PLATTE RIVER REVIVAL RESTORATION MONITORING

CITY OF CASPER

CASPER, WY

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1.0 INTRODUCTION

The Platte River Revival is a North Platte River restoration project that is considered to be in the top ten of river restoration projects in North America (http://www.casperwy.gov/residents/environment_and_waste). It is driven by a partnership of private organizations and governmental agencies, and community support of the project, through annual Volunteer Day, spans a decade. This riparian area restoration project has focused on management of Russian olive (*Elaeagnus angustifolia)* and rehabilitation of the North Platte River as it runs through the City of Casper (City). Much of the work involving Russian olive treatment and removal has been accomplished through volunteers and in-kind services, and the City plans to continue engaging volunteers in pre-treatment/baseline data collection and post-treatment monitoring within Russian olive treatment areas in the future.

In 2016, the City determined that a monitoring program for evaluating Russian olive treatment results and a geodatabase to record monitoring data were an essential component of the Platte River Revival's restoration efforts. This geodatabase could be used to identify trends in treatment efficacy, target previously treated areas for follow-up actions, and provide the long-term data needed to track treatment areas and restoration progress. The City contracted with Trihydro Corporation (Trihydro) to perform Russian olive reconnaissance and vegetation community surveys in areas where the Platte River Revival has thus far focused its attention. For the purposes of this report, these areas (in total) are referred to as the Site. The Site was previously divided by the City into 19 Weed Management Areas (WMAs) in which Russian olive had been treated during the last 10 years or was targeted for treatment in the future. The data that were collected from within these areas will be incorporated into a geodatabase, which will continue to be populated in the future as new monitoring data are collected and treatment efforts are performed.

Russian olive is a non-native tree that has become increasingly abundant in riparian areas throughout the western United States. It has been a target species for restoration projects along the North Platte River. Over the past century, Russian olive was widely planted throughout the United States as an ornamental and windbreak tree; however, it has since escaped into natural riparian areas where it frequently crowds out desirable native riparian trees such as cottonwood (*Populus spp.*) and willow (*Salix spp*.; USFS 2014). Because of its ability to colonize streambanks, Russian olive establishment and spread not only results in a loss of plant diversity, but can also cause changes in natural flooding regime and reduce the availability of soil nutrients and water (USFS 2014). Thus, projects to remove and/or reduce the abundance of Russian olive trees from within riparian areas can lead to increased native species diversity and a gradual return of the area to the natural riparian ecosystem characteristics for the area, including wildlife habitat, hydrology, soil nutrient composition, and sequestration of runoff.

This report serves to document the current locations and abundances of Russian olive trees within the Site. In addition, information regarding general Site characteristics is provided, along with prior Russian olive treatments, expected and current vegetation community characteristics within this section of the North Platte River, and recommended management strategies for each WMA. Finally, recommendations for engaging community volunteers in citizen science efforts by contributing to baseline data collection and monitoring are provided.

2.0 SITE ENVIRONMENTAL CHARACTERISTICS

2.1 SITE LOCATION, SIZE, AND TOPOGRAPHY

The Site is located within Natrona County and consists of the riparian area that parallels the North Platte River for a non-contiguous, eight mile length within the City of Casper. This segment extends from the Wyoming Game and Fish Department to the Sam H. Hobbs Regional Wastewater Facility (Figures 1-10). The Site is a mixture of riparian habitat and developed land and falls within Township 33 North, 79 West; Sections 2-4, 7-8, 12-13, 18, and 33-35. Developed areas are under a mix of both public and private ownership and typically include businesses, parking lots, and walking paths. The Site is located within the 8-digit Hydrologic Unit Code (HUC8) 10180007, and it consists of a total of 394.13 acres of riverfront property. The drainage area at the upstream portion of the Site is 10,442 square miles. At the downstream end of the Site, the total drainage area is 11,282 square miles. One major tributary, Casper Creek, enters the North Platte River approximately 8 miles from the upstream end of the Site. A complete assessment of the River condition was completed in order to inform the North Platte River Master Plan (Stantec 2012) and the findings of that assessment are detailed within it.

2.2 CLIMATE

Site annual precipitation ranges between 10 and 14 inches per year (NRCS 2008). Most of the precipitation occurs as snow and rain from October to April, and as rain from May to September. The driest period occurs between June and August, and most plant growth occurs between March and August. Local temperatures vary greatly between the summer and winter due to the high elevation and dry desertic conditions typical of central Wyoming. The average annual air temperature is between 30.4° Fahrenheit (°F) and 53.9°F, with an average freeze-free period of 94 days (NRCS 2008).

2.3 HISTORIC RUSSIAN OLIVE MANAGEMENT

Historic records provided by the City indicate that most WMAs received physical and chemical treatments for Russian olive within the past 10 years (Table 1). Physical treatments included cutting, pulling, and chipping. Chemical treatments included various types of herbicide application. Three herbicides have been used for treatment. After the cut-stump treatment was used, triclopyr ester (Garlon 4) was applied at a rate of four pounds per acre in conjunction with glyphosate. Imazapyr was also applied after physical treatments in some locations. Most Russian olive treatments (chemical and physical) occurred during the months of July, August and September, with the exception of WMA 9 and WMA 4, where work occurred in June and in February and March, respectively. Given the regrowth that occurred in WMA 4, it appears that winter (dormant season) treatment may be less effective.

2.4 SITE NATIVE PLANT COMMUNITY

Ecological Site Descriptions (ESDs) were used to characterize the expected plant community for the Site (NRCS 2008). Tree community data were obtained from the existing Platte River Revival Master Plan (Stantec 2012). As most of the WMAs are located on the riverbank, comparable landforms, soil types, and hydrology found throughout the Site result in similar vegetation patterns. ESDs suggest that the WMAs contain mostly grass communities, which account for 75%-80% of the vegetation found in this Site (NRCS 2008).

Grasses: Grass communities typically found in this area are dominated by western wheatgrass (*Pascopyrum smithii*) needle and thread (*Hesperostipa comata*), bluebunch wheatgrass (*Pseudoroegneria spicata*), and green needlegrass (*Nassella viridula*) (NRCS 2008). Riparian areas located close to the riverbank or drainages that intersect the Site typically consist of Indian ricegrass (*Achnatherum hymenoides*), prairie sandreed (*Calamovilfa gigantean*), and little bluestem (*Schizachyrium scoparium*) (NRCS 2008).

Forbs: According to ESDs, forbs typically constitute between 10%-15% of the total vegetative community in this area. Forbs common in this area include yarrow (*Achillea millefolium*), field sagewort (*Artemisia campestris*), tapertip hawksbeard (*Crepis acuminata*), and milkvetch (*Astragalus*) (NRCS 2008).

Trees and shrubs: The tree community in this area is comprised of boxelder (*Acer negundo*), crack willow (*Salix fragilis*), eastern cottonwood (*Populus deltoides*), and narrowleaf cottonwood (*Populus angustifolia*) (Stantec 2012). Common species that comprise the Site's shrub community include rabbitbrush (*Chrysothamnus viscidiflorus*), winterfat (*Krascheninnikovia lanata*), and western snowberry (*Symphoricarpos occidentalis*) (NRCS 2008).

2.5 SITE NON-NATIVE AND INVASIVE SPECIES

Non-native species are those that have not historically been part of the regional plant community but are able to establish in the region through direct and indirect anthropogenic assistance. The state of Wyoming has a Designated Weed and Pest List, which identifies non-native species likely to cause environmental and/or economic harm. Of the non-native species identified within the Site, Russian olive, cheatgrass (*Bromus tectorum*), and tamarisk (*Tamarix spp.*) are the three that may be classified as invasive. Russian olive and tamarisk are identified as noxious weeds on the state of Wyoming's Designated Weed and Pest List (WDA 2016). Cheatgrass is an invasive species found in the Site, but it is not a designated noxious weed in the state of Wyoming, although it does appear in the Natrona County Declared Noxious Weed List. Below is a brief description of life history and species characteristics information for the non-native invasive species that were encountered during Site vegetation surveys. Russian olive is the main species that the

City is currently managing through treatment in conjunction with the Platte River Revival. Some cheatgrass management has also occurred.

Russian olive: Russian olive can inhabit a range of environments with large variations in precipitation, temperature, and soil chemical composition. This species is a deciduous, woody tree that can grow up to 40 feet tall. Mature trees display thin, fibrous strips of bark. Russian olive stems form stiff, silver-scaled thorns. This species' lance-shaped leaves are also silvery in color and range from 1-3 inches in length. The olive-like seeds are light green, silver-scaled, and 0.5 inches in length. White-yellow flowers, which contain four -petals, can be found on the leaf axils in late spring. Russian olive seeds are readily dispersed by both birds and mammals. The fruits float and are therefore easily transported and dispersed along waterways (USDA 2014). Russian olive roots for symbiotic associations with nitrogen fixing bacteria, which may increase its competitive advantage over native species (BLM 2013).

Cheatgrass: Cheatgrass is an annual grass that can grow up to 75 centimeters (cm) tall. Plants produce drooping panicle inflorescences that range from 2-8 inches in length and can each bear up to eight spikelets. A single plant can produce hundreds of spikelets. Leaves range from 2-6 inches in length, and may be 2-4 mm wide. Grass color progresses from green during growth periods, to a ripened purple during maturity, to straw-yellow during senescence. This species poses an ecological threat because it is an early successional plant that can pre-empt soil water from later emerging plants, thereby interfering with native plant growth. Because it senesces and dries by mid-summer, it can become a highly flammable fuel that contributes to more severe wildfire conditions (Zouhar 2003).

Tamarisk (or saltcedar): Tamarisk is an evergreen, shrub-like, woody plant that can reach more than 20 feet in height. It produces salt-secreting leaves that range from 1.5 - 3.5 millimeters (mm) in length. Tamarisk produces flowers that range from 0.8 to 3 inches long and 3 to 5 mm wide. The flowers have 5 sepals, 5 petals, and are white to pink in color. This species poses an ecological threat because it can maintain high transpiration rates in drought-like conditions, which allows it to outcompete native species. Additionally, the salt-secreting leaves produced by tamarisk can eventually increase soil salinity, impeding the ability of native plants to establish and grow (Zouhar 2003).

3.0 METHODS

An overview of the Russian olive treatments that were previously applied within each WMA is provided in Table 1 and described in greater detail within Section 4 of this report. The City also provided geospatial data layers depicting unit boundaries and treatment areas, which were overlaid on an aerial image (Figures 1-10). Using the aerial image, unit boundaries, and known treatment years, individual trees and stands of Russian olive were identified to target areas for reconnaissance and vegetation surveys in the field.

3.1 RUSSIAN OLIVE MONITORING (RECONNAISSANCE)

Russian olive monitoring focused on Site reconnaissance, which included a visit to each WMA to observe and document old growth, new growth, and post-treatment regrowth of individual and groups of Russian olive trees. At each WMA, Russian olive shoots, saplings, trees, or stands of trees were identified and their locations were documented using a Geographic Positioning System (GPS) unit. If the area contained too many trees to efficiently record with a GPS unit, a sample point was recorded so that aerial imagery could later be used to draw in the locations of the stands. For use in developing recommendations for follow-up treatments, accessibility to the Site was estimated for pedestrian and heavy equipment traffic. Further site characterization consisted of recording observations unique to each area, such as flagged Russian olive trees, the presence of other invasive species, or removed desirable tree species.

3.2 GROUND COVER DATA COLLECTION

To characterize the plant community that was re-establishing within Russian olive WMAs, a vegetation survey was conducted. The point-line intercept method (Bonham 1989) was used to collect plant species data along a 50 meter (or approximately 165 feet) transect within each WMA (Figure 1-10). Transect locations were identified in the field with the purpose of characterizing 1) the re-establishing plant community within locations where Russian olive treatment had previously occurred and 2) the plant community within the WMA as a whole. Photos of each transect are included in Appendix A. It is important to note that within a given WMA, in many cases, only subsections of the area previously contained Russian olive and were therefore treated.

Ground cover was assessed at 1 meter (or approximately 3 feet) intervals along each transect and classified into the following general categories: bareground, litter/rock, and plant (i.e. grass, forb, or shrub). Plant "hits" were identified to species, with the exception of sedge (*Carex spp.*), which was identified to the genus. Total plant cover was calculated by dividing the number of plant hits by the total number of points (50) and then expressed as a percentage. As a follow-up to the August Kick-off Meeting, the City developed and provided to Trihydro a geodatabase that identified species and groups of species (i.e. native grass, nonnative grass, etc.) to be incorporated into the working

geodatabase (Table 2). The average total cover of these species or groups for the Site was calculated by taking the sum of their total cover for each WMA and dividing by the total number of transects (19). The vegetation survey was completed in general conformance with the procedures followed in the previous vegetation surveys that were completed for the Master Plan (Stantec 2012).

In compiling and summarizing the results for this report, individual plant species were characterized as native or non-native. The United States Department of Agriculture (USDA) Plants Database (http://plants.usda.gov/java/) was used to characterize a given species as native or non-native. In addition, a small number of species were identified as invasive, and the USDA Plants Database was also used to make this designation. Russian olive and tamarisk are designated weeds within the state of Wyoming (http://www.wyoweed.org/weeds/state-designated-weeds). Cheatgrass, foxtail barley, and curlycup gumweed are designated as noxious weeds within Natrona County (http://www.wyoweed.org/images/2016_Declared_List.pdf).

3.3 GEODATABASE

The City, along with input from Trihydro, developed a geodatabase to assist with the collection and archiving of field data. The geodatabase includes feature classes, tables, relationship classes, and valid values for populating the geodatabase. Trihydro is providing the City with GPS field data to quantify these attributes, which will offer a comprehensive synopsis of each WMA and assist with future weed management planning. The spatial accuracy of field data is ≤ 1 meter. The geodatabase format improves versatility and usability of the archived data, because attributes may be analyzed independently or a conglomeration of attributes may be utilized to run models (i.e. ArcGIS).

3.4 WEED MANAGEMENT RECOMMENDATIONS

There are numerous physical and chemical methods that can be used for Russian olive control and site restoration, and a brief summary of these has been included in the Master Plan (Stantec 2012). There is general consensus that successful long-term management programs usually include a combination of both methods, along with a plan for monitoring and follow-up treatments to resprouts and seedlings (USFS 2014). Physical control methods are typically focused on removing aboveground trunks, branches, and plant parts (fruits and seeds) in an effort to eliminate existing trees and minimize the further spread and/or recruitment of Russian olive within a site or an area. If an herbicide is to be applied as part of the control strategy, particular attention should be paid to the recommended application surface and method for applying the specific herbicide, its mode of action, and time of year when the best results are most likely to be achieved. The Master Plan (Stantec 2012) provides an overview of both physical (manual and mechanical) and chemical treatments, along with some of the major pros and cons. In general, fall treatments are recommended over treatments during other times of the year, because at this time, desirable species are dormant and will be less

susceptible to herbicides. It is recommended that trees with a large diameter trunk (> 3") are treated with the cut-stump method, which includes felling the tree and immediately treating the stump with herbicide to destroy root infrastructure and help prevent regrowth (Combs 2010). Herbicide should be applied to stumps within 15 minutes of cutting, to ensure herbicide uptake (Tamarisk Coalition 2008). Smaller diameter trees (<3") may be sprayed with herbicide, but consulting Natrona County Weed and Pest prior to herbicide application is recommended. In the growing season(s) following initial removal, limited re-growth may occur either from the stump or from live roots. Natrona County Weed and Pest recommends that regrowth be treated with a foliar application (>70%) of a tank mix of seven ounces per acre rate of aminopyralid (trade name Milestone) and three quarts per acre of four pounds triclopyr ester (trade name Garlon 4). Regrowth treatment should continue annually until the plant's root carbohydrate reserves are exhausted and can no longer support regrowth. The Platte River Revival's preferred removal method has been mechanical removal with primarily excavators and skid steers, which are used to pull Russian olive tree trunks and as much of the root system as possible out of the ground. Overall success with this method has been good.

4.0 RECONNAISSANCE AND VEGETATION SURVEY RESULTS

Russian olive reconnaissance and vegetation surveys began on August 31 and continued through September 2, 2016. Vegetation survey transect locations and results for the Russian olive reconnaissance are shown for each WMA on Figures 1-10. In Table 1, a general overview of reconnaissance findings is provided, along with other site-specific information and recommended follow-up treatment (as necessary). In Table 2, the results of the vegetation survey for each WMA is summarized to include the information that will be included in the geodatabase. A complete species list, compiled from the vegetation survey results, is included within Table 3.

4.1 WMA CHARACTERIZATION AND RECOMMENDATIONS FOR FOLLOW-UP TREATMENTS

For each WMA, a geographic orientation, historic treatment methods, a vegetation summary, and recommended management practices are detailed below. Several WMAs contain both mature and immature Russian olive trees, which may be best approached with different treatments. Recommendations for an area may include both stump-cut treatments and herbicide spraying. The City should use the criteria above in conjunction with personal judgment to determine which treatment will be most effective on each tree/stand.

WMA 1

This property consists of 11.5 acres abutting the North Platte River and surrounds the Wyoming Game and Fish Department office (Figure 1). Russian olive trees were treated by the Bureau of Land Management (BLM) fire crews and City of Casper forestry crews in 2008. The treatment consisted of cutting the existing trees and subsequently injecting them with imazapyr. The injections were not completed immediately after the cut.

The results of the vegetation surveys indicate that total ground cover for this area is 100%. Total plant cover contributed 89% to total ground cover and consisted of 44% non-native grasses and 10% Russian olive (Table 2). No native grasses or wetland species were present. Total native cover and total invasive cover represented 22% and 12%, respectively. Dominant species included crested wheatgrass, smooth brome, and rabbitbrush (Table 2).

Russian olive reconnaissance revealed that old regrowth is present in this area in the form of large, mature trees stemming from treated stumps (Figure 1). The location of the trees range from the entrance of the Wyoming Game and Fish Department parking lot at the southern boundary of the WMA to the river bank on the northern boundary. Accessibility is easy on foot, and accessibility with equipment is easy in the northern portion of the WMA but becomes progressively more difficult towards the southern portion.

The recommended treatment for this WMA is mechanical or hand removal of the mature Russian olive trees, herbicide application to remaining stumps or roots, and annual monitoring to identify resprouting trees for follow-up herbicide application.

WMA 2

This area consists of 6.83 acres of land managed by the Audubon Society (Figure 1). Utilizing funds from a forestry grant and Platte River Revival budget, the City secured full cooperation and authorization from the Audubon Society to remove Russian olive trees in 2014. The contractor, Johnny Appleseed, used a skid steer to pull mature trees and their roots out of the ground. Treatment with glyphosate followed the mechanical pulling effort. In areas where trees could not be fully removed, the cut and cut-stump treatment method was used. Natrona County Weed and Pest provided the crew and the herbicide (glyphosate) for the herbicide treatment.

The results of the vegetation surveys indicate that the total ground cover was 94% (Table 2). Total plant cover contributed 85% to total ground cover and included 20% native grasses, 10% non-native grasses, 44% wetland species, and 2% Russian olive (Table 2). Total native cover and total invasive cover represented 52% and 8%, respectively (Table 2). Dominant species included sedge and reed canarygrass.

Reconnaissance revealed that more than 75% of the treated trees in this management section have shoot regrowth (Figure 1). Most of the regrowth is immature, and all of the regrowth is confined to the Platte River Parkway, which accessible to equipment. The recommended treatment for this WMA is cutting/pulling (hand removal) of the Russian olive regrowth, herbicide application to remaining stumps or roots, and annual monitoring to identify resprouting trees for follow-up herbicide application. Cheatgrass is present within this WMA and should be monitored in the future so that a management plan can be developed if further increases in total cover and/or abundance are observed.

WMA 3

This WMA is confined to the boundary of Morad Park and encompasses a total of 39.42 acres (Figure 1). A small portion of this area was first treated in 2010. Boss Reclamation pulled and chipped Russian olive trees onsite as part of a Wyoming Game and Fish Department demonstration project. The range of the area treated in 2010 was from the boat ramp to the Audubon boundary and between the Platte River Parkway and the North Platte River. The remaining area was treated in 2014 by Johnny Appleseed Inc. under a contract with the City. The method used was pulling mature trees and their roots out of the ground with a skid steer, and in areas where trees could not be fully removed, the cut-stump treatment method was used. Natrona County Weed and Pest provided the crew and herbicide (glyphosate) to treat the cut stumps. It is estimated that 600-700 Russian olive trees were removed from the Audubon Society property and the Morad Park area during 2014.

The results of the vegetation surveys indicate that the total ground cover was 91%. Total plant cover contributed 77% to total ground cover and included 40% native grasses, 8% non-native grasses, and 24% wetland species (Table 2). No Russian olive was present in this area. Total native cover and total invasive cover represented 42% and 2%, respectively (Table 2). Dominant species included western wheatgrass and reed canarygrass.

Reconnaissance revealed that no treated Russian olive trees had regrowth (Figure 1). The disturbance area from the 2010 wood chipping treatment was still apparent, but there was no regrowth found within the mulch or the surrounding area. The recommendation for this area is to continue monitoring, as treatment areas north and west (upstream) of Morad Park contain regrowth. Access with equipment to this area progresses from easy to moderate as the park pathways give way to riparian zones along the river bank. No cheatgrass or other invasive species were noted in this WMA.

WMA 4

This private management section consists of 164.48 acres of Central Wyoming Regional Water System land on which drinking water well fields are located (Figure 2). This area was mechanically treated in 2015. Mature Russian olive trees and their roots were pulled out of the ground with an excavator by City water distribution crews. About 1,400 Russian olive trees were removed. Because the area is the drinking water wellfield, no herbicide treatments were used or will be used in the future to manage Russian olive.

The results of the vegetation survey indicate that total ground cover was 100%. Total plant cover contributed 87% to total ground cover and included 30% native grasses, 22% nonnative grasses, and 4% wetland species (Table 2). Russian olive accounted for 2% of the total plant cover (Table 2). Total native cover and total invasive cover represented 44% and 22%, respectively (Table 2). Dominant species included western wheatgrass and cheatgrass. Cheatgrass accounted for 16% of the total cover (Table 2).

Reconnaissance revealed that immature regrowth (Table 1) was widespread and present throughout the area (Figure 2). Some regrowth had been flagged with high-visibility tape while other, similar-sized regrowth had not been flagged. The recommendation for this area is re-pulling/excavating regrowth. Because herbicide cannot be applied within this WMA, consistent monitoring and treatment of regrowth is integral to long-term management and elimination of Russian olive within the WMA. Access to this area is easy regardless of equipment, due to an established network of dirt roads. It is a secured area and not open to the public. Cheatgrass cover was relatively high within this WMA and additional vegetation surveys would be helpful in better estimating cover across the WMA as a whole. Given that herbicide applications for cheatgrass are not an option in this area, continued monitoring and hand-pulling cheatgrass may be necessary to prevent further spread and/or reduce cover of this invasive grass.

WMA 5

WMA 5 consists of a series of privately-owned land on river left that parallels the North Platte River (Figure 3). The management area consists of 17.9 acres of untreated land.

The results of the vegetation survey indicate that the total ground cover is 97%. Total plant cover contributed 89% to total ground cover and included 56% non-native grasses (Table 2). Native grasses and wetland species did not account for any of the total plant cover. Russian olive represented 14% of the total cover (Table 2). Total native cover and total invasive cover represented 6% and 14%, respectively (Table 2). The dominant species within this WMA was smooth brome.

Reconnaissance revealed that large, mature Russian olives have established within the WMA (Figure 3). The recommendations for this WMA are to mechanically remove the large trees as feasible, in conjunction with cutting trees and applying herbicide to stumps. Follow-up monitoring is also recommended to identify any resprouts or regrowth, which can be retreated with cutting and herbicide application. Access to this area is mixed, as the flat areas next to the road quickly gives way to steep river banks.

WMA 6

WMA 6 is owned by the Izaak Walton League and is located directly south of WMA 5 (Figure 3). This WMA consists of 20.76 acres and was previously treated in 2015, when City fire crews and Natrona County Weed and Pest crews cut and stump treated approximately 200 Russian olive trees with glyphosate.

The results of the vegetation survey indicate that the total ground cover is 98%. Total plant cover contributed 77% to total ground cover and included 18% native grasses, 6% non-native grasses, and 28% wetland species (Table 2). Russian olive accounted for 12% of the total plant cover (Table 2). Total native cover and total invasive cover represented 36% and 12%, respectively (Table 2). Dominant species included western wheatgrass, prairie rose, and Russian olive.

Reconnaissance involved traversing a dirt access road that parallels the river on the northern boundary of the property. The north side of the road was not treated due to access safety concerns for crews cutting and treating stumps. This northern boundary contains continuous stands of mature Russian olive trees with immature trees scattered amongst the mature stands (Figure 3). Treatments were visible on the south side of the road, and treated trees had moderate shoot regrowth (Figure 3). There were a few trees on the north side of the road that could be identified as treated, and they had significant regrowth. Removal of the stands of remaining Russian olives will require a large-scale, mechanical

removal operation followed by several years of monitoring to re-treat regrowth (depending on the nature of the initial treatment). The dirt access road allows for easy access with heavy equipment.

WMA 7

WMA 7 consists of 10.97 acres that have not been previously treated (Figure 4). It is located west of the Mills Water Treatment Facility and is located almost exclusively on privately owned property.

The results of the vegetation survey indicate that the total ground cover was 99%. Total plant cover contributed 98% to total ground cover and included 56% native grasses and 56% wetland species (Table 2). Non-native grasses did not account for any of the total cover (Table 2). Russian olive accounted for 12% of the total plant cover (Table 2). Total native cover and total invasive cover represented 82% and 12%, respectively (Table 2). The dominant species was reed canarygrass.

Reconnaissance revealed that thick stands of mature Russian olive are present throughout the area (Figure 4). Accessibility is limited in this area; therefore, cutting and spraying is recommended. Monitoring the effects of the treatment to quantify and treat regrowth is also recommended.

WMA 8

WMA 8 is part of the Amoco Re-use Area and consists of a long stretch of property that parallels the south bank of the river (Figure 4). The 24.69 acre plot has been treated in the past with success. The first documented Russian olive treatment was in 2010, when BLM fire and Natrona County Weed and Pest crews stump cut mature Russian olive trees and treated the cut stump with glyphosate. This treatment effort initially occurred along the river bank from 13th Street to the Mills pedestrian bridge was repeated in 2013 by BLM fire and Casper Weed and Pest crews to the area from the Mills pedestrian bridge to Poplar Street.

The results of the vegetation survey indicated that the total ground cover was 100%. Total plant cover contributed 88% to total ground cover and included 38% native grasses, 4% non-native grasses, and 28% wetland species (Table 2). Russian olive did not account for any of the total plant cover (Table 2). Total native cover and total invasive cover represented 58% and 4%, respectively (Table 2). Dominant species included western wheatgrass and reed canarygrass.

Reconnaissance revealed that there was very little regrowth, and the existing regrowth had been flagged with high-visibility tape (Figure 4). The river bank itself is comprised of riprap, and overall, the area contains mostly native species. The recommendation for this WMA is to treat regrowth and continue to monitor the river bank. While

accessibility to this area is easy with equipment, cutting and spraying are recommended for the near term due to limited regrowth. Limited cover by cheatgrass was observed during the vegetation survey.

WMA 9

This plot parallels the northern bank of the North Platte River, and mirrors the layout of WMA 8 (Figures 5-6). The area, which consists of 27.97 acres, was previously treated by BLM fire and city forestry crews in 2009, and consisted of cutting and injecting imazapyr sometime after the cut treatment. Subsequent treatments occurred in 2014, and were conducted by City fire and Natrona County Weed and Pest crews, as well as University of Wyoming Conservation Corps and the City solid waste crews. Both crews cut Russian olive trees and treated stumps with glyphosate, thus treating a total of approximately 130 trees.

The results of the vegetation survey indicate that the total ground cover was 92%. Total plant cover contributed 89% to total ground cover and included 24% native grasses, 42% nonnative grasses, and 2% wetland species (Table 2). Russian olive accounted for 2% of the total plant cover (Table 2). Total native cover and total invasive cover represented 34% and 6%, respectively (Table 2). Dominant species included crested wheatgrass and common reed.

Reconnaissance revealed that most of these treated trees were killed successfully; however, some regrowth has occurred (Figures 5-6). This site is similar to WMA 8, as its banks are comprised of riprap, but it contains greater cover by invasive species than the southern river bank. Due to the limited regrowth in this area, selective cut-stump treatment is recommended, along with monitoring to identify and treat resprouting Russian olive trees. Limited cover by cheatgrass was observed during the vegetation survey. Continued cheatgrass monitoring, in conjunction with Russian olive monitoring, are recommended so that a cheatgrass management plan can be developed if cover increases.

WMA 10

This WMA is located between Poplar Street and First Street on the southern bank of the North Platte River and consists of 4.96 acres (Figures 6-7). The property is a series of privately owned properties. The area was previously treated in 2014 by City fire and Natrona County Weed and Pest crews, who applied glyphosate to the stump of cut Russian olives. In total, approximately 40 Russian olive trees were removed.

The results of the vegetation survey indicated that the total ground cover was 92%. Total plant cover contributed 75% to total ground cover and included 2% native grasses, 20% non-native grasses, and 10% wetland species (Table 2). Total native cover and total invasive cover represented 26% and 4%, respectively (Table 2). Dominant species included crested wheatgrass and rabbitbrush.

Reconnaissance revealed that the majority of treated trees were removed successfully, with minimal regrowth noted at the southern management area boundary (Figures 6-7). Due to the limited regrowth, selective treatment of regrowth is recommended in conjunction with monitoring.

WMA 11

WMA 11 consists of 3.60 acres that stretch from Poplar Street to First Street along the opposing river bank, which is more developed than WMA 10 (Figures 6-7). This WMA was first treated in 2008 by City fire and Natrona County Weed and Pest crews. Russian olive trees were cut and later injected with imazapyr. Subsequent treatments occurred in 2014, during which regrowth was cut and stumps were treated with glyphosate. Approximately 12 trees were treated during the 2014 treatment.

The results of the vegetation survey indicated that the total ground cover was 97%. Total plant cover contributed 85% to total ground cover and included 2% native grasses and 20% non-native grasses (Table 2). Wetland species did not account for any of the total plant cover. Russian olive accounted for 2% of the total plant cover (Table 2). Total native cover and total invasive cover represented 22% and 20%, respectively (Table 2). Dominant species included crested wheatgrass and cheatgrass. Cheatgrass accounted for approximately 18% of the total plant cover (Table 2).

Reconnaissance revealed that some regrowth has occurred since the 2014 treatment. Most of the regrowth was confined to the western portion of the management area. While accessibility is easy with equipment, selective treatment (cutting and herbicide application) and follow-up monitoring is recommended for this small management area. Cheatgrass is present within this WMA and should also be monitored during Russian olive monitoring. If cheatgrass cover continues to increase, a management plan is recommended to prevent further increase and spread of this invasive species.

WMA 12

WMA 12 consists of 8.56 acres that were previously treated in 2007 by BLM and City fire crews (Figure 7). Russian olive trees were cut and the cut stumps were treated with 4lb triclopyr ester (Garlon4). Subsequent treatments were conducted by BLM fire and city forestry crews in 2009, in which Russian olive trees were cut and later injected with imazapyr.

The results of the vegetation survey indicated that the total ground cover was 97%. Total plant cover contributed 86% to total ground cover and included 34% native grasses, 4% non-native grasses, and 22% wetland species (Table 2). Russian olive accounted for 2% of the total plant cover (Table 2). Total native cover and total invasive cover represented 66% and 2%, respectively (Table 2). Dominant species included western wheatgrass and sandbar willow.

Reconnaissance revealed fewer than three stands of mature trees were present, and there was regrowth stemming from treated stumps (Figure 7). In addition, there were flagged regrowth trees at the site, of which some had been killed successfully and others had not. Recommendations for this area are to selectively treat the regrowth (with cutting and herbicide application) and continue to monitor. Overall, this area is easily accessible.

WMA 13

This area consists of 3.62 acres of property east of Wingfoot Tire LLC (Figure 7). Russian olives in part of this area were cut and treated in 2007. In 2008 in another part of WMA 13, 71 Construction received authorization to pull Russian olives and their roots from the ground with an excavator as part of their work they did for Rocky Mountain Power.

The results of the vegetation survey indicated that the total ground cover was 99%. Total plant cover contributed 86% total ground cover and included 12% native grasses, 42% non-native grasses, and 16% wetland species (Table 2). Russian olive accounted for 2% of the total plant cover (Table 2). Total native cover and total invasive cover represented 26% and 4%, respectively (Table 2). Dominant species included smooth brome and sandbar willow.

Reconnaissance revealed that the area contains several stands of large, mature Russian olive trees (Figure 7). The regrowth in this treated area is substantial. The area is located on a steep riverbank comprised partially of large concrete debris. The western boundary of the management area is marked by chain-link fencing that designates Wingfoot Tire LLC property. The fencing, in addition to the steep gradient of the bank, inhibits the use of large equipment that would be preferred for removal. Recommendations include cut-stump treatment of trees removed with portable equipment (e.g. chainsaw) and follow-up monitoring to identify resprouts that will need to be treated.

WMA 14

WMA 14 is located in Crossroads Park and consists of 9.25 acres (Figure 8). Some segments of Russian olive were removed from this area Complete initial Russian olive removal in WMA 14 has not occurred because of access and safety issues for both heavy equipment and sawyers. In the removal areas, three different treatment methods were used and were determined by what was known, at the time, to be best management practices and by access for heavy equipment. The first treatment was cut and inject later with imazapyr in 2008. In 2009, two different methods were used. In areas where there was easy access for heavy equipment, 71 Construction and City solid waste crews used excavators to extract the Russian olives. The trees were extracted by pulling straight up to eliminate breaking roots. No herbicide treatment followed the excavator extraction. Where access was not available, the cut and inject with imazapyr herbicide method was used.

The results of the vegetation survey indicated that the total ground cover was 98%. Total plant cover contributed 86% to total ground cover and included 40% native grasses, 26% non-native grasses, and 12% wetland species (Table 2). Russian olive accounted for 6% of the total plant cover (Table 2). Total native cover and total invasive cover represented 40% and 6%, respectively (Table 2). Dominant species included western wheatgrass and smooth brome.

Reconnaissance revealed that there is substantial regrowth in some of the treated areas and significant untreated growth immediately south of the management area (Figure 8). The grove of regrowth in the northern end of the treatment area is currently being pruned to allow pedestrian access to a walking/biking trail. Recommendations include cut-stump treatment and spraying of regrowth, as well as monitoring the growth south of the management area to ensure that recruitment does not occur. Accessibility with equipment is moderate, and a network of single-track, dirt trails is present.

WMA 15

WMA 15 is located in Riverview Park and consists of 9.44 acres (Figure 15). The WMA was previously treated in 2007 by BLM and City fire crews. During the treatment, Russian olive trees were cut and stumps were treated with 4lb triclopyr ester (Garlon 4).

The results of the vegetation survey indicated that the total ground cover was 98%. Total plant cover contributed 96% to total ground cover and included 64% native grasses, no non-native grasses, and 76% wetland species (Table 2). Russian olive accounted for 2% of the total plant cover (Table 2). Total native cover and total invasive cover represented 90% and 2%, respectively (Table 2). The dominant plant species was reed canarygrass.

During reconnaissance, it was difficult to differentiate between untreated and treated trees, so regrowth could not be identified. However, all Russian olive trees on site were mature. Equipment accessibility is moderate, and a boat ramp leading to a flat river bank may be utilized seasonally to assist with equipment unloading (e.g skidsteer, tractor, etc.). Removal via cut-stump method may be the best option, with follow-up monitoring to identify resprouts that will need to be treated in the future.

WMA 16

WMA 16 is located northwest of the North Casper Soccer Complex on river left, and consists of a 1.33 acre parcel that abuts the northern bank of the North Platte River (Figure 10). This area was treated in 2012 by BLM fire and Natrona County Weed and Pest crews as well as various city crews. In each treatment, Russian olive trees were cut before being treated with glyphosate.

The results of the vegetation survey indicated that the total ground cover was 95%. Total plant cover contributed 90% to total ground cover and included 22% native grasses and 58% non-native grasses (Table 2). While some wetland species are present within the WMA, they were not recorded along the survey transect. No Russian olive trees were present in this area. Total native cover and total invasive cover represented 22% and 0%, respectively (Table 2). The dominant plant species was intermediate wheatgrass.

Reconnaissance revealed that the Russian olive treatment was successful, as no regrowth or new growth was identified (Figure 10). However, there are management areas south and west of this area that contain Russian olive trees; therefore, continued monitoring is recommended to ensure that Russian olive and noxious weed infestations or recruitment does not occur (Table 1).

WMA 17

WMA 17 is a 10.65 acres area located directly north of the North Casper Soccer Complex, on river right (Figure 10). Initial treatments were conducted by BLM and City fire crews in 2007. Treatment consisted of cutting and treating stumps with 4 pounds of triclopyr ester (Garlon 4). Cut and cut-stump treatment was repeated in 2012 by BLM fire, Natrona County Weed and Pest, and various city crews. Glyphosate was the herbicide use in the 2012 treatment.

The results of the vegetation survey indicated that the total ground cover was 78%. Total plant cover contributed 69% to total ground cover and included 12% native grasses, 18% non-native grasses, and 6% wetland species (Table 2) . Russian olive did not account for any total plant cover. Total native cover and total invasive cover represented 18% and 20%, respectively.(Table 2). Dominant species included sandbar willow, western wheatgrass, and cheatgrass. Cheatgrass accounts for 18% of the total plant cover (Table 2).

Reconnaissance revealed that the removal of a substantial stand of Russian olive trees in the middle of the area was successful, as the stands observed on aerial imagery were no longer present (Figure 10). While there was minimal regrowth observed, the regrowth is mature. The majority of Russian olive trees in the management area have been successfully eradicated. The remaining trees should be selectively cut-stump treated. Monitoring and follow-up herbicide applications should continue, as it was noted that some flagged trees had not been killed successfully. Accessibility of equipment to this area is moderate. It should also be noted that cheatgrass cover is relatively high within this WMA. Monitoring of cheatgrass should continue in conjunction with Russian olive monitoring efforts so that a management plan can be developed if this species continues to increase in cover.

WMA 18

WMA 18 is comprised of property that begins at the northern boundary of the Sam H. Hobbs Regional Wastewater Facility and extends to the bank of the North Platte River (Figure 10). The plot contains 3.72 acres that have not been previously treated for Russian olive.

The results of the vegetation survey indicated that the total ground cover was 84%. Total plant cover contributed 73% to total ground cover and included 10% native grasses, 2% non-native grasses, and 2% wetland species (Table 2). Russian olive accounted for 20% of the total plant cover, which was the most in any WMA (Table 2). Total native cover and total invasive cover represented 20% and 20%, respectively (Table 2). Dominant species included Russian olive and plains cottonwood.

Reconnaissance revealed the area contains mostly mature, old growth Russian olive trees (Figure 10). Some seedlings (new growth) were identified in this area as well. While there is no record of treatment for this area, a photo was taken of a potentially treated tree containing a scar that can be found in appendix A. Recommendations include a cut-stump treatment to all existing Russian olive stands. Additionally, the noxious weed, tamarisk, was observed in this management area (photo available in Appendix A). An aggressive basal bark treatment of the tamarisk is recommended. This treatment consists of spraying all tamarisk stems (from ground level up the stem 18 inches) with a 40% solution of triclopyr ester (Garlon 4) in a basal bark carrier. This work can be done anytime of the year, provided no snow or standing water is present.

WMA 19

WMA 19, known as Zonta Park, consists of 4.32 acres of property at the intersection of highway 258 and 13th Street (Figure 4). No previous treatments have been documented; however, many trees of varying species including boxelder, have been cut by Rocky Mountain Power to protect their transmission lines.

The results of the vegetation survey indicated that the total ground cover was 96%. Total plant cover contributed 85% to total ground cover and included 52% native grasses, 4% non-native grasses, and 42% wetland species (Table 2). Russian olive accounted for 4% of the total plant cover (Table 2). Total native cover and total invasive cover represented 62% and 4%, respectively (Table 2). The dominant species is this area was reed canarygrass.

Reconnaissance revealed that three boxelder trees have been cut along the bank, and they also had dead regrowth stemming from their stumps (photo available in appendix A). Boxelders are a native, desirable species and needed to be cut for electrical transmission line safety. A peachleaf willow (*Salix amygdaloides)* also contained a large scar, which also may be the result of tree clearing by Rocky Mountain Power. Russian olive trees in the management area

were large, and many stemmed from a dead trunk, which also indicates this area contains old regrowth. A cut-stump treatment of the Russian olives in this area is recommended, along with follow-up monitoring and treatment of regrowth.

4.2 SITE-LEVEL VEGETATION SUMMARY

Due to the close proximity to the banks of the North Platte River, most of the Site contains relatively homogenous vegetation. The plant community within developed areas, which are located closest to businesses, roads, and pedestrian walkways, consists largely of quickly establishing grasses, such as crested wheatgrass and western wheatgrass, which were likely seeded following development. These areas also contain the majority of native tree species, such as narrowleaf cottonwood, plains cottonwood, and boxelder. Riparian vegetation increases with proximity to the riverbank, and includes species such as narrowleaf cattails (Typha angustifolia), sandbar willows (Salix exigua), and reed canarygrass (Phalaris arundinacea).

Below is a general summary for the Site that describes the combined data according to the groupings that are included in the Geodatabase.

Russian olive: Russian olive trees were observed throughout the Site and ranged in size from small shoots to mature stands. Russian olive trees were not limited to riparian areas at this Site, and were also found near roads and pathways. Regrowth was often observed in treated areas where herbicide had not been previously used as part of the treatment approach. The most dense concentrations of new growth were found in untreated WMAs, in which the total percent cover ranged from 12%-20%. Conversely, the fewest Russian olive trees were found in areas that had been treated several times in the recent past, and in some of these areas, there were no Russian olive shoots identified during the reconnaissance. On average, the WMAs contained approximately 5% Russian olive cover.

Cottonwoods and other trees: Cottonwoods found within the Site consisted of narrowleaf cottonwood and plains cottonwood. While cottonwoods were distributed throughout the Site, relatively few cottonwoods received hits during the point-line-intercept transect surveys. Overall, more cottonwoods hits occurred in transects conducted in treated management areas. Other tree species that received hits include boxelder, which accounted for 2% of the total cover in a single, treated WMA. On average, the WMAs contained approximately 1% total cottonwood cover.

Willow: Willow species found within the Site include the sandbar willow. The sandbar willow was identified along vegetation survey transects within seven WMAs. The highest percentage of willow cover was found in the untreated

WMA 7, in which the willow accounted for 26% of the total cover. On average, the WMAs contained approximately 5% total willow cover.

Native grasses: The Site native grass community consists of western wheatgrass (*Agropyron smithii*), Indian ricegrass (*Achnatherum hymenoides*),, creeping meadow foxtail (*Alopecurus arundinaceus*), blue grama (*Bouteloua gracilis*), sedge (*Carex spp.*), foxtail barley (*Hordeum jubatum*), reed canarygrass (*Phalaris arundinacea*), common reed (*Phalaris arundinacea*), Kentucky bluegrass (*Poa pratensis*), alkali sacaton (*Sporobolus airoides*), and seaside arrowgrass (*Triglochin maritima*).

The WMAs that contained the highest percent of native grass cover were treated areas, of which native grasses accounted for 64% of the total cover. Both of the WMAs (WMA 1 and 5) that contained 0% native grass cover contained large, mature Russian olive trees. On average, the WMAs contained approximately 25% total native grass cover.

Non-native grasses: The non-native grass community is comprised of crested wheatgrass (*Agropyron cristatum*), field brome (*Bromus arvensis*), smooth brome (*Bromus inermis*), cheatgrass, and intermediate wheatgrass (*Thinopyrum intermedium*).

The highest percent of nonnative grass cover was found in WMA 16, in which native grasses account for 58% of the total cover. On average, the WMAs contained approximately 17% total non-native cover. Particular to this area, the primary non-native species was intermediate wheatgrass. This grass likely derived from treatment-induced disturbance and subsequent seeding, as it is an easy establisher with a rapid growth habit (Hybner et al. 2012). These characteristics make it a common restoration species, even though it is not native.

Cheatgrass was most prevalent in WMAs that had cut and removed Russian olive trees. This is likely because cheatgrass is an early successional plant that is a strong competitor in disturbed areas and typically appears after a fire or following the removal of trees and shrubs (Zouhar 2003). On average, the WMAs contained approximately 4% total cheatgrass cover.

Forbs: There were 18 forb species found within the Site, thirteen of which are native. The most prevalent forbs found within the Site consist of two native species including prairie rose (*Rosa arkansana*) and tapertip hawksbeard; and two non-native species including Canada thistle (*Cirsium arvense*) and alfalfa (*Medicago sativa*). Overall, there was a greater percentage of native forb cover than non-native forb cover within the Site. On average, the WMAs contained 6% total forb cover.

Wetland species: The wetland species found within the Site include reed canarygrass, sandbar willow, sedge, narrowleaf cattail, common reed, and seaside arrowgrass. Of the wetland species identified during vegetation surveys, only one is a non-native species (cattail). Due to the proximity of the Site to the North Platte River, most of the WMAs contained a relatively high percent of wetland species cover. While wetland cover ranged from 0-76% total cover, less than half of the areas exhibited wetland cover less than 10%. The average wetland species cover was about 20% throughout all WMAs.

Invasive cover: The invasive species present at the Site include Russian olive, tamarisk, and cheatgrass. Total invasive species cover ranged from 0- 22%, and the average WMA contained approximately 9% total invasive cover. Tamarisk was limited in both cover and distribution within the Site and was observed in only one WMA (WMA 18).

Native cover: The majority of the native cover derived from native grass cover (i.e. western wheatgrass and reed canarygrass). Total native species cover ranged from 6- 90%, and the average WMA contained approximately 40% total native cover.

5.0 USING CITIZEN SCIENCE FOR MONITORING RESTORATION EFFORTS

Volunteers from the City of Casper and from throughout the state of Wyoming have been a cornerstone of the Platte River Revival's restoration efforts. While the City plans to continue using organized workforces from partnering agencies to perform Russian olive treatments, baseline data collection and post-treatment monitoring can effectively be completed by community volunteers. Moving forward, the City may consider developing a more formalized "citizen science" program that officially incorporates volunteers and has a structured approach to data collection that interfaces with the geodatabase that has already been developed.

Citizen science, which is defined as research that engages non-professionals in the process of creating new scientific knowledge (Bonney et al. 2014), has grown considerably during the last decade (McKinley et al. 2015). Globally, it is estimated that millions of individuals are contributing to thousands of projects that would not otherwise be feasible if completed solely by paid science specialists. Citizen scientist projects are distinguished by the positive outcomes that they achieve for both science and society (Bonney et al. 2014).

Datasets produced by volunteer citizen scientists can be on par in quality with those produced by professionals in well-developed citizen science programs. Some key considerations for effective use of volunteer citizen scientists and ensuring high data quality include the following:

1. Professionally led data collection campaigns using citizen science groups.
    a. Experienced biologists can develop survey approaches and data collection rubrics that will result in informative data.
    b. Experienced biologists can provide the necessary training to volunteers.
    c. Experienced biologists should be present during data collection efforts so that they can field questions as they arise.
2. Spatial data collection using "data collector applications" such as Esri's Collector Application (http://www.esri.com/products/collector-for-arcgis) that can be installed on cellular phones to minimize the need for data sheets and post-data collection data entry.
3. Communication and collaborative design of data collection protocols.
    a. Protocols can be developed by a biologist and GIS analyst to maximize efficiency of data collection for integration into the geodatabase.

b. An experienced biologist can work with organized workforces who will be completing treatments to determine the best approach for collecting baseline data and flagging areas for treatment.

Volunteers should be interested and committed, but may include individuals from late elementary school age children to retired adults. Tasks should be matched to the group, with data collection protocols that are more involved being reserved for adults while simple, repetitive tasks being a better match for school-aged children.

Baseline data collection is an activity that could be effectively completed by citizen scientists. Both reconnaissance and vegetation surveys along transects could be completed after citizen scientists received training on these tasks. With time, a number of volunteers will become experienced in data collection protocols and can assist a lead biologist in training new volunteers and/or ensuring that protocols are closely followed in the field.

The resulting data (collected during citizen science campaigns) could be used to derive an estimate of the total number or density of Russian olive trees in a management area, in addition to classifying individual or groups of trees as immature (i.e. seedlings or resprouts) or mature. This information would be useful to the City in identifying treatment approaches. After baseline data are collected and treatments are applied, monitoring data can be compared to the baseline data to gauge treatment success and identify the need, nature, and scope of follow-up treatments. Over time, a long-term data set that documents restoration progress through time will be developed.

As a key side benefit, citizen scientists become informally trained "biologists" who develop a keen eye for spotting Russian olive trees in their community and contribute to the larger effort of riparian habitat restoration along the North Platte River. While citizen scientists may not have the expertise to complete species-level vegetation surveys in post-treatment areas, they could also be trained to identify key invasive or weed species (e.g. cheatgrass or tamarisk). This information could assist the City in targeting and managing invasive species or weeds that emerge in post-Russian olive treatment areas before they become widespread.

6.0 CONCLUSIONS

This project resulted in the characterization of 19 WMAs along the North Platte River within the Casper, Wyoming. Within each WMA, the following tasks were completed:

1. A vegetation survey was completed to characterize vegetation cover and the vegetation community.
2. An assessment of post-treatment Russian olive regrowth was completed to determine the relative success of previously applied treatments.
3. Recommendations for follow-up treatments and monitoring were provided for each WMA as necessary.
4. Recommendations for engaging community volunteers as "citizen scientists" for future baseline data collection and post-treatment monitoring was provided.

Vegetation patterns were consistent throughout the Site, as most WMAs exhibited a riverbank gradient which transitioned from upland to riparian vegetation down the slope. Site-wide, there were more native species than invasive species, which represented an average total cover of 40% and 9%, respectively. Overall, total cover by native and desirable species was high. While complete eradication of Russian olive trees within individual WMAs was rare, results observed in successfully treated areas can be used to identify future treatment planning, as Russian olives accounted for 0% of the total plant cover in these areas.

Reconnaissance revealed the success of the treatments conducted in each WMA, as well as allowing for the identification that need additional treatment. Historic treatment records clearly indicate that Russian olive control is most effective when herbicides are used in conjunction with cutting, pulling, or chipping, and when herbicides were applied immediately following these mechanical approaches Russian olive trees were most dense amongst management areas that did not immediately apply herbicide as part of their removal strategy or have not been treated recently. This result is consistent with management recommendations provided in the literature (USDA 2014).

Specific follow-up treatment recommendations have been provided within this report to assist the City with their future Russian olive management efforts. A critical component of this restoration project in the future is baseline data collection and post-treatment monitoring to quantify treatment success and determine the nature and extent of follow-up treatments to treat regrowth. Trihydro understands that the City's invasive species management has focused on Russian olive with some attention given to cheatgrass. In several locations, cheatgrass cover was determined to be greater than 15% and monitoring of cheatgrass in these areas is recommended so that a management plan can be implemented if cheatgrass cover continues to increase. In WMA 18, which is an untreated WMA, tamarisk was

observed. Tamarisk can spread quickly in riparian areas and is considered a noxious weed in the state of Wyoming. Given that tamarisk is currently localized in its distribution along the North Platte River, a plan to treat this species in the near future might be effective in eliminating it and minimizing further spread to other WMAs.

The results of the vegetation surveys revealed that the majority of the WMAs are dominated by native and/or introduced, but desirable, vegetation. This suggests that once Russian olive is treated, the understory herbaceous plant community (grasses, forbs, and shrubs) re-establishes without the need for follow-up seeding. One pattern that was noted, however, was that higher densities of non-native grasses were found in WMAs that had been completely or nearly completely eradicated of Russian olive trees. Thus, the disturbance following intensively managed/treated Russian olive areas may facilitate the establishment of invasive grass species. This result indicates that both reconnaissance to characterize Russian olive regrowth, combined with vegetation surveys to characterize the re-establishing vegetation community, is critical to using adaptive management to restore these areas.

The results of this monitoring event highlight the need for continued monitoring as a component of the Platte River Revival efforts. In some WMAs, re-treatment of Russian olive regrowth had occurred within a few years of the original treatment, and within these areas, Russian olive treatments appeared to be highly successful. In addition, monitoring can be completed by volunteers (or as part of a larger, citizen science program). It is recommended that a biologist or weed specialist is present to instruct and assist volunteers in identifying Russian olive regrowth. Because monitoring is crucial to documenting efforts and tracking successes, it is recommended that monitoring data be incorporated into the geodatabase, especially before and after treatments are applied in previously treated areas and new areas. If funds are available, and greater detail is desired, a contractor could also perform this service.

7.0 REFERENCES

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TABLES

TABLE 1. WEED MANAGEMENT AREA SUMMARY
PLATTE RIVER REVIVAL RESTORATION MONITORING
CITY OF CASPER, CASPER, WYOMING

WMA ID	Previous Treatment	Most Recent Treatment	Regrowth?	Removal Recommended?	Treatment Recommended?	Comment
1	cut, injected later with imazapyr	2008	Yes	Yes	Yes	regrowth includes several mature ELAN
2	cut and stump treat and pulled with skid steer; treated with glyphosate	2014	Yes	No	Yes	most treated trees have regrowth
3	cut and stump treat and pulled with skid steer; treated with glyphosate	2014	No	No	No	monitor
4	pulled with excavator	2015	Yes	Yes	Yes	regrowth in most treated areas
5	None	NA	Yes	Yes	Yes	large, mature ELAN stands established
6	cut and stump treatment; treated with glyphosate	2015	Yes	Yes	Yes	extensive ELAN stands, may require industrial cutting/pulling equipment
7	None	NA	No	Yes	Yes	untreated
8	cut; treated with glyphosate	2013	Yes	No	Yes	successfully managed area
9	cut; treated with glyphosate	2014	Yes	No	Yes	successfully managed area
10	cut; treated with glyphosate	2014	Yes	No	Yes	few regrowths
11	cut regrowth; treated with glyphosate	2014	Yes	No	Yes	some regrowth around ELAN stumps
12	cut; injected later with imazapyr	2009	Yes	No	Yes	no mature ELAN present, treat seedlings
13	pulled	2008	Yes	Yes	Yes	substantial regrowth present, access difficult
14	cut; injected later with imazapyr	2009	Yes	Yes	Yes	treated areas have substantial regrowth, and untreated area to the south poses a threat to management area
15	cut; treated with 4 pounds triclopyr ester	2007	Yes	Yes	Yes	all ELAN are mature, unsure where treatment occurred
16	cut; treated with 4 pounds triclopyr ester	2012	No	No	No	monitor, due to mature ELAN found N and W of the site.
17	cut; treated with 4 pounds triclopyr ester	2012	Yes	No	Yes	successfully managed area, treat seedlings and monitor
18	None	NA	No	Yes	Yes	tamarix present, cut and spray
19	None	NA	Yes	Yes	Yes	3 boxelders and other trees cut along river for electrical transmission line clearance

Notes:
NA = Not Applicable
WMA = Weed Management Area
ELAN = Russian olive

TABLE 2. 2016 PLANT COVER DATA SUMMARY
PLATTE RIVER REVIVAL RESTORATION MONITORING
CITY OF CASPER, CASPER, WYOMING

WMA ID	Russian olive	Cottonwood	Willow	Other trees	Native grasses	Cheatgrass	Other non-native grasses	Forbs	Wetland monocots	Invasive species	Native species
1	10	0	0	0	0	2	42	2	0	12	22
2	2	0	0	0	20	8	2	12	44	8	52
3	0	0	0	0	40	0	8	6	24	2	42
4	2	2	0	0	30	16	6	18	4	22	44
5	14	0	0	0	0	0	56	4	0	14	6
6	12	0	0	0	18	0	6	12	0	12	36
7	12	0	26	0	56	0	0	0	56	12	82
8	0	0	0	0	38	2	2	6	28	4	58
9	2	0	0	0	24	4	38	8	2	6	34
10	2	0	8	0	2	2	18	2	10	4	26
11	2	0	0	0	2	18	2	20	0	20	22
12	2	8	16	2	34	0	4	4	22	2	66
13	2	2	10	0	12	2	40	2	16	4	26
14	6	0	0	0	40	0	26	0	12	6	40
15	2	0	24	0	64	0	0	2	76	2	90
16	0	0	0	0	22	0	58	0	0	0	22
17	0	0	6	0	12	18	0	2	6	20	18
18	20	8	2	0	10	0	2	4	2	20	20
19	4	0	0	0	52	0	4	10	42	4	62
AVG	**4.95**	**1.05**	**4.84**	**0.11**	**25.05**	**3.79**	**16.53**	**6.00**	**18.11**	**9.16**	**40.42**

Notes:

WMA - Weed Management Area

AVG - Average

All values in the table are expressed as a percent (%).

Characteristics used to group species (e.g., native grasses or invasive species) are described in the Methods section of the report and indicated in Table 3.

For a given WMA, groups of species within this table are not mutually exclusive. As a result, adding the species and groups of species will result in greater than 100%.

TABLE 3. 2016 PLANT SPECIES LIST
PLATTE RIVER REVIVAL RESTORATION MONITORING
CITY OF CASPER, CASPER, WYOMING

	Scientific Name	Common Name	Species Code	Native/Non-native
Grasses/Grass-likes	*Achnatherum hymenoides*	Indian ricegrass	ACHY	native
	Agropyron cristatum	crested wheatgrass	AGCR	non-native
	Alopecurus arundinaceus	creeping meadow foxtail	ALAR	native
	Bouteloua gracilis	blue grama	BOGR2	native
	Bromus arvensis	field brome	BRAR5	non-native
	Bromus inermis	smooth brome	BRIN2	non-native
	[a] *Bromus tectorum*	cheatgrass	BRTE	non-native
	Carex spp.	sedge	CAREX	native
	[a] *Hordeum jubatum*	foxtail barley	HOJU	native
	Pascopyrum smithii	western wheatgrass	PASM	native
	Phalaris arundinacea	reed canarygrass	PHAR3	native
	Phragmites communis	common reed	PHAU7	native
	Poa pratensis	Kentucky bluegrass	POPR	native
	Sporobolus airoides	alkali sacaton	SPAI	native
	Thinopyrum intermedium	intermediate wheatgrass	THIN6	non-native
	Thinopyrum ponticum	tall wheatgrass	THPO7	non-native
	Typha angustifolia	narrowleaf cattail	TYAN	native
	Triglochin maritima	seaside arrowgrass	TRMA20	native
Forbs/Subshrubs	*Artemisia campestris*	field sagewart	ARCA12	native
	Artemisia ludoviciana	white sagebrush	ARLU	native
	Asclepias speciosa	showy milkweed	ASSP	native
	Chamaesyce serpyllifolia	thymeleaf sandmat	CHSE6	native
	Cirsium arvense	Canada thistle	CIAR4	non-native
	Crepis acuminata	tapertip hawksbeard	CRAC2	native
	[a] *Grindelia squarrosa*	curlycup gumweed	GRSQ	native
	Helianthus annuus	common sunflower	HEAN3	native
	Iva axillaris	povertyweed	IVAX	native
	Medicago sativa	alfalfa	MESA	non-native
	Portulaca spp.	purslane	PORTU	native
	Rosa arkansana	prairie rose	ROAR3	native
	Rumex crispus	curly dock	RUCR	non-native
	Salsola kali	Russian thistle	SAKA	non-native
	Solidago canadensis	Canada goldenrod	SOCA6	native
	Thlaspi arvense	pennycress	THAR5	non-native
	Yucca spp.	yucca	YUCCA	native
Shrubs	*Atriplex canescens*	fourwing saltbush	ATCA2	native
	Chrysothamnus spp.	rabbitbrush	CHRYS9	native
	Salix exigua	sandbar willow	SAEX	native
	Symphoricarpos occidentalis	western snowberry	SYOC	native
Trees	*Acer negundo*	boxelder	ACNE2	native
	[b] *Elaeagnus angustifolia*	Russian olive	ELAN	non-native
	Populus angustifolia	narrowleaf cottonwood	POAN3	native
	Populus deltoides	plains cottonwood	PODEM	native

Notes:

Species codes have been assigned according to the USDA Plants database (http://plants.usda.gov/java/)

[a]Noxious weed according to the Wyoming Weed & Pest Control Act Designated Weed List for Natrona County (http://www.wyoweed.org/images/2016_Declared_List.pdf)

[b]Noxious weed according to the Wyoming Weed & Pest Control Act Designated Weed List (http://www.wyoweed.org/weeds/state-designated-weeds)

FIGURES

NOTES:

- RR = RIVER RIGHT
- RL = RIVER LEFT
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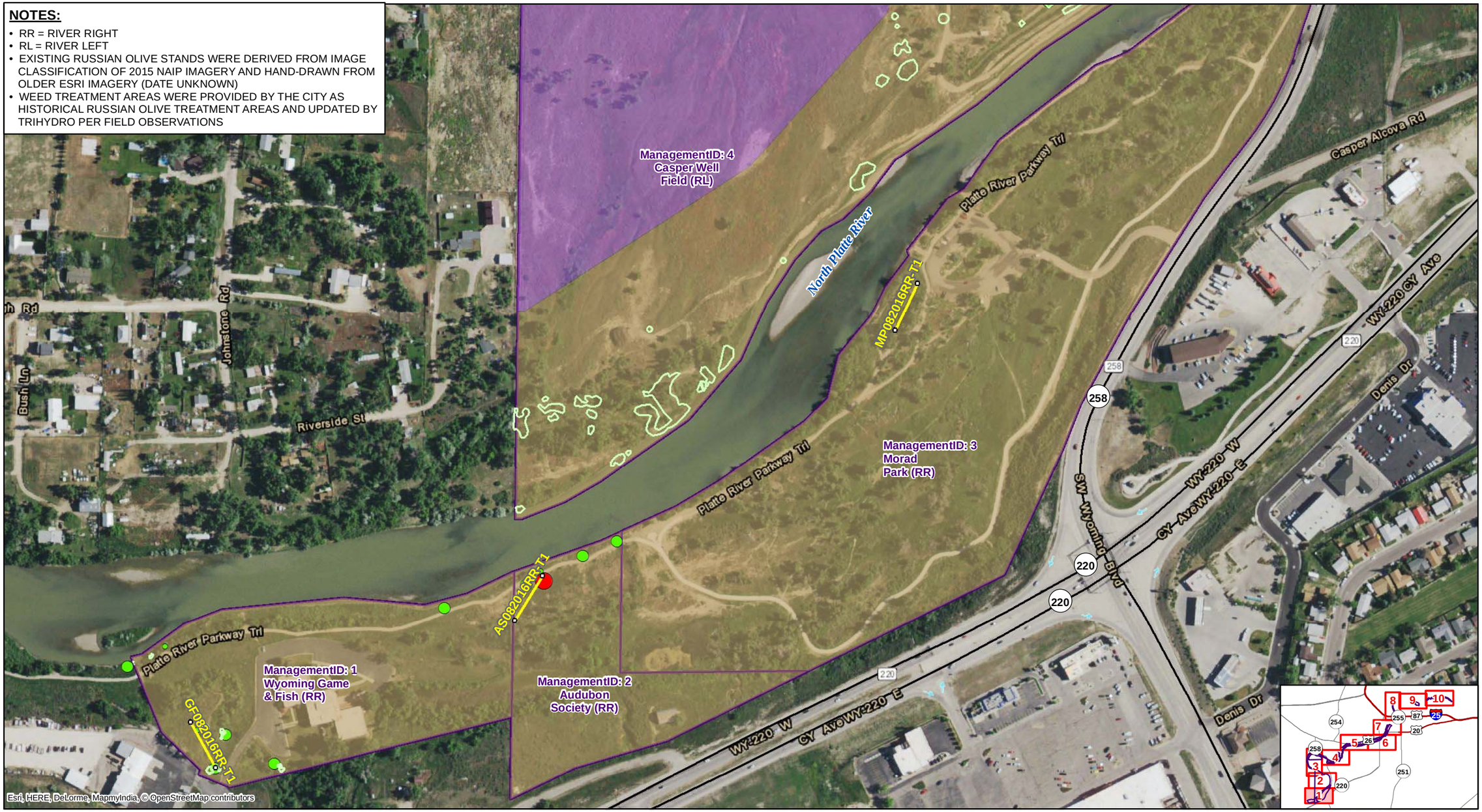
- WEED TREATMENT AREAS WERE PROVIDED BY THE CITY AS HISTORICAL RUSSIAN OLIVE TREATMENT AREAS AND UPDATED BY TRIHYDRO PER FIELD OBSERVATIONS



EXPLANATION

- TREATED RUSSIAN OLIVE
  - 1 TREE
  - 2 - 9 TREES
- UNTREATED RUSSIAN OLIVE
  - 10 OR MORE TREES
- TRANSECT END POINTS
- TRANSECT
- EXISTING RUSSIAN OLIVE STANDS
- WEED TREATMENT AREA
  - NOT PREVIOUSLY TREATED
  - PREVIOUSLY TREATED
  - WEED MANAGEMENT AREA

N

0 300'

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FIGURE 1

WEED MANAGEMENT AREAS 1 - 3

PLATTE RIVER RESTORATION MONITORING
CITY OF CASPER
CASPER, WYOMING

Drawn By: BR	Checked By: JW	Scale: 1" = 300'	Date: 12/21/16	File: Fig_PlatteRiver_DDP_RPT.mxd

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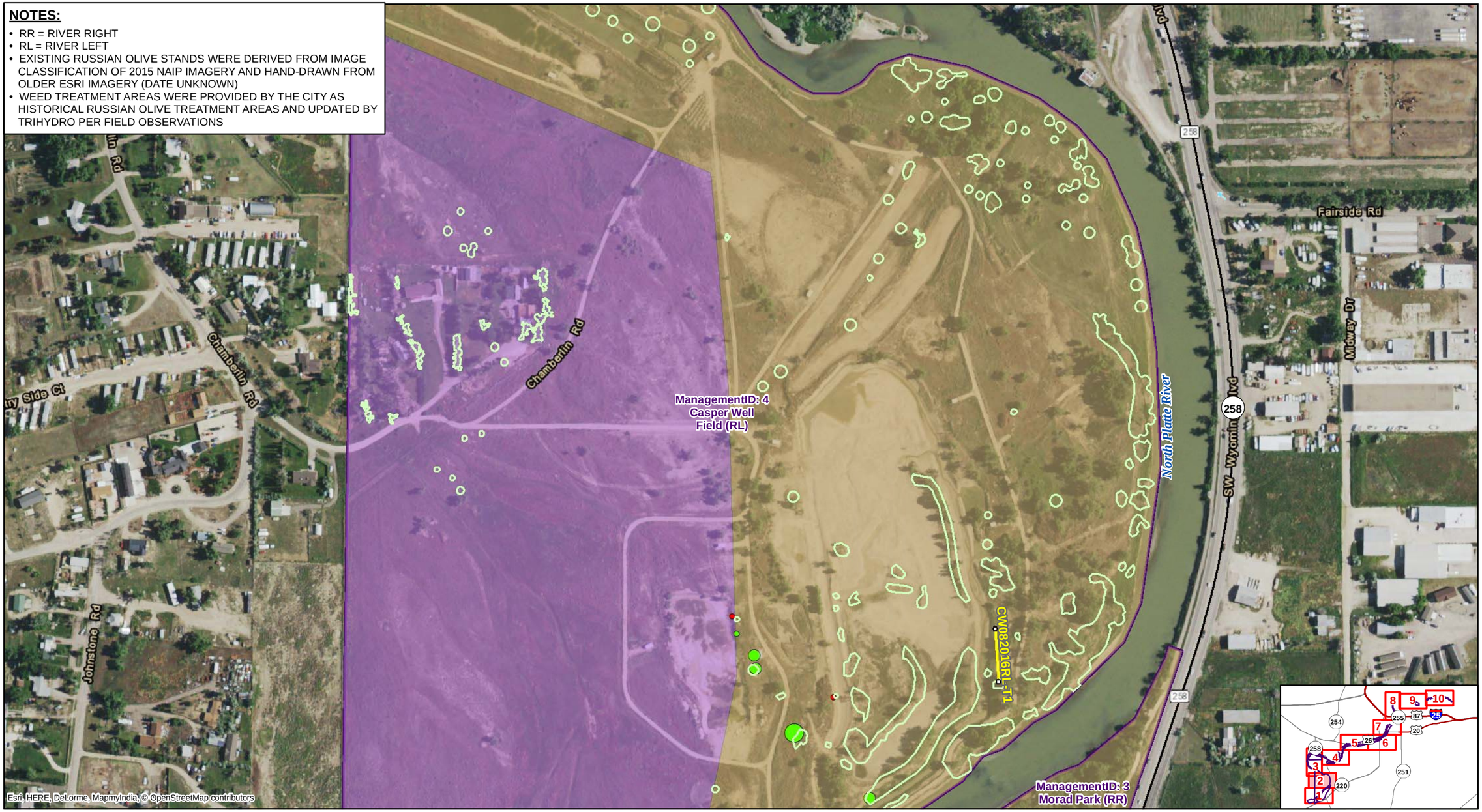

EXPLANATION

TREATED RUSSIAN OLIVE
- 1 TREE
- 2 - 9 TREES
- 10 OR MORE TREES

UNTREATED RUSSIAN OLIVE
- 1 TREE
- TRANSECT END POINTS
- TRANSECT
- EXISTING RUSSIAN OLIVE STANDS

WEED TREATMENT AREA
- NOT PREVIOUSLY TREATED
- PREVIOUSLY TREATED
- WEED MANAGEMENT AREA

N

0 300'

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FIGURE 2

WEED MANAGEMENT AREAS 4

PLATTE RIVER RESTORATION MONITORING
CITY OF CASPER
CASPER, WYOMING

Drawn By: BR	Checked By: JW	Scale: 1" = 300'	Date: 12/21/16	File: Fig_PlatteRiver_DDP_RPT.mxd

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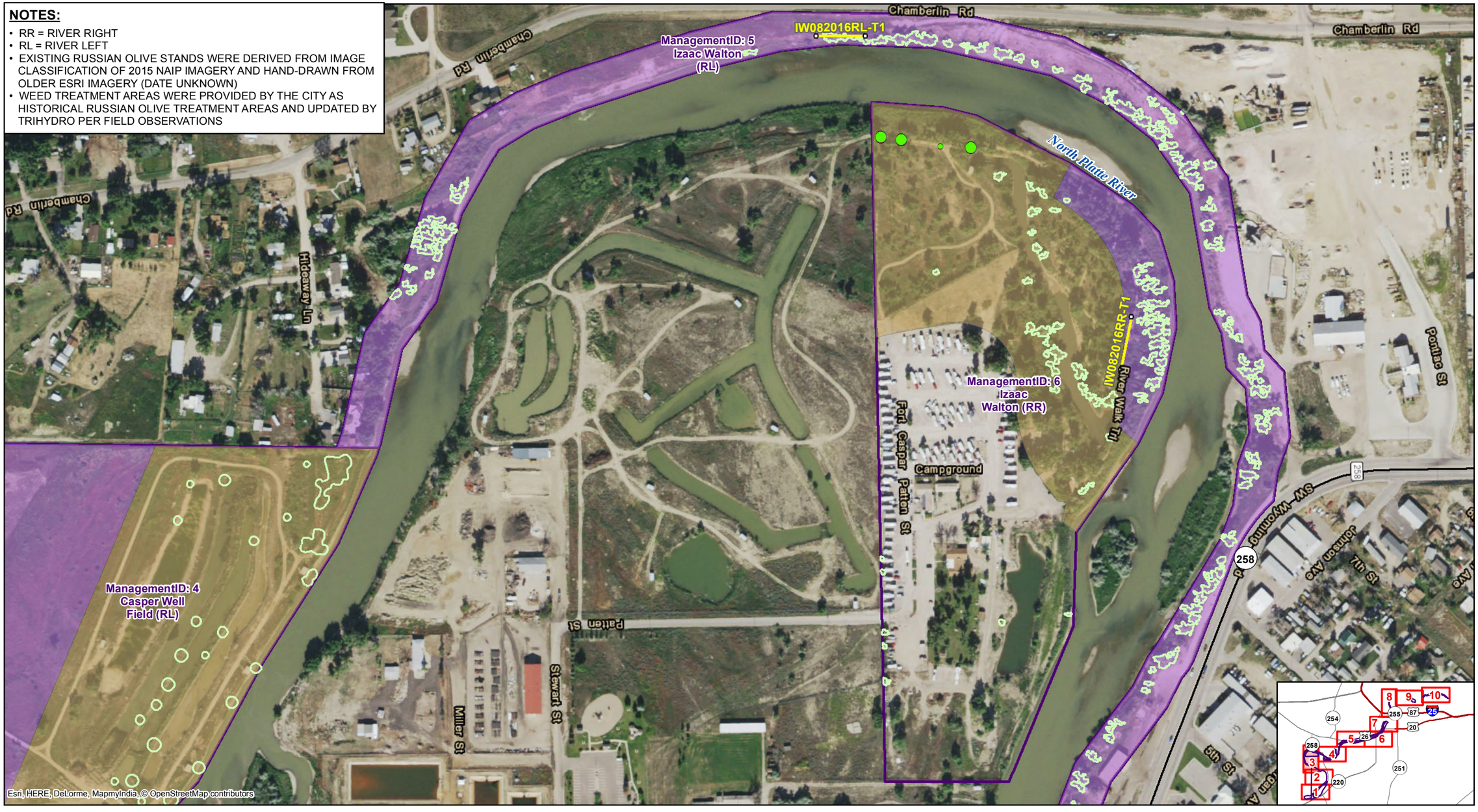

EXPLANATION

TREATED RUSSIAN OLIVE
- 1 TREE
- 2 - 9 TREES
- TRANSECT END POINTS
- TRANSECT

EXISTING RUSSIAN OLIVE STANDS

WEED TREATMENT AREA
- NOT PREVIOUSLY TREATED
- PREVIOUSLY TREATED
- WEED MANAGEMENT AREA

N

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FIGURE 3

WEED MANAGEMENT AREAS 5 - 6

PLATTE RIVER RESTORATION MONITORING
CITY OF CASPER
CASPER, WYOMING

Drawn By: BR	Checked By: JW	Scale: 1" = 300'	Date: 12/21/16	File: Fig_PlatteRiver_DDP_RPT.mxd

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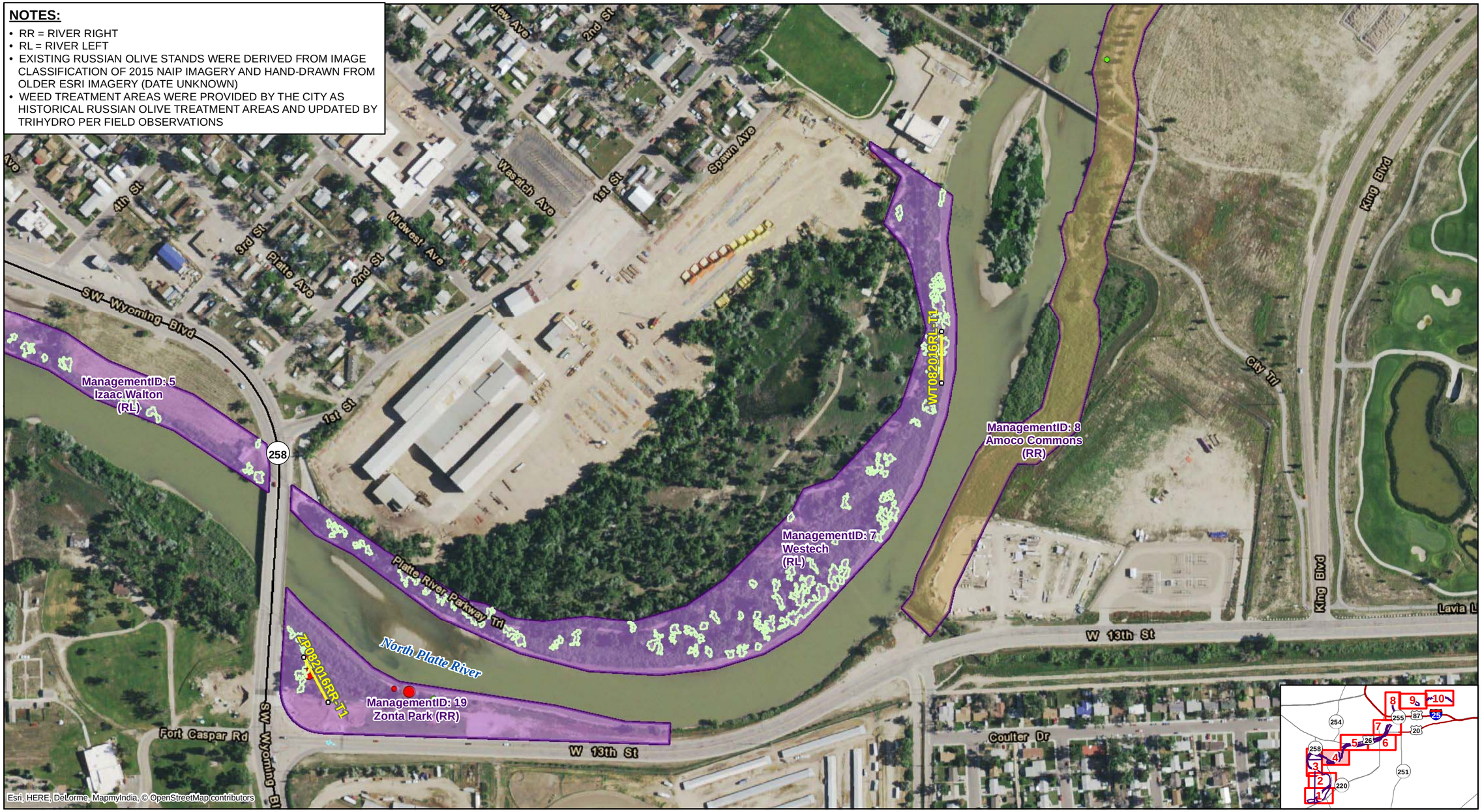

EXPLANATION

TREATED RUSSIAN OLIVE	TRANSECT END POINTS	PREVIOUSLY TREATED
1 TREE	TRANSECT	WEED MANAGEMENT AREA
UNTREATED RUSSIAN OLIVE	EXISTING RUSSIAN OLIVE STANDS	
1 TREE	WEED TREATMENT AREA	
2 - 9 TREES	NOT PREVIOUSLY TREATED	

N

0 300'

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FIGURE 4

WEED MANAGEMENT AREAS 5, 7, 8, 19

PLATTE RIVER RESTORATION MONITORING
CITY OF CASPER
CASPER, WYOMING

Drawn By: BR	Checked By: JW	Scale: 1" = 300'	Date: 12/21/16	File: Fig_PlatteRiver_DDP_RPT.mxd

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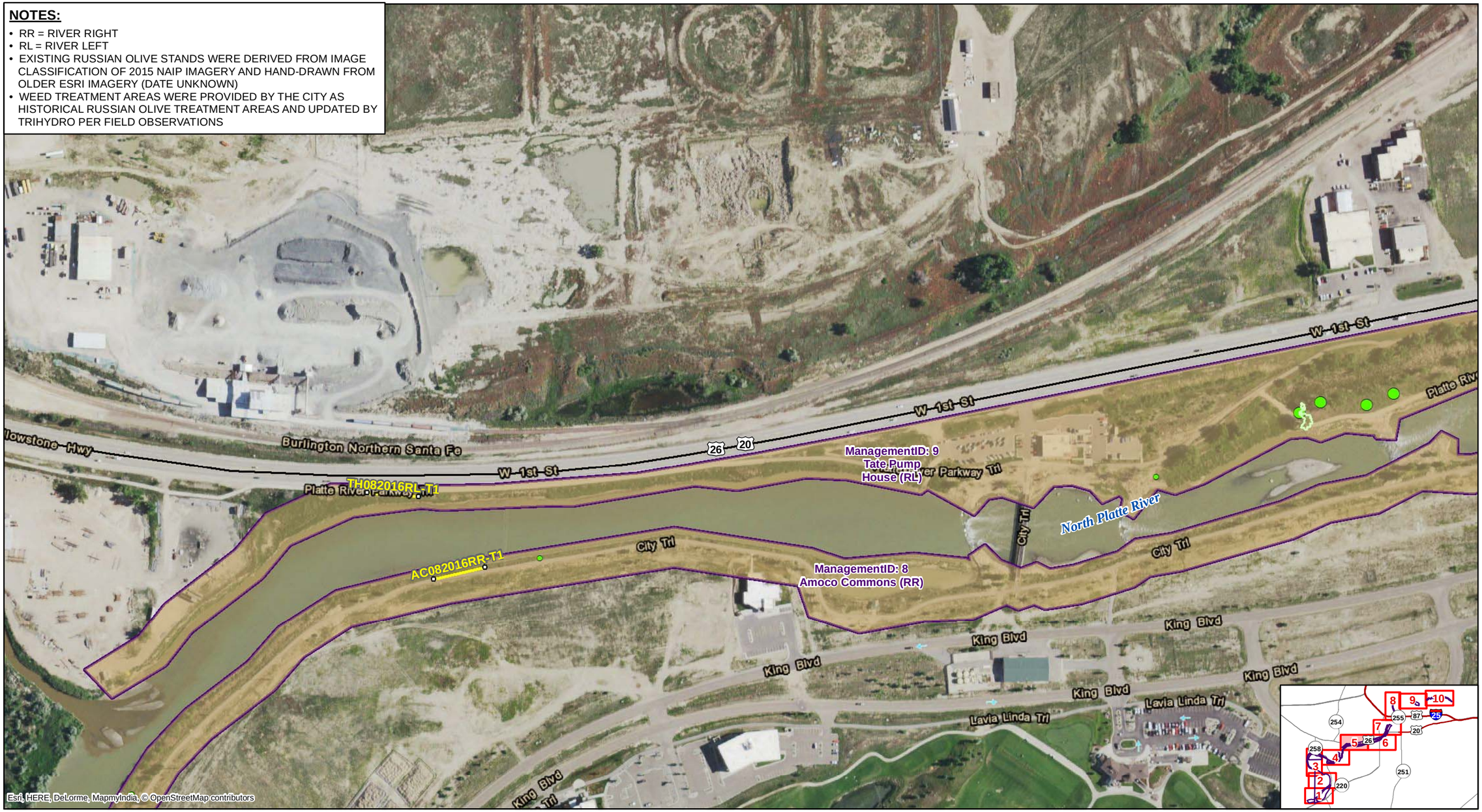

EXPLANATION

TREATED RUSSIAN OLIVE
- 1 TREE
- 2 - 9 TREES
- TRANSECT END POINTS
- TRANSECT

EXISTING RUSSIAN OLIVE STANDS

WEED TREATMENT AREA
- NOT PREVIOUSLY TREATED
- PREVIOUSLY TREATED
- WEED MANAGEMENT AREA

N

0 300'

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FIGURE 5

WEED MANAGEMENT AREAS 8 - 9

PLATTE RIVER RESTORATION MONITORING
CITY OF CASPER
CASPER, WYOMING

Drawn By: BR	Checked By: JW	Scale: 1" = 300'	Date: 12/21/16	File: Fig_PlatteRiver_DDP_RPT.mxd

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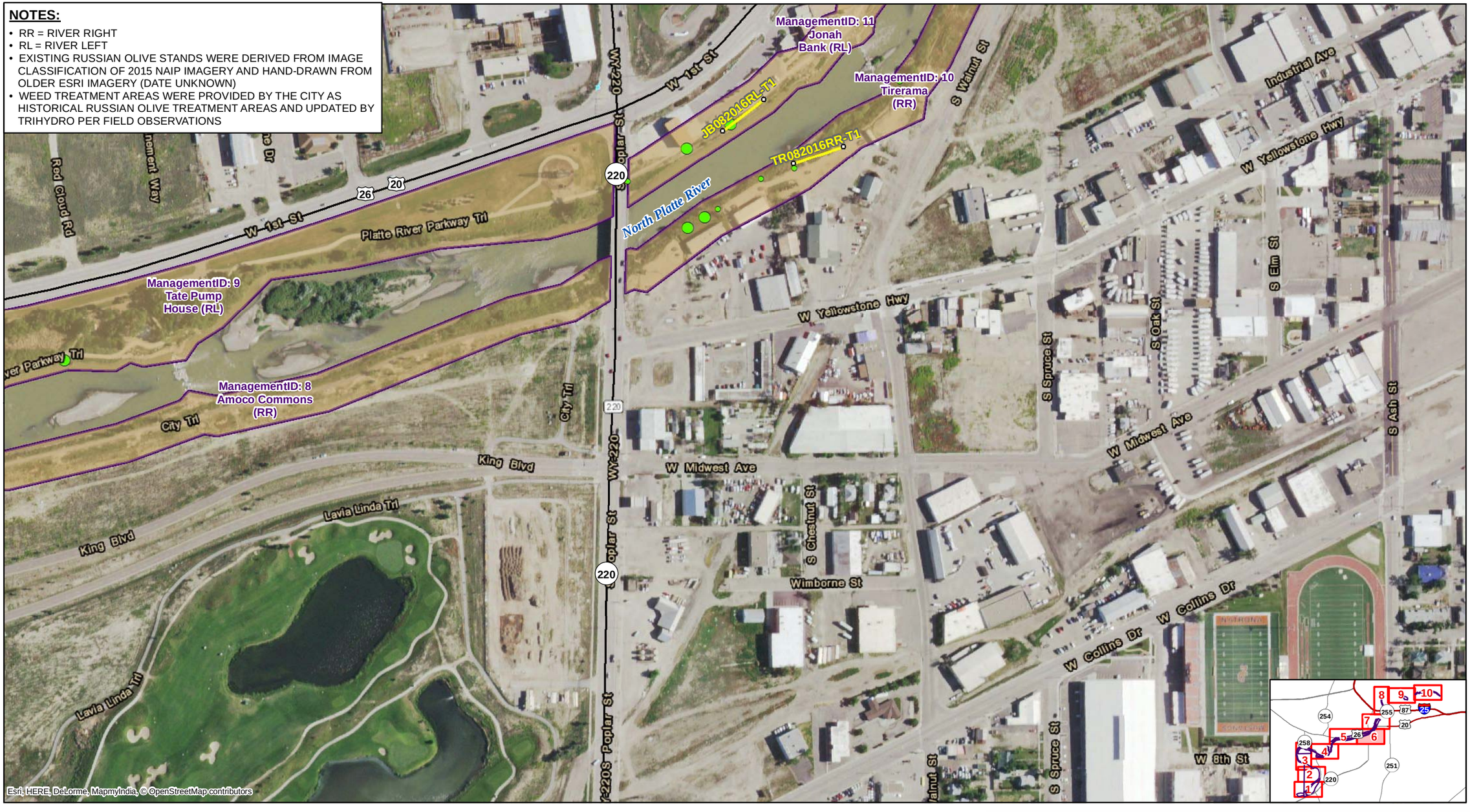

EXPLANATION

TREATED RUSSIAN OLIVE
- 1 TREE
- 2 - 9 TREES
- TRANSECT END POINTS
- TRANSECT

EXISTING RUSSIAN OLIVE STANDS

WEED TREATMENT AREA
- NOT PREVIOUSLY TREATED
- PREVIOUSLY TREATED
- WEED MANAGEMENT AREA

N

0 300'

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FIGURE 6

WEED MANAGEMENT AREAS 8 - 11

PLATTE RIVER RESTORATION MONITORING
CITY OF CASPER
CASPER, WYOMING

Drawn By: BR	Checked By: JW	Scale: 1" = 300'	Date: 12/21/16	File: Fig_PlatteRiver_DDP_RPT.mxd

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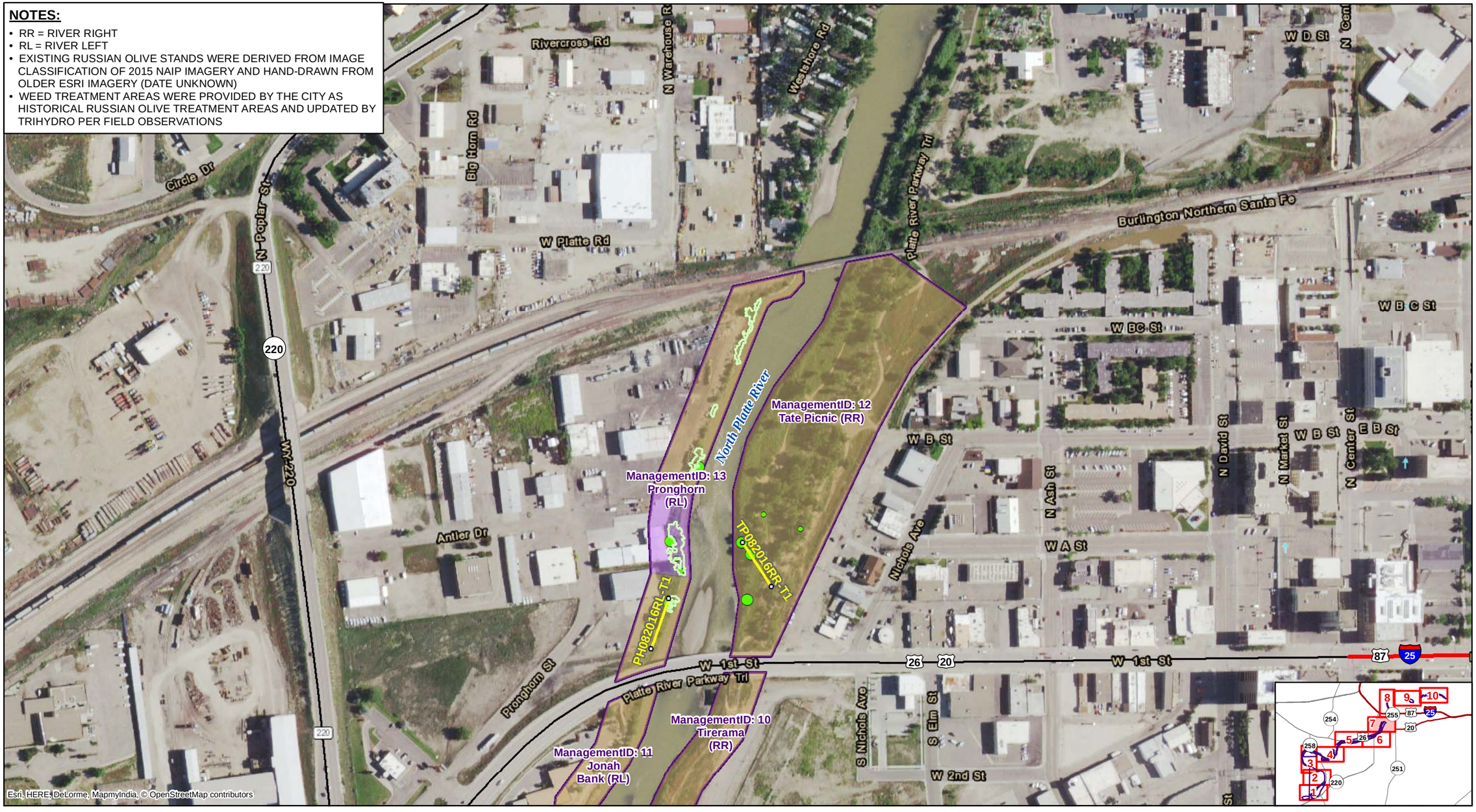

EXPLANATION

TREATED RUSSIAN OLIVE
- 1 TREE
- 2 - 9 TREES
- TRANSECT END POINTS
- TRANSECT

EXISTING RUSSIAN OLIVE STANDS

WEED TREATMENT AREA
- NOT PREVIOUSLY TREATED
- PREVIOUSLY TREATED
- WEED MANAGEMENT AREA

N

0 300'

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FIGURE 7

WEED MANAGEMENT AREAS 10 - 13

PLATTE RIVER RESTORATION MONITORING
CITY OF CASPER
CASPER, WYOMING

Drawn By: BR	Checked By: JW	Scale: 1" = 300'	Date: 12/21/16	File: Fig_PlatteRiver_DDP_RPT.mxd

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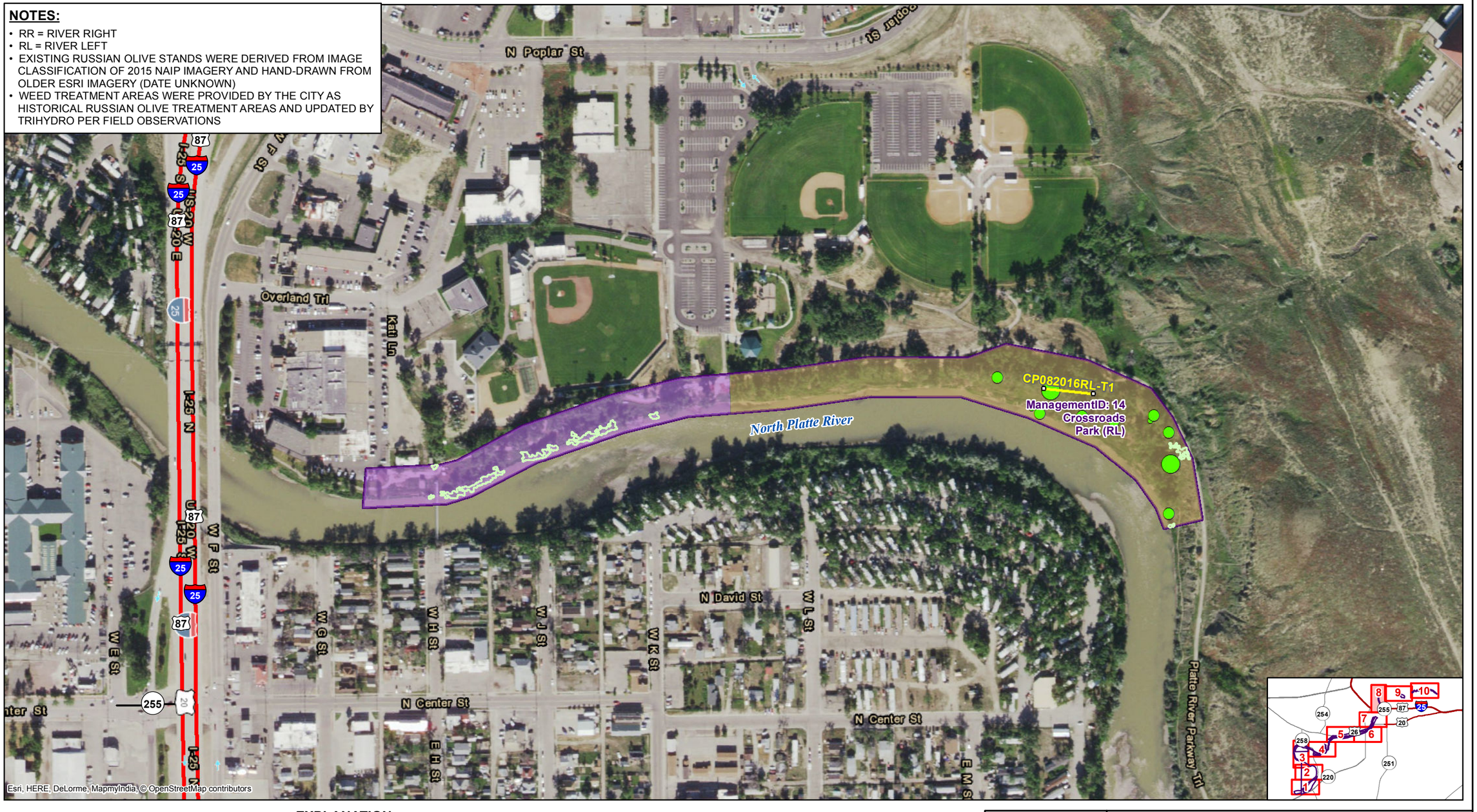

EXPLANATION

TREATED RUSSIAN OLIVE
- 1 TREE
- 2 - 9 TREES
- 10 OR MORE TREES
- TRANSECT END POINTS

TRANSECT

EXISTING RUSSIAN OLIVE STANDS

WEED TREATMENT AREA
- NOT PREVIOUSLY TREATED
- PREVIOUSLY TREATED

WEED MANAGEMENT AREA

N

0 300'

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FIGURE 8

WEED MANAGEMENT AREAS 14

PLATTE RIVER RESTORATION MONITORING
CITY OF CASPER
CASPER, WYOMING

Drawn By: BR	Checked By: JW	Scale: 1" = 300'	Date: 12/21/16	File: Fig_PlatteRiver_DDP_RPT.mxd

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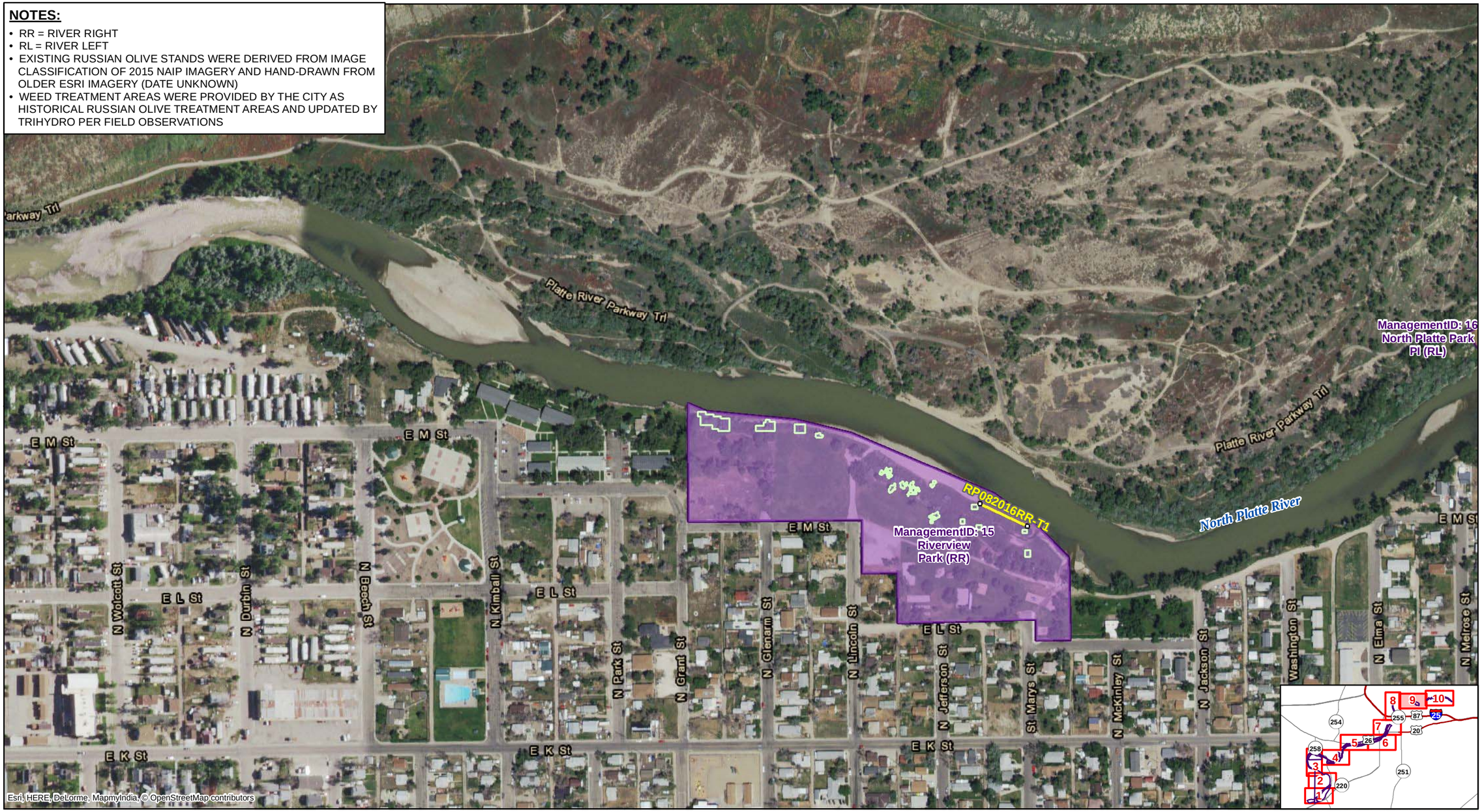

EXPLANATION

- TRANSECT END POINTS
- TRANSECT
- EXISTING RUSSIAN OLIVE STANDS
- WEED TREATMENT AREA
- NOT PREVIOUSLY TREATED
- PREVIOUSLY TREATED
- WEED MANAGEMENT AREA

N

0 300'

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FIGURE 9

WEED MANAGEMENT AREAS 15

PLATTE RIVER RESTORATION MONITORING
CITY OF CASPER
CASPER, WYOMING

Drawn By: BR	Checked By: JW	Scale: 1" = 300'	Date: 12/21/16	File: Fig_PlatteRiver_DDP_RPT.mxd

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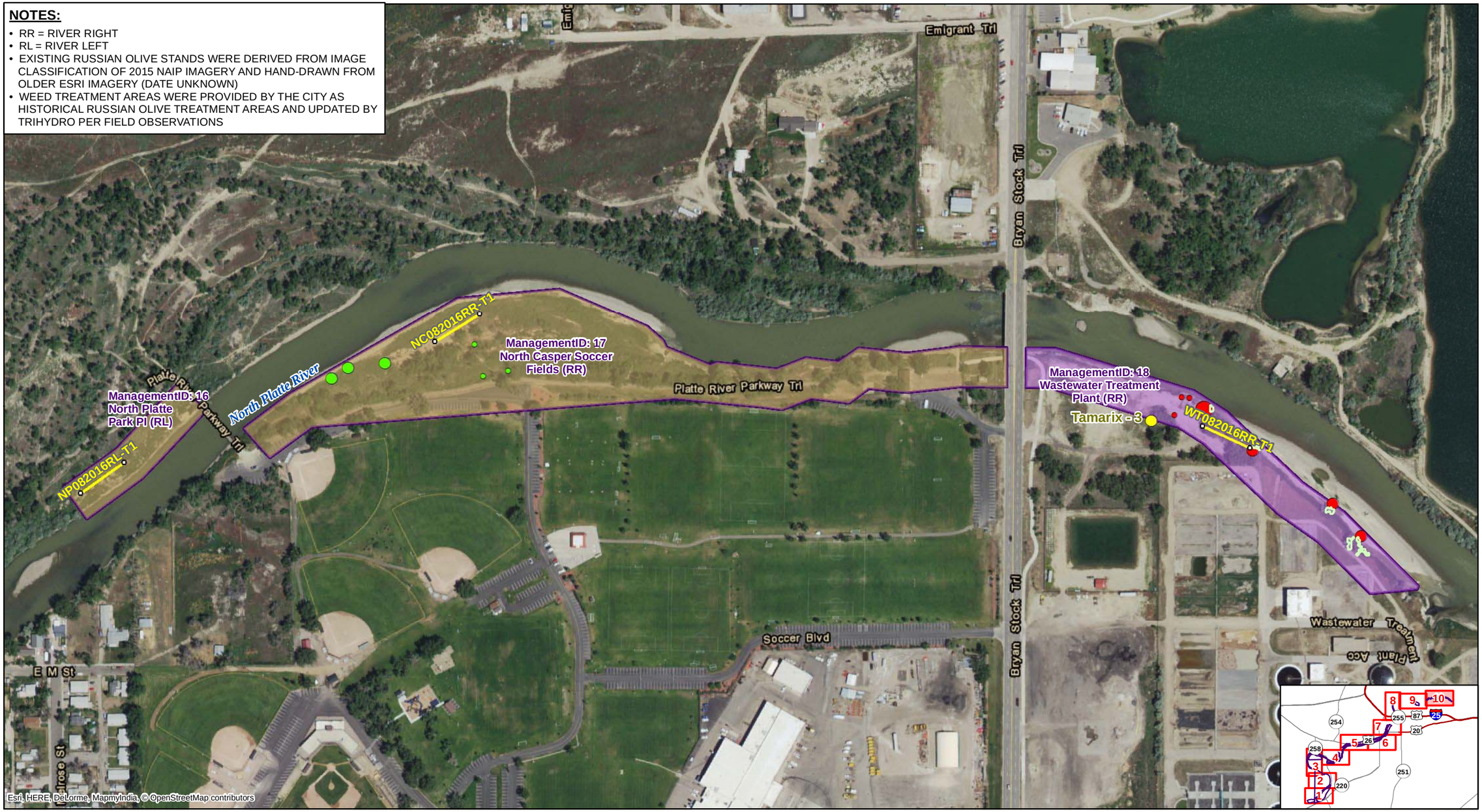

EXPLANATION

TREATED RUSSIAN OLIVE
- 1 TREE
- 2 - 9 TREES

UNTREATED RUSSIAN OLIVE
- 1 TREE
- 2 - 9 TREES
- 10 OR MORE TREES

OTHER INVASIVE TREE
- TAMARIX
- TRANSECT END POINTS

- TRANSECT
- EXISTING RUSSIAN OLIVE STANDS

WEED TREATMENT AREA
- NOT PREVIOUSLY TREATED
- PREVIOUSLY TREATED

WEED MANAGEMENT AREA

N

0 300'

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FIGURE 10

WEED MANAGEMENT AREAS 16 - 18

PLATTE RIVER RESTORATION MONITORING
CITY OF CASPER
CASPER, WYOMING

Drawn By: BR	Checked By: JW	Scale: 1" = 300'	Date: 12/21/16	File: Fig_PlatteRiver_DDP_RPT.mxd

APPENDIX A

TRANSECT PHOTOS, PLATTE RIVER REVIVAL RESTORATION MONITORING, CITY OF CASPER, CASPER, WY

APPENDIX A. TRANSECT PHOTOS
PLATTE RIVER REVIVAL RESTORATION MONITORING
CITY OF CASPER, CASPER, WYOMING

Management ID: 1 (GF082016RR)

Management ID: 2 (AS082016RR)

APPENDIX A. TRANSECT PHOTOS
PLATTE RIVER REVIVAL RESTORATION MONITORING
CITY OF CASPER, CASPER, WYOMING

Management ID: 3 (MP082016RR)

Management ID: 4 (CW082016RL)

APPENDIX A. TRANSECT PHOTOS
PLATTE RIVER REVIVAL RESTORATION MONITORING
CITY OF CASPER, CASPER, WYOMING

Management ID: 5 (IW082016RL)

Management ID: 6 (IW082016RR)

APPENDIX A. TRANSECT PHOTOS
PLATTE RIVER REVIVAL RESTORATION MONITORING
CITY OF CASPER, CASPER, WYOMING

Management ID: 7 (WT082016RL)

Management ID: 8 (AC082016RR)

APPENDIX A. TRANSECT PHOTOS
PLATTE RIVER REVIVAL RESTORATION MONITORING
CITY OF CASPER, CASPER, WYOMING

Management ID: 9 (TH082016RL)

Management ID: 10 (TR082016RR)

APPENDIX A. TRANSECT PHOTOS
PLATTE RIVER REVIVAL RESTORATION MONITORING
CITY OF CASPER, CASPER, WYOMING

Management ID: 11 (JB082016RL)

Management ID: 12 (TP082016RR)

APPENDIX A. TRANSECT PHOTOS
PLATTE RIVER REVIVAL RESTORATION MONITORING
CITY OF CASPER, CASPER, WYOMING

Management ID: 13 (PH082016RL)

Management ID: 14 (CP082016RL)

APPENDIX A. TRANSECT PHOTOS
PLATTE RIVER REVIVAL RESTORATION MONITORING
CITY OF CASPER, CASPER, WYOMING

Management ID: 15 (RP082016RR)

Management ID: 16 (NP082016RL)

APPENDIX A. TRANSECT PHOTOS
PLATTE RIVER REVIVAL RESTORATION MONITORING
CITY OF CASPER, CASPER, WYOMING

Management ID: 17 (NC082016RR)

Management ID: 18 (WT082016RR)

APPENDIX A. TRANSECT PHOTOS
PLATTE RIVER REVIVAL RESTORATION MONITORING
CITY OF CASPER, CASPER, WYOMING

Management ID: 19 (ZP082016RR)