Final

Plant Community Surveys and Mapping Report in Support of the Proposed Fallon Range Training Complex Expansion, Nevada

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Contract N62742-14-D-1863: Task Orders FZNG and FZNG, Modification 4

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Acronyms and Abbreviations

ac	acre(s)
cm	centimeter(s)
CNPS	California Native Plant Society
DoN	U.S. Department of the Navy
DVTA	Dixie Valley Training Area
FRTC	Fallon Range Training Complex
ft	feet
GIS	geographic information system
GPS	global positioning system
ha	hectare(s)
in	inches
IVC	International Vegetation Classification
km	kilometer(s)
m	meter(s)
MMU	minimum mapping unit
ManTech	ManTech International Corporation
NAIP	National Agricultural Imagery Program
NAS	Naval Air Station
NNHP	Nevada Natural Heritage Program
U.S.	United States

1. INTRODUCTION

Naval Air Station (NAS) Fallon currently manages the Fallon Range Training Complex (FRTC), which currently encompasses a combination of withdrawn and acquired lands totaling approximately over 223,600 acres (ac) (90,490 hectares [ha]) of military training land located southeast of Fallon, Nevada (Figure 1-1). The FRTC is the United States (U.S.) Department of the Navy's (DoN or Navy) premier integrated strike warfare training complex, supporting air units and special operations forces in a variety of mission areas. Since World War II, the Navy has extensively used the ranges and airspace of the FRTC to conduct military air warfare and ground training, including live-fire training activities. However, the current training areas are insufficient for implementation of realistic training scenarios and buffers required for public safety. In order to effectively meet these needs, the Navy proposes to modernize the land and airspace configurations of the FRTC. The Navy is currently proposing to expand the land administered by NAS Fallon by approximately 680,000 ac (275,200 ha). The proposed expansion areas are broken into four discontinuous areas associated with four of the current training ranges (ranges B-16, B-17, B-20, and Dixie Valley Training Area [DVTA]) (Figure 1-1):

- The area west of B-16 is the proposed B-16 Expansion Area.
- The area surrounding B-20 is the proposed B-20 Expansion Area.
- The areas west and east of B-17 and north of Highway 50 surrounding the DVTA are the proposed DVTA Expansion Areas.
- The area south of B-17 and Highway 50 and east of B-17 is the proposed B-17 Expansion Area.

Currently, the Navy is preparing an Environmental Impact Statement (EIS) to assess the potential environmental effects of the proposed FRTC expansion. In support of the EIS, Naval Facilities Engineering Command, Southwest contracted ManTech International Corporation (ManTech) to perform a variety of ecological surveys to inventory the flora and fauna within the proposed FRTC expansion areas. One component of this effort was to characterize the vegetation communities, map them, and develop a vegetation classification system. This report details the results of this task conducted in 2017 under contract N62742-14-D-1863, Task Order FZNG and in 2019 under Task Order FZNG, Modification 4 (Figure 1-1).

1.1 Vegetation Mapping Concept

Vegetation mapping is becoming an increasingly important aspect of ecological conservation, and efforts across the country are beginning to coalesce into a coherent system of categorizing, partitioning, and describing vegetation. This benefits conservation and management because it offers a uniform system to compare types of vegetation across wide regions. Developing a common system and language to discuss communities of plants allows us to quantify their characteristics, develop an understanding of baseline conditions, measure change through time, and identify resources in need of protection. However, all efforts to compartmentalize and neatly slice vegetation into bins necessarily incorporate an element of artificial division and subjectivity. Deciding exactly where to place a dividing line between a forest and meadow, or declaring the exact species membership and the quantity of each species comprising a forest or meadow is subject to data collection biases and interpretation of the observer.

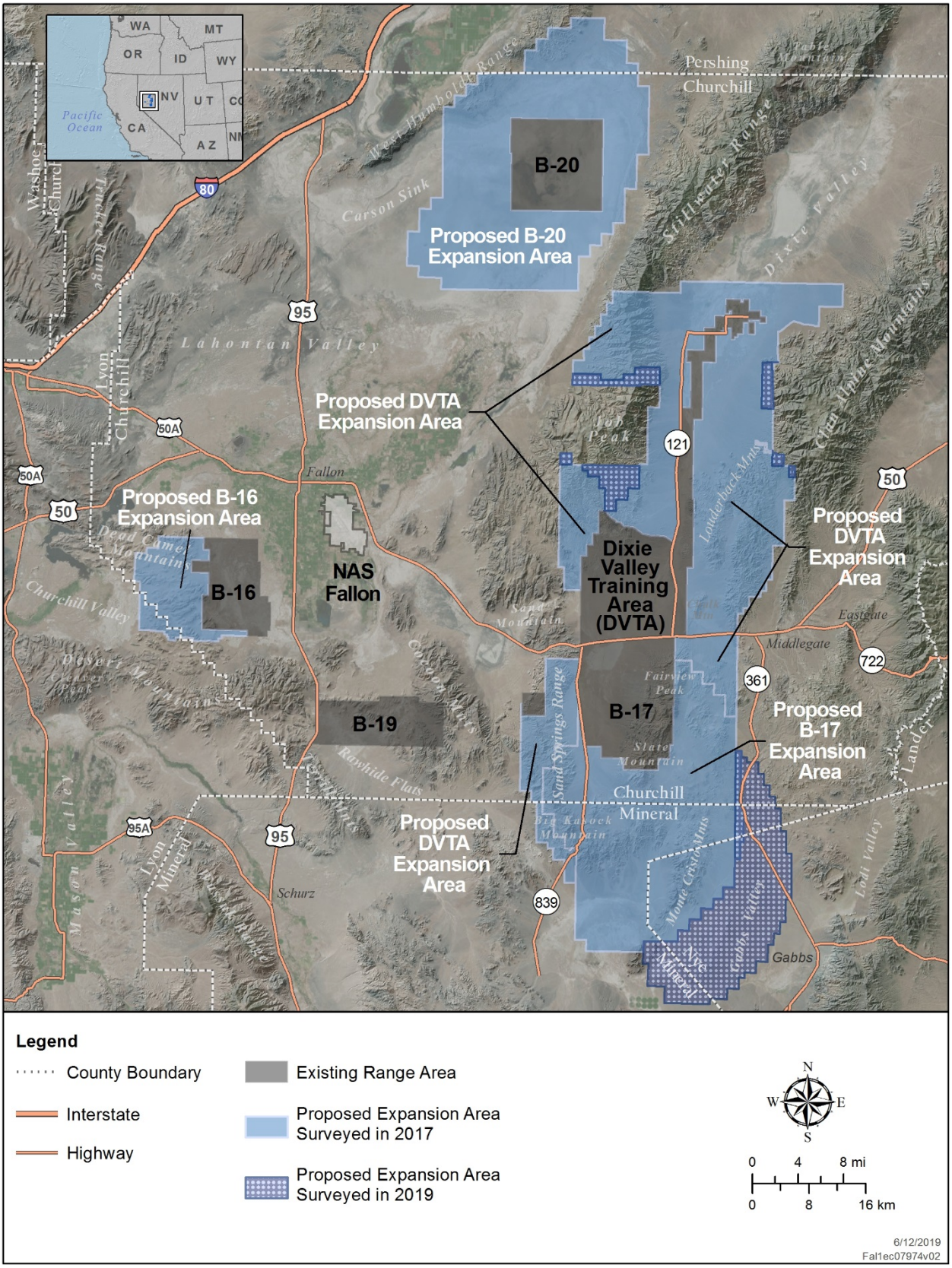

Figure 1-1. Location of Proposed FRTC Expansion Areas within Western Nevada

The International Vegetation Classification (IVC) is an attempt to supply a framework for tackling an understanding of vegetation that can be applied across the full spectrum of vegetation in the world (NatureServe 2016). IVC is a hierarchical cataloging of plant groupings that incorporates basic environmental differences, physiognomy and floristics (Table 1-1). The first two levels of the IVC deal with environmental characteristics such as aquatic versus terrestrial. Physiognomy, or the shape and form that a plant takes on at maturity, forms the basis for the next four ranks within the hierarchy, with floristics, or plant species identity, forming the last two ranks. Lower in the classification, the identities of the plants become important, with the two lowest levels concerned with the top one or two dominant plant species. In the IVC, "dominant" refers to visual dominance as well as percent cover. If a tree is present over a certain threshold, it will generally be considered to be dominant over a grass that may be present at a much higher percent cover. Similarly, shrubs can dominate over grasses, and grasses over microphytic types such as cryptobiotic crusts (Peterson 2008).

Table 1-1. Vegetation Classification Ranks Using Black Sagebrush Scrub and Pinyon Woodland as Examples

Rank	Black Sagebrush Scrub	Pinyon Woodland
Class	Desert & Semi-desert	Forest and Woodland
Subclass	Cool Semi-desert Scrub & Grassland	Temperate & Boreal Forest & Woodland
Formation*	Cool Semi-desert Scrub & Grassland	Cool Temperate Forest & Woodland
Division	Western North American Cool Semi-desert Scrub & Grassland	Western North American Pinyon-Juniper Woodland & Scrub
Macrogroup	Great Basin-Intermountain Dwarf Sagebrush Steppe & Shrubland	Intermountain Singleleaf Pinyon-Juniper Woodland
Group	Intermountain Low & Black Sagebrush Steppe & Shrubland	Great Basin Pinyon-Juniper Woodland
Alliance†	Black Sagebrush Steppe & Shrubland	Great Basin Singleleaf Pinyon-Utah Juniper/Shrub Woodland
Association§	Black Sagebrush-Shadscale Shrubland	Singleleaf Pinyon/Black Sage-Green Ephedra Shrub/Woodland

Notes: *Level of 2017 Accuracy Assessment (refer to Section 4.0).
†Level of 2017 and 2019 mapping.
§Not included in mapping.

The hierarchical nature of the IVC allows for classification at broad or narrow scales, depending on resources available and the uses to which the end result will be put. Mapping at the lowest rank, association, requires extensive data collection to tease out boundaries between subtle groupings of species, and is generally only used to map small areas. The alliance level is often convenient for both mapping and classification, as it incorporates species dominance but at a coarser scale than association. Within the higher levels, the formation level is useful for distinguishing the major physiognomic breaks within a region such as woodland versus shrubland versus grassland. When the upper levels of a finished vegetation map and classification are well constructed and verified, lower level ranks can be more confidently assigned as needed, for instance on a project by project basis. In Nevada, the Nevada Natural Heritage Program (NNHP) has developed a comprehensive IVC-compliant list of vegetation alliances with a large dataset of plots and Nevada-specific descriptions (Peterson 2008). The current vegetation classification effort relied heavily on these descriptions, as well as on the descriptions of IVC formations and alliances on the NatureServe website (http://explorer.natureserve.org/servlet/NatureServe).

For the current task, the ranks of *formation* and *alliance* were used for the purposes of classifying the vegetation within the project areas. *Formations* can be defined as broad combinations of general

dominant growth forms that are adapted to basic temperature (energy budget), moisture, and substrate conditions. *Alliances* refer to diagnostic species, including some from the dominant growth form or layer (i.e., formation), and moderately similar composition that reflect regional to subregional climate, substrates, hydrology, moisture/nutrient factors, and disturbance regimes (NatureServe 2016).

Vegetation mapping and vegetation classification, although occasionally used interchangeably, are not the same. Vegetation mapping is the process of delineating boundaries between homogenous groupings of plant communities, and vegetation can be mapped at any rank level in Table 1-1. Vegetation classification is the process of describing the members of a particular rank; vegetation can also be classified at any level, and it generally involves developing membership rules such as cover thresholds or mutually exclusive dominances for particular species. Neither of these is a habitat map, although vegetation maps and classifications can contribute to the development of a habitat map for a given plant or animal species of interest.

The final piece of the vegetation picture is the accuracy assessment. This can be an independent or internal process by which additional data is collected and compared to the map to determine if remotely sensed or extrapolated data reflect conditions on the ground in the real world. Accuracy assessments are required in any large-scale effort because the data that informs the map is collected using a sampling scheme; if it was collected as a census, the map would already be 100% accurate.

1.2 Regional Background

The project area lies within the geographic feature known as the Great Basin. The Great Basin Desert is the largest desert in the US, covering roughly 158,000 square miles (409,218 square kilometers [km]) of southern Idaho, southeastern Oregon, western Utah, eastern California, and nearly all of Nevada (MacMahon 1985) (Figure 1-2). The Great Basin is a high cold desert, with most of its elevations over 4,000 feet (ft) (1,200 meters [m]), and most of its precipitation in the form of snow, although rain showers can occur throughout the hotter months. The western part as a whole averages 9 inches (in) (22.9 centimeters [cm]) of precipitation per year, while the Fallon area averages considerably lower, at only 5 in (12.7 cm) per year (Sowell 2001).

The Great Basin Desert is located in the Basin and Range Province, named for the alternating topography between mostly north-south oriented mountain ranges and valleys with no or very few waterways leading out. The Great Basin has approximately 160 mountain ranges, with a corresponding number of basins in between. The geologic activity leading to this topography has also resulted in a diverse range of soil types, soil temperature regimes, and soil moisture regimes, resulting in high species diversity and vegetation complexity in the Great Basin. The movement of sediments downhill from the mountains to the basins produces arroyos, bajadas, and eventually playas, which support shrublands, grasslands, and alkali flat habitats, all of which in turn support their own suites of plant and animal species (NAS Fallon 2015).

Figure 1-2. Occurrence of the Great Basin within the Western United States
(*Source*: Nevada Bureau of Mines and Geology 2012)

The lowest elevation in the proposed expansion areas is 3,390 ft (1,033 m), and the lowest elevations are predominantly occupied by playas. At these low elevations, where temperatures are the hottest and the soil is the most saline, the vegetation is dominated by plant species in the family Amaranthaceae. The most common dominant shrubs in the lowest areas are saltbush (*Atriplex*) and greasewood (*Sarcobatus*) species. Other dominant Amaranthaceae species of the valley bottoms and lower bajadas include four-wing saltbush (*Atriplex canescens*) and spiny hopsage (*Grayia spinosa*). Also common in these saline areas are bud sagebrush (*Picrothamnus desertorum*), yellow rabbitbrush (*Chrysothamnus viscidiflorus*), and rubber rabbitbrush (*Ericameria nauseosa*), all in the Asteraceae (Mozingo 1987). The valley bottom wetlands in the Dixie Valley area support dense stands of rushes (*Juncus* spp.), saltgrass (*Distichlis spicata*), and narrowleaf cattail (*Typha angustifolia*) (NAS Fallon 2015). These areas have also been invaded by Russian olive (*Elaeganus angustifolia*) and are heavily disturbed by cattle and feral horses (DoN 2018a).

At slightly higher elevations, where the soils are less saline and more moisture is available, varieties of sagebrush (*Artemisia* spp.) become the dominant vegetation. Sagebrush shrublands are the most common vegetation type in the Great Basin Desert, covering nearly 40% of the area (Brussard et al. 1998). The big sagebrush (*Artemisia tridentata*) varieties and closely related *Artemisia* species are morphologically and taxonomically difficult to distinguish, particularly when not flowering. Yellow rabbitbrush (*Chrysothamnus viscidiflorus viscidiflorus*) and rubber rabbitbrush are also common in these areas, along with Nevada joint-fir (*Ephedra nevadensis*) and littleleaf horsebrush (*Tetradymia glabrata*) (Mozingo 1987).

The sagebrush-dominated regions are also the areas where cheatgrass (*Bromus tectorum*) often forms large, dense stands. The replacement of native shrubs and bunchgrasses by annual non-natives, driven by overgrazing, has led to increased fire frequency, which in turn favors further establishment of invasive plant species (Eiswerth and Shonkwiler 2006).

Riparian habitats are found in canyons and washes in the middle to upper elevations of the project area. These generally result from springs and small seeps, although a few riparian areas are perennial waterways. Species commonly encountered in the riparian areas include Fremont cottonwood (*Populus fremontii*), willows (*Salix* spp.), and Wood's rose (*Rosa woodsii*) (Peterson 2008; NAS Fallon 2015). The presence of relatively permanent water allows riparian areas to support among the highest species diversity in the Great Basin Desert (Naiman et al. 1993).

At the highest, coolest, moistest elevations of the project area, up to 8,000 ft (2,438 m) elevation, trees appear, and the vegetation changes to pinyon-juniper woodlands. Generally, the lower range of these elevations are dominated by Utah juniper (*Juniperus osteosperma*), the middle range is a mixture of Utah juniper and singleleaf pinyon pine (*Pinus monophylla*), and the upper end of the range is dominated by singleleaf pinyon pine. This woodland zone generally has an understory of sagebrush, rabbitbrushes, and other common shrubs (Peterson 2008).

2. METHODS

A traditional vegetation classification and mapping protocol proceeds along the following general steps:

1. Conduct field reconnaissance or remote sensing aerial imagery interpretation to delineate seemingly homogenous stands of vegetation.
2. Conduct a classification cluster analysis:
    a. Establish sampling strategy (stratified, random, etc.) and determine the sample point density. This density should accurately sample the variation at the lowest level at which the map is

intended to be used. For instance, if an association-level map is desired, sample density must be high enough to produce a statistically significant signal differentiating all the associations present.

b. Conduct sampling: collect relevè data within plots appropriately sized for the type of vegetation. Grasslands generally require a smaller plot than shrublands, and forests require the largest. Relevès include cover of all species present, topography, soils, and cover by vegetation layer.
c. Perform the cluster analysis of the sample data to ascertain the classes with statistical certainty. These classes become the alliances or associations of the new classification.

3. Apply the classification to the delineated stands of vegetation in step 1.
4. Perform the accuracy assessment: select a statistically sound sample of stands to verify. The sample of stands are generally stratified in some way. Return to the field to determine the percentage of delineated polygons that correspond to the correct classification found on the ground.

For Nevada, Step 2 of this process has been done, primarily by the NNHP (Peterson 2008), with additional local vegetation mapping of the existing FRTC lands (NAS Fallon 2015). This NNHP effort applied the IVC classification to the entire State of Nevada, and supplemented the existing IVC system with new plot data and additional Nevada-specific alliances and associations. In addition, the 2015 vegetation mapping project of the existing FRTC lands used IVC-compliant classifications that corresponded to the NNHP alliances (NAS Fallon 2015). For example, a common vegetation type found in the Fallon area is strongly dominated by Bailey's greasewood (*Sarcobatus baileyi*), but this did not exist within IVC prior to the NNHP work. NNHP refined and expanded the IVC classifications to allow for these situations of rare-across-the-US but locally-common vegetation communities. More recently and even more locally, the 2015 vegetation map developed for the existing FRTC lands (NAS Fallon 2015) used the NNHP-expanded IVC classification, demonstrating that the classification was likely to be applicable to the proposed expansion areas addressed in the current survey efforts and complete for the majority of the vegetation communities. ManTech planned for the possibility of detecting additional new vegetation communities that would require plot data collection, but anticipated that the vast majority of the expansion areas would fit into pre-existing communities defined by one of these prior efforts.

Having a tested, proven classification in hand, ManTech proceeded to delineate homogenous vegetation stands using aerial imagery interpretation, then applied the pre-existing classification to those stands, per Steps 1 and 3. ManTech then used field time to apply the known classes (at the alliance level) to the polygons. During that field effort and in the course of the ground-based rare plant survey effort (DoN 2018b), plot data were also collected on several new-to-IVC vegetation alliances to contribute to NatureServe. Plot data from all alliances were used to develop a key to the vegetation types using cover values and dominance of species found within each alliance.

This methodology allowed the survey effort to tackle the large scope of the project and leverage pre-existing classifications with the ability of the helicopter crew to capture both quantitative vegetation data and qualitative data in the form of high-resolution photographs.

2.1 Pre-field Data Collection and Review

2.1.1. Imagery

The first step in the vegetation mapping process was to acquire suitable publicly available imagery for the area. The U.S. Department of Agriculture Farm Service Agency maintains aerial imagery of the continental

U.S. through the National Agricultural Imagery Program (NAIP), and the products are publicly available. NAIP imagery is collected on a 3-year cycle and at 3.3 ft (1.0 m) ground sample distance with a horizontal accuracy that matches within 19.7 ft (6.0 m) of photo-identifiable ground control points (Farm Service Agency 2017). The images are available in four-band color georeferenced orthophotos, making them well-suited to integration with geographic information systems (GIS). ManTech downloaded imagery for Churchill, Nye, Mineral, and Pershing counties in geotiff format. The imagery was collected during the growing season of 2015 and was downloaded in May 2016.

Esri's online streaming basemap service for aerial imagery and topography was also consulted throughout the project. These services are integrated into the Esri ArcMap module as part of their online resources. The World Aerial Imagery layer provides 3.3 ft (1.0 m) or better satellite and aerial imagery across the globe, with the continental U.S. generally at 0.9 ft (0.3 m) resolution. This imagery is updated frequently (depending on the contributions of users, but generally at least yearly for most areas). The World Topographic Map layer includes a variety of geographic and political features and boundaries including cities, water features, contours, roads, administrative boundaries, etc., overlaid on shaded relief imagery for added context. The contour lines and shaded relief are particularly useful for vegetation mapping to aid in interpreting elevation and topographic details from aerial imagery. For instance, where canyon faces or steep terrain create shadows in full-color imagery, the vegetation may appear to vary when in fact the color difference is an artifact of the shadow, not a true change in plant species.

2.1.2. Minimum Mapping Unit

An important concept in vegetation mapping is the minimum mapping unit (MMU). The MMU is the size of the smallest feature that is being reliably mapped. Defining and maintaining consistency of the MMU within a vegetation map is particularly important both for development and interpretation.

A brief thought exercise easily demonstrates why: first, say a 1-acre (0.4-ha) patch of trees is surrounded by a 10-acre (4.0-ha) patch of grassland. Then imagine a 10-acre (4.0-ha) woodland with a 1-acre (0.4-ha) meadow in the middle. Many observers would delineate the patch of trees but not the meadow, because the coarse texture of the woodland obscures the smooth texture of the meadow while the copse of trees is easily visible. However, if the MMU is set to 5 ac (2.0 ha), neither is mapped, so that grasslands are allowed to contain inclusions of trees and woodlands are allowed to contain meadows. If the MMU is set to a smaller unit, both inclusions should be mapped, forcing conformity between different observers. Vegetation maps often define multiple MMU's, one size for upland habitats and a different size for riparian zones, which allows important features such as seeps and springs that have disproportionate ecological value to be delineated.

ManTech delineated all polygons in upland habitats at 5 ac (2.0 ha), and generally greater than 2 ac (0.8 ha) in riparian habitats. However, some smaller riparian habitats were also picked out where springs or seeps created particularly striking features on the landscape. These areas were allowed to fall beneath the 2-ac (0.8-ha) MMU.

2.1.3. Polygon Delineation

The NAIP imagery supplied the foundation of the vegetation map. Using ArcMap 10.4, ManTech delineated polygons of areas with apparently homogenous texture on top of the imagery. Working systematically through the imagery for each of the expansion areas, ManTech used the autocomplete function of ArcMap to create polygons tool to delineate boundaries between homogenous textures. "Texture" was interpreted through inspection of vegetation cover, soil color, and topography, with observers attempting to disregard signals from soils and topography and focus solely on signals from

vegetation. Use of the autocomplete tool was intended to avoid creation of topology errors, which create stacked layers of overlapping polygons instead of a single layer with each polygon sharing an exact boundary with each of its neighbors. Topology errors can result in acreage miscalculations and ambiguity of borders between vegetation types. Despite use of the autocomplete tool, some topology errors did creep in to the project, so after all polygons were created, the project was put through a topology check in ArcGIS Spatial Analyst and all topology errors were fixed. Aside from an area calculation to determine compliance with the MMU, polygons were not assigned attributes at this stage, and the data remained exclusively spatial with no attempt at determining vegetation classification information such as formation or alliance.

2.1.4. Data Collection Preparation

Vegetation in the Great Basin has been classified to a coarse extent through NatureServe and NNHP, and the 2014/2015 vegetation map completed for the existing NAS Fallon-managed lands served as a valuable refinement of the NatureServe/NNHP resource (NAS Fallon 2015). Using these, ManTech compiled a list of potential vegetation alliances likely to be encountered within the proposed expansion areas. Digital data collection protocols were developed using Esri's Collector for ArcGIS, Survey123, and ArcPad that incorporated the list of likely alliances. Collector and ArcPad applications can be used to quickly collect spatial data and limited attribute data, while Survey123 excels in providing detailed, complex tabular data collection forms. Prior to field work, we tailored Collector and ArcPad programs for vegetation data collection in the Fallon area by preparing background imagery, project boundaries, and navigational aids such as landmarks and roads; creating data collection forms that allowed the user to select entries from pre-determined domains such as vegetation types, key species lists, etc.; and prepared these tools for offline use. Survey123 forms included options to collect detailed data on additional species within each vegetation stratum, percent cover, and observations of disturbance, soils information, etc. Data collection forms were adapted from California Native Plant Society (CNPS) relevé and rapid assessment protocols.

2.2 Field Methods

Field visits consisted of two trips in 2017 and one trip in 2019 for the helicopter crew, as well as incidental data collection useful for the vegetation mapping effort by the rare plant survey crew in 2017. Using a helicopter for this data collection effort allowed ManTech to quickly collect data over the wide expanse of the project area and gain an aerial perspective on the vegetation that facilitated determination of percent cover and vegetation type boundaries. However, the aerial platform somewhat limited our ability to fully identify certain shrub species and collect detailed information on the species comprising the herbaceous layer. Some of these shortcomings were addressed by the ground-based rare plant survey, which was able to devote effort to detailed species identification and vegetation data collection (DoN 2018b).

2.2.1. Survey Timing

In 2017, the two field survey events were timed for early spring (April) and late summer (August), and in 2019 for April (Table 2-1). The exact timing of all surveys was dictated by helicopter availability, but the April 2017 and 2019 visits coincided with the beginning of the blooming period for a variety of spring annual plants and was partway into the spring green-up of most shrub species. The late summer (August 2017) trip coincided with the early stages of the fall bloom of some of the Asteraceous shrubs, but was still too early for some of the important sagebrush species and varieties. The visits were timed to balance the need to sample during the long blooming season in the Great Basin with the need to disperse data

collection efforts throughout the large project area. Airspace restrictions dictated access to several areas, and restricted areas were only visited during the late summer trip in 2017.

Table 2-1. Survey Periods, Personnel, and Areas

Dates	Personnel	Helicopter	Proposed Expansion Areas
2017			
13 – 17 April	M. Ball, E. Howe, K. Olthoff, B. Rodriguez	Sweitzer 333	DVTA and unrestricted portions of B-17.
18 – 21 April	M. Ball, E. Howe, K. Olthoff, C. Mendoza	Sweitzer 333	DVTA and unrestricted portions of B-17.
11 – 22 August	M. Ball, E. Howe, K. Olthoff, A. Grupenhoff	Hughes 500	DVTA and restricted portions of B-16, B-17, and B-20.
2019			
22 – 23 April	M. Ball, E. Howe, K. Olthoff	Hughes 500	DVTA and unrestricted portions of B-17.

2.2.2. Helicopter Protocol

Helicopters used during the surveys included a Sweitzer 333 and Hughes 500. Both aircraft comfortably carry a three-person crew and can perform 2-2.5-hour flights, depending on conditions and flight requirements. The crew flew approximately three to four flights per day. During survey events, the helicopter pilot flew at less than 500 ft (152 m) above ground level to stay below restricted airspace. Depending on terrain, vegetation complexity, and plant species, altitude varied from less than 80 ft (24 m) when collecting cover data, and was generally between 50 ft (15 m) and 100 ft (30 m) when determining boundaries between vegetation types or collecting wide-angle landscape imagery.

Transects ran roughly perpendicular to the slope or paralleling the slope depending on light conditions, terrain type, and complexity of vegetation (Appendices A and B). Perpendicular transects were favored through complex continuums such as rings of vegetation around valley bottoms and playas (such as the transition from Bailey's greasewood to intermountain greasewood [*Sarcobatus vermiculatus*] to Mojave seablight [*Suaeda nigra*] often found around dry lakebeds). This type of transect allowed the surveyors to pinpoint the contact point between the intergrading vegetation that related to variations in micro-topography and moisture regimes. Perpendicular transects were also useful in determining the break points between the upper elevation vegetation types such as the pinyon woodland, black sagebrush (*Artemisia nova*), and varieties of big sage. Transects that ran parallel to the slope on the other hand, were critical in capturing detailed photographs in good lighting and in determining the transitions from wash bottom vegetation to upland types. Vegetation complexity governed transect width, with complex areas such as the bottom of Dixie Valley mapped with much narrower transects than homogenous areas such as those dominated by Bailey's greasewood.

2.2.3. Photographer Protocol

The photographer used a Canon 5D Mark III with a 28-105 millimeter lens to capture wide angle images. Wide angle shots of vegetation context were captured at nadir (straight down) and oblique angles to provide a variety of sources for estimating percent cover and assigning vegetation alliances to a wide swath of the flight transect (Figure 2-1). Nadir photographs capture a smaller field of view and may distort size, but are critical to determining cover and identifying species, and they capture the nature of the vegetation at an exact point as the field of view corresponds exactly to the global positioning system (GPS) location attached to the image. Oblique images may not correspond to their GPS tagged location, but offer a large field of view and provide the context of multiple vegetation communities and their boundaries. To increase the quality of photographs captured from the moving, vibrating helicopter, the

wide angle camera was fitted with Cenyon Labs KS 4x4 gyroscope stabilizer. The camera recorded GPS coordinates for each image using a Canon GP-E2 GPS receiver.

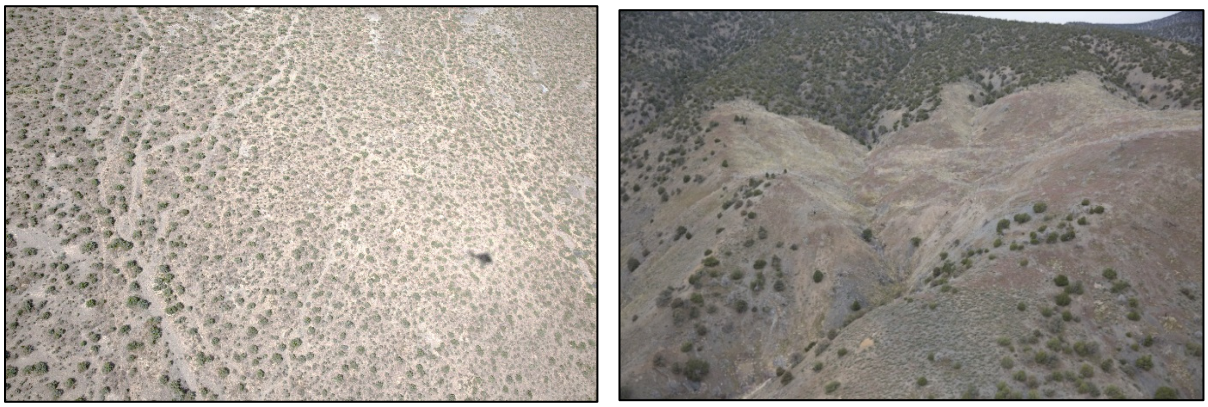

Figure 2-1. Images Captured at Nadir (left) and Oblique (right) Angles

Note: Nadir image field of view is entirely one habitat. Oblique image field of view shows two habitats in different formations.

2.2.4. Vegetation Data Collection Protocol

Using the mobile data platforms, the vegetation data collector periodically documented a single-attribute point for the vegetation type while in transit, or directed the helicopter pilot to hover for more detailed data collection. Data collection hover points enabled us to document percent cover values for dominant species within each layer, record invasive species, and refine spatial information such as delineating boundaries between alliances that were not visible in the ortho imagery. The aerial perspective was helpful in estimating percent cover and discriminating subtle changes in vegetation composition.

Although the vast majority of the data for the vegetation mapping effort was collected aerially, ground-based points were valuable as well. In conjunction with the ground-based rare plant survey, botanists collected additional assessment points and herbarium vouchers of difficult to identify shrubs (DoN 2018b). Rapid assessment points were collected within most vegetation alliances, with particular emphasis on collecting data in the alliances that are not currently recognized by IVC. Rapid assessments followed either the full CNPS protocol, or our streamlined version, “extra-rapid assessments” (ERAs). ERAs focused on collecting only the bare minimum data required to determine vegetation type: the observer’s estimate of vegetation alliance, up to five dominant species (tree if present, shrub and/or occasionally associated grasses or forbs), and the percent cover of each of those species.

The last data collection method extracted plant cover data from the aerial photographs. The entire photo dataset was imported into Adobe Lightroom CC, which can display the images overlaid on satellite imagery based on the geotagged locations. ManTech then analyzed images taken at nadir for additional percent cover data. This method focused on those vegetation types that were not assessed sufficiently using rapid assessment or ERA protocols. A technician displayed each photograph on a 27-in (68.6-cm) tablet and manipulated contrast, exposure, color saturation, etc. to maximize ease of identifying dominant species, then estimated percent cover of up to five species in a selection of photos.

2.3 Data Curation and Analysis

After the field visits concluded, the data was curated in ArcGIS 10.4. The lengthy process of assigning alliance attributes to each polygon was significantly aided by the use of a large format tablet and stylus by Wacom®. In order to preserve the integrity of the polygons drawn pre-field work, all data was first aggregated into point and line files, each of which had domains set to the available alliance names. Points

and lines were dropped on top of each polygon, then joined to the polygon layer in one batch. This ensured that no polygons were inadvertently moved or joined, preserving the topology and original location. The alliance attribute for each polygon was determined by using a combination of field data points, images collected during helicopter surveys, and inferences from the aerial photo when the former two were not available due to the distance between helicopter survey transects.

2.4 Accuracy Assessment

To assess the accuracy of the vegetation map, we reserved 567 photo points that were not used in the polygon attribution process. To select these photos, we created a grid of 1.2 x 1.6-mile (2 x 2.5-km) cells and selected one photo from each cell, without inspecting the photograph. This ensured that assessment points were well-dispersed across the project, and not biased by the person selecting the photo. These photographs were withheld from the technician attributing alliances to each polygon, such that the polygons in the vicinity of the assessment photo point were identified solely on the basis of similarity of texture and color in the ortho to known polygons.

After all polygons were attributed, the assessment points were viewed. The random selection included 475 nadir images (399 in 2017 and 76 in 2019) and 92 oblique images (all in 2017), which were analyzed separately. Nadir photos can depict a small section of habitat below the MMU, but they closely correspond to their GPS location and will accurately depict the vegetation at a precise location. Nadir photographs are similar to the relevé plots frequently used in ground based vegetation mapping efforts, which can also be hindered by a small field of view for the observer. However, percent cover estimates recorded from above are considerably more accurate than from the ground, with the added benefit of the ability to revisit the image repeatedly as needed. Members of the nadir class were assigned a single alliance that dominated the field of view and the corresponding formation.

Members of the oblique class often included multiple alliances, with some capturing up to five alliances dispersed across several formations, making them ideal for distinguishing break points and ensuring that small polygons were correctly lumped or split in accordance with the MMU (Figure 2-2). However, the field of view did not always correspond to the location of the GPS coordinates. These cases were assigned alliances and corresponding formations in order of importance within the field of view: the vegetation closest to the bottom of the photo (most likely to be close to the GPS coordinates captured with the photo), then the other alliances in order of their proportion within the field of view.

Figure 2-2. Oblique Accuracy Assessment Point Photo

Note: This image shows two alliances, and two formations: the forested upper third and portions of the lower half are Great Basin Singleleaf Pinyon – Utah Juniper Shrub Woodland, and the shrub-dominated interspaces are Wyoming Big Sagebrush Dry Steppe and Shrubland.

After each photo was assessed, the images were matched to their corresponding vegetation polygon in the map by applying a spatial join. This GIS tool matched the point information of the photo to the polygon it fell within in the map. Lastly, the number of images whose formation matched the formation given to its corresponding polygon were tallied. For oblique images, a match was counted if one of the first three formations observed within the field of view was the same as the polygon's formation.

3. RESULTS

The helicopter allowed the surveyors to access and inspect vegetation throughout a broad reach of the proposed expansion areas, logging a total of 4,343 miles (6,989 km) of survey tracks in 2017 and 801 miles (1,289 km) in 2019 (Appendices A and B). Over the three survey efforts, a total of 61,585 images were collected: 60,627 in 2017 and 958 in 2019.

3.1 Vegetation Mapping Results

A total of 26 alliances from 7 formations were recorded within the proposed FRTC expansion areas (Tables 3-1 through 3-5; Figures 3-1 through 3-4). The majority of these were in the Cool Semi-Desert Scrub and Grassland Formation. Although the proposed B-16 Expansion Area is by far the smallest of the expansion areas, it was relatively diverse, with a good representation of upland alliances (Tables 3-1 and 3-2). The proposed B-20 Expansion Area was the least diverse, as most of it is a large, unvegetated playa (Tables 3-1 and 3-4). The margins of the proposed B-20 Expansion Area, particularly at the north end, were more diverse where soils and topography became more complex. The proposed DVTA and B-17 expansion areas had by far the most diverse assemblage of vegetation alliances, consistent with their large size and topographic complexity (Tables 3-1, 3-3, and 3-5). The lowest elevations of Dixie Valley were highly complex due to the presence of small seeps and springs as well as development and grazing. The proposed DVTA Expansion Area is the only area that contains mapped riparian alliances, although small seeps were found in B-17 that fell below the 2-ac (0.8-ha) MMU.

Table 3-1. Acreages and Elevation Ranges of Vegetation Alliances Found within the Proposed FRTC Expansion Areas

FORMATION	Elevation		Area		Proposed Expansion Area			
Alliance	(ft)	(m)	(ac)	(ha)	B-16	B-17	B-20	DVTA
COOL SEMI-DESERT SCRUB & GRASSLAND								
Bailey's Greasewood Shrubland	3,460–7,120	1,055-2,170	334,009	135,169	X	X	X	X
Black Sagebrush Steppe & Shrubland	3,960–7,440	1,207–2,268	57,595	23,308		X	X	X
Wyoming Big Sagebrush Dry Steppe & Shrubland	4,320–6,880	1,317–2,097	47,778	19,335	X	X		X
Basin Big Sagebrush - Foothill Big Sagebrush Dry Steppe & Shrubland	3,400–7,200	1,036–2,195	16,683	6,751		X	X	X
Big Sagebrush - Mixed Shrub Dry Steppe & Shrubland	3,600–6,920	1,097–2,109	11,567	4,681	X	X	X	X
Shadscale Saltbush Scrub	3,960–6,000	1,207–1,829	5,445	2,203	X	X	X	X
Rubber Rabbitbrush - Sand Buckwheat - Four-part Horsebrush Sparse Scrub	3,390–6,600	1,033–2,012	5,253	2,126	X	X	X	X
Cheatgrass Ruderal Grassland	3,960–6,820	1,207–2,079	2,929	1,185		X	X	X
Nevada Joint-fir Scrub	4,440–7,120	1,353–2,170	1,045	423		X		X
Yellow Star-thistle-Dyer's Woad-Prickly Russian Thistle Ruderal Annual Forb	3,960–4,880	1,207–1,487	1,912	774	X	X	X	X
Winterfat Steppe & Dwarf Shrubland	4,080–5,740	1,244–1,750	276	112		X	X	
Fourwing Saltbush – Rubber Rabbitbrush Desert Wash	3,390–3,450	1,033–1,052	164	66				X
Bud Sagebrush Shrubland	5,460	1,664	29	12		X		
SALT MARSH								
Microphytic Playa	3,390–4,120	1,033–1,256	136,314	55,164		X	X	X
Intermountain Greasewood Wet Shrubland	3,390–6,600	1,033–2,012	69,802	28,248	X	X	X	X
Mojave Seablite - Red Swampfire Alkaline Wet Scrub	3,400–4,080	1,036–1,244	6,740	2,727		X	X	X
Western Wildrye Alkaline Wet Meadow	3,390–4,900	1,033–1,494	599	242			X	X
Saltgrass Alkaline Wet Meadow	3,390–4,140	1,033–1,262	439	178		X		X
COOL TEMPERATE FOREST & WOODLAND								
Great Basin Singleleaf Pinyon - Utah Juniper/Shrub Woodland	4,040–7,480	1,231–2,280	30,038	12,156				X
Utah Juniper/Shrub Woodland	5,000–8,280	1,524–2,524	9,353	3,785		X		X
WARM DESERT & SEMI-DESERT SCRUB & GRASSLAND								
Mojave-Sonoran Burrobrush - Sweetbush Desert Wash Scrub	3,480–6,960	1,061–2,121	19,380	7,842		X	X	X
Fremont's Smokebush - Nevada Smokebush Desert Wash Scrub	4,200–5,800	1,280–1,768	1,715	694	X	X		
TEMPERATE FLOODED & SWAMP FOREST								
Ruderal Tamarisk Riparian Scrub*	3,410–6,880	1,039–2,097	183	74				X
Great Basin Fremont Cottonwood Riparian Forest*	5,080–7,280	1,548–2,219	87	35				X
SHRUB & HERB WETLAND FORMATION								
Western Baltic Rush - Mexico Rush Wet Meadow*	3,390–3,440	1,033–1,049	228	92				X
TEMPERATE TO POLAR FRESHWATER MARSH, WET MEADOW & SHRUBLAND								
Arroyo Willow Wet Shrubland*	4,440–6,960	1,353–2,121	346	140				X

*Riparian alliance

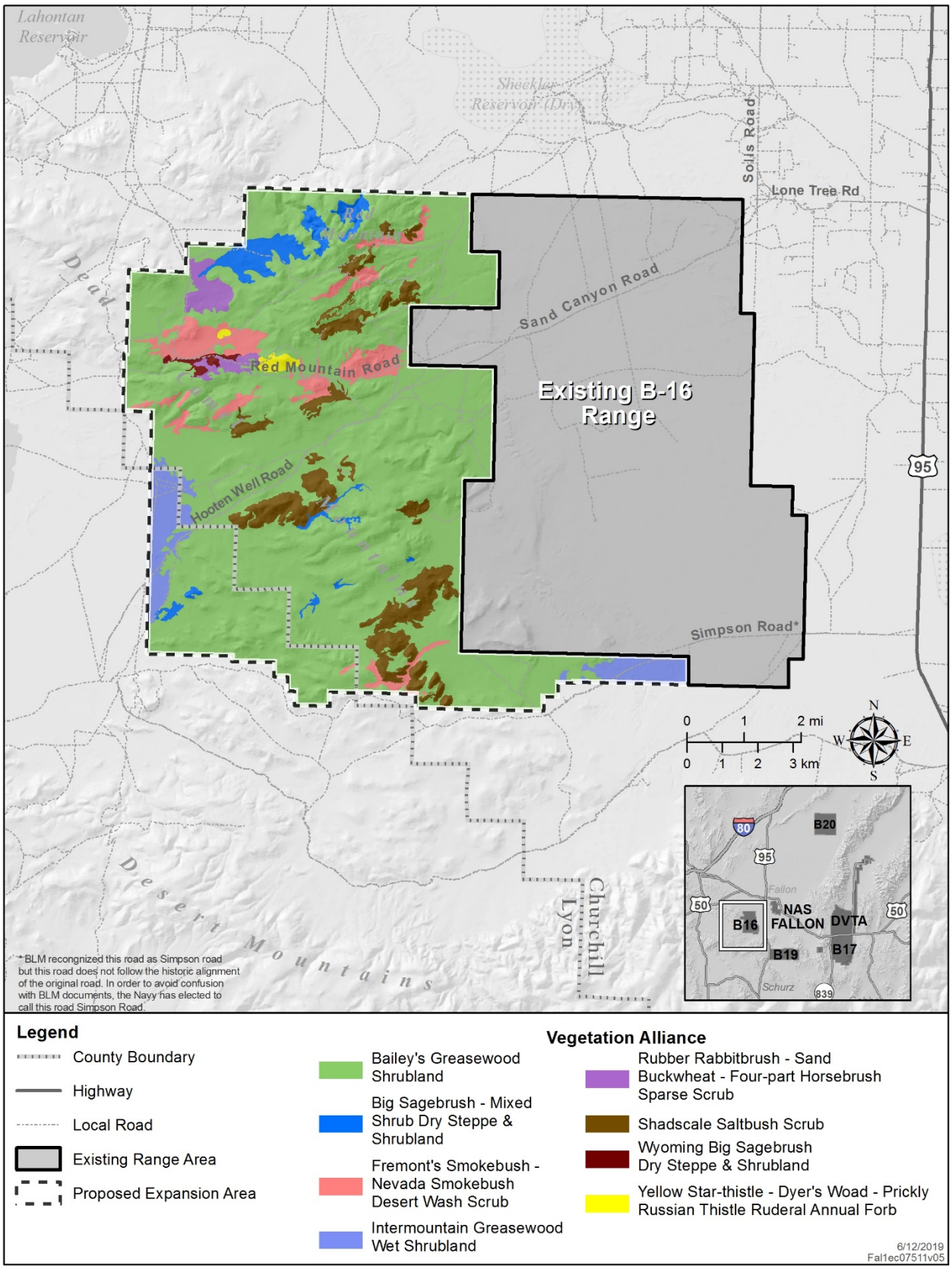

Figure 3-1. Vegetation Alliances within the Proposed B-16 Expansion Area

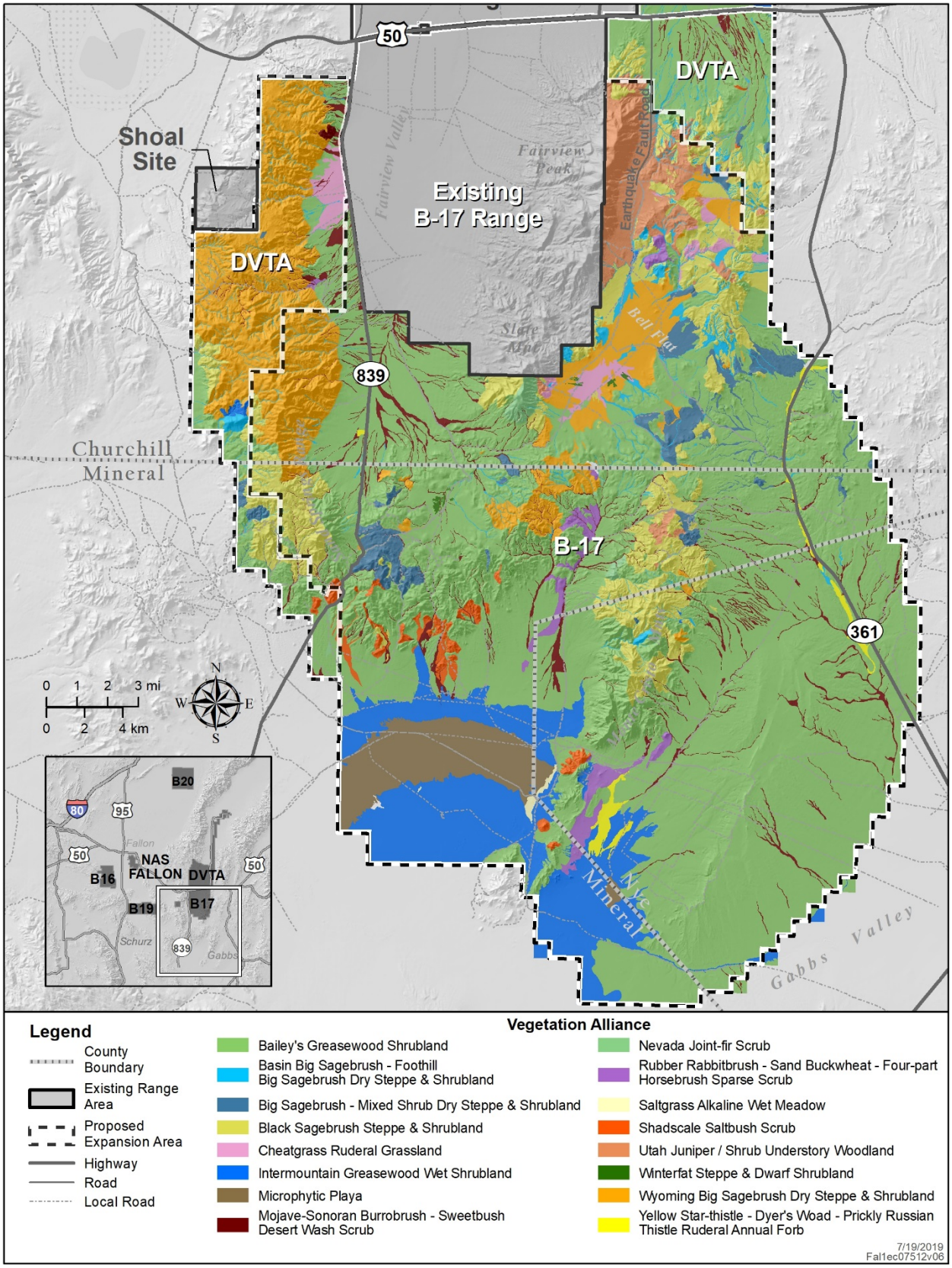

Figure 3-2. Vegetation Alliances within the Proposed B-17 and South DVTA Expansion Areas

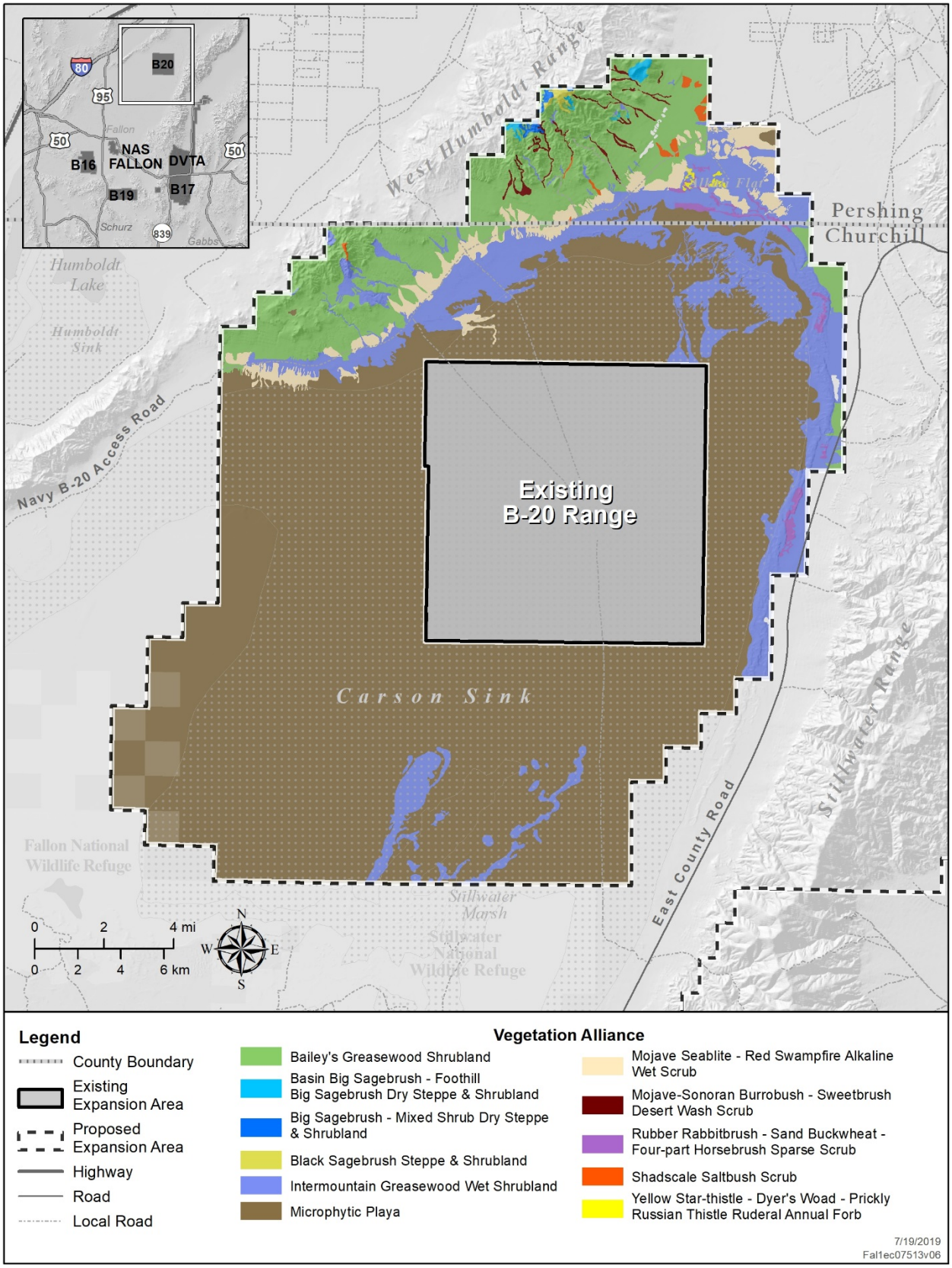

Figure 3-3. Vegetation Alliances within the Proposed B-20 Expansion Area

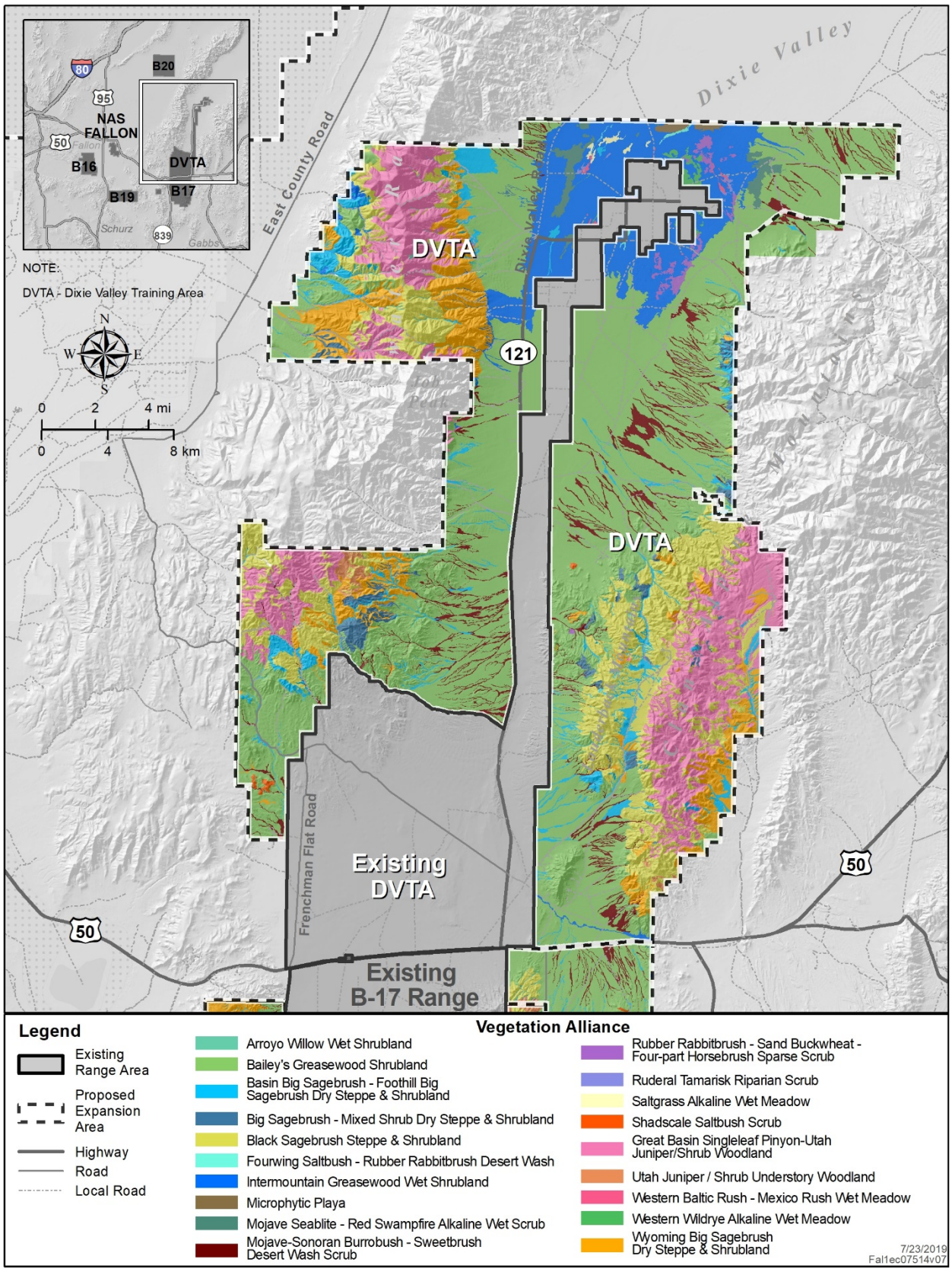

Figure 3-4. Vegetation Alliances within the Proposed North DVTA Expansion Area

Table 3-2. Acreages of Vegetation Alliances Found within the Proposed B-16 Expansion Area

Vegetation Alliance	Acres	Percent
Bailey's Greasewood Shrubland	25,262	78.4
Shadscale Saltbush Scrub	2,328	7.2
Fremont's Smokebush - Nevada Smokebush Desert Wash Scrub	1,676	5.2
Intermountain Greasewood Wet Shrubland	1,355	4.2
Big Sagebrush - Mixed Shrub Dry Steppe & Shrubland	918	2.8
Rubber Rabbitbrush - Sand Buckwheat - Four-part Horsebrush Sparse Scrub	473	1.5
Yellow Star-thistle - Dyer's Woad - Prickly Russian-thistle Ruderal Annual Forb	129	0.4
Wyoming Big Sagebrush Dry Steppe & Shrubland	105	0.3
Total	**32,246**	

Note: Refer to Figure 3-1.

Table 3-3. Acreages of Vegetation Alliances Found within the Proposed B-17 Expansion Area

Vegetation Alliance	Acres	Percent
Bailey's Greasewood Shrubland	151,022	59.7
Intermountain Greasewood Wet Shrubland	23,015	9.1
Black Sagebrush Steppe & Shrubland	19,649	7.8
Wyoming Big Sagebrush Dry Steppe & Shrubland	15,186	6.0
Microphytic Playa	8,632	3.4
Utah Juniper / Shrub Understory Woodland	8,186	3.2
Mojave-Sonoran Burrobrush - Sweetbush Desert Wash Scrub	7,238	2.9
Big Sagebrush - Mixed Shrub Dry Steppe & Shrubland	6,524	2.6
Basin Big Sagebrush - Foothill Big Sagebrush Dry Steppe & Shrubland	3,814	1.5
Rubber Rabbitbrush - Sand Buckwheat - Four-part Horsebrush Sparse Scrub	2,840	1.1
Shadscale Saltbush Scrub	2,216	0.9
Yellow Star-thistle - Dyer's Woad - Prickly Russian-thistle Ruderal Annual Forb	1,669	0.7
Cheatgrass Ruderal Grassland	1,623	0.6
Nevada Joint-fir Scrub	977	0.4
Saltgrass Alkaline Wet Meadow	224	0.1
Winterfat Steppe Dwarf Shrubland	192	0.1
Mojave Seablite - Red Swampfire Alkaline Wet Scrub*	41	<0.1
Fremont's Smokebush - Nevada Smokebush Desert Wash Scrub*	39	<0.1
Bud Sagebrush Shrubland*	29	<0.1
Total	**253,116**	

Notes: Refer to Figure 3-2. *Vegetation alliances totaling less than 100 acres are not depicted on Figure 3-2.

Table 3-4. Acreages of Vegetation Alliances Found within the Proposed B-20 Expansion Area

Vegetation Alliance	Acres	Percent
Microphytic Playa	127,234	70.2
Intermountain Greasewood Wet Shrubland	23,651	13.1
Bailey's Greasewood Shrubland	22,551	12.5
Mojave Seablite - Red Swampfire Alkaline Wet Scrub	4,968	2.7
Rubber Rabbitbrush - Sand Buckwheat - Four-part Horsebrush Sparse Scrub	803	0.4
Mojave-Sonoran Burrobrush - Sweetbush Desert Wash Scrub	580	0.3
Shadscale Saltbush Scrub	358	0.2
Basin Big Sagebrush - Foothill Big Sagebrush Dry Steppe & Shrubland	321	0.2
Big Sagebrush - Mixed Shrub Dry Steppe & Shrubland	205	0.1
Black Sagebrush Steppe & Shrubland	173	0.1
Yellow Star-thistle - Dyer's Woad - Prickly Russian-thistle Ruderal Annual Forb	109	0.1
Cheatgrass Ruderal Grassland*	94	0.1
Winterfat Steppe Dwarf Shrubland*	84	<0.1
Western Wildrye Alkaline Wet Meadow*	3	<0.1
Total	**181,134**	

Notes: Refer to Figure 3-3. *Vegetation alliances totaling less than 100 acres are not depicted on Figure 3-3.

Table 3-5. Acreages of Vegetation Alliances Found within the Proposed DVTA Expansion Area

Vegetation Alliance	Acres	Percent
Bailey's Greasewood Shrubland	135,174	46.1
Black Sagebrush Steppe & Shrubland	37,773	12.9
Wyoming Big Sagebrush Dry Steppe & Shrubland	32,487	11.1
Great Basin Singleleaf Pinyon - Utah Juniper / Shrub Understory Woodland	30,038	10.2
Intermountain Greasewood Wet Shrubland	21,782	7.4
Basin Big Sagebrush - Foothill Big Sagebrush Dry Steppe & Shrubland	12,548	4.3
Mojave-Sonoran Burrobrush - Sweetbush Desert Wash Scrub	11,561	3.9
Big Sagebrush - Mixed Shrub Dry Steppe & Shrubland	3,921	1.3
Mojave Seablite - Red Swampfire Alkaline Wet Scrub	1,731	0.6
Cheatgrass Ruderal Grassland	1,212	0.4
Rubber Rabbitbrush - Sand Buckwheat - Four-part Horsebrush Sparse Scrub	1,137	0.4
Utah Juniper / Shrub Understory Woodland	1,167	0.4
Western Wildrye Alkaline Wet Meadow	596	0.2
Microphytic Playa	448	0.2
Shadscale Saltbush Scrub	542	0.2
Ruderal Tamarisk Riparian Scrub	183	0.1
Saltgrass Alkaline Wet Meadow	215	0.1
Western Baltic Rush - Mexican Rush Wet Meadow	228	0.1
Fourwing Saltbush - Rubber Rabbitbrush Desert Wash	164	0.1
Arroyo Willow Wet Shrubland	346	0.1
Great Basin Fremont Cottonwood Riparian Forest*	87	<0.1
Nevada Joint-fir Scrub*	69	<0.1
Yellow Star-thistle - Dyer's Woad - Prickly Russian-thistle Ruderal Annual Forb*	6	<0.1
Total	**293,415**	

Notes: Refer to Figure 3-4. *Vegetation alliances totaling less than 100 acres are not depicted on Figure 3-4.

3.2 Vegetation Classification

The cover data collected during field surveys was used to generate a vegetation classification and membership rules for each alliance. The vegetation classification that accompanies a vegetation map gives explicit descriptions of the pieces that make up the map, by elaborating on and defining each piece. This makes comparison between maps possible and ensures similarity between how different observers may define a particular alliance (although it can also reveal differences). The classification should be used in conjunction with the map to determine the correct vegetation community for a particular site, and it can be used to tentatively determine the alliance for a nearby unmapped area. There are many ways to structure and present a vegetation classification, and our data conformed well to a polychotomous key (see Section 3.2.1) to supplement the alliance descriptions.

This type of key presents hierarchical, mutually exclusive choices that progressively narrow the available answers. For instance, a user can pick between tree, shrub or graminoid-dominated vegetation, then is only presented with options that fall within those categories. After the key directs the user to a particular alliance, the descriptions given below should be compared to the characteristics of the stand in question to ensure that it conforms. The early parts of the key depend on physiognomic and site characteristics such as hydrology. The lowest key choices rely on information about the dominant species in a stand and its percent cover. Dominance is related to vegetation layer, with trees always dominating shrubs, and shrubs dominating herbaceous or graminoid species. Generally, a particular species should exceed 5% relative cover of a site to dominate it, but sparse sites may have a dominant that covers less than 5%.

3.2.1. Key to Vegetation Alliances

I. Dominant vegetation shrubs; emergent trees no more than 5% absolute cover

1a. Upland sites, washes with only temporary inundation from runoff, and alkaline low-lying seeps/springs

2a. Dry washes and upland sites

3a. Stands dominated by *Artemisia* species or *Picrothamnus* species

4a. >10% relative cover of Wyoming sagebrush, all other shrubs subordinate……	*Wyoming Big Sagebrush Dry Steppe & Shrubland*
4b. >10% relative cover of black sagebrush, all other shrubs subordinate……	*Black Sagebrush Steppe & Shrubland*
4c. >10% relative cover of Basin big sagebrush, all other shrubs subordinate……	*Basin Big Sagebrush – Foothill Big Sagebrush Dry Steppe & Shrubland*
4d. >15% relative cover of bud sagebrush, all other shrubs subordinate……	*Bud Sagebrush Shrubland*

3b. Stands dominated by Amaranthaceous species

5a. Equal proportions of any sagebrush species and Bailey's greasewood, with at least one at >10% cover……..	*Big Sagebrush – Mixed Shrub Dry Steppe & Shrubland*
5b. Bailey's greasewood dominant, generally >15% but as low as 5% if no other shrubs present……	*Bailey's Greasewood Shrubland*
5c. Shadscale dominant and >5% cover……..	*Shadscale Saltbush Scrub*
5d. Winterfat dominant with any other shrubs present at lower cover……	*Winterfat Steppe & Dwarf-Shrubland*
5e. Stand dominated by intermountain greasewood, four-part horsebrush <1% cover……..	*Intermountain Greasewood Wet Shrubland*

3c. Active sand dune fields or soil composed of sand

6a. Stand dominated by four-part horsebrush, or codominant with intermountain greasewood……	*Rubber Rabbitbrush – Sand Buckwheat – Four-part Horsebrush Sparse Scrub*
6b. Stand dominated by Nevada smokebush at >5% cover……	*Fremont's Smokebush - Nevada Smokebush Desert Wash Scrub Alliance*

3d. Stands dominated by non-native annuals, former native alliance indistinguishable

7a. Stand dominated by cheatgrass at >80% with shrubs and native grasses <5% cover……	*Cheatgrass Ruderal Grassland*
7b. Russian thistle dominant at between 10% and 40% cover……	*Yellow Star-thistle – Dyer's Woad – Prickly Russian Thistle Ruderal Annual Forb*

3e. Stands not as above

8a. Sparse vegetation generally on alluvial fans or poorly recovering burned sites, dominated by Nevada joint-fir at >5% cover……	*Nevada Joint-fir Scrub*
8b. Washes at periphery of playas dominated by green rubber rabbitbrush at >5% cover, occasionally with fourwing saltbush codominant……	*Fourwing Saltbush – Rubber Rabbitbrush Desert Wash*
8c. Upland washes bisecting Bailey's greasewood or Wyoming sagebrush dominated by >5% cover of Burrobrush……	*Mojave-Sonoran Burrobrush - Sweetbush Desert Wash Scrub*
2b. Playa edges, alkaline soils, vegetation influenced by dry lakebed hydrology	
9a. Vegetation sparse and interlacing with bare microphytic playa, Mojave seablight at >3% cover with no more than 10% cover of other shrubs. If other shrubs present, they must be subordinate to Mojave seablight ……	*Mojave Seablite – Red Swampfire Alkaline Wet Scrub Alliance*
9b. Deeply incised washes and occasional flats on the periphery of playas dominated by Western wildrye at >2% cover with shrubs subordinate……	*Western Wildrye Alkaline Wet Meadow*
9c. Stand dominated by saltgrass, with shrubs no more than 10% absolute cover……	*Saltgrass Alkaline Wet Meadow*
9d. Naturally un-vegetated site maintained by seasonal inundation, total vascular plant cover no greater than 3%.....	*Microphytic Playa*
1b. Freshwater riparian shrubland, dominated by willow	
10. Riparian canyon bottom dominated by arroyo willow at >15% cover, occasionally silver buffaloberry codominant; emergent trees should be no higher than 5% cover……	*Arroyo Willow Wet Shrubland*
II. Dominant vegetation trees; tree cover exceeding 5% absolute cover	
1c. Riparian sites dominated by native deciduous trees or non-native tamarisk	
11a. Fremont cottonwood dominant, at >5% cover……	*Fremont Cottonwood Great Basin Riparian Forest*
11b. Tamarisk or Russian olive dominant, at >10% cover, willow and native shrubs subordinate……	*Ruderal Tamarisk Riparian Scrub*
1d. High-elevation upland sites dominated by native coniferous trees	
12a. Singleleaf pinyon >5% cover, with juniper no more than 95% cover……	*Great Basin Singleleaf Pinyon – Utah Juniper/ Shrub Woodland*
12b. Utah juniper dominant, with singleleaf pinyon occupying no more than 5% absolute cover in the stand……	*Utah Juniper/Shrub Woodland*
III. Dominant vegetation riparian graminoids; emergent shrubs or trees no more than 5% absolute cover	
13. Any rush, sedge, bulrush, or spikerush dominant with emergent shrubs or trees no more than 5% cover……	*Western Baltic Rush – Mexico Rush Wet Meadow*

3.2.2. Alliance Descriptions

Each mapped alliance is described below, including the rules for membership within the alliance, commonly encountered associates, and elevation ranges. Alliances are presented grouped under their respective formations. These descriptions are valid for the mapped areas, although they could be used with caution in the near vicinity. Characteristics such as elevation and co-occurring species can change within a given alliance from one area to another, although the dominant species remains the same. All photographs were taken during the course of the surveys from a helicopter.

3.2.2.1 Cool Semi-Desert Scrub and Grassland Formation

The Cool Semi-Desert Scrub and Grassland Formation encompasses the bulk of the survey areas (i.e., proposed expansion areas), both in acres and in the number of alliances within it. These alliances are dominated by shrubs or non-native annual species and occur at all but the highest elevations of the proposed expansion areas. Although some alliances occur in washes and canyons, none of the members of this formation are truly riparian.

Bailey's Greasewood Shrubland

The most common alliance in the survey areas, Bailey's Greasewood Shrubland encompassed 334,009 ac (135,169 ha) and occurred in all of the proposed expansion areas. This alliance is based on the presence of Bailey's greasewood and occurs at elevations of 3,460-7,120 ft (1,055-2,170 m) (Table 3-1). Total cover in this alliance is generally sparse, with Bailey's greasewood generally occupying between 15% and 30%, with some cases as low as 5% if no other shrubs are present. Particularly low cover of the dominant shrub usually include high cover of cheatgrass, and these areas are presumably facing cheatgrass invasion. Other shrubs commonly found in this alliance include bud sagebrush and winterfat (*Krascheninnikovia lanata*) at up to 35% cover, shadscale (*Atriplex confertifolia*) up to 15% cover, intermountain greasewood up to 20%, and big sagebrush occasionally up to 30% cover. Understory forbs were quite diverse, including non-native cheatgrass and flixweed (*Descurainia sophia*), Menzie's fiddleneck (*Amsinckia menziesii*), yellow pepperweed (*Lepidium flavum*) and desert dandelion (*Malacothrix glabrata*) (Figure 3-5).

Despite being the most common vegetation type recorded in this project, this alliance is not currently recognized by IVC, although the NNHP does include it and notes that this is likely an oversight related to the general lack of biological inquiry in the area. Data conforming to IVC submittal standards were collected for this alliance and will be submitted to assist in adding this alliance to IVC.

Figure 3-5. Bailey's Greasewood Shrubland Alliance

Black Sagebrush Steppe and Shrubland

This alliance occurred at slopes between 3,960 and 7,440 ft (1,207 and 2,268 m) that intergrade into pinyon woodland at the upper elevations and are occupied by black sagebrush, a diminutive relative of the Basin and Wyoming varieties of big sagebrush, that prefers steeper, rockier, less productive sites (Figure 3-6). The fourth largest in area, this alliance covers 57,595 ac (23,308 ha) within the proposed B-17, B-20, and DVTA expansion areas (Table 3-1). Black sagebrush occurs at up to 50% cover and should always contribute over 10%. This alliance was also heavily invaded with cheatgrass, at times with up to 70% cover when shrub cover was low. Bailey's greasewood can provide up to 30% cover, with sticky rabbitbrush and Wyoming big sagebrush (*Artemisia tridentata wyomingensis*) up to 15% cover. On slopes that transition to pinyon or juniper woodland, singleleaf pinyon and Utah juniper can occur at less than 4%. Both Basin big and Wyoming sagebrush can accompany black sagebrush in this alliance, but at a lower cover and only up to 20%. Understory elements include Sandberg bluegrass (*Poa secunda*), non-native crested wheatgrass (*Agropyron cristatum*), grizzlybear pricklypear (*Opuntia polyacantha* var. *erinacea*), and ricegrass (*Stipa hymenoides*).

Figure 3-6. Black Sagebrush Steppe and Shrubland Alliance

Wyoming Big Sagebrush Dry Steppe and Shrubland

Wyoming big sagebrush occurs as the dominant shrub in upland sites between approximately 4,320 ft and 6,880 ft (1,317 and 2,097 m) elevation, and occupied 47,778 ac (19,335 ha) (Table 3-1) within all of the proposed expansion areas except B-20. Stands of this alliance are composed of approximately 20-30% cover of Wyoming big sagebrush, or as much as 50% in some cases. Cover occasionally drops as low as 10% with an understory of grasses and forbs, but with shrubs subordinate (Figure 3-7). This alliance was also found to be heavily invaded by cheatgrass, with some stands registering up to 80% cover. Accompanying shrubs included sticky rabbitbrush and Nevada joint-fir with up to 15% cover, and occasionally Bailey's greasewood up to 10% cover. The understory contained up to 30% cover of James' galleta (*Hilaria jamesii*), as well as Sandberg bluegrass, tailcup lupine (*Lupinus caudatus caudatus*), and desert trumpet (*Eriogonum inflatum*).

Figure 3-7. Wyoming Big Sagebrush Dry Steppe and Shrubland Alliance

Basin Big Sagebrush – Foothill Big Sagebrush Dry Steppe and Shrubland

Wetter sites between 3,400 and 7,200 ft (1,036 and 2,195 m) such as wash bottoms and talus slopes within Wyoming big sagebrush stands were frequently occupied by Basin big sagebrush (*Artemisia tridentata tridentata*) and rubber rabbitbrush (Figure 3-8). This alliance covers 16,683 ac (6,751 ha) of the proposed expansion areas except B-16 (Table 3-1). Membership in this alliance requires that at least one of the two key species occurs at up to 40% cover and always over 10%. Cheatgrass can also occur at up to 40% in heavily invaded sites. Both species of greasewood can be associated with this alliance, but only up to approximately 30% cover. Basin wildrye (*Leymus cinereus*) and saltgrass occur in the graminoid layer, with only sparse forbs.

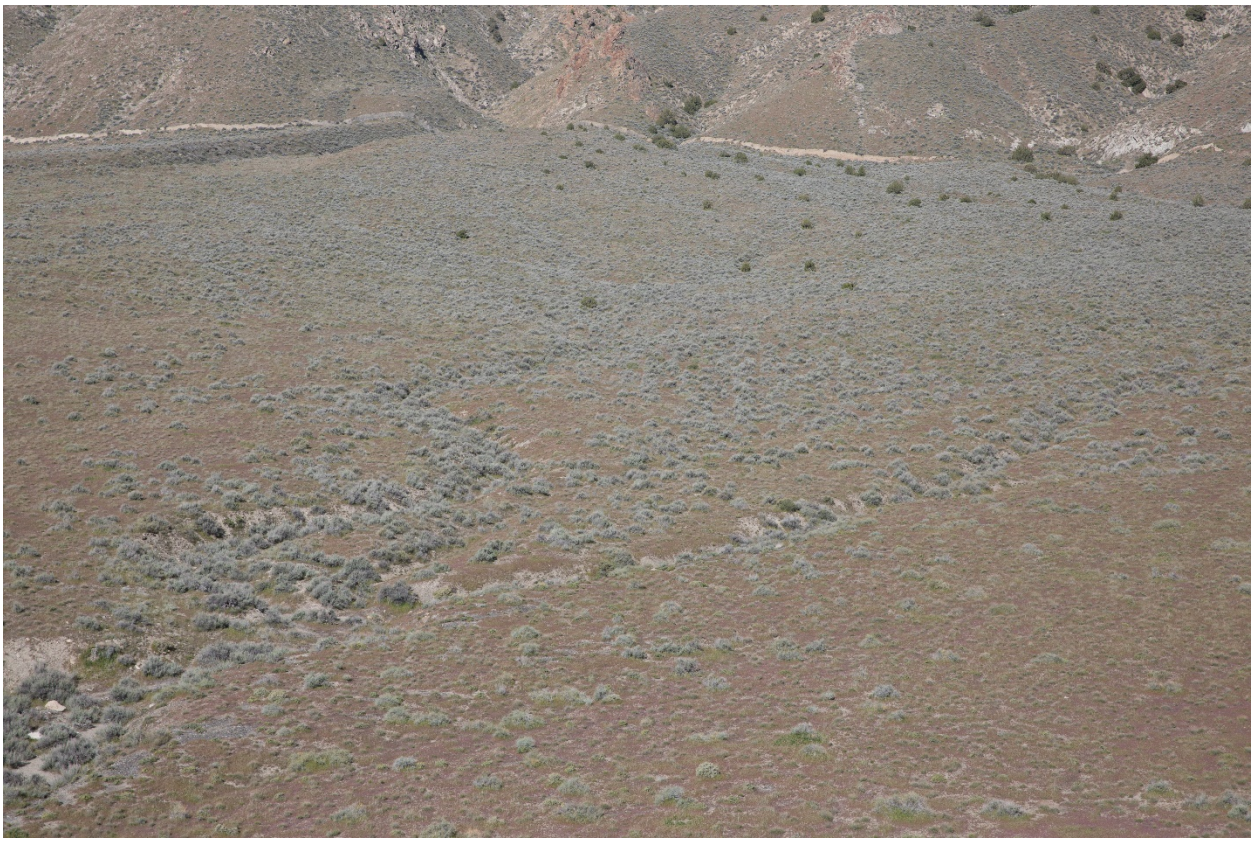

Figure 3-8. Basin Big Sagebrush – Foothill Big Sagebrush Dry Steppe and Shrubland Alliance

Note other alliances adjacent to the wash containing subject alliances: Wyoming Big Sagebrush Dry Steppe in right foreground, and Great Basin Singleleaf Pinyon – Utah Juniper/Shrub Woodland in background.

Big Sagebrush – Mixed Shrub Dry Steppe and Shrubland

The transition zone between Wyoming big sagebrush stands and Bailey's greasewood stands between 3,600 and 6,920 ft (1,097 and 2,109 m) merits its own alliance, as these areas contain co-dominant proportions of these species (Figure 3-9). A total of 11,567 ac (4,681 ha) of this alliance were mapped and it occurred within all the proposed expansion areas (Table 3-1). In order to qualify, the greater of the two key species should occur at above 10% cover, with shrubs other than the codominant being subordinate. These stands also frequently contain winterfat at up to 15% cover, and spiny hopsage and Nevada joint-fir at 5-10% cover; cheatgrass can occupy up to 65% cover.

Figure 3-9. Big Sagebrush – Mixed Shrub Dry Steppe and Shrubland Alliance

Shadscale Saltbush Scrub

Shadscale occupies lower elevations in sparse vegetation and frequently participates in other alliances, particularly Bailey's Greasewood. Delineating boundaries between these alliances can be difficult as they often intergrade. Sites between 3,960 and 6,000 ft (1,207 and 1,829 m) elevation can be dominated by shadscale at 5-25% cover, with all other shrub species subordinate. Occurring within all the proposed expansion areas, a total of 5,445 ac (2,203 ha) of this alliance were mapped (Table 3-1, Figure 3-10). Total vegetation cover is generally very low in these stands, although cheatgrass can grow at up to 40% cover in some stands. Shrub associates can include Mojave seablight, Nevada joint-fir, and both species of greasewood. Other non-native species in this alliance include saltlover (*Halogeton glomeratus*), clasping pepperweed (*Lepidium perfoliatum*), Russian thistle (*Salsola tragus*), and flixweed, all generally below 5% cover, although some stands can contain higher cover of salt-lover. Native forbs and graminoids can include silverscale saltbush (*Atriplex argentea*), squirreltail (*Elymus elymoides*), and Sandberg bluegrass.

Figure 3-10. Shadscale Saltbush Scrub Alliance
Note: This stand includes significant cover of Nevada joint-fir, center.

Rubber Rabbitbrush – Sand Buckwheat – Four-part Horsebrush Sparse Scrub

The playas and sinks that dominate low-lying areas in the project area provide a source of wind-transported sand that is deposited on the north and northeastern edges in short dunes. These dune fields can be partially stabilized by a community of shrubs and grasses that can withstand the periodic burial and exposure of moving dune fields. Where this community is dominated by four-part horsebrush (*Tetradymia tetrameres*) at 5-10% cover and intermountain greasewood at up to 20% cover, it falls into its own alliance (Figure 3-11). This alliance was found in all the proposed expansion areas, occurs between 3,390 and 6,600 ft (1,033 and 2,012 m) elevation, and encompasses 5,253 ac (2,126 ha) of the survey areas (Table 3-1). These stands occupy the leeward sides of dune faces, and occasionally creep up onto the tops of lower, protected dunes. Common shrub associates include four-wing saltbush and Mojave seablight at up to 10% cover, and rubber rabbitbrush up to 5%. Russian thistle can be particularly troublesome, occurring at up to 10% cover. Ricegrass and desert needlegrass (*Stipa hymenoides*) are often present at low cover, and a wide assortment of sand-loving annuals occur in spring.

Figure 3-11. Rubber Rabbitbrush – Sand Buckwheat – Four-part Horsebrush Sparse Scrub Alliance

Cheatgrass Ruderal Grassland Alliance

Although cheatgrass pervaded the survey areas and occurred at some level in most alliances, 2,929 ac (1,185 ha) were so thoroughly invaded by cheatgrass that they were defined as the Cheatgrass Ruderal Grassland Alliance (Table 3-1, Figure 3-12). Within the proposed B-17 (Figure 3-2) and B-20 (Figure 3-3) expansion areas, cheatgrass occupied up to 100% of the cover of these areas, spanned between the elevations of 3,960 and 6,820 ft (1,207 and 2,079 m), and was always over 80% cover. Shrubs and native grasses were less than 5%, and the original native alliance was so obscured as to be undefinable. These areas are likely linked to disturbance such as fires, overgrazing, or a combination of the two. The native shrubs shadscale and rubber rabbitbrush occasionally occurred at low levels (less than 2%).

Figure 3-12. Cheatgrass Ruderal Grassland Alliance
Note sharp line between adjacent alliance in background (possibly corresponding to a burn scar), and evidence of cattle grazing, center.

Nevada Joint-fir Scrub

Although a common associate of other alliances, Nevada joint-fir only rarely dominates a stand. However, on rocky, cobbly slopes and alluvial fans, particularly in the proposed B-17 Expansion Area, it can be the dominant shrub species, occupying up to 10% cover and occasionally as low as 5%. Associated subordinate shrubs included Mojave burrobrush (*Ambrosia salsola*), Bailey's greasewood, and sticky rabbitbrush (Figure 3-13). This alliance occupied 1,045 ac (423 ha) within the proposed B-17 and DVTA expansion areas and occurred between the elevations of 4,440 and 7,120 ft (1,353 and 2,170 m) (Table 3-1). Cheatgrass can heavily infest these stands, occasionally as high as 30% cover. Areas with particularly high cheatgrass cover and remnant Nevada joint-fir may indicate a past burn, particularly when sticky rabbitbrush and cheatgrass are both present. These stands may represent a transitional phase from Bailey's greasewood or shadscale-dominated stands into fire-affected stands dominated by Nevada joint-fir and cheatgrass.

Figure 3-13. Nevada Joint-fir Scrub Alliance
Note: This stand includes sticky rabbitbrush and Sandberg bluegrass.

Yellow Star-thistle – Dyer's Woad – Prickly Russian Thistle Ruderal Annual Forb Alliance

For this alliance, one or more of the diagnostic species may be present. During the current surveys, only Russian thistle was observed. Russian thistle was frequently found in the survey areas, occurring between the elevations of 3,960 and 4,880 ft (1,207 and 1,487 m). In sandy sites in all four proposed expansion areas, Russian thistle was dense enough to characterize the stand, with between 10 and 40% cover. In B-20, these stands were closely associated with the Rubber Rabbitbrush – Sand Buckwheat – Four-part Horsebrush Sparse Scrub, occupying the tops of dunes and windward sides (Figure 3-14). In the other areas, this alliance was found on flat sandy areas, generally intermixed with heavy cover of cheatgrass as well. Where cheatgrass and Russian thistle both occur to the exclusion of other species, the alliance should be given to the species with higher cover. Shadscale, desert needlegrass, smokebush (*Psorothamnus polydenius*), and four-part horsebrush may also occur within this alliance, but never at greater than 2% cover. This alliance occurred in all of the proposed expansion areas and covered 1,912 ac (774 ha) (Table 3-1).

Figure 3-14. Yellow Star-thistle – Dyer's Woad – Prickly Russian Thistle Ruderal Annual Forb Alliance
Note occasional emergent shrubs: intermountain greasewood, four-part horsebrush, and Mojave seablight.

Winterfat Steppe and Dwarf Shrubland

Winterfat generally occurs alongside and subordinate to Wyoming big sagebrush and Bailey's greasewood, but occasionally will dominate a stand on its own (Figure 3-15). These stands covered 276 ac (112 ha) in alluvial fans and wide valleys of the proposed B-17 and B-20 expansion areas between 4,080 and 5,740 ft (1,244 and 1,750 m) (Table 3-1). Winterfat cover can be as high as 15%, with sticky rabbitbrush, bud sagebrush, Bailey's greasewood, and Wyoming big sagebrush subordinate. Cheatgrass can occupy approximately 10% cover, and the understory is generally sparse.

Figure 3-15. Winterfat Steppe and Dwarf Shrubland Alliance
Note: This stand is heavily invaded with cheatgrass, particularly in foreground.

Fourwing Saltbrush – Rubber Rabbitbrush Desert Wash

Green rubber rabbitbrush (*Ericameria nauseosa* var. *oreophylla*) occupies sites with seasonal moisture in similar fashion to white rabbitbrush (*E. n.* var. *hololeuca*), except the former prefers alkaline sites, while the latter tends to be found in higher elevation washes, between 3,390 and 3,450 ft (1,033 and 1,052 m), and along road bar ditches. Green rubber rabbitbrush occupies from 5 to 20% cover in this alliance with other shrubs subordinate (Figure 3-16). These can include Torrey's saltbush (*Atriplex torreyi*), fourwing saltbush, and intermountain greasewood. Western wildrye may also be present at up to 10% cover. Stands of this alliance are extremely sparse, often with only 25% total cover. This alliance was mapped only within the proposed DVTA Expansion Area and encompassed 164 ac (66 ha) (Table 3-1).

Figure 3-16. Fourwing Saltbrush – Rubber Rabbitbrush Desert Wash Alliance

Bud Sagebrush Shrubland

A single 29-ac (12-ha) stand of Bud Sagebrush Shrubland was mapped at the north end of the proposed B-17 expansion area at 5,460 ft (1,664 m) elevation (Figure 3-2). It occurred on a bench between a wash bottom and hills dominated by Bailey's Greasewood Shrubland. This alliance is indicated by a strong dominance of bud sagebrush at approximately 25% cover with winterfat subordinate at approximately 5% cover and small contributions of Sandberg bluegrass at 2% cover (Figure 3-17). Additional annual species are likely present during the spring, and other perennial grass species probably co-occur in other stands (Peterson 2008). Because only one stand was mapped, only one rapid assessment plot was completed, so the range of species and cover values may be broader if additional stands are documented. Peterson (2008) notes that "little information is available" for this alliance, although he anticipates it may prove to be more common than presently documented.

Figure 3-17. Bud Sagebrush Shrubland
(Note presence of bud sagebrush and subordinate winterfat shrubs)

3.2.2.2 Salt Marsh Formation

Alliances within the Salt Marsh Formation generally occur on the margins of playa areas, where hydrologic conditions make conditions suitable for shrubby members of the Amaranthaceae family and few others. These alliances are often sparse and of low diversity, and generally occur on flat areas and the washes that bisect playa margins.

Microphytic Playa

The lowest-lying areas of the project are subjected to seasonal inundation by shallow lakes, occurring between 3,390 and 4,120 ft (1,033 and 1,256 m) within the proposed B-17, B-20, and DVTA expansion areas (Table 3-1). The lack of outflow from these areas forces the water to evaporate, leaving residues of salts and other minerals that preclude colonization by most plants (Figure 3-18). These areas are sometimes classified as "barren" in vegetation mapping, but they do support microscopic communities of cryptobiotic crusts, algae, lichens, diatoms, etc. At the margins, salt-tolerant species such as intermountain greasewood and Mojave seablight may intrude at low cover. The large playa that forms the majority of the proposed B-20 Expansion Area (Figure 3-3) makes this the second-largest alliance mapped, at 136,314 ac (55,164 ha).

Figure 3-18. Microphytic Playa Alliance
Note: Playa was partially inundated at the time of the survey.

Intermountain Greasewood Wet Shrubland

Intermountain greasewood occurs between the elevations of 3,390 and 6,600 ft (1,033 and 2,012 m) occupies seasonally or intermittently mesic sites generated by alkaline seeps and springs, or accumulation of surface flow on the margins of playas. A fringe of intermountain greasewood rings the playa areas throughout the survey areas and occasional washes and seeps in the proposed DVTA Expansion Area. This was the third-largest alliance recorded, at 69,802 ac (28,248 ha) and was found within all the proposed expansion areas (Table 3-1). The alliance is sparse, with 10–45% cover of intermountain greasewood, although this can be as low as 5% when no other shrubs are present (Figure 3-19). Cheatgrass was common in stands of this alliance, with some infested at up to 65% cover. Other shrubs commonly included four-part horsebrush at up to 30%; Mojave seablight, rubber rabbitbrush, and fourwing saltbush up to 20%; and Bailey's greasewood up to 10%, with the latter generally on the edges of stands or drier microsites. Understory is generally sparse but can include ricegrass, alkali sacaton (*Sporobolus airoides*), and desert needlegrass.

Figure 3-19. Intermountain Greasewood Wet Shrubland Alliance

Mojave Seablight – Red Swampfire Alkaline Wet Scrub

Mojave seablight interlaces with intermountain greasewood on playa edges and alkaline soils at low elevations between 3,400 and 4,080 ft (1,036 and 1,244 m) (Table 3-1). The alliance covered 6,740 ac (2,727 ha) within all proposed expansion areas except B-16, and is characterized by very sparse cover with 3–30% Mojave seablite with no more than 10% cover of other shrubs (Figure 3-20). The most common associated shrubs are intermountain greasewood and fourwing saltbush, both generally less than 10% cover. Stands often occur on black cryptobiotic crust soils, with crust comprising up to 60% cover. Non-native Russian thistle and salt-lover can occupy up to 5% cover, and cheatgrass and annual wheatgrass (*Eremopyron triticeum*) up to 30% cover.

Figure 3-20. Mojave Seablite – Red Swampfire Alkaline Wet Scrub Alliance
Note transition to Intermountain Greasewood Wet Shrubland Alliance in back left.

Saltgrass Alkaline Wet Meadow

Saltgrass occupies small mesic sites on edges of playas with reliable year-round water. This alliance covered 439 ac (178 ha) within the proposed B-17 and DVTA expansion areas, and was heavily dominated by saltgrass, at up to 90% cover between the elevations of 3,390 and 4,140 ft (1,033 and 1,262 m) (Figure 3-21). Associated shrubs include Mojave seablight, intermountain greasewood, rubber rabbitbrush, and Torrey's saltbrush, none of which should exceed 10% cover.

Figure 3-21. Saltgrass Alkaline Wet Meadow Alliance

Note: This stand also has significant cover of non-native salt-lover, and transitions to Intermountain Greasewood Wet Shrubland in the background.

Western Wildrye Alkaline Wet Meadow

Several flat plains and washes in the dune field margins contain stands dominated by western wildrye, occurring between the elevations of 3,390 and 4,900 ft (1,033 and 1,494 m) at 2–20% cover. Although shrubs occasionally occur intermixed with the wild rye, they never exceed 15% cover, and do not exceed the cover of wildrye (Figure 3-22). Associated shrubs include Basin big sagebrush, Torrey's saltbush, green rubber rabbitbrush, intermountain greasewood, and Mojave seablight. Saltgrass, cheatgrass, clasping pepperweed, and crested wheatgrass comprise the sparse understory. A total of 599 ac (242 ha) of this alliance were mapped within the proposed DVTA and B-20 expansion areas (Table 3-1).

Figure 3-22. Western Wildrye Alkaline Wet Meadow Alliance

3.2.2.3 Cool Temperate Forest and Woodland Formation

This formation contains the two high-elevation tree alliances. Neither of these produces stands of trees at sufficient density to be considered forest, and in combination with the shrub understory, this places it into a woodland instead. The boundary between the lower-lying shrublands and woodland stands can be difficult to distinguish, and likely fluctuates to some extent over decades. In some sites, both singleleaf pinyon and Utah juniper may be invading sagebrush habitat, assisted by changes in fire regimes and/or overgrazing.

Great Basin Singleleaf Pinyon – Utah Juniper/Shrub Woodland

Pinyon-juniper woodland occurred only within the proposed DVTA Expansion Area at elevations of 4,040 to 7,480 ft (1,231 to 2,280 m) and encompassed 30,038 ac (12,156 ha) (Table 3-1, Figure 3-23). The threshold for designating a site as woodland was 5% relative cover of trees, with up to 95% absolute cover of Utah juniper. Understory shrubs included black and Wyoming big sagebrush up to 40% cover, and Basin big sagebrush up to 20%. An understory of Sandberg bluegrass, Newberry's milkvetch (*Astragalus newberryi* var. *castoreus*), and carpet phlox (*Phlox hoodii*) is often accompanied by a diverse assemblage of annual and perennial forbs.

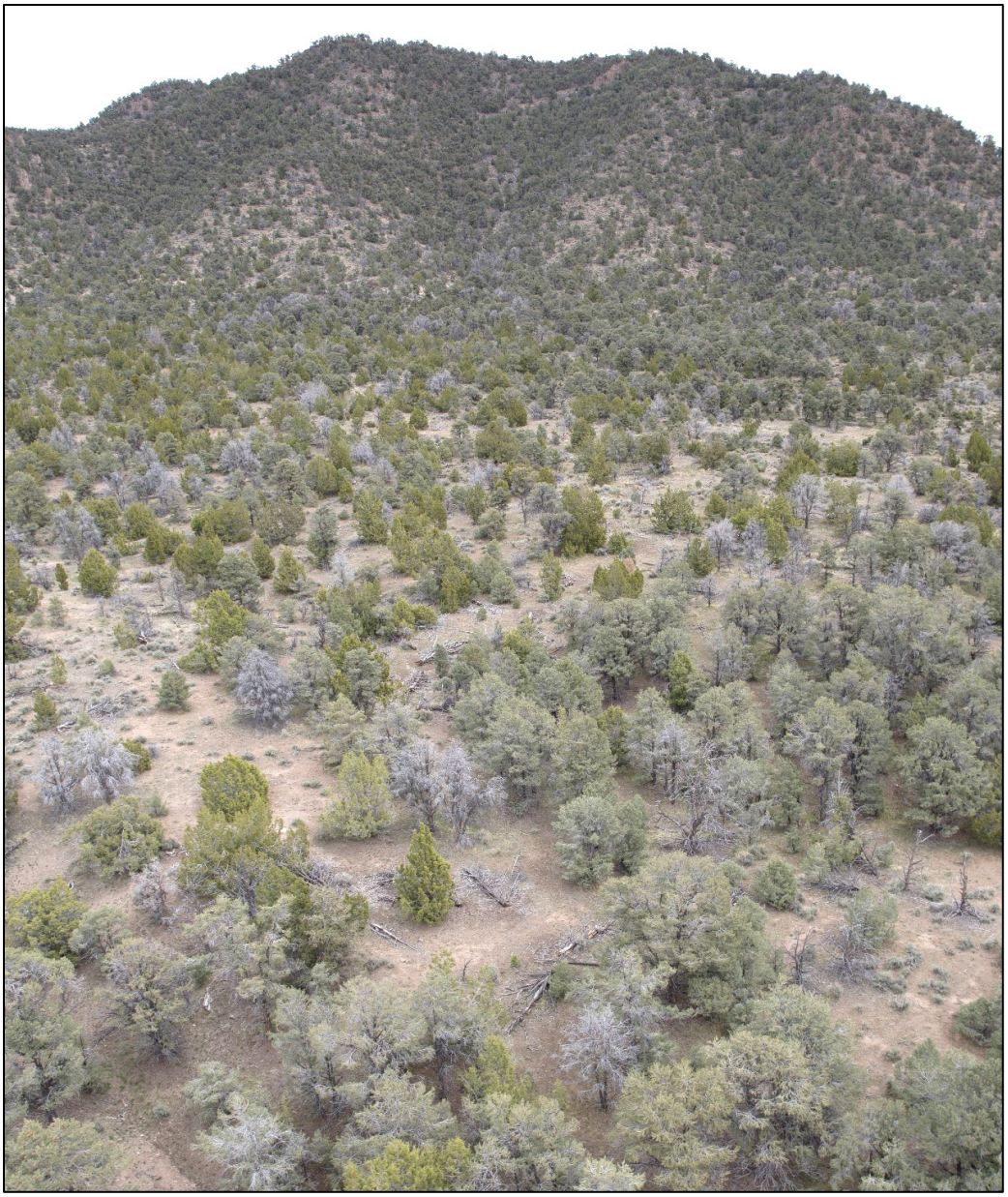

Figure 3-23. Great Basin Singleleaf Pinyon – Utah Juniper/Shrub Woodland Alliance
Note Utah juniper intermixed with singleleaf pinyon, left and background.

Utah Juniper/Shrub Woodland

Stands with tree cover over 5%, with no more than 5% absolute cover of singleleaf pinyon pine, are designated as Utah Juniper Shrub Woodland, and generally occur between 5,000 and 8,280 ft (1,524 and 2,524 m). Utah juniper cover ranges up to 15%, with an understory of black and Wyoming big sagebrush up to 30% (Figure 3-24). Basin big sagebrush can occur up to 15%, and some lower elevation sites can also contain up to 10% cover of Bailey's greasewood. Cheatgrass comprises up to 15% cover in this alliance. Understory graminoids and forbs are generally sparse but can include James' galleta and ricegrass. A total of 9,353 ac (3,785 ha) was mapped within the proposed B-17 and DVTA expansion areas (Table 3-1).

Figure 3-24. Utah Juniper Shrub Woodland Alliance

3.2.2.4 Warm Desert & Semi-Desert Scrub & Grassland Formation

The two alliances of this formation occur in dry washes and sand dune areas throughout the survey areas.

Mojave-Sonoran Burrobrush – Sweetbush Desert Wash Scrub

Dry washes winding through Bailey's greasewood are often dominated by Mojave burrobrush at 5–50% cover with few other shrubs present (Figure 3-25). The washes channel runoff and only contain water during and shortly after rainfall events, which benefits burrobrush's high germination rates, short lifespan, and shallow root systems. This alliance occurs between the elevations of 3,480 and 6,960 ft (1,061 and 2,121 m) (Table 3-1). The regular disturbance precludes colonization by most other shrubs, although Wyoming big sagebrush, intermountain and Bailey's greasewood, spiny hopsage, and bud sagebrush can occur on the margins at less than 10% cover. The understory is generally sparse, but cheatgrass can occur at up to 25% cover. Sandberg bluegrass, ricegrass, and annual forbs contribute to the understory. This alliance occurs on all proposed expansion areas except for B-16 and encompassed 19,380 ac (7,842 ha) (Table 3-1).

Figure 3-25. Mojave-Sonoran Burrobrush – Sweetbush Desert Wash Scrub Alliance
Note: Adjacent alliance above the wash is Wyoming Big Sagebrush Dry Steppe and Shrubland.

Fremont's Smokebush - Nevada Smokebush Desert Wash Scrub Alliance

Nevada smokebush (*Psorothamnus polydenius*) is a sand-loving shrub that likely occurred over a wider range than it does presently. It occurred within the proposed B-16 and B-17 expansion areas between 4,200 and 5,800 ft (1,280 and 1,768 m) and on 1,715 ac (694 ha) (Table 3-1). Documented stands included high cover of cheatgrass and Russian thistle, which may be in the process of replacing Nevada smokebush (Figure 3-26). This alliance is characterized by up to 15% cover of smokebush, with only occasional occurrences of Bailey's greasewood, Nevada joint-fir, and sticky rabbitbrush at less than 5% cover. Cheatgrass was ubiquitous in these stands, occupying 15–40% cover. Bare ground is likely occupied by ephemeral annual species, but this is a sparse and depauperate alliance in general.

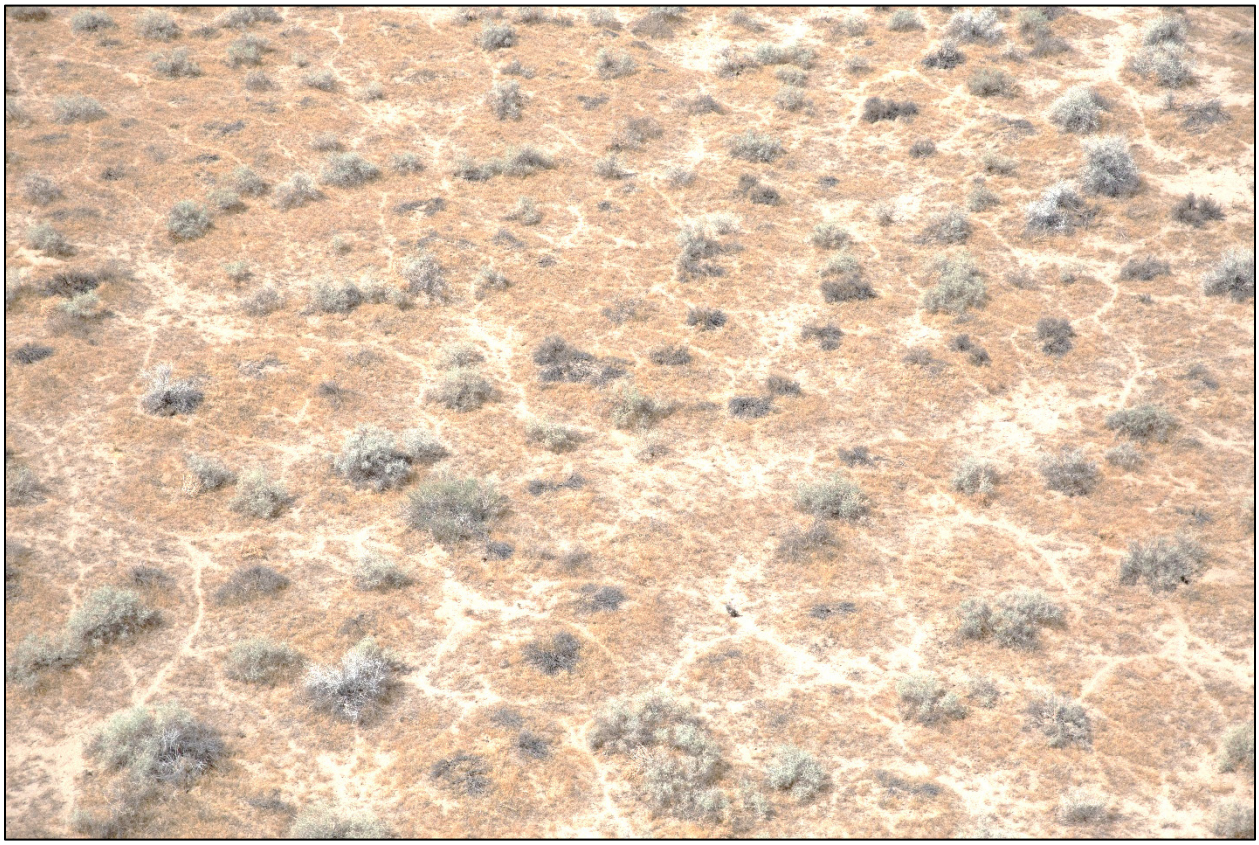

Figure 3-26. Fremont's Smokebush - Nevada Smokebush Desert Wash Scrub Alliance

3.2.2.5 Temperate Flooded & Swamp Forest Formation

This riparian forest formation occurs only in the proposed DVTA Expansion Area (Table 3-1), particularly in the Stillwater and Louderback mountains.

Ruderal Tamarisk Riparian Scrub

Tamarisk or salt cedar (*Tamarix ramosissima)* occurred in the proposed DVTA Expansion Area and in some of the canyons in the Stillwater Mountains. The low-elevation stands are associated with homesteads and disturbance, while the mountain canyon stands are native willow or cottonwood riparian areas that have been invaded more recently. Stands of Russian olive are also lumped into this non-native tree dominated alliance, which ranged from approximately 3,410 to 6,880 ft (1,039 to 2,097 m) and covered 183 ac (74 ha) (Table 3-1, Figure 3-27). Cover of tamarisk or Russian olive ranges from 10 to 90%, with a depauperate understory generally composed of non-native forb or grass species such as five-hook bassia (*Bassia hyssopifolia*) and rabbitfoot grass (*Polypogon monspeliensis*).

Figure 3-27. Ruderal Tamarisk Riparian Scrub Alliance
Note the mix of Russian olive and tamarisk, with the Western Baltic Rush – Mexico Rush Wet Meadow Alliance (center).

Great Basin Fremont Cottonwood Riparian Forest

Fremont cottonwood trees create shady gallery forests along the middle slopes and bases of wet canyons on both sides of the Stillwater Mountains between 5,080 ft and 7,280 ft (1,548 m and 2,219 m) elevation (Table 3-1, Figure 3-28). Understory shrub species include arroyo and red willow (*Salix laevigata*), Russian olive up to 30% cover, and desert snowberry (*Symphoricarpos longiflorus*) at up to 5% cover, with particularly wet sites harboring perennial water lovers such as narrowleaf cattail and stream orchid (*Epipactis gigantea*). These sites can be highly diverse, often including members of the rush (*Juncus*) and sedge (*Carex*) genera, or heavily disturbed by wildlife and feral ungulates. They provide water for wildlife and nesting sites for riparian bird species. Russian olive and tamarisk infestations in this alliance present an opportunity for improvement of this valuable resource. A total of 87 ac (35 ha) of cottonwood groves were mapped only within the proposed DVTA Expansion Area (Table 3-1).

Figure 3-28. Fremont Cottonwood Great Basin Riparian Forest Alliance

Note: This stand transitions to Arroyo Willow Wet Shrubland as it descends (right). Adjacent alliance is Basin Big Sagebrush – Foothill Big Sagebrush Dry Steppe and Shrubland.

3.2.2.6 Shrub and Herb Wetland Formation

Western Baltic Rush – Mexico Rush Wet Meadow

This alliance is heavily dominated (occasionally up to 100% cover, and always over 50%) by one or more species of rush (*Juncus*), sedge (*Carex*), bulrush (*Schoenoplectus*), and/or spikerush (*Eleocharis*). This alliance occurred only within the proposed DVTA Expansion Area at elevations of 3,390 and 3,440 ft (1,033 and 1,049 m). The majority was found near perennial water, and many areas fell below the 2-ac (0.8-ha) MMU, so this alliance may be more common than represented here. The mapped stands totaled 228 ac (92 ha) (Table 3-1). Stands may be intermixed with Russian olive or tamarisk stands, and may have alkali sacaton, squirreltail, green rubber rabbitbrush, Mojave seablite, or intermountain greasewood on the margins (Figure 3-29).

Figure 3-29. Western Baltic Rush – Mexico Rush Wet Meadow Alliance
Note: Adjacent alliance is Mojave Seablite – Red Swampfire Alkaline Wet Scrub, and shrubs in background are tamarisk.

3.2.2.7 Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland Formation

Arroyo Willow Wet Shrubland

Riparian zones dominated by arroyo willow (*Salix lasiolepis*) grow on seasonally flooded stream benches and occasionally seeps, and often form stringer communities along moist drainages with nearly year round water, particularly in the Stillwater Mountains. Found only within the proposed DVTA Expansion Area at elevations between 4,440 and 6,960 ft (1,353 and 2,121 m), this alliance totals 346 ac (140 ha) (Table 3-1). The tall shrub layer is dominated by arroyo willow which forms a dense overstory ranging from 15-70% cover (Figure 3-30). Arroyo willow was often accompanied by silver buffaloberry (*Shepherdia argentea*) at up to 40% cover and an understory of Wood's rose, common dogbane (*Apocynum cannabium*), Basin big sagebrush, rubber rabbitbrush, and desert snowberry, all representing under 5% cover. Rarely, emergent Fremont cottonwood trees may be present, but should not exceed 5% absolute cover. Willow stands provide important habitat for mammals, birds, and invertebrates, as well as a diverse assemblage of graminoids and forbs that need shade and moisture.

Figure 3-30. Arroyo Willow Wet Shrubland Alliance
Note emergent Fremont cottonwood tree at top.

4. ACCURACY ASSESSMENT

Total accuracy of the vegetation map was 87% at the formation level, averaged from the two accuracy assessment photo classes. This percentage was derived from an average of the separate analyses of the nadir and oblique accuracy assessment photos (see section 2.4). Accuracy at the formation level for the nadir points was 90%, while the oblique points fell slightly lower, at 85% (Tables 4-1 and 4-2). In both cases, accuracy was related to the number of sampling points, although this was less true for the oblique images. The discrepancy between classes in the accuracy/number of points relationship is likely related to the fact that the Cool Semi-Desert Scrub & Grassland Formation is fragmented and sliced by the Warm Desert & Semi-Desert Scrub & Grassland Formation where washes bisect Bailey's Greasewood Shrubland Alliance. The failed oblique images often either had the GPS point fall within a wash that was not visible in the image, or the wash was visible but the GPS point fell just outside the thin linear strip in the upland vegetation. This also accounts for the overall low accuracy of the Warm Desert formation.

Table 4-1. Accuracy of Nadir Assessment Points by Formation

Formation	Number of Matches	Number of Assessment Points	Accuracy
Cool Semi-Desert Scrub & Grassland	293	308	95%
Salt Marsh	51	57	89%
Cool Temperate Forest & Woodland	10	15	67%
Warm Desert & Semi-Desert Scrub	4	18	22%
Shrub & Herb Wetland	0	1	0%
Total	**358**	**399**	**90%**

Table 4-2. Accuracy of Oblique Assessment Points by Formation

Formation	Number of Matches	Number of Assessment Points	Accuracy
Salt Marsh	12	13	92%
Cool Semi-Desert Scrub & Grassland	54	63	86%
Cool Temperate Forest & Woodland	11	13	85%
Warm Desert & Semi-Desert Scrub & Grassland	1	2	50%
Temperate Flooded & Riparian Scrub	0	1	0%
Total	**78**	**92**	**85%**

The overall lower accuracy of the oblique assessment indicates that even though we allowed for multiple alliances within the field of view, these points retained some inherent inaccuracy. The formations with more common alliances were more likely to rank higher in the accuracy assessment, as the greater number of sampling points reduced the chance for error resulting from photo collection protocol. Alliances and formations that were rare are generally the small, linear riparian or wash types that were particularly sensitive to this type of error. However, the combined accuracy of 87% indicates that the map is of high enough quality to be useful on the ground and reflective of the vegetation in the surveyed areas.

5. CONCLUSIONS AND RECOMMENDATIONS

The mapped vegetation of the proposed FRTC expansion areas is primarily shaped by the forces of hydrology, elevation and soils, with marked differences in the floristic and physiognomic characteristics as these factors vary. The low-lying, regularly inundated areas generally support members of the Salt Marsh Formation and are dominated by members of the Amaranthaceae family. As elevation increases, water is both less available and less saline and soils become better drained, allowing a greater diversity of grasses, forbs and shrubs to appear. The middle slopes are almost entirely dominated by the Bailey's Greasewood Shrubland Alliance, with an interlacing of other alliances along washes and rocky slopes. The very highest, coldest elevations are dominated by trees, split between Utah juniper and singleleaf pinyon pine. A few small niche habitats such as graminoid-dominated wetlands and willow-dominated canyons occur where perennial fresh water is available, and these sites support a rich assemblage of flora and fauna.

The vast scale of this landscape and project was well-suited to survey from the air. The aerial platform allowed surveyors access to nearly every corner of the site, and greatly facilitated comparison of vegetation communities across the survey areas. It was possible to develop and test membership rules across a large area and determine valid and repeatable methods for delineating stands and break points between adjacent communities.

Future vegetation mapping efforts that encompass this large of a footprint should incorporate a similar approach, although some valuable lessons were learned that could be useful adaptations for future similar survey efforts. Formalizing a low/high approach to survey points may be particularly useful. Beginning a survey of a stand at low altitude first can help to identify the component species and determine densities for comparison to membership rules. This low level inspection can be as low as needed, including a brief stop on the ground. Then, proceeding to a higher altitude can help with defining the stand boundaries and putting each neighboring alliance in context. Incorporating nadir and oblique images at both stages would ensure that field observations could be revisited later as needed.

On the whole, the observed vegetation fits well into IVC, with the somewhat glaring exception of the Bailey's Greasewood Shrubland Alliance. As noted by the NNHP, this oversight is likely to be corrected as projects such as this effort continue to map the vegetation of Nevada. Further collection of cover data in that alliance and others will help IVC continue to refine and improve their descriptions of each community.

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Appendix A: 2017 Survey Tracks and Photo Points

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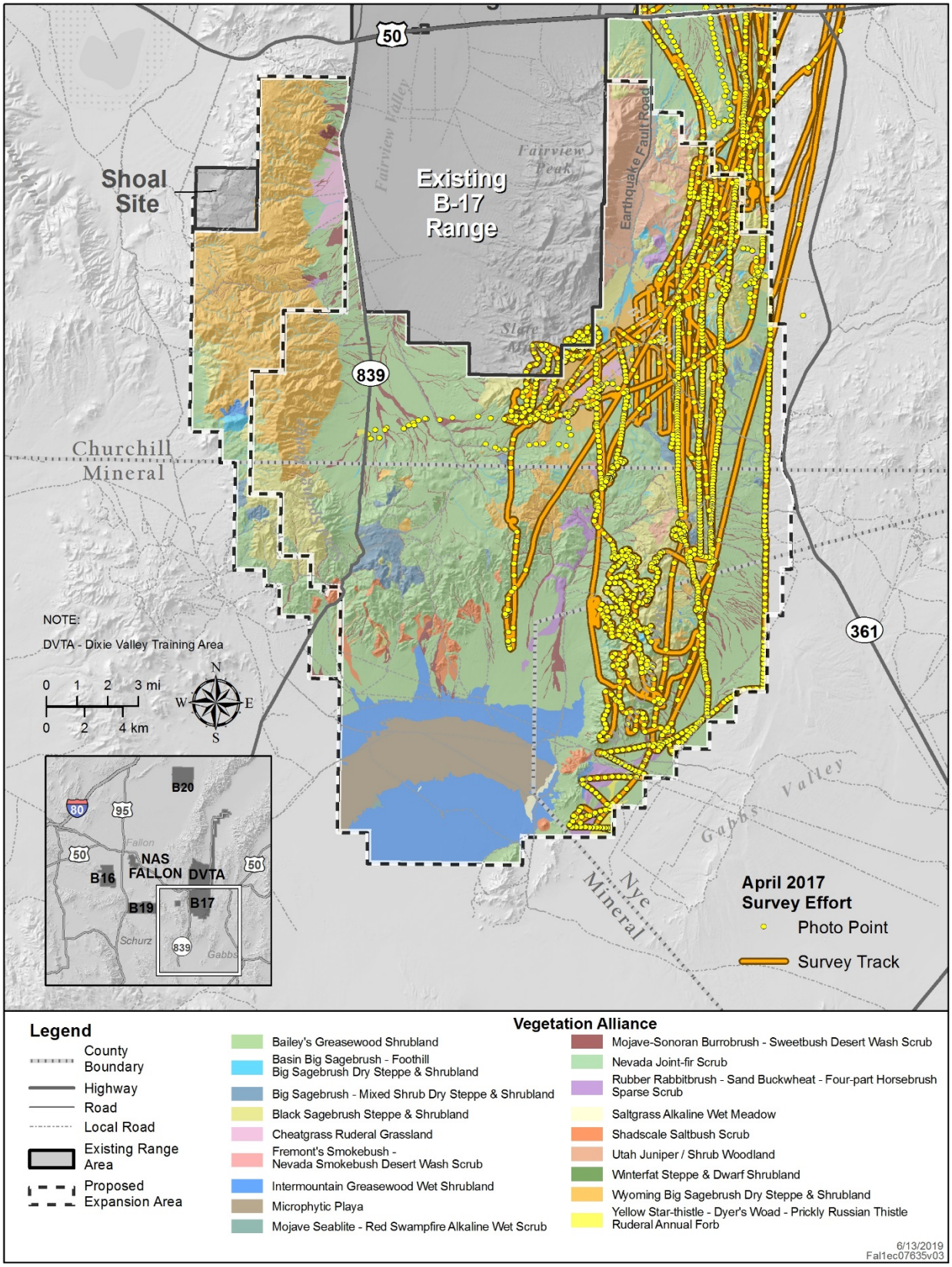

Figure A-1. April 2017 Survey Tracks and Photo Points – Proposed B-17 and Southern DVTA Expansion Areas

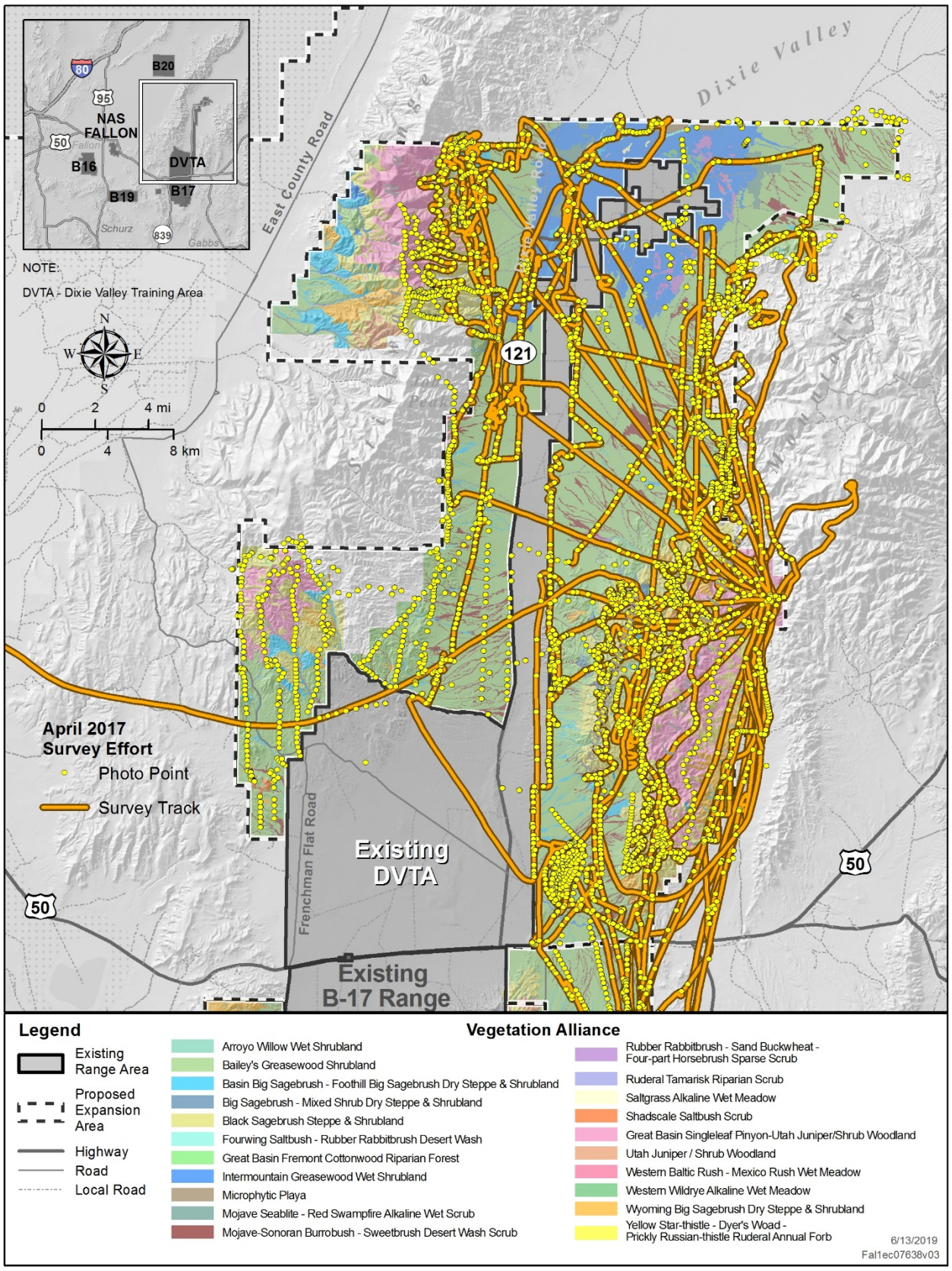

Figure A-2. April 2017 Survey Tracks and Photo Points – Proposed Northern DVTA Expansion Area

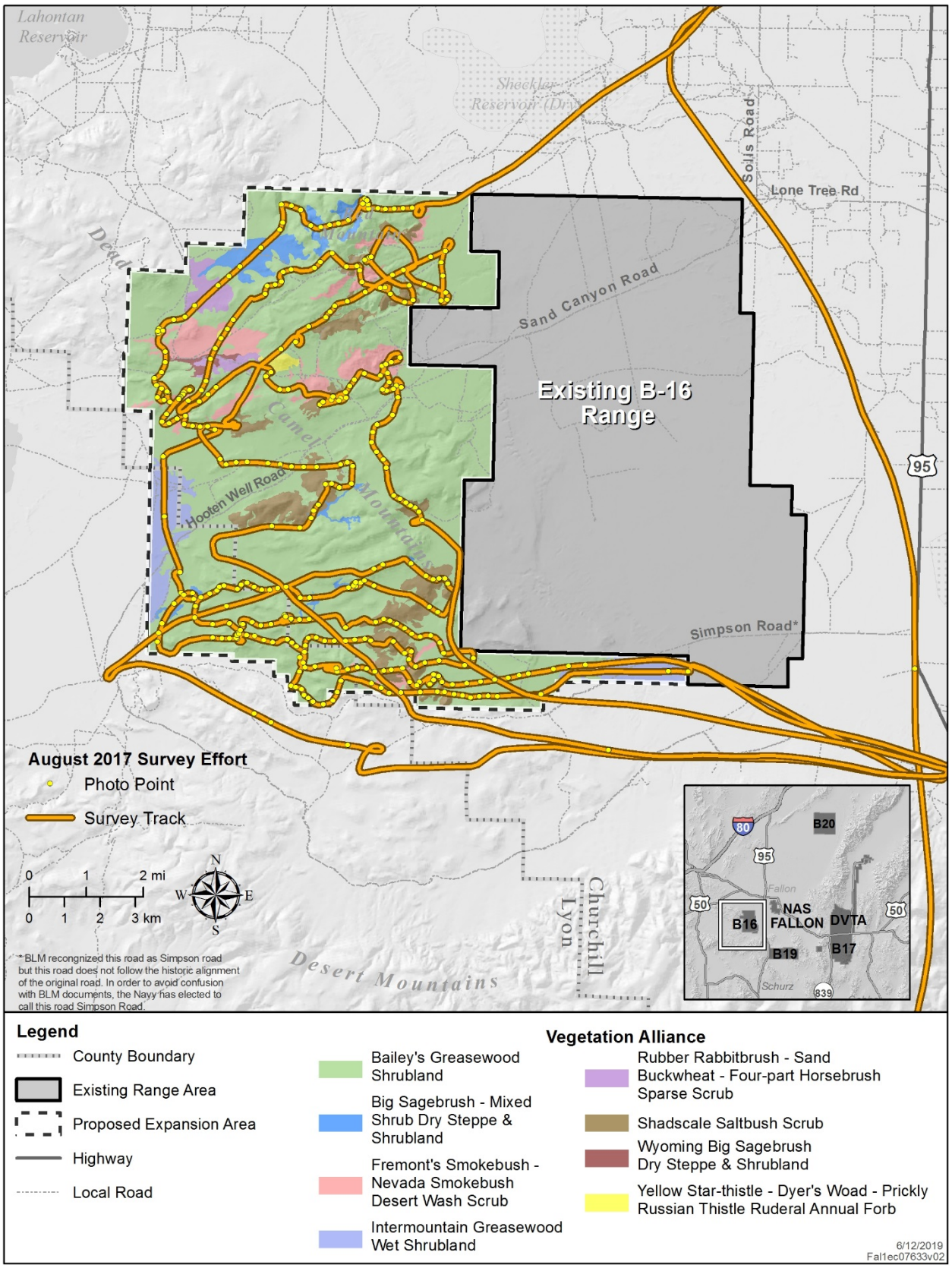

Figure A-3. August 2017 Survey Tracks and Photo Points – Proposed B-16 Expansion Area

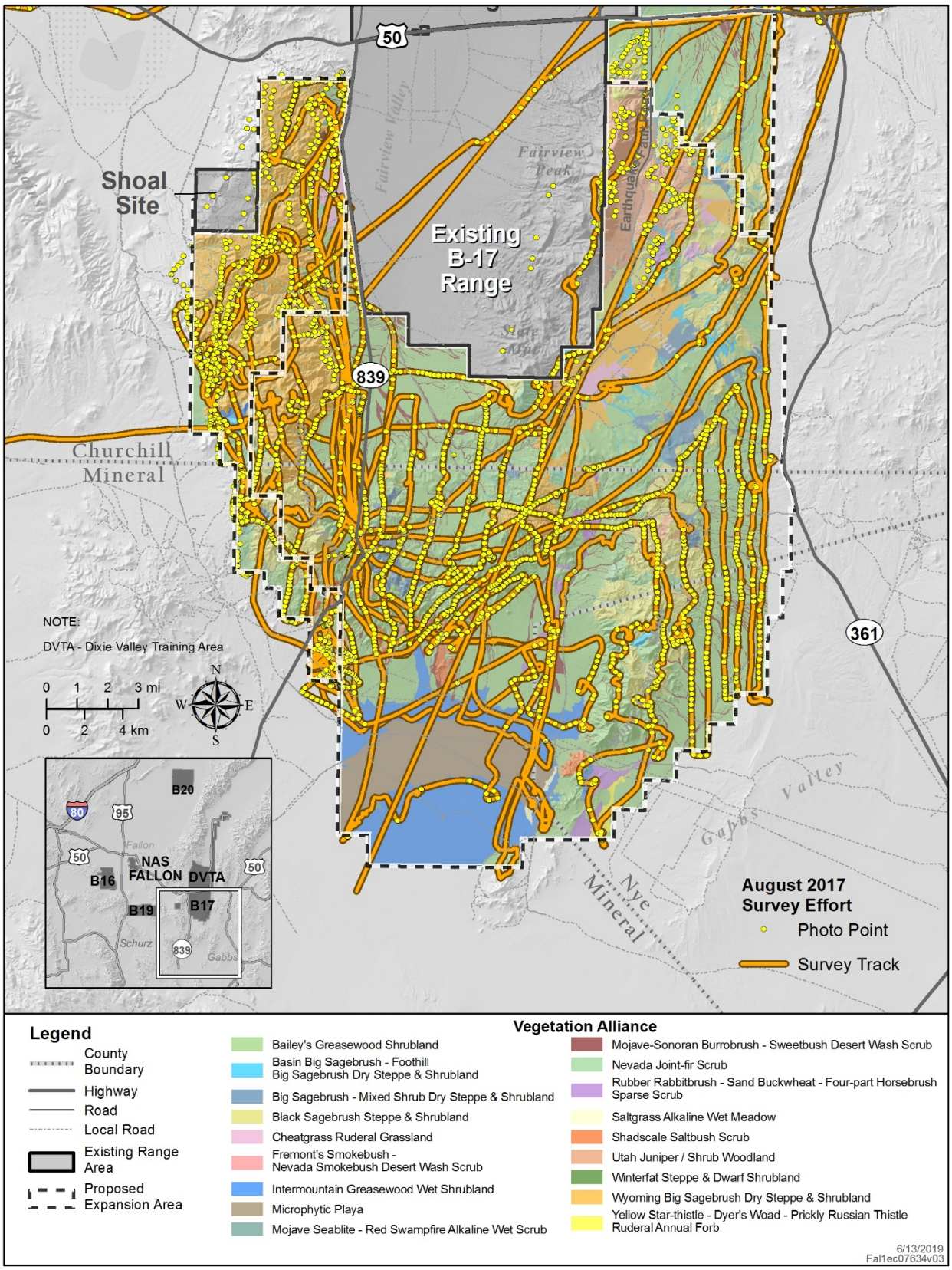

Figure A-4. August 2017 Survey Tracks and Photo Points – Proposed B-17 and Southern DVTA Expansion Areas

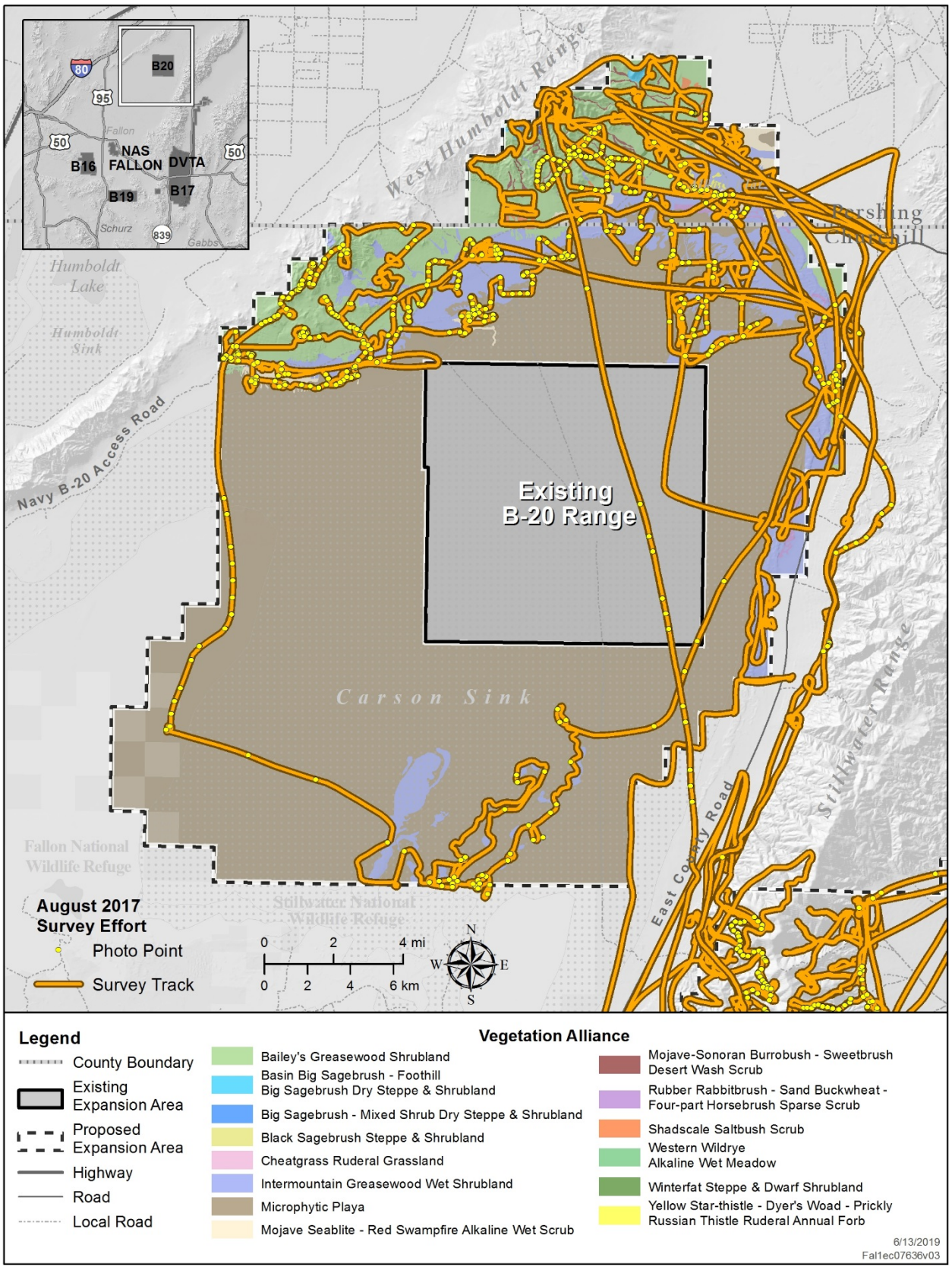

Figure A-5. August 2017 Survey Tracks and Photo Points – Proposed B-20 Expansion Area

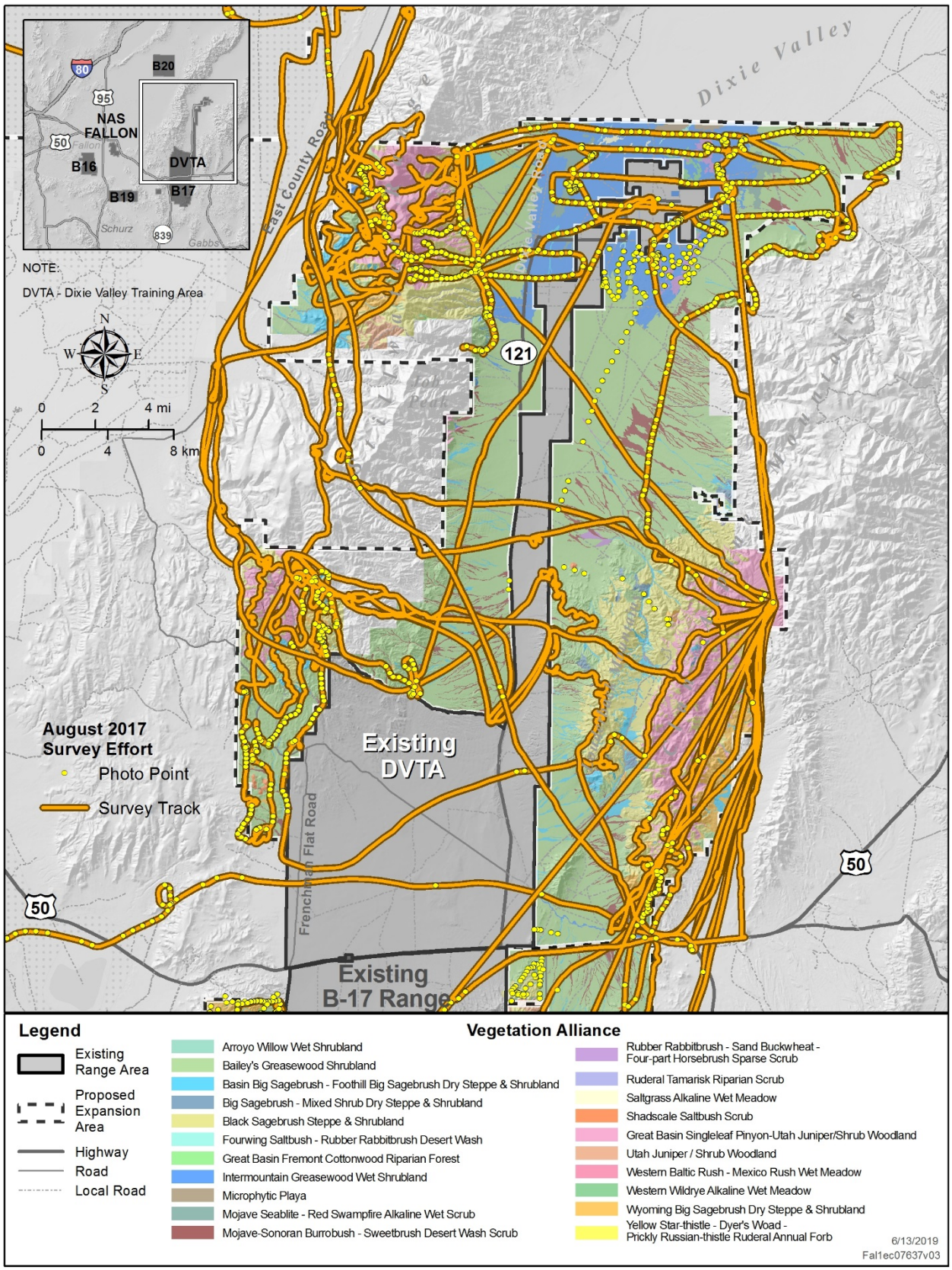

Figure A-6. August 2017 Survey Tracks and Photo Points – Proposed Northern DVTA Expansion Area

Appendix B: 2019 Survey Tracks and Photo Points

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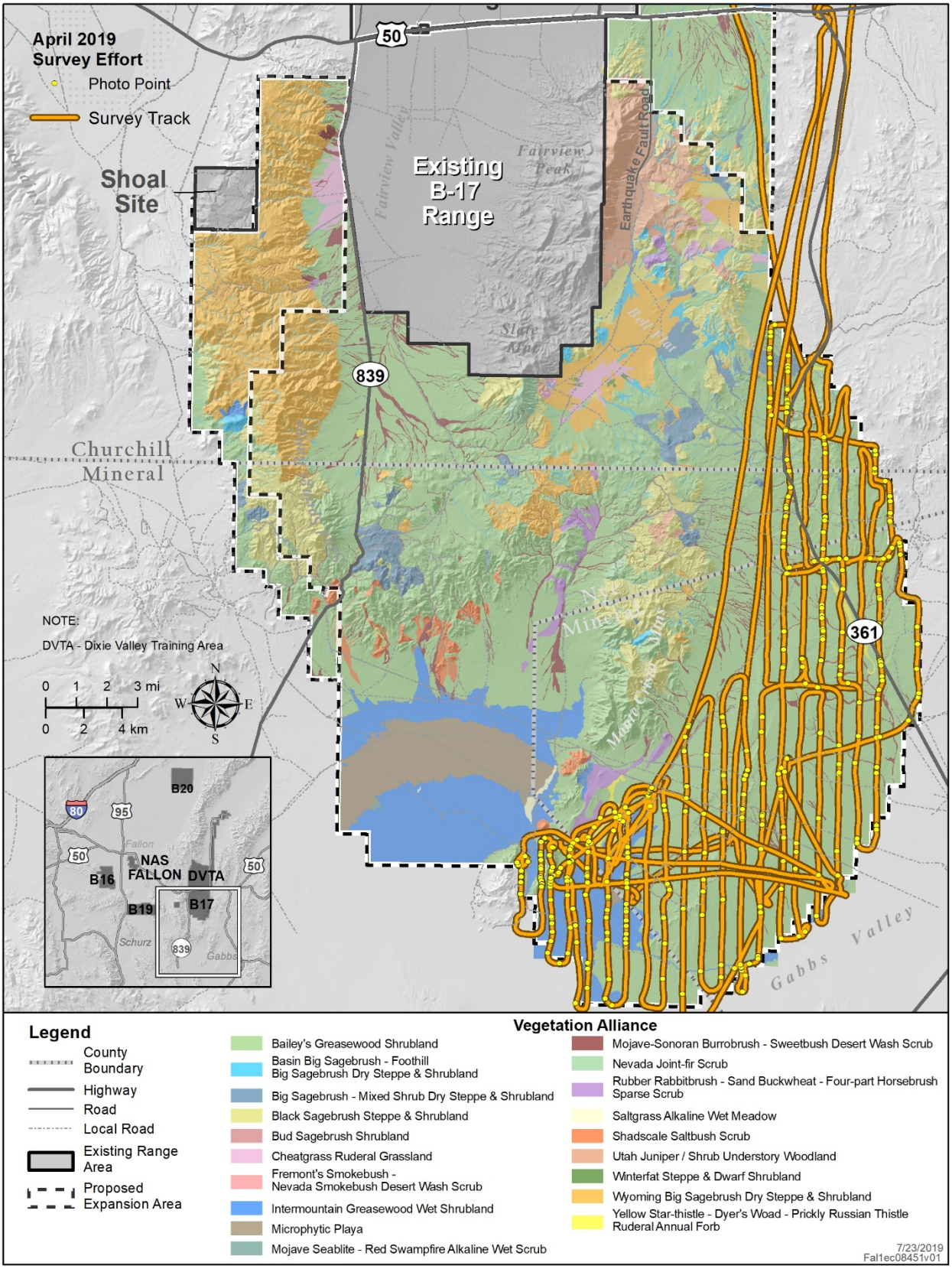

Figure B-1. April 2019 Survey Tracks and Photo Points – Proposed B-17 and Southern DVTA Expansion Areas

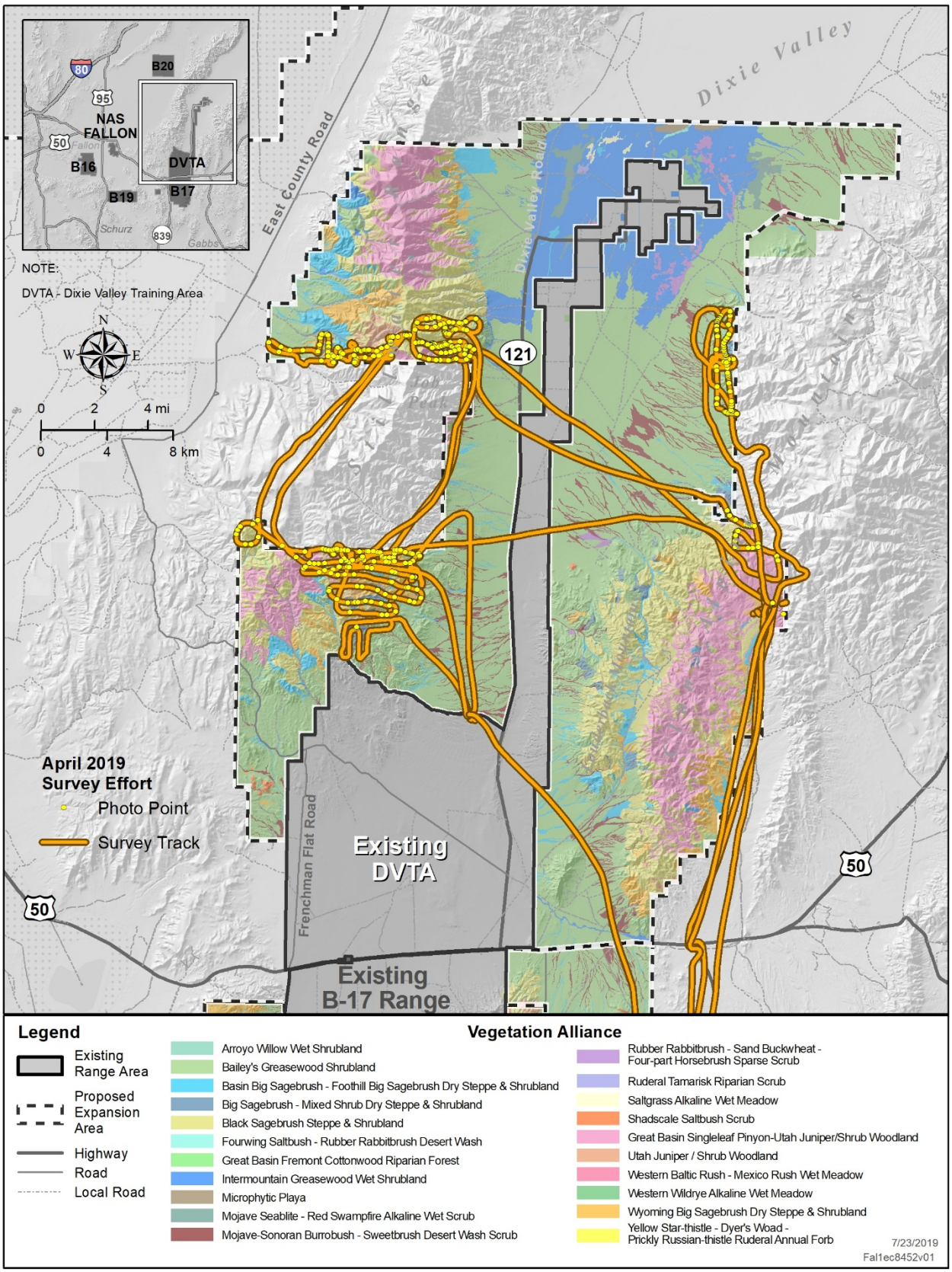

Figure B-2. April 2019 Survey Tracks and Photo Points – Proposed Northern DVTA Expansion Area