plantings in FY 2006. This area had been revegetated with native grass species in FY 2004 as part of the 300-FF-1 Operable Unit. The substrate at this site is sandy.

Canopy cover data was collected for the 300-FF-1 Operable Unit in 2006, after 3 years of growth. Canopy cover averaged 50.2% with 18.6% native cover and 31.6% invasive cover. The most abundant native species was Sandberg's bluegrass (*Poa secunda*) with 9.4% cover followed by bluebunch wheatgrass with 7.6% cover. The most abundant invasive species was cheatgrass (*Bromus tectorum*) with 16.9% cover. Biotic crust had a cover of 0.8%. Twenty-four native species were recorded during this monitoring.

Sagebrush (*Artemisia tridentata*) transect monitoring was performed at the 618-4 site in 2010, 4 years after planting (Figure 62). At the time of 2010 monitoring, sagebrush had an average survival rate of 57% with many of the shrubs producing seed and acting as seed sources at the site. Eighteen native species were observed on the site during shrub monitoring.

Canopy cover data for the site was collected again in June 2018 (Figure 63). Data was collected from 25 plot frames. Canopy cover for the site was 53.7% with 33.6% native cover and 20.1% invasive cover (Table 63). The dominant native species was sagebrush with 19.0% cover, followed by rubber rabbitbrush (*Ericameria nauseosa*) at 6.7% cover. Cheatgrass was the dominant invasive species for the site with 18.7% cover. Biotic crust cover measured 0.2%. Thirteen native species were recorded in 2018.

Diffuse knapweed (*Centaurea diffusa*) and rush skeletonweed (*Chondrilla juncea*), both Washington State Class B noxious weeds, were observed at this site but not detected in any plot frames.

At the time of 2018 monitoring, this site was 14 years old. Native cover was successful at this site and had increased since 2006 (Table 64). Invasive species cover had decreased since 2006. Though native species diversity had decreased, the number of native species detected in 2018 monitoring was still relatively high. The ratio of native to invasive species cover improved from 2:3 in 2008 to 3:2 in 2018. Sagebrush had significant cover at this site, and the shrub planting in FY 2006 was a success. Biotic crust levels are not high at this site but given the sandy substrate, the soil may be prone to erosion and not support a biotic crust community. It is expected this site will continue to succeed into the future and no further actions are recommended.

Table 63. Percent Canopy Cover and Frequency of Occurrence at the 618-4 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	X	X
<i>Achnatherum hymenoides</i> (Indian ricegrass)	X	X
<i>Agropyron cristatum</i> ^a (crested wheatgrass)	0.8	12.0
<i>Artemisia tridentata</i> (big sagebrush)	19.0	12.0
<i>Bromus tectorum</i> ^a (cheatgrass)	18.7	100.0
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	X	X
<i>Chondrilla juncea</i> ^b (rush skeletonweed) (B)	X	X
<i>Chrysothamnus viscidiflorus</i> (yellow rabbitbrush)	X	X
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	6.7	20.0
<i>Eriogonum niveum</i> (snow buckwheat)	4.6	32.0
<i>Erodium cicutarium</i> ^a (redstem stork's bill)	0.4	16.0
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.1	4.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.1	4.0
<i>Machaeranthera canescens</i> (hoary tansyaster)	0.2	8.0
<i>Oenothera pallida</i> (pale evening primrose)	0.3	12.0
<i>Phacelia</i> sp. (phacelia)	X	X
<i>Plantago patagonica</i> (woolly plantain)	0.1	4.0
<i>Poa secunda</i> (Sandberg bluegrass)	0.8	32.0
<i>Psoraleidum lanceolatum</i> (lemon scurfpea)	1.9	16.0
<i>Purshia tridentata</i> (antelope bitterbrush)	X	X
Crust	0.2	8.0
Soil	84.5	100.0

Table 63. Percent Canopy Cover and Frequency of Occurrence at the 618-4 Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
Litter	14.5	100.0
Total canopy cover (excludes crust/soil/litter)	53.7	
Total Native % Cover	33.6	
Total Invasive % Cover	20.1	

^a Invasive species

^b Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames

Table 64. Percent Canopy Cover Comparison at the 618-4 Site in 2006 and 2018.

	Canopy Cover (%)	
	2006	2018
Native Cover	18.6	33.6
Big sagebrush	X	19.0
Rubber rabbitbrush	X	6.7
Bluebunch wheatgrass	7.6	-
Sandberg's bluegrass	9.4	0.8
Biotic crust	0.8	0.2
Invasive Cover	31.6	20.1
Cheatgrass	16.9	18.7
Russian thistle	2.1	-
Diffuse knapweed	0.1	X

X = present but not counted in plot frames



Figure 62. The 618-4 Burial Ground Site in 2010.



Figure 63. The 618-4 Burial Ground Site in 2018.

4.6.2 316-1 Site / 300 RFBP Site (300 Area South Process Pond)

The 316-1 site and 300 RFBP site were revegetated as one unit in FY 2004 at the same time as the 618-4 Site. Unlike the 618-4 site, no sagebrush (*Artemisia tridentata*) seedlings were planted at this site. The substrate at this site is sandy.

Canopy cover data was collected for the 300-FF-1 Operable Unit in 2006, after 3 years of growth (Figure 64). Canopy cover averaged 50.2% with 18.6% native cover and 31.6% invasive cover. The most abundant native species was Sandberg's bluegrass (*Poa secunda*) with 9.4% cover followed by bluebunch wheatgrass with 7.6% cover. The most abundant invasive species was cheatgrass (*Bromus tectorum*) with 16.9% cover. Biotic crust had a cover of 0.8%. Twenty-four native species were recorded during this monitoring.

Canopy cover data for the 316-1 site was collected in June 2018 (Figure 65). Data was collected from 25 plot frames. Canopy cover for the site was 42.6% with 14.1% native cover and 28.5% invasive cover (Table 65). The dominant native species was rubber rabbitbrush (*Ericameria nauseosa*) at 10.0% cover followed by Sandberg's bluegrass (*Poa secunda*) with 2.7% cover. Cheatgrass was the dominant invasive species for the site with 12.2% cover followed by crested wheatgrass (*Agropyron cristatum*) with 9.8% cover. Biotic crust cover measured 9.1%. Seven native species were recorded in 2018.

Diffuse knapweed (*Centaurea diffusa*) and rush skeletonweed (*Chondrilla juncea*), both Washington State Class B noxious weeds, were observed at this site with 1.5% and 0.6% cover, respectively. Canada thistle (*Cirsium arvense*), a Washington State Class C noxious weed, was also observed on this site.

At the time of 2018 monitoring, this site was 14 years old. Native and invasive cover had decreased slightly since 2006, and the ratio of native to invasive species cover had changed from 2:3 to 1:2 (Table 66). Native species diversity had also decreased. Sagebrush is not present at this site and the overstory is dominated by rubber rabbitbrush. Biotic crust levels had increased. Additional sagebrush plantings are recommended at this site to increase native cover and reintroduce sagebrush into this disturbed area.

Table 65. Percent Canopy Cover and Frequency of Occurrence at the 316-1 / 300-RFBP Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Achillea millefolium</i> (common yarrow)	X	X
<i>Agropyron cristatum</i> ^a (crested wheatgrass)	9.8	48.0
<i>Amsinckia lycopsoides</i> (tarweed fiddleneck)	X	X
<i>Bromus tectorum</i> ^a (cheatgrass)	12.2	100.0
<i>Centaurea diffusa</i> ^b (diffuse knapweed) (B)	1.5	20.0
<i>Chondrilla juncea</i> ^b (rush skeletonweed) (B)	0.6	4.0
<i>Cirsium arvense</i> ^b (Canada thistle) (C)	X	X
<i>Draba verna</i> ^a (spring draba)	0.1	4.0
<i>Ericameria nauseosa</i> (rubber rabbitbrush)	10.0	52.0
<i>Erodium cicutarium</i> ^a (redstem stork's bill)	0.8	32.0
<i>Festuca sp.</i> (fescue)	0.1	4.0

Table 65. Percent Canopy Cover and Frequency of Occurrence at the 316-1 / 300-RFBP Site in 2018. (2 Pages)

Species	% Cover	% Frequency of Occurrence
<i>Holosteum umbellatum</i> ^a (jagged chickweed)	0.2	8.0
<i>Lactuca serriola</i> ^a (prickly lettuce)	0.1	4.0
<i>Lepidium latifolium</i> ^a (broadleaved pepperweed)	0.7	8.0
<i>Lepidium perfoliatum</i> ^a (clasping pepperweed)	X	X
<i>Melilotus officinalis</i> ^a (sweet clover)	X	X
<i>Machaeranthera canescens</i> (hoary tansyaster)	X	X
<i>Poa secunda</i> (Sandberg bluegrass)	2.7	88.0
<i>Pseudoroegneria spicata</i> (bluebunch wheatgrass)	1.3	12.0
<i>Sisymbrium altissimum</i> ^a (tall tumbled mustard)	X	X
<i>Tragopogon dubius</i> ^a (yellow salsify)	2.5	4.0
Crust	9.1	88.0
Soil	57.7	100.0
Litter	42.3	100.0
Total canopy cover (excludes crust/soil/litter)	42.6	
Total Native % Cover	14.1	
Total Invasive % Cover	28.5	

^a Invasive species^b Washington State Classified Noxious Weed (class)

X = present but not counted in plot frames

Table 66. Percent Canopy Cover Comparison at the 316-1 / 300 RFBP Site in 2006 and 2018.

	Canopy Cover (%)	
	2006	2018
Native Cover	18.6	14.1
Big sagebrush	X	-
Rubber rabbitbrush	X	10.0
Bluebunch wheatgrass	7.6	1.3
Sandberg's bluegrass	9.4	2.7
Biotic crust	0.8	9.1
Invasive Cover	31.6	28.5
Cheatgrass	16.9	12.2
Crested wheatgrass	4.9	9.8
Russian thistle	2.1	-
Diffuse knapweed	0.1	1.5

X = present but not counted in plot frames



Figure 64. Revegetated Process Ponds in the 300-FF-1 Operable Unit (2006).



Figure 65. The 316-1 / 300 RFBP Site in 2018.

5.0 DISCUSSION

5.1 5-YEAR MONITORING SITES

Revegetation of remediated and disturbed sites on the Hanford Site is performed to support the U.S. Department of Energy, Richland Operations Office's goal of meeting cleanup and revegetation requirements mandated in the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*. Revegetation and monitoring activities of remediated and disturbed sites on the Hanford Site are conducted in accordance with the *Hanford Site Revegetation Manual* (DOE/RL-2011-116, Rev. 1), area specific revegetation plans (DOE/RL-96-17, Rev. 6, Appendix H, DOE/RL-2005-93, Rev. 1, Appendix G, and DOE/RL-2001-47, Rev. 3, Appendix C), as well as other area and/or site-specific guidance such as Mitigation Action Plans and Memorandums of Agreement.

Landscapes within semi-arid climates take decades or even centuries to reestablish naturally to functional and sustainable ecosystems after disturbances. The Hanford Site presents many challenges to revegetation efforts due to its complex shrub-steppe ecosystem, decades of natural and anthropogenic disturbances, widespread invasive species (e.g., cheatgrass, *Bromus tectorum* and Russian thistle, *Salsola kali*), and limited fill material that often has a high percentage of rock (gravel and cobbles). It is also important to realize that habitats within a landscape may differ significantly from one another. Not all plants grow in the same soil or climatic conditions. A prescription that is successful for one site may not work for another. Factors such as substrate, moisture, adjacent topography and species composition, prescribed species and application rates, seasonal timing for planting, annual precipitation, and proper planting and seeding techniques all influence the success of a particular revegetation site.

MSA is responsible for monitoring and evaluating Hanford Site revegetation sites previously restored by the RCCC and CHPRC within areas that have transitioned to MSA, and for monitoring restoration areas associated with site reliability projects implemented by MSA. MSA's goal through revegetation monitoring is to ensure the success of the restoration process. As described in this report, this is accomplished by conducting annual monitoring of representative revegetated sites to provide quantitative data (shrub density and canopy cover percentages) that can be used to evaluate trends, individual site success or failure, and provide insight regarding the effectiveness of different planting strategies for different conditions. Sites that are not meeting the prescribed success criteria are evaluated to determine if additional revegetation efforts need to be implemented to achieve success.

A total of 40 revegetated sites were monitored during routine 5-year monitoring by MSA in 2018 (Table 67). Ten of these sites (100-F-47, 100-F-48, 118-F-1, 118-F-6, 100-F CTA, 100-F Trailer Village, 118-F-5, 100-F-57, 100-F-26, 118-F-3) had additional revegetation actions implemented in the winter of FY 2018; eight of those were completely reworked and two had supplemental shrub plantings to increase shrub density. These sites had been identified as needing additional revegetation actions in previous monitoring based on representative sites in the area that had failed the prescribed success criteria. Different revegetation methods were employed at these sites and the success of these different methods will be tracked throughout the 5-year monitoring period. Though these sites all had successful shrub density, the plants had only been in the ground for about 5 months at the time of 2018 monitoring. Future monitoring at these sites will

provide valuable information, both about the success of different revegetation methods and about the effectiveness of these additional revegetation actions.

The remaining 30 revegetated sites had no additional revegetation actions and were monitored with routine 5-year monitoring. Monitoring for each site entailed documentation of native shrubs (sagebrush [*Artemisia tridentata*], antelope bitterbrush [*Purshia tridentata*] and spiny hopsage [*Grayia spinosa*]) within established transect areas and documentation of native and invasive canopy cover percentages, as well as frequency of occurrence for each species observed on the site. For each site monitored, these data were evaluated against the success criteria of 600 plants/ha (240 plants/ac) for native shrub density and 25% native cover (shrubs, grasses, forbs combined).

Of the 40 revegetated sites, 10 did not have shrub transects. Two sites (600-379, L-525) lacked shrub transects due to the site being too small or the transect area being converted to industrial use; the remaining eight sites did not have transects established during the first year of growth and were not monitored until 2018. Twenty-one of the 30 sites monitored for shrub density are currently meeting the shrub density success criteria of over 600 plants/ha (240 plants/ac).

Additional revegetation actions designed to increase shrub density are recommended at the nine failing sites. Thirty-eight of the 40 sites were monitored for native canopy cover. None of the 38 sites had native cover of 25% or greater within the 5-year monitoring window. Many of the sites have a substrate of predominantly gravel and cobbles, reducing the total surface area where plants can establish. This may be a factor preventing sites from achieving 25% native ground cover. In these areas, it would make logical sense to measure 25% native ground cover as 25% coverage of all substrate that is not rock, rather than as 25% coverage of all substrate.

In future monitoring efforts, it is recommended that *Rock/Cobble* is measured as a separate substrate and total canopy cover is measured for the non-rock/cobble substrates. For example, at the 100-D-30/104 site, cobble is a large component of the substrate (Figure 66). If cobble had been measured and had a coverage of 40%, this would leave only 60% of the substrate available for plants to establish. Using traditional methods, the 100-D-30/104 site has 11.8% native cover. Adjusting for cobble, the 100-D-30/104 site would have about 20% native cover in the available growing spaces. This will provide a more accurate representation of site success.



Figure 66. Substrate at the 100-D-30/104 Site, Showing High Amounts of Cobble.

Washington State-listed noxious weeds were observed on 31 of the 38 sites monitored in 2018. Diffuse knapweed (*Centaurea diffusa*), a Class B noxious weed, was the most common weed observed on revegetation sites. Noxious weed treatment is recommended for some sites (Table 67).

Table 67. The 2018 5-Year Revegetation Monitoring Summary (4 Pages)

Site	Year Planted	Monitoring Year	Shrub Density (goal >240 plants/ac)	Native Canopy Cover % (goal >25)	Recommendations/ Notes	Future Work Planned
B/C Area Sites						
100-C-7:1	FY 2014	5	269	10.4	Reseed grasses and forbs in understory to increase native cover. Treat noxious weeds recorded in > 25% of plot frames.	Reseeding with grasses and forbs in FY 2019.
Pit 24 (Upland)	FY 2015	4	256	12.5	Treat noxious weeds (knapweed, salt cedar).	Treating for noxious weeds in FY 2018.
100-B-35	FY 2016	3	360	9.5	Continue to monitor.	None.

Table 67. The 2018 5-Year Revegetation Monitoring Summary (4 Pages)

Site	Year Planted	Monitoring Year	Shrub Density (goal >240 plants/ac)	Native Canopy Cover % (goal >25)	Recommendations/ Notes	Future Work Planned
N Area Sites						
130-N-1:1	FY 2015	4	253	9.7	Rework the loamy strips from electrical towers to the site.	Supplemental shrub planting scheduled for FY 2020.
100-N-96	FY 2016	3	146	9.5	Rework entire site to increase native grasses, forbs, and shrubs.	Site rework scheduled for FY 2020.
100-N-83	FY 2017	2	393	6.1	Continue to monitor.	None.
100-N CTA	FY 2017	2	178	11.5	Increase shrub density.	Supplemental shrub planting scheduled for FY 2020.
100-N-61:1	FY 2015	1	N/A	9.4	Increase native cover.	Supplemental shrub planting scheduled for FY 2020.
D Area Sites						
100-D-30/104	FY 2015	4	320	11.8	Continue to monitor.	None.
100-D-100	FY 2016	3	359	7.7	Continue to monitor.	None.
100-D Trailer Village	FY 2017	2	138	3.9	Increase shrub density.	None for FY 2020, candidate for future rework.
100-D-48:2	FY 2015	1	N/A	20.2	Continue to monitor.	None.
100-D-49:2	FY 2015	1	N/A	14.3	Noxious weed treatment; continue to monitor.	Treating for noxious weeds in FY 2019.
116-D-8	FY 2012	1	N/A	12.0	Change representative monitoring site.	None.
H Area Sites						
100-H-28:2	FY 2016	3	214	12.5	Increase shrub density.	None for FY 2020, candidate for future rework.
600-385	FY 2017	2	142	7.7	Increase shrub density.	None for FY 2020, candidate for future rework.
100-H-24	FY 2015	1	N/A	14.8	Continue to monitor.	None.

Table 67. The 2018 5-Year Revegetation Monitoring Summary (4 Pages)

Site	Year Planted	Monitoring Year	Shrub Density (goal >240 plants/ac)	Native Canopy Cover % (goal >25)	Recommendations/ Notes	Future Work Planned
116-H-1	FY 2016	1	N/A	8.6	Continue to monitor.	None.
F Area Sites						
100-F-47	FY 2012, Shrubs added in FY 2018	1	1060	N/A	Supplemental shrub planting was done in FY2018 (Dec/Jan). Possibly treat noxious weeds.	Treating for noxious weeds in FY 2019.
100-F-48	FY 2012, Shrubs added in FY 2018	1	856	N/A	Supplemental shrub planting was done in FY2018 (Dec/Jan). Possibly treat noxious weeds.	Treating for noxious weeds in FY 2019.
118-F-1	FY 2018	1	607	8.1	None, reworked in 2018.	None.
118-F-6	FY 2018	1	603	6.4	None, reworked in 2018.	None.
100-F-26	FY 2018	1	388	4.0	None, reworked in 2018.	None.
118-F-3	FY 2018	1	473	5.9	None, reworked in 2018.	None.
100-F-57	FY 2018	1	1182	10.6	None, reworked in 2018.	None.
100-F Container Transfer Area	FY 2018	1	308	7.3	None, reworked in 2018.	None.
100-F Trailer Village	FY 2018	1	631	4.8	None, reworked in 2018.	None.
118-F-5	FY 2018	1	336	4.0	None, reworked in 2018.	None.
600 Area Sites						
600-301	FY 2014	5	20	13.2	Increase shrub density.	Supplemental shrub planting scheduled for FY 2019.

Table 67. The 2018 5-Year Revegetation Monitoring Summary (4 Pages)

Site	Year Planted	Monitoring Year	Shrub Density (goal >240 plants/ac)	Native Canopy Cover % (goal >25)	Recommendations/ Notes	Future Work Planned
600-369:3	FY 2014	5	372	4.8	Cheatgrass heavily impacts this site, restoration of 25% native cover highly unlikely.	None.
600-370	FY 2014	5	275	5.6	Supplementing with shrubs and forbs.	Supplemental planting scheduled for FY 2019.
600-356	FY 2015	4	0	7.5	Rework entire site.	Rework scheduled for FY 2019.
600-379	FY 2015	3	N/A	2.1	Rework entire site (avoiding established shrubs where possible). Add forbs (e.g., phlox, yarrow, cryptantha) to seed mix. Treat for noxious weeds.	None for FY 20, candidate for future rework.
600-358	FY 2016	3	163	9.0	Additional shrub planting to increase shrub density.	Supplemental shrub planting scheduled for FY 2019.
300 Area Sites						
300-288:2	FY 2017	2	279	14.4	Continue to monitor.	None.
300-North A,B,C,D	FY 2013	1	N/A	12.3	Continue to monitor.	None.
618-2 & 3	FY 2016	1	N/A	7.3	Continue to monitor.	None.
200 Area Sites						
L-840 (200-W Export Water Pipeline)	FY 2017	2	N/A	10.6	Establish new transect.	None.
L-525 (200-E Export Water Pipeline)	FY 2017	2	4	8.8	Establish new transect.	None.
L-419 (200-E Export Water Pipeline)	FY 2018	1	639	2.8	Continue to monitor.	None.

5.2 LONG-TERM TREND SITES

The *Hanford Site Revegetation Manual* (DOE/RL-2011-116, Rev. 1) makes a distinction between fifth-year success criteria and “Desired Future Condition” for revegetation sites. This distinction is important as restoration sites will not have reached a mature state after 5 years. Fifth-year success criteria lists target shrub survival as 600 plants/ha (240 plants/ac), perennial grass cover as 10%, and seeded forb/legume cover as 2 plants/m² (0.2 plants/ft²). “Desire Future Condition” lists desirable native plant cover for each soil type at some point in the undefined future, broken down by shrub, perennial grass, and forb cover. A cover of 25% native plants is listed in the *Hanford Site Revegetation Manual* as a “Desired Future Condition,” not as a condition that defines success after 5 years. No 5-year success criteria concerning total native plant cover is listed in the *Hanford Site Revegetation Manual*.

The criteria requiring total canopy cover of greater than 25% for native plants after 5 years is found in the 100 Area RDR/RAWP, (DOE/RL-96-17, Rev. 6, Appendix H), *Remedial Design Report/Remedial Action Work Plan for the 100-N Area* (DOE/RL-2005-93, Rev. 1, Appendix G), and *Remedial Design Report/Remedial Action Work Plan for the 300 Area* (DOE/RL-2001-47, Rev. 3, Appendix C). These documents state if this is not achieved the cause should be identified and rectified with additional plantings, fertilization, irrigation, or soil amendments, as applicable. Rectifying an unsuccessful revegetation site requires many resources, is expensive, and there is no guarantee it will be more successful. Identifying the cause of site failure is unlikely, as variables such as precipitation, freezing, hot temperatures, planting time, plant quality, seeding techniques, soil quality, seed quality, site topography, non-native species invasion, and many other factors may interact at the time of planting and for years after planting. Additionally, as the revegetation services contractor changes, site-specific planting techniques, seeding rates, and seed mixes have been lost. Without this information and without being able to discern the exact cause(s) of site failures, successfully rectifying an unsuccessful site presents quite a challenge. The time table of reaching 25% cover after 5 years and before the site is fully mature presents the question – Is it more effective to rectify unsuccessful plantings or to not intervene and wait for natural processes to take place?

In order to provide an answer to this question, MSA performed long-term trend monitoring of revegetation sites planted 10 to 16 years ago. The goal of this effort was to characterize the native canopy cover of sites past their fifth year of growth. These results would be used to determine if sites had successful native canopy cover past their final year of monitoring. Twelve revegetation sites planted from 2002 to 2007 were monitored to determine revegetation success after 10 to 16 years of growth. Canopy cover was measured to determine total native cover, invasive cover, native species diversity, the ratio of native to invasive species cover, and dominant native species at the sites. Data collected from older revegetation sites may show that sites trend towards success in the long term, or may indicate that without intervention, unsuccessful sites will not improve in this time period. These data will be used to inform future revegetation efforts, especially intervention efforts at unsuccessful sites.

This report provides long-term trend data for the following sites, with the year planted in parentheses: 116-B/C Misc. (FY 2007), 100-C-9 (FY 2007), 118-B-2 & 3 (FY 2007), 128-C-1 (FY 2005), 116-K-1 and 116-K-2 (FY 2006), 116-N-3 (FY 2005), 120-N-1 & 2 (FY 2003), 116-D/DR North (FY 2002), 116-F-14 (FY 2004), 316-1/300 RFBP (FY 2004), and 618-4 (FY 2004).

One of the challenges that was encountered when analyzing historic data from long-term trend sites was interpreting vast differences in plant species cover. Past *River Corridor Closure Contractor Revegetation and Mitigation Monitoring* reports (WCH-24, WCH-133, WCH-223, WCH 288, WCH-362, WCH-428, WCH-512) include measurements of site cover that exceed 100% in areas with significant cobble cover (e.g., 116-N-3 results in 2009 [WCH-362], 100-F Area results in 2009 [WCH-362], 100-C-9 results in 2011 [WCH-512]) and high yearly fluxuations of native canopy cover (e.g. +46.8% and +56.2% [WCH-512], -43.7% and -43.5% [WCH-428], +40.3% and +31.2% [WCH-362]). Though fluxuations in native canopy cover are to be expected, changes to this degree in a time period as short as a year are at least partially due to observer bias. Though the same monitoring techniques have been used on monitoring sites, individual differences in estimation can drastically change the results. This problem could be solved by having the same individual monitor all sites throughout all years, but this is not realistic. Cross-training monitoring staff is likely the most realistic solution.

When comparing historic data to current data, observer bias can be controlled for by analyzing changes in the ratio of native species cover to invasive species cover. This ratio is reported in Table 68. From initial monitoring to 2018, six sites saw improvements in the ratio of native to invasive species cover (116-B/C Misc, 118-B-2 & 3, 128-C-1, 120-N-1 & 2, 116-F-14, 618-4), four sites saw the ratio of native to invasive species cover decrease (116-K-1, 116-N-3, 116-D/DR North, 316-1), and two sites saw little to no change (100-C-9 and 116-K-2). The majority of sites have not seen the native to invasive species cover ratio worsen, indicating that native species are outcompeting invasive species at most long-term trend sites.

Native species canopy cover was measured at 5-year and long-term monitoring sites in 2018. This reduces observer bias, as the same observer collected data at all sites. Average native cover at the long-term trend sites monitored in 2018 was 20.5%. At all of the 5-year monitoring sites, average native cover was 9.0%. This indicates that long-term sites trend towards increased native cover. Though 20.5% does not meet success criteria, the trend towards increasing native cover over time indicates that as revegetation sites age, their native cover increases. Unless a site has reached its maximum achievable cover (which may be less than 100% due to rock/cobble and other substrate factors), we can theorize that site native cover will continue to increase.

Biotic crust increased by an average of 5.6% at long-term trend sites. Biotic crust typically takes decades to form and helps retain soil moisture and prevent erosion. Increases of biotic crust cover are a positive indicator of site health at long-term trend sites.

Continued monitoring of long-term trend sites is recommended in order to track and establish patterns of recovery at older revegetation sites. From 2018 long-term trend monitoring, it appears that native species cover at revegetation sites continues to increase past the fifth year of monitoring. At these 10- to 16-year old sites, native species are outcompeting invasive species and biotic crust levels are increasing. These data indicate that sites will likely continue to recover and may reach 25% native cover success criteria after the fifth year of monitoring. For sites that still have relatively low (less than 15%) native cover after 10 years, intervention will likely be the only way to increase native species cover. In order to gain more information about long-term site recovery, continued monitoring of long-term trend sites is recommended.

Table 68. 2018 Long Term Trend Site Monitoring

Site	Year Planted	Ratio Native Species Cover : Invasive Species Cover		Change in Biotic Crust Cover (%)	2018 Native Species Cover (%)	Recommendations
		Initial Monitoring	2018 Monitoring			
100-B/C Area						
116-B/C Misc.	FY 2007	6:7	6:2	+ 13.3	20.6	Site is approaching successful cover. Additional sagebrush plantings recommended.
100-C-9	FY 2007	6:7	6:8	+ 6.5	15.4	Knapweed treatment needed. Additional sagebrush plantings recommended.
118-B-2/3	FY 2007	6:26	6:3	+ 6.6	23.5	Site is approaching successful cover and trending positively. No recommendations.
128-C-1	FY 2006	4:4	4:3	+ 1.1	16.0	Native species are outcompeting invasive weeds. Continued monitoring recommended.
100-K Area						
116-K-1	FY 2006	4:2	4:5	+ 7.5	16.8	Knapweed treatment needed. Additional sagebrush plantings recommended.
116-K-2	FY 2006	5:3	5:2.5	- 1.9	28.4	No recommendations.
100-N Area						
116-N-3	FY 2005	3:2	1:2	+ 5.9	11.6	Continued monitoring recommended. Future intervention may be required.
120-N-1&2	FY 2003	1:2	2:1	+ 5.7	20.3	Additional sagebrush plantings recommended.
100-D Area						
116-D/DR-North	FY 2002	7:3	5:3	+ 7.5	25.1	No recommendations.
100-F Area						
116-F-14	FY 2005	3:4	3:1	+ 7.0	20.6	No recommendations.
300 Area						
618-4	FY 2004	2:3	3:2	- 0.6	33.6	No recommendations.
316-1 / 300 RFBP	FY 2004	2:3	1:2	+ 8.3	14.1	Additional sagebrush plantings recommended.

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APPENDIX A

2018 REVEGETATION MONITORING TAXONOMY LIST

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APPENDIX A
2018 REVEGETATION MONITORING TAXONOMY LIST

2018 Revegetation Monitoring Taxonomy List. (5 Pages)

Current Scientific Name (USDA 2018)	Synonyms (Hitchcock and Cronquist 1973; Sackschewsky and Downs 2001)	Common Name (USDA 2018)	Native or Introduced	Washington State Noxious Weed Class (A, B, or C)
<i>Achillea millefolium</i>		common yarrow	Native	
<i>Achnatherum hymenoides</i>	<i>Oryzopsis hymenoides</i>	Indian ricegrass	Native	
<i>Agoseris sp.</i>		agoseris	Native	
<i>Agropyron cristatum</i>		crested wheatgrass	Introduced	
<i>Aliciella leptomeria</i>	<i>Gilia leptomeria</i>	sand gilia	Native	
<i>Allium ascalonicum</i>		wild onion	Introduced	
<i>Ambrosia acanthicarpa</i>		flatspine bur ragweed	Native	
<i>Amsinckia lycopsoides</i>	<i>Benthamia lycopsoides</i>	tarweed fiddleneck	Native	
<i>Artemisia biennis</i>		biennial wormwood	Native	
<i>Artemisia tridentata</i>		big sagebrush	Native	
<i>Astragalus purshii</i>		woollypod milkvetch	Native	
<i>Astragalus succumbens</i>		Columbia milkvetch	Native	
<i>Balsamorhiza careyana</i>		Carey's balsamroot	Native	
<i>Brassica sp</i>		mustard	Introduced	
<i>Bromus arvensis</i>	<i>Bromus japonicus</i>	field brome	Introduced	
<i>Bromus tectorum</i>		cheatgrass	Introduced	
<i>Calochortus macrocarpus</i>		sagebrush mariposa lily	Native	
<i>Carex sp.</i>		sedge	Native	
<i>Centaurea diffusa</i>		diffuse knapweed	Introduced	B
<i>Chaenactis douglasii</i>		Douglas' dustymaiden	Native	
<i>Chenopodium album</i>		lambsquarters	Native	

2018 Revegetation Monitoring Taxonomy List. (5 Pages)

Current Scientific Name (USDA 2018)	Synonyms (Hitchcock and Cronquist 1973; Sackschewsky and Downs 2001)	Common Name (USDA 2018)	Native or Introduced	Washington State Noxious Weed Class (A, B, or C)
<i>Chenopodium leptophyllum</i>	<i>Chenopodium album</i>	narrowleaf goosefoot	Native	
<i>Chondrilla juncea</i>		rush skeletonweed	Introduced	B
<i>Chorispora tenella</i>		crossflower	Introduced	
<i>Chrysothamnus viscidiflorus</i>		yellow rabbitbrush	Native	
<i>Cirsium arvense</i>		Canada thistle	Introduced	C
<i>Convolvulus arvensis</i>		field bindweed	Introduced	C
<i>Coreopsis sp.</i>		tickseed	Native	
<i>Coreopsis tinctoria</i>	<i>Coreopsis atkinsoniana</i>	golden tickseed	Native	
<i>Cornus sericea</i>	<i>Cornus stolonifera</i>	redosier dogwood	Native	
<i>Cryptantha circumscissa</i>		cushion cryptantha	Native	
<i>Descurcania pinnata</i>		western tansymustard	Native	
<i>Delphinium nuttallianum</i>		upland larkspur	Native	
<i>Draba verna</i>		spring draba	Introduced	
<i>Elymus elymoides</i>	<i>Sitanion hystrix</i>	squirreltail	Native	
<i>Epilobium brachycarpum</i>	<i>Epilobium paniculatum</i>	tall annual willowherb	Native	
<i>Ericameria nauseosa</i>	<i>Chrysothamnus nauseosus</i>	rubber rabbitbrush	Native	
<i>Erigeron pumilus</i>		shaggy fleabane	Native	
<i>Eriogonum niveum</i>		snow buckwheat	Native	
<i>Eriogonum vimineum</i>		wickerstem buckwheat	Native	
<i>Erodium cicutarium</i>		redstem stork's bill	Introduced	
<i>Erysimum asperum</i>	<i>Cheirinia aspera</i>	western wallflower	Native	
<i>Fritillaria pudica</i>		yellowbell	Native	
<i>Galium aparine</i>		stickywilly	Native	

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<i>Grayia spinosa</i>	<i>Atriplex spinosa</i>	spiny hopsage	Native	
<i>Helianthella uniflora</i>		oneflower helianthella	Native	
<i>Hesperostipa comata</i>	<i>Stipa comata</i>	needle and thread grass	Native	
<i>Holodiscus discolor</i>		oceanspray	Native	
<i>Holosteum umbellatum</i>		jagged chickweed	Introduced	
<i>Hordeum leporinum</i>		hare barley	Introduced	
<i>Hypericum perforatum</i>		common St. Johnswort	Introduced	C
<i>Koeleria macrantha</i>		prairie Junegrass	Native	
<i>Lactuca serriola</i>		prickly lettuce	Introduced	
<i>Lamium amplexicaul</i>		henbit deadnettle	Introduced	
<i>Lepidium latifolium</i>	<i>Cardaria latifolia</i>	broadleaved pepperweed	Introduced	B
<i>Lepidium perfoliatum</i>		clasping pepperweed	Introduced	
<i>Leymus cinereus</i>		basin wildrye	Native	
<i>Linum lewisii</i>		prairie flax	Native	
<i>Lomatium grayi</i>		Gray's biscuitroot	Native	
<i>Lomatium sp.</i>		desertparsley	Native	
<i>Lycium barbarum</i>		matrimony vine	Introduced	
<i>Machaeranthera canescens</i>		hoary tansyaster	Native	
<i>Malva neglecta</i>		common mallow	Introduced	
<i>Matricaria recutita</i>		German chamomile	Introduced	
<i>Medicago sativa</i>		alfalfa	Introduced	
<i>Melilotus officinalis</i>	<i>Melilotus alba</i>	swetclover	Introduced	
<i>Mentzelia albicaulis</i>		whitestem blazingstar	Native	

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<i>Microsteris gracilis</i>		slender phlox	Native	
<i>Morus alba</i>		white mulberry	Introduced	
<i>Nicotiana attenuata</i>		coyote tobacco	Native	
<i>Penstemon acuminatus</i>		sharp-leaf penstemon	Native	
<i>Phalaris arundinacea</i>		reed canarygrass	Introduced	C
<i>Phlox longifolia</i>		long-leaf phlox	Native	
<i>Phragmites australis</i>		common reed	Introduced	B
<i>Plantago lanceolata</i>		narrow-leaf plantain	Introduced	
<i>Plantago patagonica</i>		woolly plantain	Native	
<i>Poa bulbosa</i>		bulbous bluegrass	Introduced	
<i>Poa secunda</i>	<i>Poa sandbergii</i>	Sandberg bluegrass	Native	
<i>Polygonum aviculare</i>		prostrate knotweed	Introduced	
<i>Polygonum convolvulus</i>		black bindweed	Introduced	
<i>Polypogon monspeliensis</i>		annual rabbit-foot grass	Introduced	
<i>Populus balsamifera</i>	<i>Populus trichocarpa</i>	black cottonwood	Native	
<i>Prunus virginiana</i>		chokecherry	Native	
<i>Pseudoroegneria spicata</i>	<i>Agropyron spicatum</i>	bluebunch wheatgrass	Native	
<i>Psoraleidium lanceolatum</i>	<i>Psoralea lanceolata</i>	lemon scurfpea	Native	
<i>Purshia tridentata</i>		antelope butterbrush	Native	
<i>Raphanus raphanistrum</i>		wild radish	Introduced	
<i>Ribes aureum</i>		golden currant	Native	
<i>Rosa woodsii</i>		Woods' rose	Native	
<i>Salix amygdaloides</i>		peach-leaf willow	Native	

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<i>Salix exigua</i>		narrowleaf willow	Native	
<i>Salsola kali</i> ^a		Russian thistle	Introduced	
<i>Sanguisorba minor</i>	<i>Poterium sanguisorba</i>	small burnet	Introduced	
<i>Sisymbrium altissimum</i>		tall tumbled mustard	Introduced	
<i>Sphaeralcea munroana</i>		Munro's globemallow	Native	
<i>Sporobolus cryptandrus</i>		sand dropseed	Native	
<i>Tamarix ramosissima</i>		saltcedar	Introduced	B
<i>Tragopogon dubius</i>		yellow salsify	Introduced	
<i>Triticum aestivum</i>		common wheat	Introduced	
<i>Triticum sp.</i>		wheat	Introduced	
<i>Ulmus pumila</i>		Siberian elm	Introduced	
<i>Verbascum thapsus</i>		common mullein	Introduced	
<i>Verbena bracteata</i>		bigbract verbena	Native	
<i>Vicia sp.</i>		vetch	Native	
<i>Vulpia microstachys</i>	<i>Festuca microstachys</i>	desert fescue	Native	

Hitchcock, C. L., and A. Cronquist, 1973, *Flora of the Pacific Northwest*, University of Washington Press, Seattle, Washington.

Sachschesky, M. R., and J. L. Downs, 2001, *Vascular Plants of the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington.

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