INL/EXT-12-27776

Fiscal Year 2012 Revegetation Assessment

November 2012

The INL is a U.S. Department of Energy National Laboratory
operated by Battelle Energy Alliance

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Idaho National Laboratory
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ABSTRACT

This report summarizes the Fiscal Year 2012 Revegetation Assessment by Battelle Energy Alliance, LLC. This assessment was conducted to supplement documentation related to the Storm Water Pollution Prevention Plan for Construction Activities and to ensure that disturbed vegetation and soil at various locations are being restored. This report provides the following information for each site being monitored by the Idaho National Laboratory Environmental Support and Services:

- Summary of each site
- Assessment of vegetation status and site stabilization at each location
- Actions and Resolutions for each site.

Ten disturbed sites were evaluated for this assessment. Six have achieved final stabilization. The remaining four sites not meeting the criteria for final stabilization will be evaluated again in the next fiscal year.

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ACRONYMS

ACOE	Army Corp of Engineers
BEA	Battelle Energy Alliance, LLC
BORAX	Boiling Water Reactor Experiment
CFA	Central Facilities Area
CGP	General Permit for Storm Water Discharge from Construction Activities
DOE-ID	U.S. Department of Energy Idaho Operations Office
EPA	U.S. Environmental Protection Agency
ES&S	Environmental Support and Services
ESRP	Eastern Snake River Plain
ft	feet
FY	Fiscal Year
GI	Geomorphic Investigations
GPS	Global Positioning System
GSS	Gonzales-Stoller Surveillance, LLC
ICM	Interceptor Canal Mound
ICP	Idaho Cleanup Project
INL	Idaho National Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
ISU	Idaho State University
IWP	Industrial Waste Pond
LTS	Long-term Stewardship Site
MFC	Materials and Fuels Complex
NOAA	National Oceanic and Atmospheric Association
NSTR	National Security Test Range
RRTR	Radiological Response Training Range
RWMC	Radioactive Waste Management Complex
SPC	Construction Specification
STD	Standard Deviation
VAM	vesicular-arbuscular mycorrhizae
VSP	Visual Sample Plan 6.0
VZRP	Vadose Zone Research Park

Fiscal Year 2012 Revegetation Assessment

1. Introduction

Revegetation of disturbed sites at the Idaho National Laboratory (INL) is required to comply with some aspects of both federal (7 USC 2814) and state (IDAPA 02.06.22) noxious weed control laws. Revegetation is identified as a method for prevention and/or control of noxious weeds. Executive Order 13112, Invasive Species, also specifies revegetation as a control measure to limit the spread of invasive species. In addition, revegetation may be required by project specific environmental checklists that require projects to complete and verify successful revegetation of disturbed soils.

Battelle Energy Alliance, LLC (BEA) complies with the National Pollutant Discharge Elimination System (40 CFR 122) General Permit for Storm Water Discharges from Construction Activities (CGP) issued by the U.S. Environmental Protection Agency (EPA) in 2012. New projects, disturbing one or more acres of land, require coverage under the 2012 CGP. A Notice of Intent for coverage under the new CGP must be submitted to the EPA at least 14 calendar days prior to earth disturbing activities. The INL Site currently uses the INL Site Storm Water Corridor to determine when a construction activity has the potential to impact "waters of the United States" under the CGP requirements. The INL Storm Water Corridor is defined "as an area that has a reasonable potential to discharge storm water to the Big Lost River."

A letter (Stenzel 2008) was submitted to the U. S. Army Corps of Engineers (ACOE) on May 7, 2008. The letter requested the ACOE to perform a Jurisdictional Determination concerning the applicability of Section 404 of the Clean Water Act and Sections 9 and 10 of the Rivers and Harbors Act of 1899 for the Big Lost River, Little Lost River, and Birch Creek. The ACOE responded with a letter dated May 26, 2009 (Brochu 2009) that stated "Due to the workload and priorities we are unable to complete your request. If you propose a specific project which may affect wetlands, playas, streams, creeks, or other waters such as the Big Lost River, Little Lost River or Birch Creek we shall reinitiate your request." Therefore, until a specific project is initiated and ACOE performs the Jurisdictional Determination or BEA submits another request, BEA will continue to comply with the CGP requirements.

For the 2012 Revegetation Assessment, two sites were located within the INL Storm Water Corridor. These sites are the Geomorphic Investigations for Flood Bounds (GI) and the Vadose Zone Research Park (VZRP). Eight additional sites not in the INL Storm Water Corridor were also evaluated. These included the Boiling Water Reactor Experiment (BORAX)-V, Central Facilities Area (CFA)-04 Pond Remediation, CFA Former Fire Station II, Large-scale Infiltration Basin, Lincoln Boulevard Borrow Source, Materials and Fuels Complex (MFC) Industrial Waste Pond, MFC Vehicle Barrier Project, and National Security Test Range (NSTR) Project.

A digital camera sampling and analysis method was used to assess specific well sites at the VZRP and disturbed areas at the GI located within the INL Storm Water Corridor. It was also used to assess all other sites except the MFC Vehicle Barrier Project, MFC Industrial Waste Pond, and NSTR. This method was used to quantitatively determine when revegetation of a disturbed area is complete. Visual observations will continue to be used on newly disturbed sites or until the sites appear to be reaching the final stabilization requirement.

Anderson and Shumar (1989) recommended using cover of perennial species as the best quantitative measure for evaluating the success of reclamation plantings, although visual observation of the area may suffice for many projects. They recommended using the point interception frame described by Floyd and Anderson (1987). Digital photography has been shown to be as accurate as traditional point-frame sampling if the information is abstracted from the images using techniques comparable to those used in point sampling. Manually specifying either plant cover of species at a few points on the images is

equivalent conceptually to the fixed point-frame sampling recommended by Floyd and Anderson (1987) (Booth et. al., 2006 as cited in Schafer 2009).

1.1 Purpose

The purpose of this report is to comply with Contract Data Requirements List item number F.24 by providing this revegetation assessment to the Department of Energy, Idaho Operations Office (DOE-ID).

1.2 Organization

This report is organized by individual site and provides the following information:

- A historical background summary of each site
- An assessment of background vegetation
- An assessment of the revegetation effort and site stabilization status
- Actions and Resolutions for the site.

2. Background

Revegetation efforts for replanting and rebuilding the soil on disturbed land are an ongoing practice at the INL Site, and an annual report of these activities is submitted in accordance with BEA's contract with the DOE-ID. Revegetation sites being assessed for final stabilization in fiscal year (FY) 2012 are listed in Table 1.

Table 1. Sites included in the 2012 revegetation assessment.

Site Name
BORAX-V
CFA-04 Pond Remediation
CFA former Fire Station II
Geomorphic Investigations for Flood Bounds (located within INL Storm Water Corridor)
Large-scale Infiltration Basin
Lincoln Boulevard Borrow Source
Materials and Fuels Complex Industrial Waste Pond
Materials and Fuels Complex Vehicle Barrier Project
National Security Test Range Project Power Pole 179
Vadose Zone Research Park (located within INL Storm Water Corridor)

For the GI and VZRP projects, the INL used the definition of final stabilization for arid and semi-arid areas provided by the 2003 CGP. Final stabilization was achieved at these two revegetation sites located within the INL Storm Water Corridor based on this definition. The CGP defines final stabilization for arid and semi-arid areas as follows:

In arid and semi-arid areas only, all soil disturbing activities at the site have been completed and both of the following criteria have been met:

a. Temporary erosion control measures (e.g., degradable rolled erosion control product) are selected, designed, and installed along with an appropriate seed base to provide erosion control for at least three years without active maintenance,

b. The temporary erosion control measures are selected, designed, and installed to achieve 70% vegetative cover within three years.

Future projects located within the INL Storm Water Corridor will be evaluated under the 2012 CGP criteria for final stabilization.

Disturbed sites not located within the INL Storm Water Corridor are considered to have reached final stabilization when vegetation within the disturbed area has reached 70% cover of native, perennial background vegetation.

The location of the INL in the Eastern Snake River Plain (ESRP), including altitude, latitude, and intermountain setting, affects the climate of the Site. Air masses crossing the ESRP have first crossed a mountain barrier and precipitated a large percentage of inherent moisture. Therefore, annual rainfall at the INL is light, and the region is classified as arid to semi-arid (Clawson et. al. 1989).

Vegetation at the INL typically consists of a shrub overstory with a perennial grass and forb understory. Wyoming big sagebrush (*Artemisia tridentata* subspecies *wyomingensis*) is the most common shrub. Basin big sagebrush (*Artemisia tridentata* subspecies *tridentata*) is dominant or co-dominant with Wyoming big sagebrush on sites having deep soils or accumulations of sand on the surface. Communities dominated by big sagebrush occupy most of the central portions of the INL and most areas included in this assessment. Green rabbitbrush (*Chrysothamnus viscidiflorus*) is the next most abundant shrub in many of these communities. Other common shrubs include gray rabbitbrush (*Ericameria nauseosus*), winterfat (*Krascheninnikovia lanata*), spiny hopsage (*Grayia spinosa*), prickly phlox (*Leptodactylon pungens*), broom snakeweed (*Gutierrezia sarothrae*), and horse-brush (*Tetradymia canescens*).

The most common native grasses found within sagebrush communities across the INL and in the assessment areas include thickspiked wheatgrass (*Elymus lanceolatus*), bottlebrush squirreltail (*Elymus elymoides*), Indian ricegrass (Achnatherum *hymenoides*), needle-and-thread grass (*Hesperostipa comata*), and Sandberg bluegrass (*Poa secunda*). Great Basin wildrye (*Leymus cinerus*) and western wheatgrass (*Pascopyrum smithii*) can also be found in localized patches. Bluebunch wheatgrass (*Pseudoroegneria spicata*) is rare at the lowest elevations but is common at slightly higher elevations to the southwest and along the eastern side of the INL; it is often the dominant grass on alluvial fans and slopes of the buttes and foothills (Anderson, et. al. 1996).

Cheatgrass (*Bromus tectorum*), an invasive annual species, is also widespread and well established across the INL. Goodrich and Gale (1999) noted that in similar situations, cheatgrass should be recognized as a component of the potential plant community. Gonzales-Stoller Surveillance, LLC (GSS) and Idaho State University (ISU) identified the Bromus tectorum Semi-natural Herbaceous Vegetation and Sisymbrium altissmum-Bromus tectorum Semi-natural Herbaceous Vegetation classes (Shive 2011).

In addition, nearly monotypic stands of crested wheatgrass (*Agropyron cristatum*) can be found in localized areas across the INL, including several of the sites near MFC included in this assessment. Crested wheatgrass remains productive for more than 30 years, and stand mortality is virtually unknown, except in cases of extreme drought during critical phenological stages (Hardy BBT Limited 1989). Anderson and Marlette (1986) point out that crested wheatgrass may inhibit or preclude the re-establishment of native species on disturbed sites and may become the dominant species. GSS reported that in areas with no anthropogenic influence, crested wheatgrass was found to invade sagebrush stands and out-compete the native plant species (Shive 2011). GSS and ISU identified a crested wheat vegetation class at the INL as “Agropyron cristatum (Agropyron desertorum) Semi-natural Herbaceous Vegetation” (Shive 2011).

Big sagebrush is the climax species on most of its range (Eddleman and Doescher 1978, Jensen at. al. 1988). While seedling establishment may begin immediately following a disturbance, it usually takes a decade or more before big sagebrush dominates a site (Welch and Criddle 2003), though some researchers argue 25-45 years is typical (Watts and Wambolt 1996, Wambolt et. al. 2001). Because roots of big sagebrush species, particularly Wyoming big sagebrush, are infected with the vesicular-arbuscular mycorrhizae (VAM) *Glomus microcarpus* and *Gigaspora* spp. (Bethlenfalvay and Dakessian 1984;

Doerr, et. al. 1971; Hurley and Wicklow-Howard 1986) and VAM associated with Wyoming big sagebrush are killed by heating or chemical alteration of the soil, VAM, and thus sagebrush, take several years to recolonize after soil-altering disturbance (Wicklow-Howard 1989).

Absence of VAM probably inhibits Wyoming big sagebrush establishment on disturbed soils. For example, 2.5 years after restoration work, VAM had not yet colonized a coal-mined site in south-central Wyoming even though stockpiled topsoil was replaced. When VAM-infected and noninfected Wyoming big sagebrush seedlings were transplanted on the site, there was no significant difference in growth between the 2 groups: both showed poor establishment. However, in the greenhouse, biomass gain of the infected group was significantly greater (about 1.5 times more, $p=0.05$) compared to the uninfected group. This suggests that on the disturbed site, VAM were unable to survive anywhere but inside Wyoming big sagebrush roots, and establishment of VAM and host Wyoming big sagebrush probably will not occur until the chemistry of lower soil horizons changes with succession (Stahl et. al. 1988).

None of the subspecies of big sagebrush resprout after fire or other disturbance, and prior to re-establishment, big sagebrush communities are mostly populated with associated grasses (Sheehy and Winward 1981). As expected, shrub cover on disturbed sites across the INL is much lower than that found on undisturbed sites, and grasses associated with big sagebrush communities account for most of the perennial vegetation found on disturbed sites included in this assessment.

National Oceanic and Atmospheric Administration (NOAA) Idaho National Laboratory Mesonet data at CFA indicate that precipitation during the fall of 2011 and spring of 2012 was below average. Plant growth was not as vigorous compared to the last several years.

3. Site Revegetation Assessment Summary

The State of Idaho Department of Environmental Quality's "Catalog of Stormwater Best Management Practices for Idaho Cities and Counties" notes that construction activities should maintain and preserve the vegetative canopy. In addition, Minnesota Pollution Control Agency and Environmental Protection Agency Region V developed stormwater guidance for small construction operators to use canopy cover when determining compliance with the 70% final stabilization requirement. Based on this information, canopy cover is used to determine final stabilization of revegetation sites at the INL.

Canopy cover is the area of the ground surface spanned by the canopy of the plant, and is used because it determines the underlying plant community. A high percentage of plant cover generally increases the soil infiltration rate, thereby reducing runoff and soil erosion. Plant cover also reduces wind erosion.

For specific well sites at the VZRP located within the Stormwater Corridor, two trenches at the GI Project, BORAX-V, CFA-04 Pond, CFA Former Fire Station 2, Large Scale Infiltration Basin, and the Lincoln Boulevard Borrow Source, Environmental Support and Services (ES&S) personnel performed digital camera sampling and analysis as described in "Establishing Revegetation Performance Measures at INL" (Schafer 2009) to determine canopy cover on disturbed sites of the assessment area. Invasive and annual species were not included when determining percent cover. Where digital camera sampling was performed, resulting transect quadrate photos were interpreted using the program SamplePoint (discussed in Schafer, 2009), and were categorized as being grass, forb, shrub, cactus, litter, soil, rock, unknown, or annual. Because the 2012 CGP requires the establishment of perennial vegetation, annual species such as cheat grass, desert alyssum (*Alyssum desertorum*), and mustard species were classified in the same category as invasive species and not used to calculate total cover.

For each location, results are summarized as percent by category and percent by category within the background data for each site. In addition to the categories previously listed, the tables include a category for "% Cover" computed as the total cover percent as the sum of the means for the percentages for grass, forb, shrub, and cactus. Invasive and annual species, rock, soil, litter, and unknown species were not considered in the percent cover calculations. These summary tables are included in Appendix A. Appendix C contains Global Positioning System (GPS) coordinates for transect photos. For sites where

digital camera sampling was not conducted, this report relies on visual observations. Visual observations were used to evaluate these sites.

Statistical analysis was performed using SigmaStat 3.0. A Mann-Whitney U- test was used on sample locations that showed a non-parametric distribution. SigmaStat is able to determine whether or not the data is normally distributed, and in cases where the distribution was normal, a paired t-test was performed. The t-test is a type of parametric test. This means that the test itself is based upon certain assumptions about the data. In particular, the values are assumed to approximate a normal distribution, and the standard deviations of both sets of numbers are assumed to be equal.

For many types of data, non-parametric tests are also available. These do not rely upon the data conforming to any particular distribution; that is, they are "robust". The Mann-Whitney U-test is appropriate for comparing two sets of numbers to see whether or not they are different.

Maps of former Long Term Stewardship (LTS) Program sites included in this report were taken from the *Weed Control and Revegetation Report for Fiscal Year 2006* (ICP 2007) to show site locations and areas recommended for weed control and are representative of conditions the last time the sites were assessed in 2006.

4. BORAX-V

During the operational history of INL, numerous revegetation sites have been created and placed into the Long Term Stewardship (LTS) Program as a result of the Idaho Cleanup Project (ICP) activities and other programs . During these activities, the contaminated surface and subsurface soil was removed, and the clean soil that replaced the contaminated soil at many sites was either sterile or otherwise unsuitable for plant growth (e.g., too much gravel, too many rocks, and/or littered with debris).

The BORAX-V site is a former LTS site located in the southwest portion of the INL, north and east of Radioactive Waste Management Complex (RWMC) (Figure 1). The *Weed Control and Revegetation Report for Fiscal Year 2006* (ICP 2007) recommended that this site continue to be monitored and weeds continued to be controlled until the disturbed area meets 70% cover of the background species.

4.1 Site Background Conditions

The most recent assessment of the revegetation site (ICP 2007) noted the following:

> "This site looks better every year. The entire site has numerous forbs (i.e., curlycup gumweed (*Grindelia squarrosa*), globemallow (*Sphaeralcea ambigua*), purple aster (*Symphyotrichum patens*), flax (*Linum perenne*) and desert dusty maiden (*Chaenactis macrantha*)). The entire site has native grasses (i.e., Sandburg's bluegrass and Indian ricegrass). The entire site has some gray rabbitbrush and green rabbitbrush. The west side of the site contains additional native grasses (i.e., ryegrass, bottlebrush squirreltail and several wheatgrasses) as well as cheatgrass and crested wheatgrass. The west side also contains hoary aster (*Dieteria canescens*), yellow sweet clover (*Melilotis indicus*), grey rabbitbrush, green rabbitbrush and abundant kochia (*Kochia scoparia*). Sandberg's bluegrass is also abundant. A few small bare patches have kochia, Russian thistle (*Salsola kali*) and halogeton (*Halogeton glomeratus*). The road and perimeter of the site have several wheatgrasses, globemallow, sagebrush, flax, curlycup gumweed, ryegrass, green rabbitbrush and grey rabbitbrush."

It was further recommended that bare and gravelly areas of the site be reseeded and that monitoring occur until the disturbed area meets 70% cover of the background vegetation.

Background vegetation is composed of sagebrush, rabbitbrush, crested wheatgrass, buckwheat, other wheatgrasses, bottlebrush squirreltail, rye grass, Indian ricegrass, some cheatgrass, and prickly pear cactus (*Opuntia polyacantha*).

4.2 Site Assessment

The site is separated into an eastern and western half by an access road. The road has been barricaded, but it is evident from the state of the road, lack of vegetation, and observable vehicle tracks around the barricade that the road is still used.

A background transect was placed south of the disturbed area on the east side of the old access road. The disturbed area transects were placed on parallel to the road on the western side of the disturbed area and in a diagonal on the east side of the road as shown in Figure 2. Transects were located in an attempt to capture areas bare of vegetation. Table C-1 lists GPS coordinates for plots at this location. Figure B-1 shows a typical background vegetation plot.

Mean perennial cover of the disturbed area at BORAX-V is 105.5% of background (Table A-1). There is no statistically significant difference between total cover on disturbed plots versus background plots ($p=0.563$). Figure B-2 shows a representative plot of the disturbed area.

4.3 Actions and Resolutions

The disturbed area has achieved final stabilization.

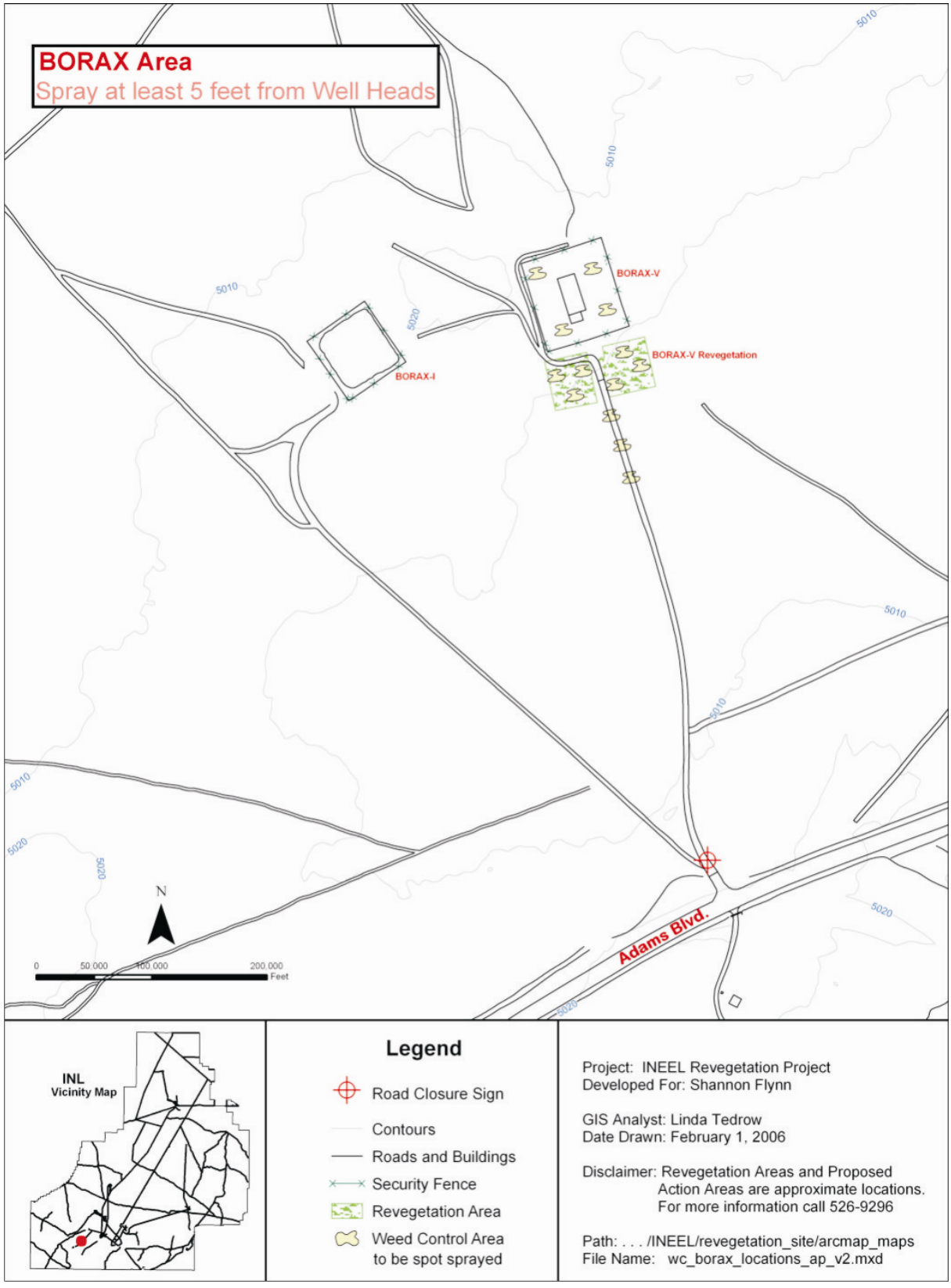

Figure 1. Map of the BORAX-V Revegetation Area.

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Figure 2. BORAX-V Transect Locations.

5. CFA-04 Pond Remediation

The CFA-04 Pond remediation site is also an LTS site. It is located south of CFA and south of building CFA-674 (Figure 3). The *Weed Control and Revegetation Report for Fiscal Year 2006* (ICP January 2007) projected the site to achieve 70% cover within 5 years.

5.1 Site Background Conditions

The 2006 assessment noted the following:

"The site looks worse than last year, especially on the northeast side. The woodchips on the north side are thick. There is a large crop of kochia with some halogeton, purple mustard, and Russian thistle on the north end. There are also some great patches of native thickspike and western wheatgrasses. There are numerous large tumble mustards (*Sisymbrium altissimum*) and cheatgrass is common. The bottom of the pit looks great for grass coverage but it looks somewhat unhealthy. The east entrance road to the site has mostly Russian thistle and kochia with some halogeton, yellow sweetclover, native wheatgrasses and mustards. There are shrubs, both sagebrush and rabbitbrush, on the perimeter. The perimeter on the north side of the site also contains crested wheatgrass. The west side of the site also has Indian ricegrass and other wheatgrasses. The south side of the site has ryegrass."

The 2006 assessment also noted that activities associated with small mammal trappings was having a negative effect on the revegetation effort and it was recommended to discontinue the activity.

Background vegetation is composed of sagebrush, rabbitbrush, crested wheatgrass, buckwheat, other wheatgrasses, squirreltail, rye grass, and Indian ricegrass.

5.2 Site Assessment

Vegetation appears to be uniformly distributed throughout the disturbed area, and large bare patches were not observed. Thickspike and western wheatgrass were the most common native grasses encountered during this assessment. Transects were located as shown in Figure 4. Table C-2 lists GPS coordinates for plots at this location. Figure B-3 shows a typical background vegetation plot.

Mean perennial cover of the disturbed area at the CFA-04 Pond remediation site is 88.2% (Table A-2) of background, and there was no statistically significant difference between mean cover values of the disturbed area and background ($p=0.721$). Figure B-4 shows vegetation typically encountered in the disturbed area.

5.3 Actions and Resolutions

The disturbed area has achieved final stabilization, and it is recommended that it no longer be monitored and included in future assessments.

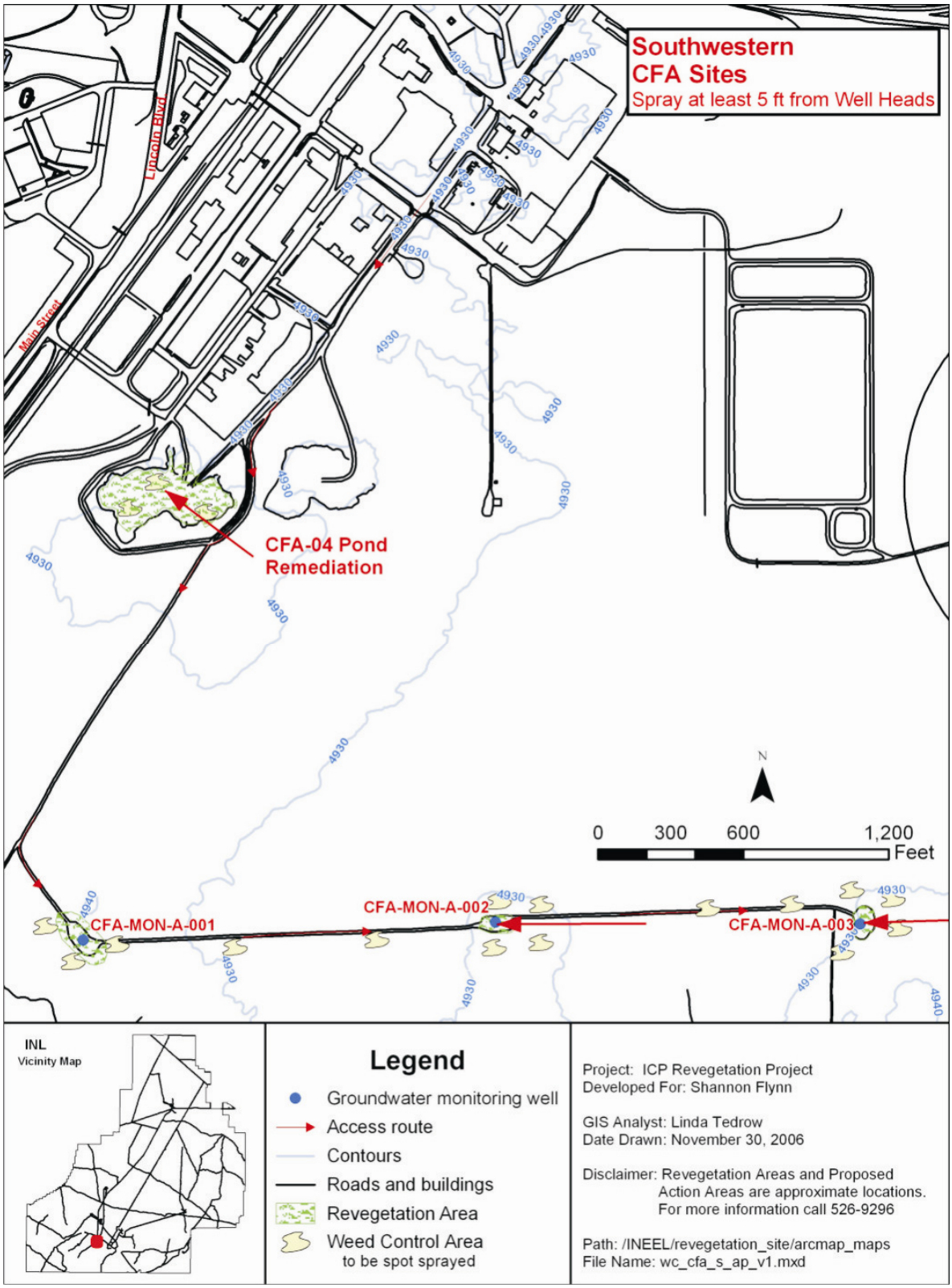

Figure 3. Map of the CFA-04 Pond Remediation Revegetation Area.

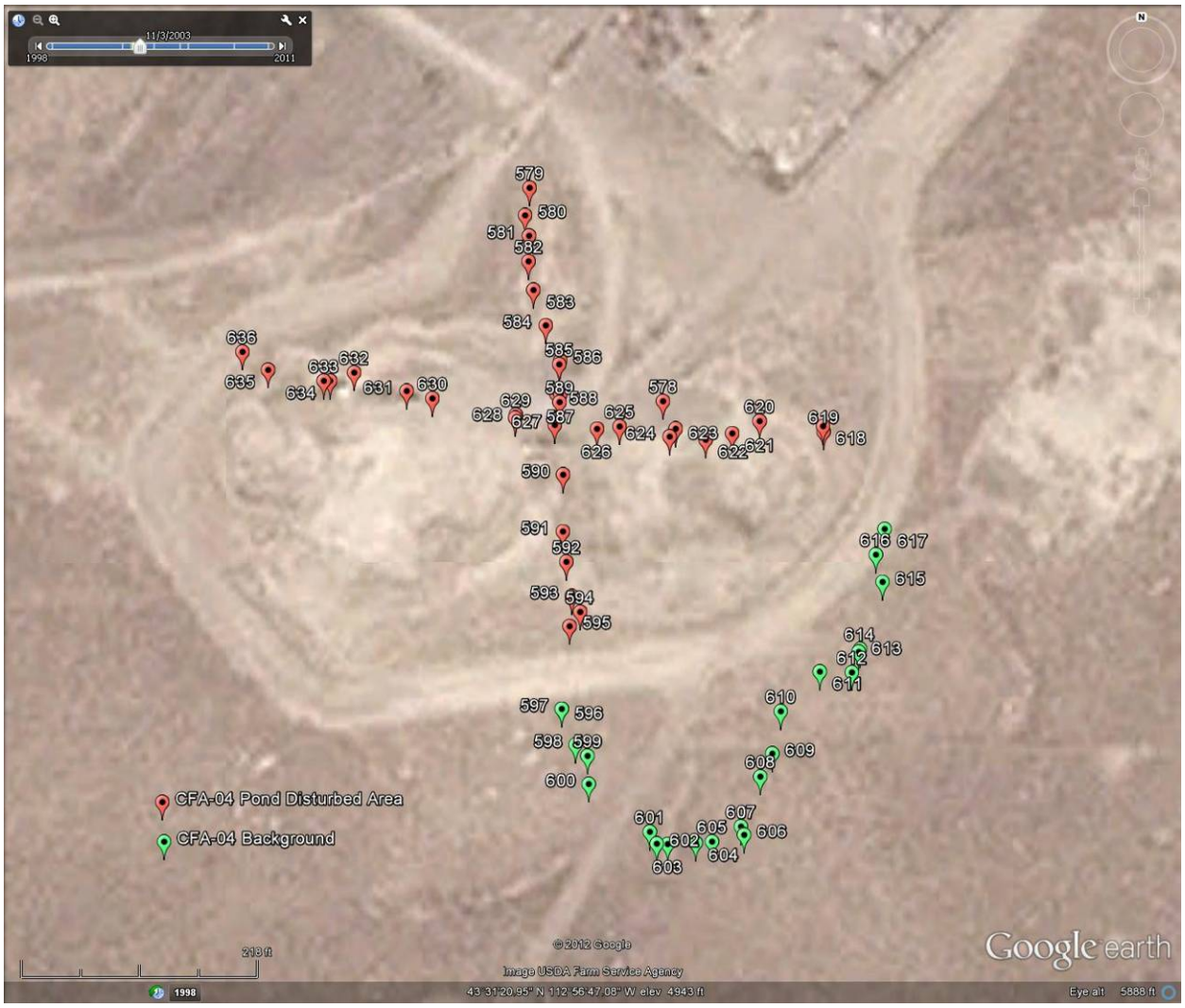

Figure 4. CFA-04 Pond Remediation Transect Locations.

6. CFA Former Fire Station 2

The CFA Former Fire Station 2 is also an LTS site located along Lincoln Boulevard, just south of mile marker 5, approximately 4 miles north of CFA (Figure 5). On November 16, 2005, bare areas, approximately 50 ft long by 20 ft wide (five drill lines each) on the south and east sides of the site were reseeded. Green rabbitbrush is the predominate shrub in the disturbed area. The disturbed area is surrounded by a crested wheatgrass monoculture, and crested wheatgrass is the most common grass in the disturbed area.

6.1 Site Background Conditions

The 2006 assessment stated that crested wheatgrass was the dominant species, and noted the western half of the site had been mowed. Field bindweed (*Convolvus arvensis*) and hoary cress (*Cardaria draba*) were noxious weeds found on the site. Desert alyssum, Russian thistle, and halogeton were common.

In 2012, green rabbitbrush was the predominate shrub in the disturbed area. The disturbed area is surrounded by a crested wheatgrass monoculture, and crested wheatgrass is the most common grass in the disturbed area. No mowing had occurred at the time of this assessment. Minor amounts of desert alyssum (*Alyssum desertorum*) and halogeton were noted. Background vegetation is composed mainly of crested wheatgrass.

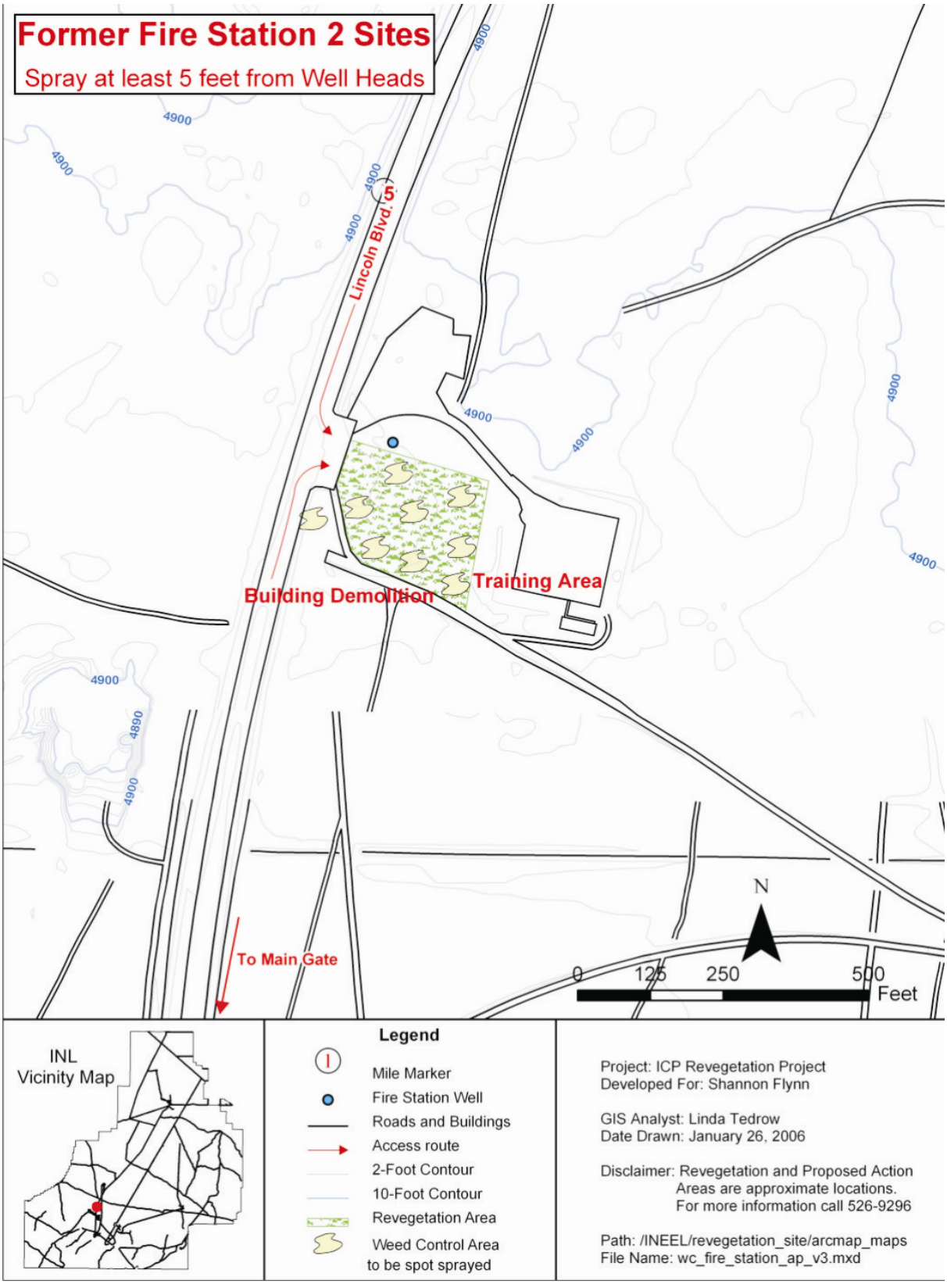

Figure 5. Map of the CFA Former Fire Station 2 Revegetation Site.

6.2 Site Assessment

Vegetation appears to be uniformly distributed throughout the disturbed area, but a small bare area is present near the center of the site. Wood chips in this area are fairly thick. The assessment of the disturbed area was limited to the area with wood chips since distinguishing the rest of the disturbed area from the background vegetation was difficult. The area assessed appears to be the area reseeded in 2005. Transects were located as shown in Figure 6. One transect was placed running east to west through the center of the disturbed site and another running north to south. Table C-3 lists GPS coordinates for plots at this location. Figure B-5 shows a typical background vegetation plot. A Background transect was placed south of the site as shown in Figure 7.

Mean perennial cover of the disturbed area at the CFA Former Fire Station 2 site is 80.0% (Table A-3) of background, and there was no statistically significant difference between mean cover values of the disturbed area and background (p=0.543). Figure B-6 shows vegetation typically encountered in the disturbed area.

Figure 6. CFA Former Fire Station 2 Disturbed Area Transects.

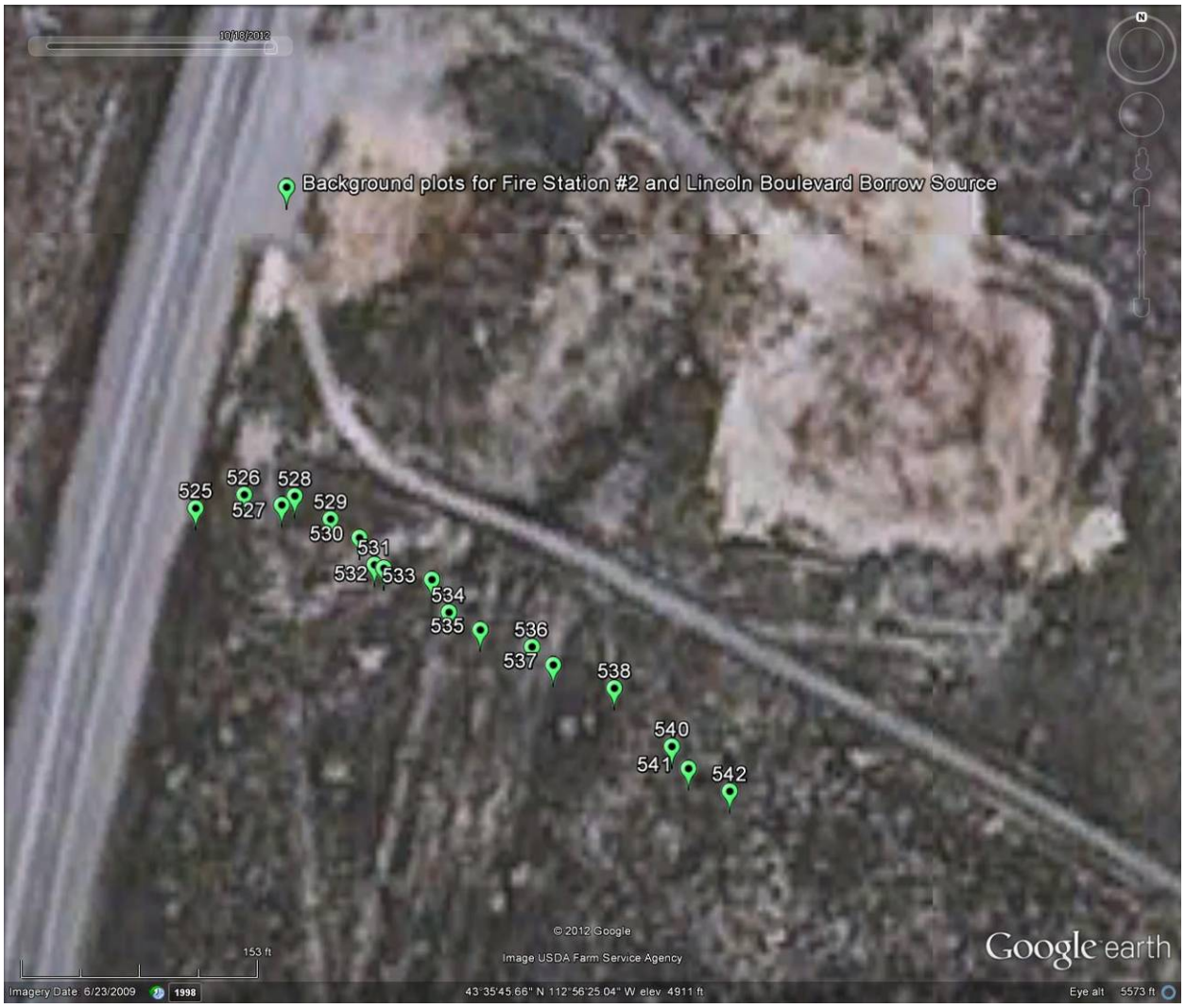

Figure 7. CFA Former Fire Station 2 Background Transect.

6.3 Actions and Resolutions

The disturbed area has achieved final stabilization and will no longer be included in future assessments.

7. Geomorphic Investigations for Flood Bounds

During the Geomorphic Investigations (GI) Project, eight trenches near the Big Lost River on the INL Site were excavated for the purpose of collecting soil and geomorphic and stratigraphic data of the Holocene and Pleistocene deposits for evaluating historical river and flood information (Figure 8). The project began in May 2002 and continued through October 2002. The trenches ranged from 60 to 900 feet in length.

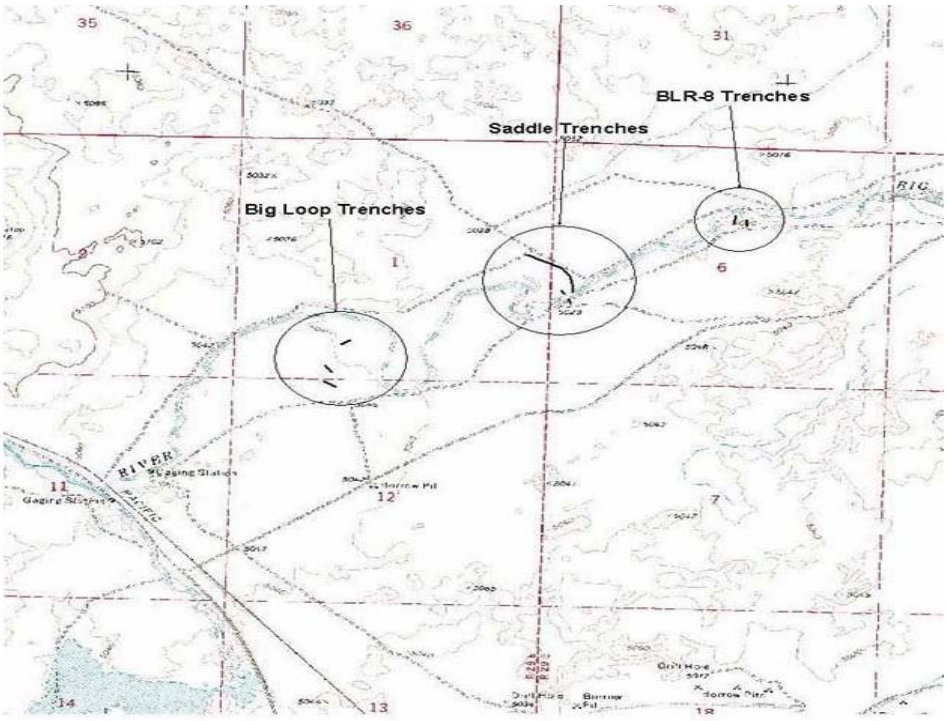

Figure 8. Map of the Geomorphic Investigations Project

The S. M. Stoller Corporation backfilled, contoured, seeded, and installed new silt fencing in September 2007. The seed mix included Wyoming big sagebrush, thickspiked wheatgrass, Indian ricegrass, needle and thread grass, and bottlebrush squirreltail. Approximately 1,000 Wyoming big sagebrush seedlings were also planted. Electric fences were placed around the trenches located on the west side of the Big Lost River, however, these fences were removed in 2009.

In 2009, the erosion fences (silt fences) installed at the ends of the BLR-8 and Saddle Trenches were removed and replaced with straw wattles. The straw wattles appear to be more durable than the silt fences while serving the same purpose. In addition, it was determined that silt fences were no longer required for the Big Loop Trenches because of the distance from the Big lost River and the level topography where the trenches are located.

7.1 Site Background Conditions

The GI Project is located within a sagebrush steppe community. Wyoming big sagebrush is dominant on undisturbed sites in this area, although other species of big sagebrush are co-dominant. Bottlebrush squirreltail is the dominant grass. Other plant species observed throughout the background include: tapertip hawksbeard (*Crepis acuminata*), cushion buckwheat (*Eriogonum ovalifolium)*, shaggy fleabane (*Erigeron pumilus)*, bluebunch wheatgrass, green rabbitbrush, and Hood's phlox (*Phlox hoodii*).

Only the Big Loop Trenches are located within the undisturbed sagebrush steppe community. Both the BLR-8 and Saddle Trenches are located within the Tin Cup Fire scar (Forman 2010).

Cheatgrass is present in the vegetation communities that surround all of the trenches.

In 2011, digital camera sampling was conducted on the BLR-8 trenches, and it was noted that final stabilization had been achieved. In 2012, visual assessments were conducted on the long Saddle Trench and the middle and northeast Big Loop Trenches. Cheat grass and other annuals were prevalent and the areas did appear to meet the 70% criteria for final stabilization. Digital Camera sampling was performed on the southwest Big Loop and the north and south Saddle Trenches.

7.2 Site Assessment

The S.M. Stoller Corporation previously monitored the GI Project revegetation progress (Forman 2010). Gonzales-Stoller Surveillance, LLC (GSS) replaced the S.M. Stoller Corporation. Correspondence from GSS personnel indicated they would no longer be monitoring or performing any revegetation activities at the GI Project (Forman 2011).

For this assessment, digital camera sampling was performed on the remaining trenches that had not achieved final stabilization, e.g. the southwest Big Loop trench and the north and South Saddle trenches.

7.2.1 Saddle Trenches

Perennial grasses observed within the disturbed area include bottlebrush squirreltail, needle and thread grass, Indian ricegrass, and western wheatgrass. Wyoming big sagebrush and green rabbitbrush plants were also present.

Disturbed area transects were located as shown in Figure 9, and GPS locations are included in Table C-4. Disturbed area transects were run down the middle of the trenches parallel to the long axis. Figure 10 shows the location of the background transect for trenches associated with the GI project. Table C-6 contains GPS locations for the background vegetation.

Figure 9. North and South Saddle Trenches Disturbed Area Transects.

Figure 10. Geomorphic Investigations for Flood Bounds Background Area Transect.

Cheatgrass is prevalent in both trenches. In the north trench, needle and thread grass, bottlebrush squirreltail, and Indian ricegrass plants were observed. Other species identified were Wyoming big sagebrush, green rabbitbrush, orange globemallow (*Sphaeralcea munroana*), and western tansymustard (*Descurainia pinnata*), though mustard species were rare compared to previous years. Cover in disturbed area of the north trench has reached 40.5% of background (Table A-4) and there was no statistically significant difference between cover values for the disturbed area versus background (p=0.366).

Perennial grasses in the South trench included western wheatgrass, needle and thread grass, bottlebrush squirreltail, and Indian ricegrass. Orange globemallow and silvery lupine (*Lupinus argenteus*) were also observed. Cover in the disturbed area is 54.3% of background (Table A-5) and there was a statistically significant difference in total mean cover between background and the disturbed area (p=0.020).

Figure B-7 is a plot representative of background vegetation for the trenches associated with the Geomorphic Investigations for Flood Bounds . Figures B-8 and B-9 represent plots typically found on the north and south Saddle trenches respectively.

7.2.2 Southwest Big Loop Trench

Perennial grasses observed within the disturbed area of the southwest Big Loop Trench included: bottlebrush squirreltail, needle and thread grass, Sandberg bluegrass , and thickspiked wheatgrass. Sandberg bluegrass appeared to be the most common perennial grass observed. Wyoming big sagebrush plants and silvery lupine were also observed.

The southwest Big Loop Trench is dominated by cheatgrass. Forbs observed included: silvery lupine and shaggy fleabane. Perennial grasses included bottlebrush squirreltail, Sandberg bluegrass, and thickspiked wheatgrass. Wyoming big sagebrush plants were also found on this site.

The background transect for this location is the same as that used for the Saddle Trenches as shown in Figure 10. Disturbed area transects were placed as shown in Figure 11, and GPS locations are included in table C-5.

Figure 11. Southwest Big Loop Trench Disturbed Area Transect.

Cover in the disturbed area is 13.1% of background (Table A-6) and there was a statistically significant difference for cover in the disturbed plots versus background (p= <0.001) which is likely due to the high amount of cheatgrass in the disturbed area (annual species in the disturbed area are 939.9% of background levels).

Figure B-10 is representative of plots found on the southwest Big Loop trench.

7.3 Actions and Resolutions

In 2012, Russian thistle was not observed at the GI Project. Western tansymustard and Jim Hill tumble mustard populations were light. Wyoming big sagebrush and green rabbit brush, where it occurred, showed good growth. Cheatgrass was present at all of the trenches and was the dominant grass species at all but the BLR-8 trenches.

A 20-year study in southern Idaho showed succession on former big sagebrush steppe was initially dominated by Russian-thistle, Jim Hill tumble mustard, and western tansymustard. An increase in cheatgrass and bottlebrush squirreltail followed; after that, there was a temporary increase in mustards and a decrease in Russian-thistle. The community eventually stabilized as a cheatgrass-bottlebrush squirreltail cover type (Hironaka and Tisdale 1963). Brandt and Rickard (1994) reported similar results, where tumble mustard codominated recently disturbed sites along with Russian-thistle, prickly-lettuce (*Lactuca serriola*), and bur ragweed (*Ambrosia acanthicarpa*). Cheatgrass dominated slightly older seres.

Some of these communities dominated by annuals may be stable (Hironaka and Tisdale 1963). Cline and Rickard (1973) state that on the Atomic Energy Commission's Hanford Reservation in Washington, some areas have supported cheatgrass-tumble mustard-tansymustard communities for 30 or more years.

The concept of potential natural communities based only on native species is seriously challenged by cheatgrass. Where cheatgrass is highly adapted, it might have to be recognized as a component of the potential plant community (Goodrich and Gale 1999). In these situations, cheatgrass may remain the de facto climax dominant, regardless of site potential.

Cheatgrass maintains its dominance on many sites by adaptations that facilitate early and rapid growth, including a type of carbohydrate metabolism that permits growth at relatively low temperatures (Chatterton 1994). Because cheatgrass can commence growth and deplete soil moisture before native plants break dormancy, it gains a competitive advantage in cold, semiarid environments (Harris 1967). This is evidenced by greater physiological stress and reduced total root length measured in perennial shrubs and grasses growing with cheatgrass than in plants growing without cheatgrass as a neighbor (Melgoza and Nowack 1991, Melgoza et. al. 1990, Walker and Smith 1197). Cheatgrass also has greater top-growth yields per unit water used compared to summer-growing perennial grasses. This high water-use efficiency is partly due to early season growth, when transpiration rates are low (Hironaka 1961, Hulbert 1955).

When there is a lack of native annual grasses, cheatgrass fills that niche, and has truncated succession on many sites (Daubenmire 1970, Franklin and Dyrness 1973). Results presented by Young and Evans (1973) suggest that as long as there is a seed source and a suitable seedbed, cheatgrass will dominate on big sagebrush sites after removal of shrub overstory. They did not encounter an assemblage of native annual plants that was capable of preventing cheatgrass dominance on big sagebrush sites.

Because cheatgrass is very persistent once it becomes established, eradication of large infestations is not usually a reasonable goal. The extent to which cheatgrass dominates a plant community greatly determines the appropriate suppression strategy (McIver and Starr 2001, Mosely et.al. 1999), and cheatgrass response to management options is very site specific (Harris and Goebel 1976, Young and Allen 1997). Effective control of cheatgrass requires 1) eliminating live plants, 2) preventing seed formation, and 3) controlling seed germination and emerging seedlings (Monsen 1994). In plant communities where cheatgrass is present but herbaceous perennials remain abundant, cheatgrass control measures should include the needs of the perennial plants. Control without replacement by desirable perennials will likely result in the reestablishment of cheatgrass or some other undesirable species (Mosely et. al. 1999).

It is inappropriate to manage cheatgrass ranges as if they were perennial grass-dominated ranges (Young 1991). Large areas that are mostly devoid of perennials and have fire-free intervals of 5 or fewer years have probably crossed a threshold, and the cheatgrass community probably represents a relatively stable "steady state" (Laycock 1991, Mosely et. al. 1999), such as exists on many depleted sites within Wyoming big sagebrush habitat types of the Snake River Plain and other portions of the Columbia River Basin (Mosely et. al. 1999). Some authors suggest that it may be best to reclassify these communities as annual grasslands, and manage them accordingly (Vallentine and Stevens 1994, Young et. al. 1987).

The Trenches were evaluated in accordance with the 2003 CGP criteria that states:

> The In arid and semi-arid areas only, all soil disturbing activities at the site have been completed and both of the following criteria have been met:
>
> A. a. Temporary erosion control measures (e.g., degradable rolled erosion control product) were selected, designed, and installed along with an appropriate seed base to provide erosion control for at least three years without active maintenance,
>
> b. The temporary erosion control measures were selected, designed, and installed to achieve 70% vegetative coverage within three years.

It was determined the above criteria was satisfied since an appropriate seed mix was selected and used and appropriate erosion controls were selected, designed and installed to provide erosion control for at least 3 years without active maintenance. The temporary erosion control measures were selected, designed, and installed to achieve 70% vegetative coverage within 3 years.

A vegetative cover greater than 70% (including annual and perennial species) was achieved on all of the Trenches,

The intent of the 2003 CGP was to reduce erosion and sedimentation. Although several Trenches have significant annual species (cheatgrass), the sites are considered stable and to have met the intent of the CGP.

A Notice of Termination from the CGP requirements was submitted by BEA (Stenzel 2012) and the Department of Energy Idaho Operations (Perkins 2012) to the EPA on June 19, 2012. The Department of Energy Idaho Operations Office received a letter (EPA 2012) from the EPA dated July 16, 2012 stating that the coverage was terminated as of midnight July 16, 2012. Battelle Energy Alliance, LLC has not yet received a letter. However, the EPA's NOI Processing Center has indicated to BEA personnel, that the request was received and would be processed as soon as their system was operational.

However, while the disturbed locations at the GI Project have met the CGP requirements, they have not achieved the 70% cover of native perennial background final stabilization criteria used across the INL. Because succession in areas invaded by cheatgrass is slow, and at this time it is not practical or economical to disturb soil and revegetate the area again, it is recommended that the disturbed areas of the GI Project be visually evaluated every three to five years until they appear to be reaching the criteria for final stabilization. BEA should continue to explore and evaluate technologies and relevant scientific information regarding the eradication of cheatgrass that may assist these areas in achieving 70% cover of native perennial background vegetation.

8. Large Scale Infiltration Basin

The Large Scale Infiltration Basin is also an LTS site located about 0.9 miles south of the RWMC (Figure 12). The *Weed Control and Revegetation Report for Fiscal Year 2006* (ICP January 2007) recommended that the site be monitored until the disturbed area meets 70% cover of background. The

site is now part of the Radiological Response Training Range (RRTR). Vehicle traffic is allowed on the disturbed area as part of training exercises, and vehicle tracks were observed within the basin.

8.1 Site Background Conditions

The Large Scale Infiltration Basin is located within a sagebrush steppe community. Wyoming big sagebrush is dominant on undisturbed sites in this area, although other species of big sagebrush also occur. Plant species observed throughout the background include: tapertip hawksbeard, cushion buckwheat, bluebunch wheatgrass, Indian ricegrass, needle and thread grass, bottlebrush squirrel tail, green rabbitbrush, and Hood's phlox.

Native species appear to be establishing well at the Large Scale Infiltration Basin. Squirreltail is evident with occasional sagebrush and some of both grey and green rabbitbrush all the way around the rim. There is also some crested wheatgrass and cheatgrass as well as native wheatgrasses and Indian ricegrass. The perimeter and interior has mostly sagebrush, crested wheatgrass, mixed wheatgrasses, bottlebrush squirreltail, foxtail barley (*Hordeum jubatum*), and both grey and green rabbitbrush with some cheatgrass. Annual and nonnative species within the disturbed area include halogeton, desert alyssum, and cheatgrass.

The 2006 assessment recommended the Large Scale Infiltration Basin continue to be monitored until it reaches the 70% criteria for final stabilization.

8.2 Site Assessment

Vegetation appears to be uniformly distributed throughout the disturbed area. However, a few small bare areas do exist. Transects were located as shown in Figure 13. Table C-7 lists GPS coordinates for plots at this location. Figure B-11 shows a typical background vegetation plot.

Mean perennial cover of the disturbed area at the Large Scale Infiltration Basin site is 62.1% (Table A-7) of background, and there is a statistically significant difference between mean cover values of the disturbed area compared to background ($p=0.015$), and this is likely due to background vegetation containing more shrub cover. Figure B-12 shows vegetation typically encountered in the disturbed area.

8.3 Actions and Resolutions

The disturbed area at the Large Scale Infiltration Basin is close to meeting 70% percent cover of background vegetation. Reaching the final stabilization criteria at the site may be hampered by vehicle traffic associated with RRTR activities. It is recommended that the site continue to be visually evaluated in the yearly revegetation assessment to determine if activities associated with the RRTR are impacting revegetation efforts, and that digital camera sampling be conducted if it appears that RRTR activities are not impeding growth of vegetation and when the area appears to reach the 70% criteria for final stabilization.

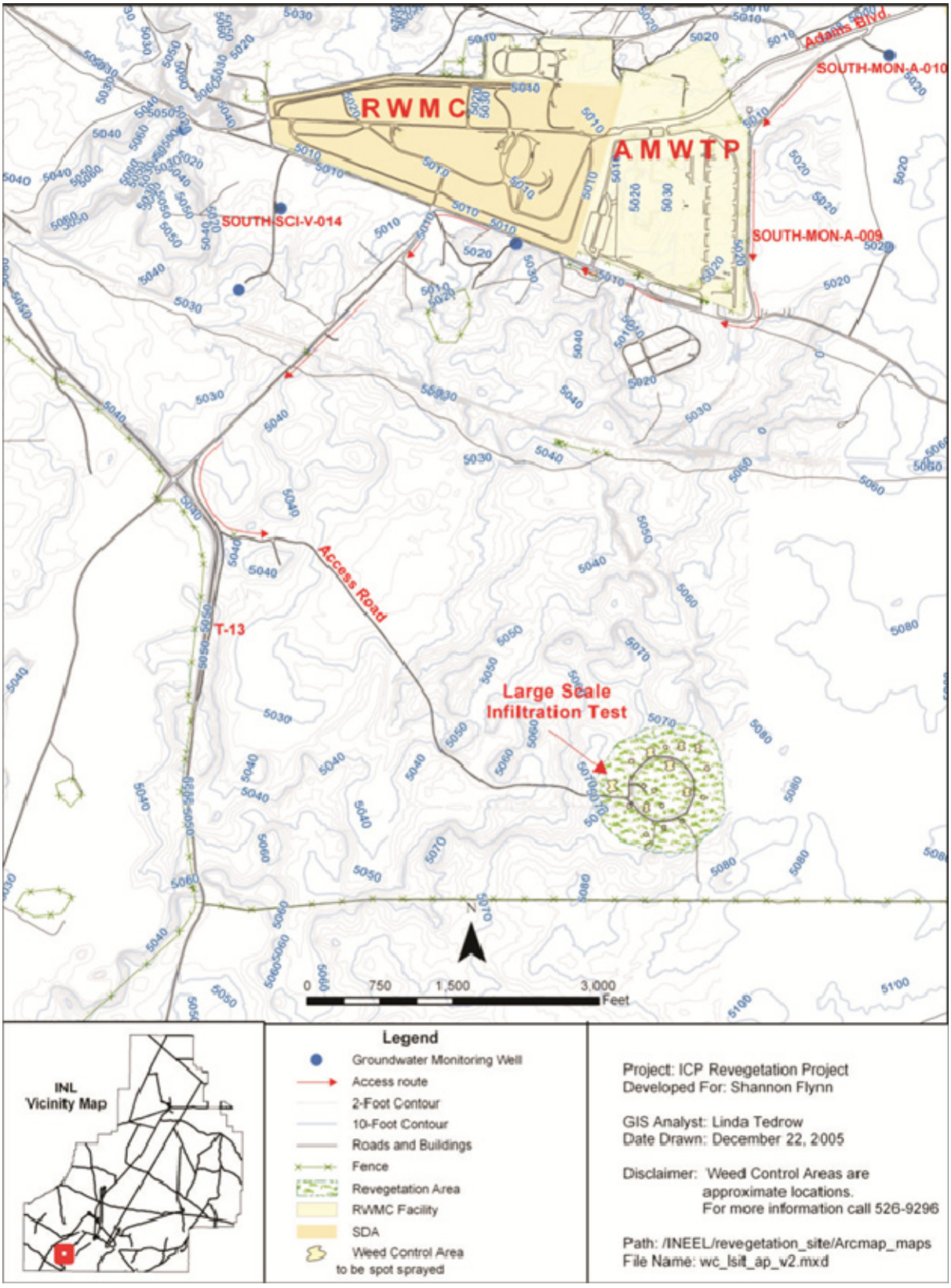

Figure 12. Map of the Large Scale Infiltration Basin.

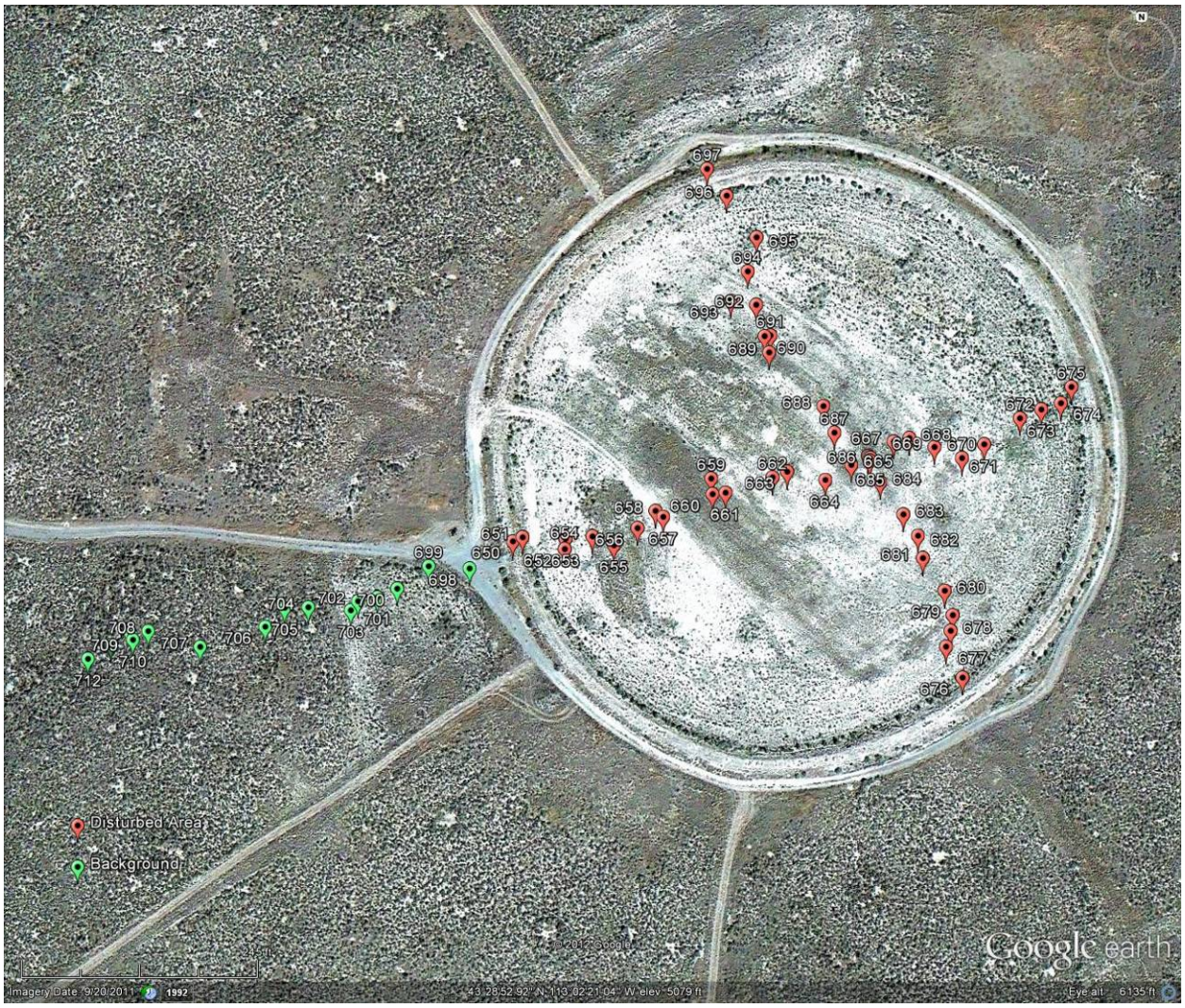

Figure 13. Large Scale Infiltration Basin Transects.

9. Lincoln Boulevard Borrow Source

The Lincoln Boulevard Borrow Source is another LTS site located west of Lincoln Boulevard, about 10 miles northeast of CFA and about 1 mile south of Mile Marker 11 on Lincoln Boulevard (Figure 14).

9.1 Site Background Conditions

The 2006 assessment noted the following:

> "North side—Great grass (i.e., wheatgrasses and Indian ricegrass) establishment; all large bunches with ample seed production. Native annuals (i.e., white-stem blazing star (*Mentzelia albicaulis*), mustards, western stickseed (*Lappula occidentalis*) and desert alyssum) were evident. Some large bare areas are also present. Cheatgrass, halogeton, Russian thistle, and kochia are all common with two huge strips of Russian thistle, especially on the north end. On the west edge, 2 wash-outs are present: the first is much larger than last year. The second wash-out is north of the first wash-out. So much soil material is being lost to the old gravel pit from the second wash-out that the hole should be filled. Some native forb growth including globemallow and desert dusty maiden is evident. No shrubs are present. There is still evidence of vehicle traffic but vegetation is growing in the ruts. Pronghorn sign is scattered throughout the site. The perimeter has sagebrush, crested wheatgrass, other wheatgrasses, Indian ricegrass and globemallow."

Wash-outs and vehicle traffic were not noted in the 2012 assessment of the site. Vehicle traffic in 2012 appeared to be limited to the two-track road that splits the site and provides access to the gravel pit. Crested wheatgrass is the dominant species at the site. Other species noted within the disturbed area include rabbitbrush, Indian rice grass, sagebrush, and wheatgrasses. Cheatgrass, halogeton, and kochia were noted in small amounts, mostly along the road splitting the north and south sides of the disturbed area. Native forbs observed include globemallow and desert dusty maiden. Very few shrubs are present. The area appears to be trending toward a crested wheatgrass monoculture.

9.2 Site Assessment

Vegetation appears to be uniformly distributed throughout the disturbed area. Transects were located as show in Figure 14. It was difficult to distinguish boundaries of the disturbed area, so transects did not span the entire disturbed area. Plots were located in areas with the least amount of cover, and actual cover may be higher than what is reported in this assessment. Table C-8 lists GPS coordinates for disturbed area plots at this location. Figure B-13 shows a typical background plot. Because the disturbed site is located in close proximity and in the same type of vegetation, the background transect for the CFA Former Fire Station 2 site was used for background at this location as shown in Figure 7.

Mean perennial cover of the disturbed area at the Lincoln Boulevard Borrow Source site is 86.3% (Table A-8) of background, and there was no statistically significant difference between mean cover values of the disturbed area and background ($p=0.203$). Figure B-14 shows vegetation typically encountered in the disturbed area.

9.1 Actions and Resolutions

The disturbed area has achieved final stabilization, and it is recommended that it no longer be monitored and included in future assessments.

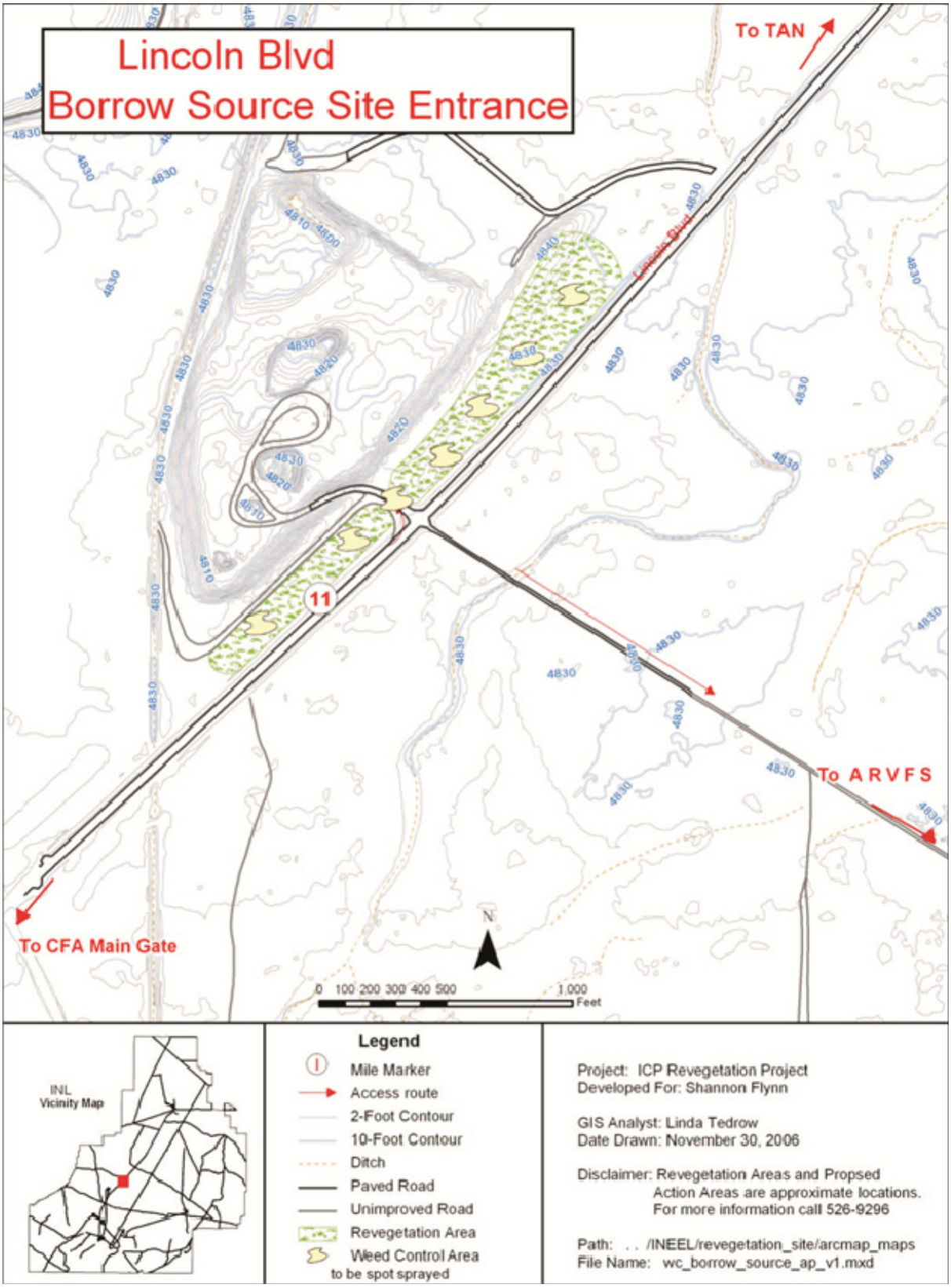

Figure 14. Map of the Lincoln Boulevard Borrow Source.

Figure 15. Lincoln Boulevard Borrow Source Transects

10. Materials and Fuels Complex Industrial Waste Pond

Contaminated soil was excavated from the MFC Industrial Waste Pond (IWP) and the area was recontoured prior to being reseeded in 2004 with the same native seed mixture used at the Interceptor Canal Mound.

10.1 Site Background Conditions

Previous evaluations were performed in 2005 and 2006 (INL 2007). Seven locations within the revegetated area around the IWP were surveyed in 2006. Weedy plant species dominated areas both inside and outside the recontoured/reseeded area. The 2006 evaluation indicated the contaminated topsoil was removed and not replaced. Furthermore, the soil around the MFC IWP was extremely compacted.

10.2 Site Assessment

As in 2011, the southern end of the MFC IWP has a good perennial vegetative cover. Species present include Wyoming big sagebrush, green rabbitbrush, crested wheat grass, and globemallow. Several young sagebrush plants were observed. This small area may be close to reaching the 70% criteria.

Canada thistle is present in the area surrounding the MFC IWP and ranges from sparse to thick depending on the location. Cheatgrass is present towards the southern end and becomes very thick at the northern end of the MFC IWP. Crested wheatgrass appears to be increasing throughout the area based on the number of young plants observed. This is expected since crested wheatgrass is prevalent in the area surrounding the MFC complex. Kochia was present, especially in the bare areas. Russian knapweed (*Rhaponticum repens*) is present along the eastern side of the IWP, though it appeared to be less prevalent than in 2011.

10.3 Actions and Resolutions

Crested wheatgrass and Wyoming big sagebrush appear to be increasing in certain areas of the revegetation site. A visual evaluation was performed in 2012, and site conditions are similar to what was encountered in 2011.

It is recommended that the site continue to be monitored for weeds and that visual observations continue until the entire site appears to reach final stabilization, at which time the digital camera sampling method will be used to confirm the site has reached 70% of background cover.

11. Materials and Fuels Complex Vehicle Barrier Project

The MFC Vehicle Barrier project included installation of vehicle gate barriers, Delta vehicle crash barriers, and precast concrete vehicle barriers. The precast concrete vehicle barriers were placed around the south and approximately half way up the east side of the MFC facility. An area approximately 10 ft wide was disturbed. The barriers were placed in the middle of the disturbed areas.

Seeding was performed in accordance with Construction Specification SPC-1000, Section 32 9219. Table 2 shows the seed mixture that was specified in SPC-1000; the same seed mixture recommended for MFC Equipment Enclosure and Search Station project. A seed drill was used to plant the seeds, and wood chips were added once the seeding was completed. The work was performed during the week of October 12, 2008.

Table 2. Equipment Vehicle Barrier project seed mixture.

Species	Rate of Application (pounds per acre pure live seed)
Indian Rice Grass “Rimrock”	2
Thickspiked wheatgrass “Bannock”	2
Bottlebrush Squirreltail	2
Green Rabbitbrush	1
Silverleaf Lupine	1

11.1 Site Background Conditions

The MFC Vehicle Barrier Project is located within an area consisting almost entirely of crested wheatgrass, with thickspiked wheatgrass present in very small amounts. It is expected that the disturbed areas of the MFC Vehicle Barrier Project will eventually revert back to a crested wheatgrass monoculture.

11.2 Site Assessment

A visual vegetation assessment was performed in 2012. Based on the visual observation, a determination was made not to use the digital camera sampling and analysis method.

As in previous years, crested wheatgrass is the most prevalent grass in both the background and the disturbed areas. Cheat grass is present in most areas and abundant in some. Bottlebrush squirreltail was more common along the barrier on the east side of MFC. It was abundant in some locations and sparse in

others. In 2012, areas on the road side of the concrete barriers and within the barriers near the NOAA tower had been mowed.

The east barrier may be nearing the 70% criteria. On the east side of the east barrier, there is considerably more cheatgrass and kochia. Bottlebrush squirreltail was relatively abundant along the east barrier. Canada thistle was observed within the disturbed area of the east barrier site.

The northeast portion of the barrier is expected to meet the 70% criteria (Figure 6). This area is dominated by crested wheatgrass with bottlebrush squirreltail and a few Wyoming big sagebrush plants intermixed.

Cheatgrass appears to be the most dominant grass species along the south barrier (Figure 7). Kochia, tanseymustard, and Canada thistle were also present in this area. This portion of the barrier project is not expected to meet the 70% criteria at this time.

The west side barrier appears to meet the 70% criteria. Vegetation along this portion of the barrier consists primarily of crested wheatgrass. A few small bare areas exist.

A soil pile was located on the south side of the road that runs east and west along the southern barriers. In late October 2010, the soil pile was removed to grade. In the 2010 Annual Revegetation Assessment, it was suggested that the area be revegetated using an appropriate seed mix, and hydroseeding of the area was performed in 2012.

11.3 Actions and Resolutions

Because the area surrounding the project is dominated by crested wheatgrass, it is expected that crested wheatgrass will eventually become the dominant species on the disturbed sites. Visual evaluations should continue to be performed and weeds monitored. On subsequent visits to the site, it was noted that thistle had been sprayed, and this should continue as long as infestations are observed.

Mowing of areas will likely continue as part of INL fuel management in accordance with the environmental assessment for Wildland Fire Management (DOE/EA-1732). For these areas, vegetation should be considered complete until mowing no longer occurs.

A visual evaluation should be performed again in 2013 to determine whether digital camera sampling and analysis should be performed on the area within the barriers. Crested wheatgrass will be used to determine final stabilization.

The reseeded soil pile should be monitored for weeds and weed control performed as necessary. Visual observations of the area will continue until revegetation establishment approaches 70%, at which time digital camera sampling will be performed to verify final stabilization.

12. National Security Test Range Project

On September 9, 2008, a survey of sites disturbed by the NSTR project along the T-25 road was performed by NSTR personnel and the S. M. Stoller Corporation (Saupe 2009). The survey identified seven locations that required seeding (Table 3).

Table 4 shows the seed mix recommended by the S. M. Stoller Corporation for reseeding the seven disturbed sites. Disturbed sites were seeded late fall 2008.

Table 3. Table showing T-25 road sites where seeding was recommended.

Location	Comments
Wide spot north of power pole 138	A large mud rick has been bladed at an angle and should be revegetated.
Across from power pole 146	There is an area that appears to have been backed into during construction. This area

	needs to be seeded.
North of power pole 170	Disturbed during construction, reseed.
Power pole 176	Truck turn around area. Revegetate on the west side of the pole.
Power pole 179	Disturbed during construction, reseed.
North of power pole 181	Disturbed during construction, reseed.
Turn-off on east end of range access road	Reseed south half.

Table 4. Recommended seed mixture for T-25 road disturbed sites.

Species	Rate of Application (pounds per acre pure live seed)
Indian Rice Grass "Rimrock"	2
Thickspiked wheatgrass "Bannock"	2
Bottlebrush Squirreltail	2
Green Rabbitbrush	1

12.1 Site Background Conditions

The NSTR Project is located within a sagebrush steppe community. Wyoming big sagebrush is dominant on undisturbed sites in this area, although other species of big sagebrush are co-dominant. Needle and Thread grass and Indian ricegrass are the dominant grasses. Other plant species observed throughout the background include: tapertip hawksbeard, cushion buckwheat, shaggy fleabane, green rabbitbrush, and Hood's phlox.

All sites along the T-25 road associated with the NSTR project achieved final stabilization prior to the 2012 revegetation assessment except the area near power pole 179. In 2011, mean perennial cover at the location was 33.9% of background.

12.2 Site Assessment

12.2.1 North of Power pole 179

A visual assessment of the site was conducted in 2012. Tumble mustard and skeleton weed were not as prevalent as in 2011. However, heavy gravel at the southern end of the disturbed area is still impeding regrowth of the vegetation and the area appears to be receiving some vehicle traffic. Native grasses in the disturbed area include needle and thread grass, Indian rice grass, and thickspiked wheat grass. Green rabbitbrush is also re-establishing. Site conditions appear similar to 2011.

12.3 Actions and Resolutions

It is recommended that the disturbed area north of power pole 179 continue to be monitored for progress towards meeting the 70% criteria for final stabilization.

13. Vadose Zone Research Park

The Vadose Zone Research Park (VZRP) is a field-scale research facility designed to investigate the behavior of water and solute movement through the vadose zone. The site is located northwest of Central Facilities Area along the Big Lost River and adjacent to the new Idaho Nuclear Technology and Engineering Center (INTEC) Percolation Ponds. An important feature of this research facility is that it established a natural baseline for subsurface conditions prior to the inception of the new INTEC Percolation Ponds. The site consists of several two-track roads, numerous well locations, and a vehicle crossing across the Big Lost River (Figure 12).

13.1 Site Background Conditions

The VZRP is located within a large area previously burned by wildfire. Background vegetation was assumed to be represented by the reestablished burn area. Perennial vegetation observed within the background transects included sagebrush, rabbitbrush, shaggy fleabane, lupine, Indian rice grass, needle and thread grass, bottlebrush squirreltail, crested wheatgrass, and thickspiked wheatgrass. Western tansymustard, and Jim Hill tumblemustard were annual species present. Cheat grass is prevalent throughout the background. Hoary aster is prevalent along roadsides, disturbed areas, and limited in background areas.

13.2 Site Assessment

Previous assessments of the VZRP determined that all disturbed locations had met final stabilization requirements except wells 201A, 202A, 203, 204, and 209.

The 2011 annual report stated that wells 202A, 203, and 204 would be visually evaluated to determine if digital camera is warranted. A visual observation was performed, and it was obvious that these well sites would not meet the 70% of background criteria. The heavy cheatgrass infestation is making it impossible for establishment of native perennial vegetation. Jim Hill tumblemustard was also present at this location. A few native grasses were observed. These included bottlebrush squirreltail and Sandberg bluegrass. In addition, rabbitbrush and shaggy fleabane were also noted.

Digital camera sampling was conducted on wells 201A and 209. Cover of background vegetation was measured by combining all background transects from the 2011 assessment as shown in Figure 17. Figure B-15 shows a vegetation plot typical of the background area.

13.2.1 Well 201A

This well is located on the southeast side of the new INTEC Percolation Ponds. Vegetation in the disturbed area includes shaggy fleabane, phlox, bottlebrush squirrel tail, green rabbitbrush, and cushion buckwheat. Cheat grass, desert alyssum, and Jim Hill tumblemustard are also present. Transects were located as shown in Figure 18. Plot coordinates are listed in tables C-9. Figure B-16 shows a typical disturbed area plot for well 201A.

Native perennial vegetation in the disturbed area around well 201A is 78.5% of background (Table A-9), and there is not a statistically significant difference between the background and disturbed vegetation (p=0.0.075). The site has achieved final stabilization.

13.2.2 Well 209

The well is located on the southwest side of the new INTEC Percolation Ponds. The south, east, and west sides of the disturbed site are primarily covered with cheatgrass and Jim hill tumblemustard. The north side has quite a few Sandberg bluegrass plants mixed with a few bottlebrush squirreltail and green rabbitbrush plants. The surrounding area contains significant amounts of cheatgrass. Transects were located as shown in Figure 19. Plot coordinates are listed in tables C-9. Figure B-17 shows a typical disturbed area plot for well 201A.

Native perennial vegetation in the disturbed area around well 209 is 49.8% of background (Table A-10), and there is a statistically significant difference between mean cover for the background and disturbed vegetation (p=0.001). The site has not achieved final stabilization.

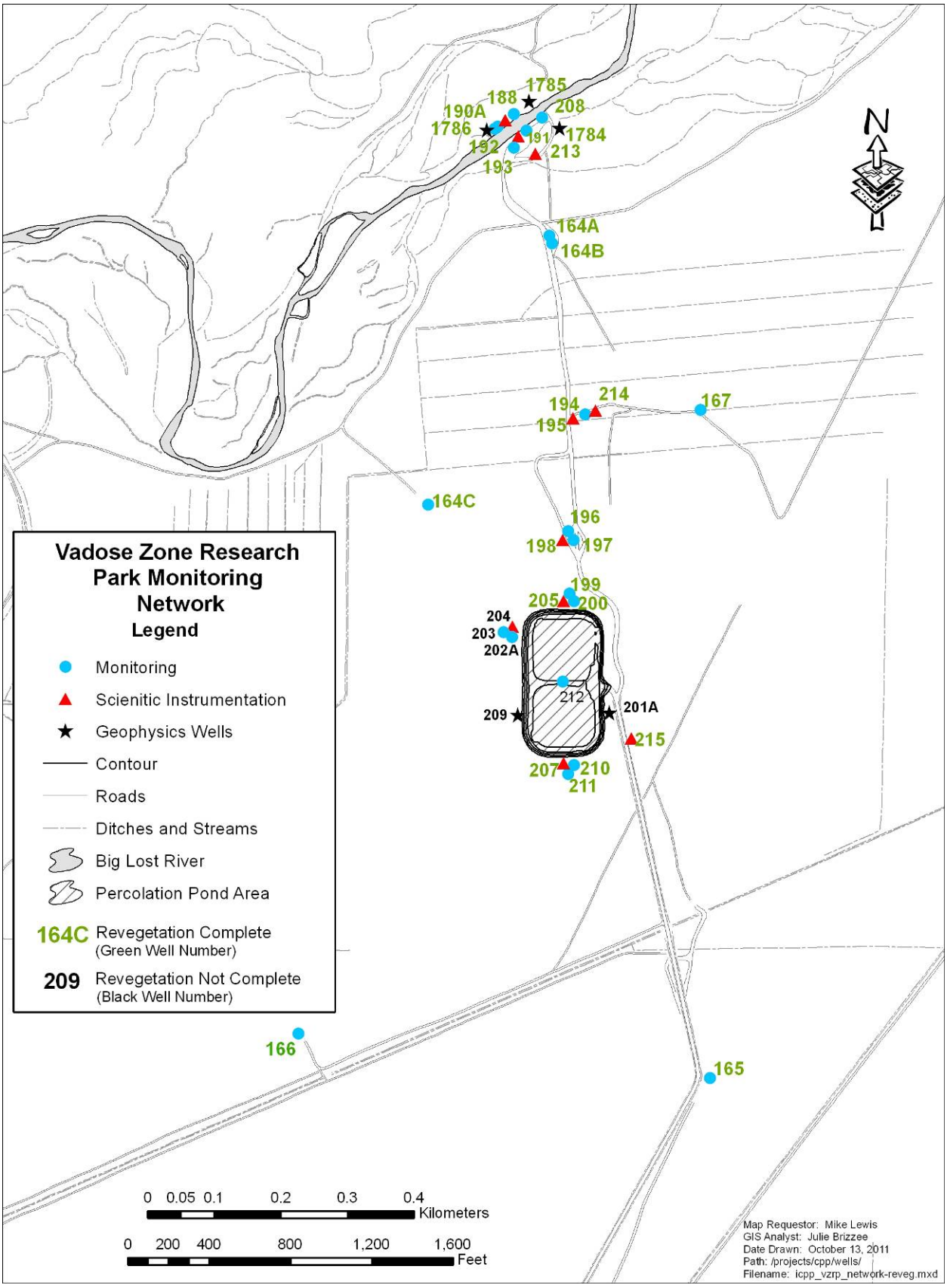

Figure 16. Map of the Vadose Zone Research Park.

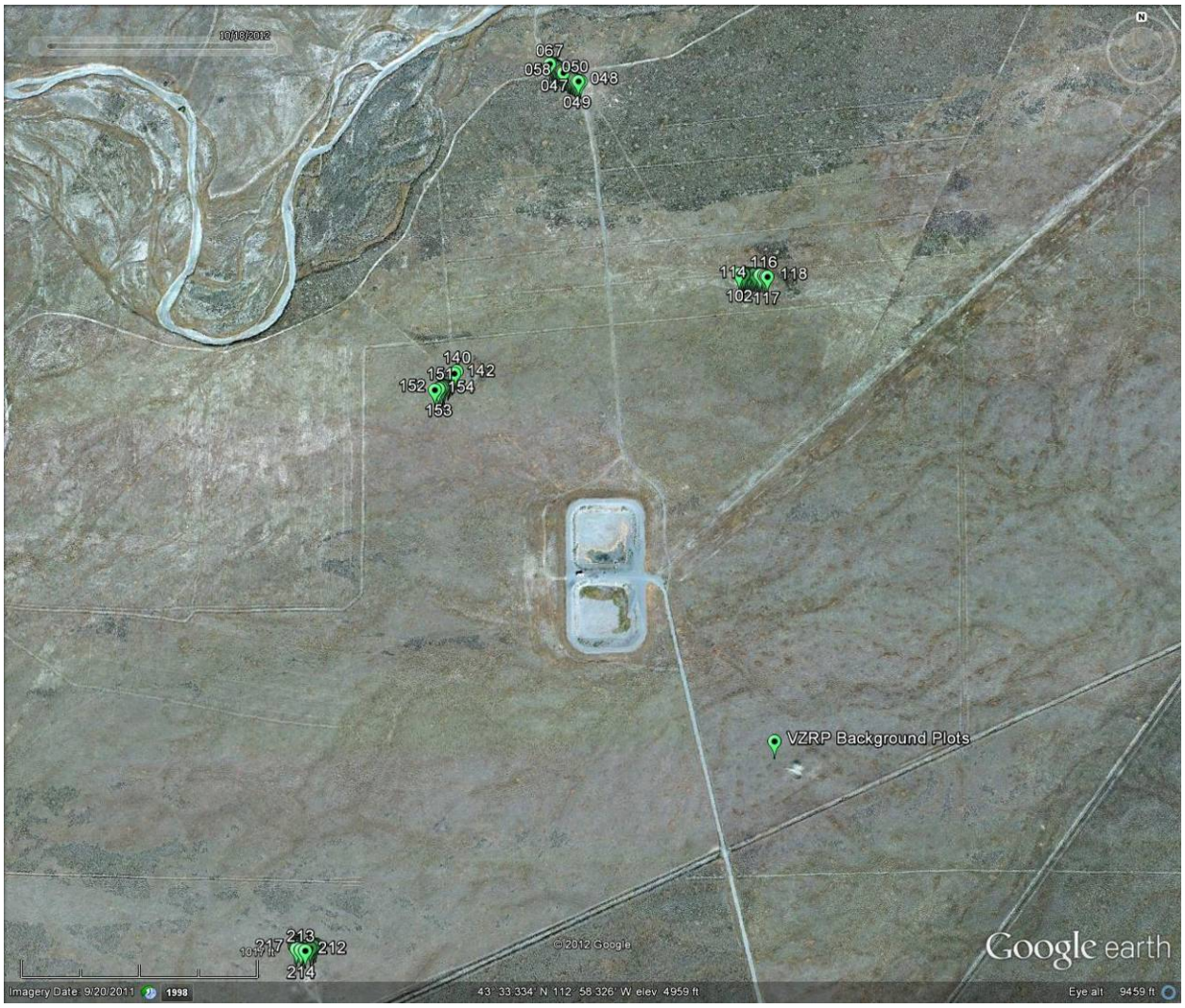

Figure 17. VZRP Background Transect Locations.

13.3 Actions and Resolutions

The disturbed areas surrounding well 201A has achieved final stabilization.

Wells 202A, 203, 204, and 209 still exhibit a high concentration of annual species such as tansymustard and cheatgrass. These wells are all located adjacent to the berm of the new INTEC Percolation Ponds. It does not appear that weed control has been conducted on the graveled berm. Cheatgrass on the berm provides a constant seed source to the disturbed areas of the wells adjacent to it. Even if intensive restoration of the disturbed areas around those wells were to take place, it is likely that cheatgrass would continue to invade.

As with the trenches for the GI Project, disturbed sites at the VZRP were revegetated to the requirements for "final stabilization" found in Appendix A (definition section) of the 2003 CGP. This definition and the requirements are discussed in section 7.3 of this report.

Figure 18. VZRP Well 201A Disturbed Area Transect Locations.

Figure 19. VZRP Well 209 Disturbed Area Transect Locations.

The criteria was satisfied at the VZRP since the perennial seed mix and erosion controls were selected, designed and installed to provide erosion control for at least 3 years without active maintenance, and the temporary erosion control measures were selected, designed, and installed to achieve 70% vegetative coverage within 3 years.

However, while the disturbed locations at the VZRP have met the CGP requirements, they have not achieved the 70% cover of native perennial background final stabilization criteria used across the INL. Because succession in areas invaded by cheatgrass is slow, and at this time it is not practical or economical to disturb soil and revegetate the area again, it is recommended that the disturbed areas of the VZRP be visually evaluated every three to five years until they appear to be reaching the criteria for final stabilization. BEA should continue to explore and evaluate technologies and relevant scientific information regarding the eradication of cheatgrass that may assist these areas in achieving 70% cover of native perennial background vegetation.

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Appendix A
Assessment Summary Tables

Table A-1. Comparison of BORAX-V revegetation to background vegetation.

Category	% in Background	% in Disturbed Area	Disturbed Percentage of Background
Cover% (STD)	34.4 (20.4)	36.3(16.2)	105.5
Grass% (STD)	12.6 (15.3)	21.0(15.8)	166.7
Forb% (STD)	0.00 (0.00)	0.35(1.00)	NA
Shrub% (STD)	21.8(18.8)	10.9(18.8)	50.0
Cactus%(STD)	0.00 (0.00)	0.00 (0.00)	NA
Litter% (STD)	24.5(11.0)	24.3(8.45)	99.2
Soil% (STD)	38.3(17.4)	28.8(13.4)	75.2
Rock% (STD)	2.2(3.30)	9.7(11.1)	440.9
Unknown% (STD)	0.67(0.82)	0.71(0.81)	106.0
Annual% (STD)	0.00(0.00)	0.29(1.24)	NA
# of Quadrates Used for Background: 12 # of Total Sample Points Used for Background: 768 # of Quadrates Used for Disturbed Area: 27 # of Total Sample Points Used for Disturbed Area: 1728			

Table A-2. Comparison of CFA-04 Pond Remediation revegetation to background vegetation.

Category	% in Background	% in Disturbed Area	Disturbed Percentage of Background
Cover% (STD)	26.2 (17.5)	23.1(16.95)	88.2
Grass% (STD)	2.51(6.07)	19.1(12.4)	761.0
Forb% (STD)	0.00(0.00)	0.35(1.00)	NA
Shrub% (STD)	23.7(19.1)	3.61(16.00)	152.3
Cactus%(STD)	0.00 (0.00)	0.04 (0.27)	NA
Litter% (STD)	24.5(11.6)	46. 1(21.3)	188.2
Soil% (STD)	48.1(15.1)	22.8(19.7)	47.4
Rock% (STD)	0.413 (0.85)	3.26(3.02)	789.3
Unknown% (STD)	0.9(0.932)	0.84(0.81)	93.3
Annual% (STD)	0.00(0.00)	4.82(13.14)	NA
# of Quadrates Used for Background: 23 # of Total Sample Points Used for Background: 1472 # of Quadrates Used for Disturbed Area: 36 # of Total Sample Points Used for Disturbed Area: 2304			

Table A-3. Comparison of CFA Former Fire Station II revegetation to background vegetation.

Category	% in Background	% in Disturbed Area	Disturbed Percentage of Background
Cover% (STD)	41.6 (12.04)	33.3(27.56)	80.0
Grass% (STD)	37.8(16.53)	33.1(27.26)	87.6
Forb% (STD)	0.00 (0.00)	0.00(0.00)	NA
Shrub% (STD)	3.78(9.92)	0.26(0.89)	6.89
Cactus%(STD)	0.00 (0.00)	0.00(0.00)	NA
Litter% (STD)	39.0(8.52)	53.3(30.63)	136.7
Soil% (STD)	15.7(11.37)	5.3(5.13)	33.8
Rock% (STD)	2.88(4.66)	6.4(14.49)	222.2
Unknown% (STD)	0.84(0.82)	1.71(1.03)	203.6
Annual% (STD)	0.00(0.00)	0.00(0.00)	NA
# of Quadrates Used for Background: 19 # of Total Sample Points Used for Background: 1216 # of Quadrates Used for Disturbed Area: 12 # of Total Sample Points Used for Disturbed Area: 768			

Table A-4. Comparison of revegetation of Geomorphic Investigations for Flood Bounds North Saddle Trench to background vegetation.

Category	% in Background	% in Disturbed Area	Disturbed Percentage of Background
Cover% (STD)	34.8(16.5)	14.1(10.88)	40.5
Grass% (STD)	22.0(11.82)	11.2(10.02)	50.9
Forb% (STD)	0.27(0.62)	0.67(1.23)	248.1
Shrub% (STD)	12.5(19.35)	2.23(5.90)	178.4
Cactus%(STD)	0.00(0.00)	0.00(0.00)	NA
Litter% (STD)	43.1(13.77)	52.7(23.3)	122.2
Soil% (STD)	18.2(12.03)	19.2(19.71)	105.5
Rock% (STD)	0.00(0.00)	4.49(7.14)	NA
Unknown% (STD)	2.09(1.67)	1.36(2.31)	65.1
Annual% (STD)	1.83(2.28)	8.26(12.35)	451.4
# of Quadrates Used for Background: 12 # of Total Sample Points Used for Background: 768 # of Quadrates Used for Disturbed Area: 7 # of Total Sample Points Used for Disturbed Area: 448			

Table A-5. Comparison of revegetation of Geomorphic Investigations for Flood Bounds South Saddle Trench to background vegetation.

Category	% in Background	% in Disturbed Area	Disturbed Percentage of Background
Cover% (STD)	34.8(16.5)	18.9(9.85)	54.3
Grass% (STD)	22.0(11.82)	17.7(11.08)	80.5
Forb% (STD)	0.27(0.62)	0.87(1.77)	322.2
Shrub% (STD)	12.5(19.35)	0.34(1.03)	2.72
Cactus%(STD)	0.00(0.00)	0.00(0.00)	NA
Litter% (STD)	43.1(13.77)	59.7(13.70)	138.5
Soil% (STD)	18.2(12.03)	3.14(4.57)	172.5
Rock% (STD)	0.00(0.00)	0.52(1.57)	NA
Unknown% (STD)	2.09(1.67)	0.53(0..8)	253.6
Annual% (STD)	1.83(2.28)	17.2(10.04)	939.9
# of Quadrates Used for Background: 12 # of Total Sample Points Used for Background: 768 # of Quadrates Used for Disturbed Area: 9 # of Total Sample Points Used for Disturbed Area: 576			

Table A-6. Comparison of revegetation of Geomorphic Investigations for Flood Bounds Southwest Big Loop Trench to background vegetation.

Category	% in Background	% in Disturbed Area	Disturbed Percentage of Background
Cover% (STD)	34.8(16.5)	4.57(3.37)	13.1
Grass% (STD)	22.0(11.82)	2.71(3.07)	12.3
Forb% (STD)	0.27(0.62)	0.72(1.26)	266.7
Shrub% (STD)	12.5(19.35)	1.14(2.78)	9.1
Cactus%(STD)	0.00(0.00)	0.00(0.00)	NA
Litter% (STD)	43.1(13.77)	68.3(9.90)	158.5
Soil% (STD)	18.2(12.03)	2.99(4.09)	16.4
Rock% (STD)	0.00(0.00)	1.71(2.81)	NA
Unknown% (STD)	2.09(1.67)	1.00(1.23)	47.8
Annual% (STD)	1.83(2.28)	21.5(9.38)	1174.9
# of Quadrates Used for Background: 12 # of Total Sample Points Used for Background: 768 # of Quadrates Used for Disturbed Area: 22 # of Total Sample Points Used for Disturbed Area: 1408			

Table A-7. Comparison of revegetation of Large Scale Infiltration Basin to background vegetation.

Category	% in Background	% in Disturbed Area	Disturbed Percentage of Background
Cover% (STD)	36.9(19.88)	22.9(16.20)	62.1
Grass% (STD)	10.9(11.03)	20.1(13.63)	184.4
Forb% (STD)	0.00(0.00)	0.03(0.23)	NA
Shrub% (STD)	25.9(23.15)	2.77(11.89)	106.9
Cactus%(STD)	0.00(0.00)	0.00(0.00)	NA
Litter% (STD)	26.1(12.09)	17.8(8.73)	68.2
Soil% (STD)	31.4(16.87)	56.7(18.58)	180.6
Rock% (STD)	4.27(3.80)	1.70(2.56)	39.8
Unknown% (STD)	1.37(1.43)	0.87(0.81)	63.5
Annual% (STD)	0.00(0.00)	0.07(0.32)	NA
# of Quadrates Used for Background: 15 # of Total Sample Points Used for Background: 960 # of Quadrates Used for Disturbed Area: 49 # of Total Sample Points Used for Disturbed Area: 3136			

Table A-8. Comparison of revegetation of Lincoln Blvd Borrow Source to background vegetation.

Category	% in Background	% in Disturbed Area	Disturbed Percentage of Background
Cover% (STD)	41.6(12.04)	35.88(17.80)	86.3
Grass% (STD)	37.8(16.53)	34.6(18.08)	91.5
Forb% (STD)	0.00(0.00)	0.68(2.20)	NA
Shrub% (STD)	3.78(9.92)	0.55(2.47)	14.6
Cactus%(STD)	0.00(0.00)	0.03(0.24)	NA
Litter% (STD)	39.0(8.52)	33.9(11.96)	86.9
Soil% (STD)	15.7(11.37)	25.5(14.84)	162.4
Rock% (STD)	2.88(4.66)	1.98(3.37)	68.8
Unknown% (STD)	0.84(0.82)	0.80(0.87)	95.2
Annual% (STD)	0.00(0.00)	2.04(6.05)	NA
# of Quadrates Used for Background: 19 # of Total Sample Points Used for Background:1216 # of Quadrates Used for Disturbed Area: 36 # of Total Sample Points Used for Disturbed Area:2304			

Table A-9. Comparison of VZRP well 201A to background vegetation

Category	% in Background	% in Disturbed Area	Disturbed Percentage of Background
Cover% (STD)	21.9(12.51)	17.2(12.65)	78.5
Grass% (STD)	14.0(11.85)	13.3(7.76)	95.0
Forb% (STD)	4.0(4.84)	0.57(0.80)	14.3
Shrub% (STD)	3.88(10.84)	3.35(12.53)	86.3
Cactus%(STD)	0.00(0.00)	0.00(0.00)	NA
Litter% (STD)	37.1(12.56)	54.5(11.68)	146.9
Soil% (STD)	17.2(8.95)	7.04(4.66)	40.9
Rock% (STD)	12.0(11.45)	6.82(5.18)	56.8
Unknown% (STD)	1.43(1.24)	1.47(0.96)	102.8
Annual% (STD)	10.4(15.32)	13.1(8.93)	123.0
# of Quadrates Used for Background: 83 # of Total Sample Points Used for Background: 5312 # of Quadrates Used for Disturbed Area: 14 # of Total Sample Points Used for Disturbed Area:896			

Table A-10. Comparison of VZRP well 209 to background.

Category	% in Background	% in Disturbed Area	Disturbed Percentage of Background
Cover% (STD)	21.9(12.51)	10.9(14.94)	49.8
Grass% (STD)	14.0(11.85)	9.29(14.82)	66.4
Forb% (STD)	4.0(4.84)	0.25(0.50)	6.25
Shrub% (STD)	3.88(10.84)	0.74(2.56)	19.1
Cactus%(STD)	0.00(0.00)	0.57(2.50)	NA
Litter% (STD)	37.1(12.56)	54.0(18.88)	145.6
Soil% (STD)	17.2(8.95)	5.85(9.27)	34.0
Rock% (STD)	12.0(11.45)	4.60(8.77)	38.3
Unknown% (STD)	1.43(1.24)	1.42(0.24)	99.3
Annual% (STD)	10.4(15.32)	23.3(16.37)	224.0
# of Quadrates Used for Background: 83 # of Total Sample Points Used for Background: 5312 # of Quadrates Used for Disturbed Area: 19 # of Total Sample Points Used for Disturbed Area: 1216			

Appendix B

FY 2011 Revegetation Photographs

Figure B-1. Background vegetation plot at BORAX-V.

Figure B-2. Disturbed vegetation plot at BORAX-V.

Figure B-3. Background Vegetation Plot at CFA-4 Pond Remediation Site.

Figure B-4. Disturbed Vegetation Plot at CFA-04 Pond Remediation Site.

Figure B-5. Background Vegetation Plot at the CFA Former Fire Station 2 Site.

Figure B-6. Disturbed Vegetation Plot at the CFA Former Fire Station 2 Site.

Figure B-7. Background Vegetation Plot at the Geomorphic Investigations for Flood Bounds.

Figure B-8. Disturbed Vegetation Plot at the North Saddle Trench.

Figure B-9. Disturbed Vegetation Plot at the South Saddle Trench.

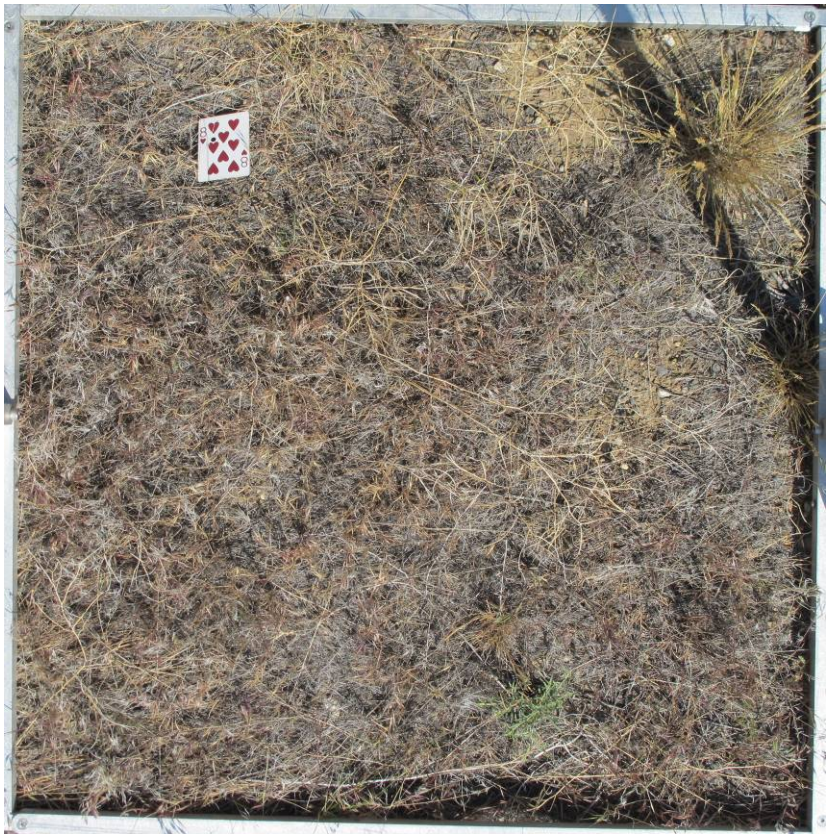

Figure B-10. Disturbed Vegetation Plot at the Southwest Big Loop Trench.

Figure B-11. Background Vegetation Plot at the Large Scale Infiltration Basin.

Figure B-12. Disturbed Vegetation Plot at the Large Scale Infiltration Basin.

Figure B-13. Background Vegetation Plot at the Lincoln Boulevard Borrow Source.

Figure B-14. Disturbed Vegetation Plot for the Lincoln Boulevard Borrow Source.

Figure B-15. Background Vegetation Plot for the VZRP.

Figure B-16. Disturbed Vegetation Plot for Well 201A.

Figure B-17. Disturbed Vegetation Plot for Well 209.

Appendix C

GPS Coordinates

Table C-1. BORAX-V GPS locations

Borax-V	
East	
Waypoint	Latitude and Longitude
544	N43 31.053 W113 00.550
545	N43 31.051 W113 00.546
546	N43 31.051 W113 00.545
547	N43 31.048 W113 00.542
548	N43 31.050 W113 00.540
549	N43 31.050 W113 00.537
550	N43 31.050 W113 00.535
551	N43 31.049 W113 00.533
552	N43 31.047 W113 00.531
553	N43 31.048 W113 00.533
554	N43 31.047 W113 00.524
555	N43 31.048 W113 00.522
BKGD	
Waypoint	Latitude and Longitude
556	N43 31.040 W113 00.517
557	N43 31.040 W113 00.520
558	N43 31.036 W113 00.521
559	N43 31.033 W113 00.524
560	N43 31.032 W113 00.524
561	N43 31.028 W113 00.529
562	N43 31.027 W113 00.531
563	N43 31.026 W113 00.533
564	N43 31.022 W113 00.537
West	
Waypoint	Latitude and Longitude
565	N43 31.021 W113 00.555
566	N43 31.022 W113 00.556
567	N43 31.025 W113 00.556
568	N43 31.025 W113 00.557
569	N43 31.029 W113 00.558
570	N43 31.032 W113 00.559
571	N43 31.035 W113 00.562
572	N43 31.037 W113 00.562
573	N43 31.039 W113 00.564
574	N43 31.039 W113 00.564
575	N43 31.043 W113 00.566
576	N43 31.051 W113 00.566
577	N43 31.050 W113 00.565

Table C-2. CFA-04 Pond Remediation GPS Locations

CFA-04 Pond	
N-S	
Waypoint	Latitude and Longitude
579	N43 31.395 W112 56.798
580	N43 31.390 W112 56.799
581	N43 31.387 W112 56.798
582	N43 31.383 W112 56.798
583	N43 31.379 W112 56.797
584	N43 31.374 W112 56.794
585	N43 31.368 W112 56.792
586	N43 31.368 W112 56.791
587	N43 31.363 W112 56.791
588	N43 31.363 W112 56.792
589	N43 31.362 W112 56.792
590	N43 31.351 W112 56.791
591	N43 31.342 W112 56.791
592	N43 31.338 W112 56.790
593	N43 31.332 W112 56.789
594	N43 31.330 W112 56.787
595	N43 31.328 W112 56.790
BKGD	
Waypoint	Latitude and Longitude
596	N43 31.315 W112 56.791
597	N43 31.315 W112 56.791
598	N43 31.310 W112 56.788
599	N43 31.308 W112 56.786
600	N43 31.304 W112 56.786
601	N43 31.297 W112 56.773
602	N43 31.295 W112 56.771
603	N43 31.295 W112 56.769
604	N43 31.295 W112 56.763
605	N43 31.295 W112 56.760
606	N43 31.296 W112 56.753
607	N43 31.297 W112 56.754
608	N43 31.305 W112 56.750
609	N43 31.308 W112 56.747
610	N43 31.315 W112 56.745
611	N43 31.321 W112 56.737
612	N43 31.321 W112 56.730
613	N43 31.324 W112 56.729

614	N43 31.324 W112 56.729
615	N43 31.334 W112 56.724
616	N43 31.339 W112 56.725
617	N43 31.342 W112 56.723
E-W	
Waypoint	Latitude and Longitude
618	N43 31.358 W112 56.736
619	N43 31.357 W112 56.736
620	N43 31.359 W112 56.750
621	N43 31.357 W112 56.755
622	N43 31.356 W112 56.761
623	N43 31.358 W112 56.767
624	N43 31.357 W112 56.768
625	N43 31.358 W112 56.779
626	N43 31.358 W112 56.784
627	N43 31.358 W112 56.793
628	N43 31.359 W112 56.801
629	N43 31.360 W112 56.801
630	N43 31.362 W112 56.818
631	N43 31.364 W112 56.824
632	N43 31.366 W112 56.835
633	N43 31.365 W112 56.841
634	N43 31.365 W112 56.840
635	N43 31.367 W112 56.853
636	N43 31.370 W112 56.858

Table C-3. CFA Former Fire Station 2 GPS Locations.

Fire Station #2	
W-E	
Waypoint	Latitude and Longitude
637	N43 35.801 W112 56.449
638	N43 35.800 W112 56.451
639	N43 35.799 W112 56.443
640	N43 35.801 W112 56.442
N-S	
Waypoint	Latitude and Longitude
641	N43 35.787 W112 56.450
642	N43 35.787 W112 56.448
643	N43 35.787 W112 56.446
644	N43 35.792 W112 56.447
645	N43 35.792 W112 56.447
646	N43 35.794 W112 56.445
647	N43 35.796 W112 56.446
648	N43 35.800 W112 56.445
649	N43 35.803 W112 56.443
Background	
Waypoint	Latitude and Longitude
525	N43 35.758 W112 56.476
526	N43 35.760 W112 56.469
527	N43 35.758 W112 56.463
528	N43 35.759 W112 56.461
529	N43 35.757 W112 56.456
530	N43 35.755 W112 56.452
531	N43 35.752 W112 56.449
532	N43 35.752 W112 56.448
533	N43 35.751 W112 56.441
534	N43 35.747 W112 56.438
535	N43 35.745 W112 56.434
536	N43 35.743 W112 56.426
537	N43 35.741 W112 56.423
538	N43 35.739 W112 56.414
539	N43 35.736 W112 56.410
540	N43 35.733 W112 56.406
541	N43 35.731 W112 56.403
542	N43 35.728 W112 56.397

Table C-4.Saddle Trenches Disturbed Area GPS Locations.

Saddle Trenches	
South	
Waypoint	Latitude and Longitude
410	N43 31.625 W113 03.380
411	N43 31.632 W113 03.382
412	N43 31.632 W113 03.384
413	N43 31.634 W113 03.387
414	N43 31.634 W113 03.388
415	N43 31.635 W113 03.390
416	N43 31.637 W113 03.392
417	N43 31.638 W113 03.393
418	N43 31.638 W113 03.394
North	
Waypoint	Latitude and Longitude
419	N43 31.662 W113 03.419
420	N43 31.658 W113 03.413
421	N43 31.659 W113 03.414
422	N43 31.656 W113 03.410
423	N43 31.657 W113 03.409
424	N43 31.655 W113 03.406
425	N43 31.658 W113 03.396

Table C-5. Southwest Big Loop Disturbed Area GPS Locations.

SW-Big Loop Trench	
Waypoint	Latitude and Longitude
426	N43 31.261 W113 04.228
427	N43 31.262 W113 04.228
428	N43 31.261 W113 04.224
429	N43 31.261 W113 04.223
430	N43 31.262 W113 04.226
431	N43 31.264 W113 04.232
432	N43 31.266 W113 04.231
433	N43 31.264 W113 04.230
434	N43 31.269 W113 04.237
435	N43 31.270 W113 04.238
436	N43 31.271 W113 04.238
437	N43 31.272 W113 04.239
438	N43 31.274 W113 04.240
439	N43 31.276 W113 04.243
440	N43 31.276 W113 04.243
441	N43 31.276 W113 04.243

442	N43 31.276 W113 04.247
443	N43 31.278 W113 04.247
444	N43 31.280 W113 04.250
445	N43 31.279 W113 04.250
446	N43 31.283 W113 04.253

Table C-6. Geomorphic Investigations for Flood Bounds Background GPS Locations.

Background GI Project	
Waypoint	Latitude and Longitude
380	N43 31.957 W113 02.684
381	N43 31.955 W113 02.689
382	N43 31.955 W113 02.707
383	N43 31.950 W113 02.705
384	N43 31.947 W113 02.705
385	N43 31.947 W113 02.709
386	N43 31.946 W113 02.710
387	N43 31.945 W113 02.711
388	N43 31.943 W113 02.714
389	N43 31.943 W113 02.715
390	N43 31.942 W113 02.718
391	N43 31.942 W113 02.719

Table C-7. Large Scale Infiltration Basin GPS Locations.

Large Scale Infiltration Basin	
W-E	
Waypoint	Latitude and Longitude
650	N43 28.873 W113 02.369
651	N43 28.873 W113 02.367
652	N43 28.871 W113 02.357
653	N43 28.873 W113 02.357
654	N43 28.874 W113 02.351
655	N43 28.872 W113 02.346
656	N43 28.875 W113 02.340
657	N43 28.877 W113 02.334
658	N43 28.878 W113 02.336
659	N43 28.883 W113 02.323
660	N43 28.881 W113 02.323
661	N43 28.881 W113 02.319
662	N43 28.884 W113 02.308
663	N43 28.885 W113 02.305
664	N43 28.883 W113 02.296
665	N43 28.886 W113 02.290

666	N43 28.887 W113 02.286
667	N43 28.890 W113 02.280
668	N43 28.890 W113 02.277
669	N43 28.889 W113 02.271
670	N43 28.887 W113 02.264
671	N43 28.889 W113 02.259
672	N43 28.894 W113 02.251
673	N43 28.895 W113 02.246
674	N43 28.896 W113 02.241
675	N43 28.899 W113 02.239
S-N	
Waypoint	Latitude and Longitude
676	N43 28.850 W113 02.264
677	N43 28.855 W113 02.268
678	N43 28.858 W113 02.267
679	N43 28.860 W113 02.266
680	N43 28.864 W113 02.268
681	N43 28.870 W113 02.273
682	N43 28.874 W113 02.274
683	N43 28.877 W113 02.278
684	N43 28.883 W113 02.283
685	N43 28.887 W113 02.286
686	N43 28.887 W113 02.286
687	N43 28.891 W113 02.294
688	N43 28.896 W113 02.297
689	N43 28.905 W113 02.309
690	N43 28.908 W113 02.310
691	N43 28.908 W113 02.309
692	N43 28.913 W113 02.312
693	N43 28.914 W113 02.318
694	N43 28.919 W113 02.314
695	N43 28.924 W113 02.312
696	N43 28.932 W113 02.319
697	N43 28.936 W113 02.324
BKGD	
Waypoint	Latitude and Longitude
698	N43 28.868 W113 02.379
699	N43 28.868 W113 02.389
700	N43 28.865 W113 02.396
701	N43 28.863 W113 02.401
702	N43 28.862 W113 02.406
703	N43 28.861 W113 02.407
704	N43 28.861 W113 02.417

705	N43 28.861 W113 02.423
706	N43 28.858 W113 02.427
707	N43 28.854 W113 02.443
708	N43 28.857 W113 02.455
709	N43 28.857 W113 02.459
710	N43 28.856 W113 02.459
711	N43 28.855 W113 02.464
712	N43 28.852 W113 02.469

Table C-8. Lincoln Boulevard Borrow Source Disturbed Area GPS Locations.

Lincoln Boulevard Borrow Source	
North	
Waypoint	Latitude and Longitude
480	N43 40.091 W112 52.234
481	N43 40.090 W112 52.236
482	N43 40.088 W112 52.228
483	N43 40.085 W112 52.239
484	N43 40.084 W112 52.243
485	N43 40.085 W112 52.244
486	N43 40.086 W112 52.236
487	N43 40.083 W112 52.244
488	N43 40.080 W112 52.248
489	N43 40.079 W112 52.249
490	N43 40.076 W112 52.253
491	N43 40.074 W112 52.256
492	N43 40.071 W112 52.258
493	N43 40.071 W112 52.258
494	N43 40.069 W112 52.266
495	N43 40.065 W112 52.271
496	N43 40.064 W112 52.271
497	N43 40.062 W112 52.273
498	N43 40.060 W112 52.277
499	N43 40.058 W112 52.279
500	N43 40.054 W112 52.284
501	N43 40.053 W112 52.286
502	N43 40.051 W112 52.287
503	N43 40.048 W112 52.293
504	N43 40.046 W112 52.293
505	N43 40.044 W112 52.296
506	N43 40.043 W112 52.297
507	N43 40.040 W112 52.301
508	N43 40.041 W112 52.302
509	N43 40.038 W112 52.311

South	
Waypoint	Latitude and Longitude
510	N43 40.015 W112 52.322
511	N43 40.015 W112 52.323
512	N43 40.017 W112 52.325
513	N43 40.014 W112 52.329
514	N43 40.013 W112 52.331
515	N43 40.012 W112 52.332
516	N43 40.009 W112 52.336
517	N43 40.008 W112 52.341
518	N43 40.006 W112 52.341
519	N43 40.003 W112 52.345
520	N43 40.001 W112 52.341
521	N43 39.998 W112 52.349
522	N43 39.996 W112 52.350
523	N43 39.993 W112 52.355
524	N43 39.992 W112 52.358

Table C-9. VZRP GPS locations.

VZRP Well 209	
T1	
Waypoint	Latitude and Longitude
447	N43 33.262 W112 58.362
448	N43 33.263 W112 58.363
449	N43 33.259 W112 58.366
450	N43 33.259 W112 58.364
451	N43 33.259 W112 58.362
452	N43 33.258 W112 58.362
453	N43 33.257 W112 58.363
454	N43 33.253 W112 58.362
455	N43 33.252 W112 58.364
456	N43 33.252 W112 58.364
T2	
Waypoint	Latitude and Longitude
457	N43 33.256 W112 58.363
458	N43 33.257 W112 58.364
459	N43 33.257 W112 58.363
460	N43 33.259 W112 58.363
461	N43 33.260 W112 58.364
462	N43 33.261 W112 58.365
463	N43 33.260 W112 58.368
464	N43 33.263 W112 58.367
465	N43 33.263 W112 58.367

VZRP Well 201A	
T1	
Waypoint	Latitude and Longitude
466	N43 33.265 W112 58.266
467	N43 33.261 W112 58.264
468	N43 33.262 W112 58.261
469	N43 33.261 W112 58.261
470	N43 33.253 W112 58.254
471	N43 33.254 W112 58.258
472	N43 33.254 W112 58.259
473	N43 33.254 W112 58.260
T2	
Waypoint	Latitude and Longitude
474	N43 33.256 W112 58.254
475	N43 33.255 W112 58.254
476	N43 33.255 W112 58.256
477	N43 33.259 W112 58.257
478	N43 33.261 W112 58.257
479	N43 33.263 W112 58.258

VZRP Background	
Waypoint	Latitude and Longitude
47	N43 33.634 W112 58.338
48	N43 33.635 W112 58.341
49	N43 33.635 W112 58.342
50	N43 33.636 W112 58.344
51	N43 33.636 W112 58.345
52	N43 33.637 W112 58.347
53	N43 33.638 W112 58.348
54	N43 33.638 W112 58.350
55	N43 33.639 W112 58.351
56	N43 33.640 W112 58.352
57	N43 33.640 W112 58.354
58	N43 33.641 W112 58.356
59	N43 33.642 W112 58.358
60	N43 33.644 W112 58.359
61	N43 33.645 W112 58.361
62	N43 33.646 W112 58.362
63	N43 33.646 W112 58.363
64	N43 33.647 W112 58.365
65	N43 33.648 W112 58.367
66	N43 33.648 W112 58.368
67	N43 33.648 W112 58.370

102	N43 33.490 W112 58.178
103	N43 33.490 W112 58.176
104	N43 33.490 W112 58.175
105	N43 33.490 W112 58.173
106	N43 33.490 W112 58.171
107	N43 33.490 W112 58.170
108	N43 33.490 W112 58.168
109	N43 33.490 W112 58.166
110	N43 33.490 W112 58.164
111	N43 33.490 W112 58.162
112	N43 33.490 W112 58.160
113	N43 33.490 W112 58.158
114	N43 33.489 W112 58.156
115	N43 33.489 W112 58.154
116	N43 33.489 W112 58.152
117	N43 33.489 W112 58.150
118	N43 33.488 W112 58.149
140	N43 33.418 W112 58.463
141	N43 33.417 W112 58.465
142	N43 33.416 W112 58.465
143	N43 33.415 W112 58.466
144	N43 33.413 W112 58.468
145	N43 33.412 W112 58.470
146	N43 33.411 W112 58.471
147	N43 33.410 W112 58.472
148	N43 33.407 W112 58.476
149	N43 33.407 W112 58.476
150	N43 33.406 W112 58.477
151	N43 33.406 W112 58.479
152	N43 33.405 W112 58.481
153	N43 33.406 W112 58.481
154	N43 33.404 W112 58.485
208	N43 33.008 W112 58.597
209	N43 33.008 W112 58.599
210	N43 33.007 W112 58.600
211	N43 33.006 W112 58.602
212	N43 33.004 W112 58.607
213	N43 33.005 W112 58.611
214	N43 33.005 W112 58.611
215	N43 33.007 W112 58.609
216	N43 33.007 W112 58.611
217	N43 33.006 W112 58.616
218	N43 33.009 W112 58.615

219	N43 33.009 W112 58.615
220	N43 33.008 W112 58.617
221	N43 33.007 W112 58.616
222	N43 33.009 W112 58.617