Paul Beier note: The observer spent <45 minutes at each site. So a blank field does not mean "absent." Every species in the table was present in a Flagstaff riparian area in September 2017.

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Report summarizing plant identification consulting work for the Flagstaff Floodplain Management Plan.

Methods:
Per direction from City of Flagstaff Stormwater Section Project Manager Jim Janacek, 12 previously identified sites within the Rio de Flag and its major tributaries were visited during a two-week period from September 14-24, 2017. Approximately ½-3/4 hour was spent at each site, and a list of plant species based on observation was created for each site. If a plant was not known to species level, samples were taken and further identification work was done using keys, texts, and comparative specimens at the Deaver Herbarium at NAU. Return trips were made to 4 of the sites to gain additional samples or get better material after studying the original samples. Eighteen of these samples will be made into herbarium specimens and accessioned at the Deaver Herbarium.

Only plants growing within the riparian zones or drainage ways were noted; adjacent upland species were not inventoried. Some of the plants growing in the dry drainage ways are more often associated with upland or forest floor habitats, but these were listed if they were growing within the lower banks of the various drainage sites.

It should be noted that the above methodology requested will not create a complete list of all plants that may be growing in these sites. A strong effort

was made to note as many species as possible, but some species not in flower may have easily been overlooked. At each of the 4 sites where a second visit was made, several additional species were added to the original lists, which would imply that more species could probably be added to the other sites also. A valuable follow-up project might visit the same sites in late spring or early summer, in order to fill out the lists with additional early season species.

It is also important to know that this list does not differentiate between those species that were abundant at a site versus those that might have been seen only once. That type of annotation would require a much longer period of fieldwork and a different methodology. However, observations of consistently abundant and potentially useful plants are discussed in the Results section.

Several species pairs are listed together where there are two very similar taxa that are difficult to tell apart without microscopic work, and it was not practical to test all of the individuals encountered to verify which species was present. In most cases, the two species are ecologically interchangeable, and the specific information would not add to the value of this survey.

Results:
A matrix (Appendix A) was created listing the plant species found at each site. A total of 156 different species were observed within the riparian zones or drainage way banks of the identified sites. 52 (33%) of these species are introduced. This would be considered a high number for a flora of an entire area, but is not unusual for disturbed areas adjacent to development. Riparian zones also typically support a greater number of exotic species than undisturbed uplands.

The matrix is divided into 4 sections:

Trees & shrubs – 14 species (2 exotic)
Perennial forbs – 55 species (16 exotic)
Annual forbs – 47 species (18 exotic)
Graminoids – 40 species (16 exotic)

The plants observed were primarily a mix of facultative and upland species, with only a few true riparian obligates. This is probably due to the intermittent nature of water in these drainage ways. Upland species were

only listed if they were found within the banks of the drainage ways; many of these same species are common in and around Flagstaff in Ponderosa Pine forests and associated mountain meadows, and were present at some of the sites where they are not listed, but above the banks in the surrounding uplands. The matrix identifies riparian obligates (3) and facultative wetland (16) species, as so designated by USDA in either the Arid West or Western Mountains. The remaining species are either facultative, facultative upland, or upland per USDA. The majority of the riparian species were found in the northernmost sites, along the uppermost two Rio de Flag locations, and Schultz Creek.

The matrix also notes the number of exotic species per site, and gives the percentage of total species. It is harder to observe a pattern to these numbers, with the most "pristine" sites in order by the percentage of native species being Ponderosa Wash, Spruce Avenue Wash, Fanning Drive Wash, Schultz Creek, and Clay Avenue Wash. Spruce Ave, Clay Ave, and Schultz Creek visually appear to be the least disturbed, with drainages coming in directly from the forested areas to the north, but Ponderosa and Fanning are small areas that appear to be highly disturbed, but still retain predominantly native species. At Ponderosa Wash, the native species are dominant in both number of species and density, whereas at the Fanning site native species are high in number, but the few exotic species appear higher in density of occurrence. However, as mentioned earlier, to fully analyze the composition of each site by density/frequency of species would be a far more rigorous task requiring different methodology than requested for this project.

Discussion:
Although not requested as part of this project, I would offer a few observations about the potential use of these lists for the design of restoration projects at sites along these drainages.

Among all the native plants identified as occurring in these sites, perennial graminoids, forbs, shrubs and trees will be more valuable than the annuals in stabilizing soils in the floodplains and channel banks. True wetland obligates will not be useful as none of these sites have enough water to create viable populations (the three species were observed at only two of the sites, and there in small quantities).

Of the trees and shrubs observed, all of the native species could be appropriate for restoration projects adjacent to the actual drainage channel.

Pinus ponderosa (Ponderosa Pine) was most frequently recorded; in fact, this keystone species of the dominant surrounding biotic community was present at all sites in the adjacent upland areas. It is found in the drainage channels only where water is intermittent and not of sufficient volume to be periodically scouring. *Rosa woodsii* (Wood's Rose) was the most common and widespread shrub, and is more adapted to the drainage ways than most of the other upland species. The three facultative wetland species, *Acer negundo* (Boxelder), *Populus angustifolia* (Narrowleaf cottonwood), and *Salix lasiolepis* (Arroyo Willow) will do better in sites that stay moist for greater periods of the year; they were all found in the more northern drainage sites. They could do well in other sites with some supplemental irrigation as part of a development project.

Although trees and shrubs tend to be the most visually important species in a given area, the graminoids may ultimately be the most important for good ecosystem function. The perennial native graminoids observed in these sites that will be most useful for restoration are *Pascopyrum smithii* (Western wheatgrass – rhizomatous), *Elymus trachycaulus* (Slender wheatgrass – clumping), *Poa fendleriana* (Muttongrass – clumping), *Muhlenbergia rigens* (Deergrass – clumping), *Muhlenbergia wrightii* (Spike muhly – clumping), *Bouteloua gracilis* (Blue gramma – clumping to sod-forming), and *Carex occidentalis* (Western sedge – clumping). Most of these are upland species that seem to also grow well in dry creek beds, on the banks, and in the surrounding floodplains. Many of the other natives observed could also be used, but may be of lesser import due to their being shorter-lived or preferring more pristine habitats.

Elymus repens (Quackgrass – rhizomatous), *Dactylis glomerata* (Orchardgrass – clumping), *Bromus inermis* (Smooth brome – rhizomatous), *Poa pratensis* (Kentucky Bluegrass – rhizomatous), and *Schedonorus arundinaceus* (Tall fescue – clumping) are introduced pasture grasses that were commonly seen in large numbers at many of the sites. These species will probably end up being a part of any modified site along the drainage ways due to their current prevalence and adaptability to these ecosystems. Quackgrass is listed by the State of Arizona as a noxious weed, and the others are known to act weedy and be potentially invasive according to many different sources, although they have no official status in Arizona. Quackgrass was dominant at only one site (Rio de Flag near Herold Ranch), although it was also present at 50% of the other locations. Due to its

rhizomatous nature, this would be a difficult species to eradicate, and it is contributing to soil stabilization.

Other Arizona listed noxious weeds that were observed at several sites are the following forbs: *Acroptilon repens* (Russian knapweed – rhizomatous perennial), *Centaurea diffusa* (Diffuse knapweed – biennial to perennial), *Convolvulus arvensis* (Field bindweed – rhizomatous perennial), *Linaria dalmatica* (Dalmatian toadflax – rhizomatous perennial), and *Onopordum acanthium* (Scotch thistle – biennial). In my opinion, *Acroptilon repens*, *Centaurea diffusa*, and *Onopordum acanthium* should be targeted for elimination when populations form in disturbed areas and along waterways. These species seem more prone to dense infestations that crowd out other preferable native species than the other two.

A number of native forbs that were found in these sites will also be useful components of a restoration mix. They will add color and interest, as well as providing various ecosystem functions (wildlife habitat and forage, pollinator support, etc). The most frequently encountered, showy upland species that also are found in the drainage ways are:

Achillea millefolium (Common yarrow)
Cirsium wheeleri (Wheeler's thistle)
Geranium caespitosum (Pineywoods geranium)
Heliomeris multiflora (Showy goldeneye)
Ipomopsis aggregata (Scarlet gilia)
Mirabilis decipiens (Broadleaf four o'clock)
Sphaeralcea fendleri (Fendler's globemallow)
Symphyotrichum falcatum/ericoides (White heath aster)
Thalictrum fendleri (Fendler's meadowrue
Verbena macdougallii (MacDougall's verbena)

Epilobium ciliatum (Fringed willowherb) and *Sidalcea neomexicana* (New Mexico checkermallow) were also observed in several sites each, but these are both facultative wetland species, and would need more moisture to be successful over the long-term.

It should be noted that there are some very common non-showy native species that were present in significant numbers. Two perennial ragweeds, *Ambrosia psilostachya* and *A. tomentosa* seem to thrive in disturbed sites, and help bind soil due to their rhizomatous nature. These are typically not

used in landscaping or restoration due to their allergenic pollen and rather drab appearance, but will probably end up being part of any restoration due to their presence in the surrounding ecosystems. Sageworts (rhizomatous herbaceous *Artemisias*), are also allergenic, but while their flowers are not showy, their vegetative form is attractive and potentially useful. Both *Artemisia dracunculus* (False tarragon) and *A. ludoviciana* (White sagewort) are probably available in seed and in the nursery trade. *Rumex mexicanus* is one of the native docks that was found in a number of sites, but only directly in the drainage channel or areas where water may pond for periods of time. It is unlikely to be available in the trade.

Milkweeds were not observed in very many sites; only one, *Asclepias subverticillata* (Horsetail milkweed), was seen in two different locations. However, this species, along with *A. tuberosa* (Butterflyweed), *A. asperula* (Antelope horns), and *A. speciosa* (showy milkweed – in moister locations) would all be valuable local native plants to use in restoration for both pollinator support and general beauty.

While perhaps not as important for restoration over the long term, annual and biennial plants also play a role in ecosystems, and should not be overlooked completely. A number of native species were observed, many in great numbers, and some such as *Helianthus annuus* (Common sunflower), *Verbesina encelioides* (Golden Crownbeard), *Erigeron divergens* (Spreading fleabane), *Oenothera elata* (Hooker's evening primrose), *Amauriopsis dissecta* (Ragleaf bahia) , and *Coreopsis tinctoria* (Golden tickseed) would be attractive additions to most seed mixes.