3.4 Plant Collection and Identification

Specimens of any unknown taxa that were collected were pressed for later identification at the WA Herbarium. Identifications were undertaken by experienced botanists Bethea Loudon and David Coultas. External experts of particular families or genera were consulted for any specimens considered to be difficult to identify or of taxonomic interest.

Taxon nomenclature generally follows *FloraBase* (DPaW 2016e) with all names checked against the current DPaW Max database to ensure their validity. However, in cases where names of plant taxa have been published recently in scientific literature but have not been adopted on *FloraBase* (DPaW 2016e), nomenclature in the published literature is followed. The conservation status of each taxon was checked against *FloraBase*, which provides the most up-to-date information regarding the conservation status of flora taxa in Western Australia.

Specimens of interest, including significant flora taxa, range extensions of taxa and potential new taxa, will be sent to the WA Herbarium for consideration for vouchering as soon as practicable. However, this process is via donation, and the WA Herbarium may not voucher all specimens, in accordance with its own requirements. The specimen vouchering will be supported by completed Threatened and Priority Flora Report Forms submitted to DPaW (Species and Communities Branch) in the case of listed significant flora (e.g. Threatened and Priority flora taxa).

3.5 Floristic Analysis

Classification analysis of quadrat floristic data to define VTs was conducted using quadrats from the Study Area incorporating data collection in 2014 and 2016. The resultant VTs were compared to those presented in Woodman Environmental 2014a for consistency and to clarify regional significance of mapped VTs.

Classification analysis of quadrat floristic data to determine the regional significance of VTs was conducted using quadrats from both the Study Area and several other Atlas studies conducted in the vicinity of the Study Area. This approach produced a single VT dataset across these studies, and provides a level of regional context when assessing the distribution and conservation significance of VTs. The classification analysis was conducted on a taxon and quadrat data matrix compiled from quadrat data, utilising a total of 1119 quadrats and 640 perennial vascular taxa from the following studies:

- 108 quadrats from the Mount Webber Direct Shipping Ore Project (Woodman Environmental 2012c, 2013a);
- 164 quadrats from the McPhee Creek Iron Ore Project (Woodman Environmental 2013b, 2014b);
- 302 quadrats from the McPhee Creek Haul Road Project Study Area (Woodman Environmental 2014c);
- 188 quadrats from the McPhee Creek Rail Spur Project Study Area (Woodman Environmental 2014d); and
- 357 quadrats established in the Study Area as part of this study.

The locations of these studies are shown on Figure 1.

Taxa belonging to several categories were removed prior to analysis, as listed below:

- Ephemeral taxa – the presence of ephemeral taxa is strongly influenced by seasonal conditions, with fewer taxa and individuals usually present following below-average rainfall. As the taxon data matrix was compiled from quadrats surveyed over several years with differing seasonal conditions, ephemeral taxa were excluded to remove variation associated with this factor;
- Introduced taxa – introduced taxa were excluded as their distributions are generally defined by the presence of disturbance (e.g. clearing, animal movement) rather than particular habitat types;
- Singletons (taxa recorded only once in the quadrat dataset) – singletons were removed as they provide little information in datasets;
- Known and putative hybrids – hybrids were removed as they are generally present as isolated individuals and at scattered locations only, and as they are generally of unknown or presumed origin;
- Taxa where identification was unclear – such taxa were removed from the analysis where identification was unclear due to poor available material in the field;
- Taxa present in recently burnt areas only – a number of quadrats across most of the studies utilised for the floristic analysis had been recently burnt, including many in the Study Area that were noted as being burnt within the last year. Fire in the Pilbara region results in prolific germination of many taxa, with a large proportion of these being ephemeral taxa (Woodman Environmental field observations). There are also a number of short-lived perennial taxa that also germinate prolifically following fire in the Pilbara region that were recorded in recently burnt quadrats, but were completely absent (or almost so) from unburnt quadrats. To attempt to mitigate variation in taxon composition as a result of fire history, such taxa were also removed from the analysis. These include taxa such as *Heliotropium skeleton, Crotalaria novae-hollandiae*, *Trichodesma zeylanicum* and several *Cullen* species; and
- Taxa with ephemeral above-ground parts only – a number of perennial taxa that produce ephemeral above-ground parts which senesce when conditions are unfavourable were also removed from the analysis. Such taxa, while easily identifiable at some sites when conditions were favourable, could not be confidently identified at all sites because such material was absent or in poor condition. Taxa in this category included rhizomatous taxa such as *Cheilanthes* and *Fimbristylis* species, and taxa with woody rootstocks such as *Ptilotus nobilis* subsp. *nobilis* and *Zornia albiflora*.

Some perennial taxa and infra-taxa were also amalgamated where taxonomy was unclear or could not be determined in all cases, such as *Grevillea wickhamii* variants. All taxa omitted and amalgamated from the floristic analysis (other than ephemerals, hybrids or singletons) are presented in Appendix F.

Initially, an OptimClass analysis was undertaken to determine the most suitable approach to classification based on the available data. OptimClass (Tichý *et al.* 2010) evaluates the quality of a set of different partitions of the same dataset, based on the number of taxa that are faithful to clusters of that partition. Faithful taxa are identified using the Fisher's exact

test for the right-tailed hypothesis, which is a suitable measure of statistical fidelity of taxa to clusters of quadrats (Sokal & Rohlf 1995; Chytrý et al. 2002).

For the OptimClass analysis a selection of the most widely-used techniques in community ecology were tested, including Unweighted Pair-Group Method using Arithmetic Averages (UPGMA), Beta Flexible Clustering and Ward's Method in combination with a Bray-Curtis Index, Similarity Ratio, Chord Distance and none or logarithmic and/or power transformations of species percentage foliage cover. The full list of combinations tested is shown in Appendix G. The cluster analyses used to calculate OptimClass values were performed using the software packages JUICE 7.0.123 (Tichý 2002) and PC-ORD 6.08 (McCune & Mefford 2011).

The OptimClass analysis influenced the selection of a classification analysis using a one-layer data matrix (presence/absence data only) with no transformation, with Beta Flexible Clustering ($\beta = 0.25$) as the clustering tool, and Bray-Curtis as the similarity ratio.

Classification analysis was conducted using the PATN (V3.12) package (Belbin & Collins 2009), with the results of the classification produced as a dendrogram. A taxon and quadrat matrix was produced, with the matrix sorted into taxon groups generated from the classification. Indicator taxon analysis (INDVAL) was conducted using PC-ORD (McCune & Mefford 2011) using the method of Dufrene & Legendre (1997). The INDVAL measures were used to determine the indicator taxa for each VT and a Monte Carlo permutation test was used to test for the significance of the indicator taxa. The Bray-Curtis coefficient was used to generate an association matrix for the classification analysis. This association matrix consisted of pairwise coefficients of similarities between quadrats based on floristic data. Agglomerative, hierarchical clustering, using flexible UPGMA (ß=-0.25), was used to generate a quadrat classification dendrogram (Sneath & Sokal 1973).

3.6 Vegetation Type Mapping and Description

OptimClass analysis of Study Area quadrat data identified approximately 13 quadrat clusters as the optimal number when applying the classification parameters outlined in Section 3.5. The classification dendrogram and taxon group matrix were initially examined at the 13-cluster level, to determine the plausibility of clusters.

Quadrats within each group were manually compared to determine the level in the dendrogram at which to delineate VTs. The manual comparison was also utilised to identify any quadrats that had been misclassified by the analysis. Such misclassification of quadrats has occurred in previous floristic analyses conducted by Woodman Environmental, with higher numbers of quadrats deemed misclassified in previous floristic analyses of Pilbara region quadrat datasets (e.g. Woodman Environmental 2014c) compared to floristic analyses of quadrat datasets from areas outside the Pilbara region, including the Coolgardie and Geraldton Sandplains regions (e.g. Woodman Environmental 2013d, 2014e). A number of factors potentially contribute to quadrat misclassification, including disturbance history (fire or grazing – both particularly common factors in the Pilbara bioregion), situation of quadrats in ecotones (the transition zone between VTs), misidentification of taxa during survey (most often because of poor available material), naturally low taxon richness, and the relatively homogenous species composition of vegetation in the Pilbara region across

widely differing soil, substrate and topographical types (Woodman Environmental field observations). This process determined a final number of clusters that were considered to represent VTs.

Manual comparison of quadrats in the floristic analysis identified a number of apparently misclassified quadrats within the dendrogram following the investigation of their soil, topography and taxon composition. This appeared to be most often related to the situation of quadrats in ecotones or where species richness was very low reducing the ability of the analysis to place them properly. These misclassified quadrats were investigated to determine their relationships to other groups in the dendrogram, based primarily on dominant taxon composition, and to a lesser extent soil, substrate and topographical type, and were then reassigned to the most appropriate group. This process is subjective, relying on knowledge of the Study Area and its species composition, landforms and disturbance history, and also a general knowledge of vegetation patterns in the Pilbara region. A list of all quadrats manually reassigned, and the reasoning for the reassignment, is presented in Appendix H.

VT descriptions have been adapted from the National Vegetation Information System (NVIS) Australian Vegetation Attribute Manual Version 6.0 (Executive Steering Committee for Australian Vegetation Information (ESCAVI) 2003). This model follows nationally-agreed guidelines to describe and represent VTs, so that comparable and consistent data is produced nation-wide. It must be noted that the NVIS system utilises vegetation descriptions derived from structural characteristics of the individual community units, while the VTs presented in this report have been derived from analysis of site floristics, excluding any structural component. VTs therefore may include multiple structural types. Considering the effect of disturbance factors such as fire on vegetation structure, this approach is designed to provide a map of VTs that reflect taxon composition and the influences of the physical and chemical environment rather than disturbance history.

For the purposes of this report, it is considered that a VT is equivalent to a NVIS sub-association as described in ESCAVI (2003). Common taxa within each stratum were generally defined as taxa that occurred in greater than one-third of quadrats established within a particular VT (however this varied slightly depending on the number of quadrats); these may include taxa not in the VT description, as the VT description is based on dominance within each stratum, as well as the frequency that a taxon was recorded within each VT.

The locations of quadrats within each VT were used in conjunction with aerial photography interpretation and field notes taken during survey to develop VT mapping polygon boundaries. These VT mapping polygon boundaries were then digitised using Geographic Information System (GIS) software.

3.7 Vegetation Condition Mapping

Vegetation condition was recorded at all quadrats, and also opportunistically within the Study Area where areas of disturbance to vegetation were noted (e.g. weed infestations, areas of heavy grazing, mineral exploration). Vegetation condition was described using a vegetation condition scale adapted from Keighery (1994) that was utilised by DPaW during the Pilbara Biodiversity Survey (McKenzie *et al.* 2009), and is presented in Appendix E.

Vegetation condition polygon boundaries for the Study Area were developed using this information in conjunction with aerial photography interpretation, and were digitised as for VT polygon boundaries.

3.8 Significant Flora and Vegetation

EPA Guidance Statement No. 51 (EPA 2004) considers that any taxon listed as Threatened under relevant legislation (WC Act, EPBC Act), or classified by DPaW as Priority flora, is considered to be significant. Such taxa are therefore addressed in this report. Guidance Statement No. 51 (EPA 2004) also notes that a flora taxon may also be considered as significant if it meets one of the following criteria:

- It has a keystone role in a particular habitat for threatened species, or supporting large populations representing a significant proportion of the local regional population of a species;
- It is of relic status;
- It has anomalous features that indicate a potential new discovery;
- It is representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range);
- It is a restricted subspecies, variety, or naturally occurring hybrid;
- It displays local endemism/has a restricted distribution; and
- It is poorly reserved.

It is considered that the criterion of level of reservation (i.e. presence in conservation reserves such as national parks or nature reserves) is difficult to apply in the context of this report, as the Pilbara region is both relatively poorly-surveyed and poorly-reserved, and it is therefore not possible to accurately determine the reservation status of a particular taxon. However, level of reservation may be relevant in the context of addressing the significance of a taxon that meets one of the other criteria listed above, particularly listed Threatened or Priority flora taxa, as taxa meeting these criteria may be of higher significance if they are not or are poorly reserved.

Significant taxa are discussed in Section 5.2.

No classification of the potential local significance of locations of significant flora taxa has been undertaken as part of this study, as has previously been undertaken by Woodman Environmental for other studies conducted for Atlas (e.g. Woodman Environmental 2014c). It is considered that such a classification is best undertaken as part of any overall impact assessment that may need to be undertaken for the Project, as significant flora data may change prior to such an impact assessment being conducted.

EPA Guidance Statement No. 51 (EPA 2004) considers that vegetation listed as a TEC under the EPBC Act, or classified as a TEC or PEC by DPaW, is considered to be significant. Such vegetation is therefore addressed in this report. Guidance Statement No. 51 (EPA 2004) also notes that vegetation may also be considered as significant if it meets one of the following criteria:

- It is uncommon or scarce;
- It contains unusual species;
- It has a novel combination of species;
- It plays a role as a refuge;
- It plays a role as a key habitat for threatened species or large populations representing a significant proportion of the local to regional total population of a species;
- It is representative of the range of a unit (particularly, a good local and/or regional example of a unit in 'prime' habitat, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range); and
- It has a restricted distribution.

These criteria are generally applicable to VTs mapped in the Study Area, and are therefore used to determine whether a VT is locally significant (with 'local' referring to the Study Area). It is more difficult to apply these criteria in a regional context, as there is no publicly-available Pilbara-wide dataset of VTs. However, the floristic analysis of quadrats from the Study Area and a number of other studies in the vicinity of the Study Area (see Section 3.5) has produced a relatively geographically-widespread VT dataset that provides a reasonable level of context when considering the significance of VTs. These criteria are therefore applied to the VTs mapped in the Study Area in the context of this VT dataset, to determine potentially regionally significant VTs.

Significant vegetation is discussed in Section 6.4.

4 ADEQUACY AND LIMITATIONS OF SURVEY

4.1 Adequacy of Survey

The Study Area covers approximately 26,021.8 ha, with 357 quadrats established within it. Quadrats were established in all preliminary vegetation patterns discernable by initial aerial photograph interpretation (see Section 3.2 and 3.3), both to adequately sample variation in vegetation throughout the Study Area, and to ensure adequacy of sampling for vascular plant taxa. Historic discussion held with Dr. Stephen van Leeuwen of DPaW indicated that a sampling intensity of one 50 m x 50 m quadrat per square kilometre provides an acceptable level of sampling to characterise vegetation assemblages in the Pilbara. This sampling intensity has also been adopted by other mining companies (for example, BHPBilliton) as their standard for flora and vegetation surveys for Environmental Impact Assessment in the Pilbara. Given the size of the Study Area, 260 quadrats are required to meet this ratio. The number of quadrats established in the Study Area exceeds this amount, and is therefore considered to be an acceptable number.

To provide an indication of the adequacy of this survey, a species accumulation curve was produced using PC-ORD (V6.08) (McCune and Mefford 2011). Species accumulation curves represent a theoretical model of the relationship between sampling intensity and species accumulation; when sampling intensity is increased, species accumulation is reduced, and a species accumulation curve becomes asymptotic.

The species accumulation curve for quadrat data from the Study Area was generated using all native taxa (both annual and perennial) recorded within each quadrat. Species accumulation calculations for the Study Area were then undertaken via PC-ORD, utilising the Chao-2 estimator for species richness (Chao 1987), and compared to the actual number of species recorded in the Study Area. This gives some indication as to whether sufficient quadrats have been surveyed to adequately sample the species richness in the Study Area. As the generation of species accumulation curves includes quadrat data only, and not opportunistically-recorded taxa, the indication of adequacy of survey provided is considered to be conservative.

Figure 5 presents the species accumulation curve generated from quadrat data from the Study Area. Using the Chao-2 estimator, the recorded number of taxa within quadrats is equivalent to 89.5 % of the estimated taxon richness in the Study Area. Sampling was therefore considered to be adequate using this estimation measure.

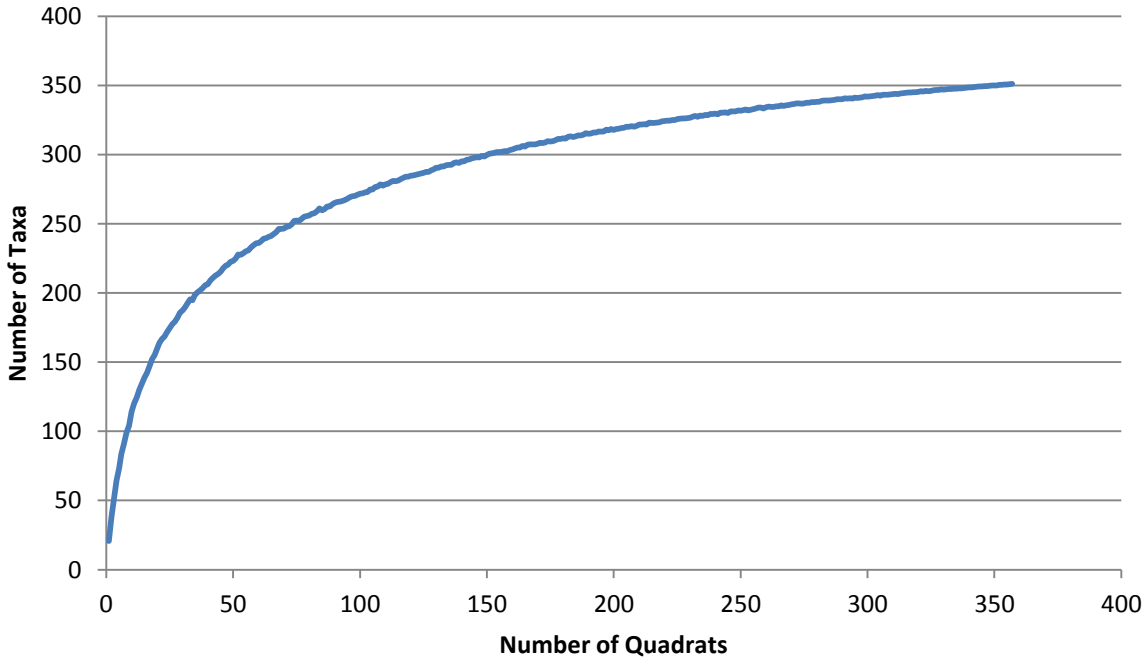

Figure 5: Study Area Species Accumulation Curve

It is of interest that the estimated number of taxa in the Study Area from quadrats only using Chao-2 was 392; when opportunistic records of taxa are included, 413 taxa were recorded in the Study Area (see Section 5.1), indicating that the Study Area was well-sampled.

Another adequacy of survey measure is that developed by Mueller-Dombois and Ellenberg (1974), who suggest that a cut-off point might be when a 10% increase in quadrats surveyed results in a 5% (or less) increase in taxa recorded. This measure was also calculated using all native taxa recorded within each quadrat. The number of quadrats established in the Study Area satisfies this adequacy measure suggested by Mueller-Dombois and Ellenberg (1974), with the final taxon increase value of 1.52 % recorded following a 10 % increase in quadrats.

4.2 Limitations of Survey

Table 8 presents the limitations of the flora and vegetation survey of the Study Area in accordance with EPA Guidance Statement No. 51 (EPA 2004).

Table 8: Limitations of the Flora and Vegetation Survey of the Study Area

Limitation	Limitation of Survey	Comment
Level of survey	No	Level 2 Detailed Survey: The detailed field survey conducted in March and May 2014 and in May 2016, within the usual peak flowering season in the Pilbara region. Replicated quadrats were established in each vegetation pattern identified in the Study Area. EPA (2004) indicates that survey should also be undertaken in other seasons, and it is noted that some perennial taxa expected to occur in the Study Area flower in other seasons (e.g. Winter). However, it is considered that survey in the peak flowering season only is adequate in this case, as it considered likely that most taxa that flower outside the peak flowering season could be identified during the survey period.
Competency/experience of the consultant(s) carrying out the survey	No	Senior personnel undertaking the survey have had experience in conducting similar assessments, including assessments in nearby areas in the Pilbara region such as the McPhee Creek Haul Road Project (Woodman Environmental 2014c). Senior personnel provided guidance to less experienced botanists throughout the survey where necessary.
Scope (floral groups that were sampled; some sampling methods not able to be employed because of constraints?)	No	All vascular groups that were present during the detailed survey were sampled. No constraints prevented appropriate sampling techniques (quadrat establishment, foot transects) being employed.
Proportion of flora identified, recorded and/or collected	Potential minor	A high proportion of perennial vascular taxa were recorded based on the intensity and method of survey. A high proportion of ephemeral vascular taxa were recorded based on the intensity and method of survey, and above-average rainfall prior to the 2014 survey. Although rainfall prior to the 2016 survey was lower than average, numerous ephemeral taxa were present and identifiable however the entire suite of taxa that may potentially have been present may not have been recorded in 2016 (see timing/weather/season/cycle below). Unknown vascular taxa were collected, with specimens identified at the WA Herbarium. Adequacy of survey measures indicate a high percentage (89.5%) of taxa expected to occur in the Study Area was recorded (Chao-2 estimator), and the number of quadrats established in the Study Area satisfies the criterion suggested by Mueller-Dombois and Ellenberg (1974), with an increase of 1.52 % in species recorded per increase of 10 % of quadrats.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data	No	Sources of information used included government databases (DPaW, DoE) and several reports and unpublished data from the vicinity of the Study Area. Good contextual information for the Study Area was available prior to the survey.
The proportion of the task achieved and further work which might be needed	Potential minor	The Level 2 survey was completed, with the survey including some searching for significant flora taxa. No further survey within the Study Area is considered necessary at this time however searching for significant flora may be required depending on the location of future impact areas and determination of potentially undescribed taxa.

Limitation	Limitation of Survey	Comment
Timing/weather/season/cycle	Potential minor	The field survey was conducted in Autumn following significant Summer rainfall in 2014, corresponding with the optimum flowering period for the Pilbara region. The 2014 flowering period was considered by Woodman Environmental to be good, with above-average rainfall (477 mm compared to the average of 273.9 mm) (Bureau of Meteorology 2016) over the Summer 'wet season' (December 2013 – March 2014). The 2016 field survey was conducted in Autumn following lower than average rainfall (185 mm compared to the average of 243.8 mm) (Bureau of Meteorology 2016) over the Summer 'wet season' (December 2015 – March 2016) with no rainfall immediately prior to the survey in April. The 2016 flowering period was considered to be average by Woodman Environmental however the majority of taxa recorded were able to be identified in the absence of flowering or fruiting material.
Disturbances (e.g. fire, flood, accidental human intervention etc.), which affected results of survey	Potential minor	A significant proportion of the Study Area was burnt by an intense fire in October 2013 (Outback Ecology 2013). It is considered that the fire did not greatly affect the ability to identify vascular taxa in the Study Area, as above-average rainfall over the Summer 'wet season' in 2014 subsequent to the fire promoted significant growth of re-sprouting perennial taxa and germination and growth of non-sprouting taxa. It is likely that the final number of taxa recorded may be higher than if the Study Area was unburnt, as many taxa in the Pilbara appear to only germinate prolifically following fire (Woodman Environmental field observations). However, the fire has had a significant impact on the composition of vegetation in the Study Area, with post-fire coloniser taxa dominating burnt areas, but often absent from unburnt areas. This resulted in the approach to analysis of floristic data being altered, with taxa considered to be present only in recently burnt areas excluded from the analysis. The fire also affected mapping of VTs in some parts of the Study Area, with boundaries of VTs being difficult to determine both in the field and on aerial photography in some instances. Portions of the 2016 extension area had been very recently burnt by a very hot fire and experienced limited germination as a result of low rainfall post-fire. Proposed quadrats in these areas were not undertaken, instead field notes on soil, geology and taxa present were recorded in order to match the landform to a VT based on previous experience of the area (2014 survey). The remainder of the 2016 extension area had not been significantly affected by fire in recent years.
Intensity of survey	No	The survey intensity was considered adequate to identify floristic groupings of terrestrial flora as required by a Level 2 survey, with replication of quadrats in VTs and foot searching undertaken throughout the Study Area.
Completeness and mapping reliability	Potential minor	The survey of the Study Area was considered complete in terms of mapping of VTs. Searching for significant flora taxa was undertaken in 2016, however this did not include targeted survey of all potential habitat for conservation significant flora. Mapping reliability was considered good as high resolution aerial photography was used, with 357 quadrats established in the Study Area. Foot and vehicle transects were employed, however recent fire affected mapping reliability in some instances.
Resources and experience of personnel	No	Adequate resources including experienced field personnel and taxonomists with appropriate expertise in Pilbara region flora were utilised.
Remoteness and/or access problems	No	Access to the Study Area was considered adequate. Some parts of the Study Area were difficult to access on foot because of the distances from traversable vehicle tracks and the steep, hilly terrain, and therefore were surveyed less intensely than areas close to traversable vehicle tracks. However, remoteness or access issues are not considered to have affected the results of the survey.

5 RESULTS – FLORA OF THE STUDY AREA

5.1 Vascular Flora Census

A total of 413 discrete vascular flora taxa including one known hybrid (listed on *FloraBase* (DPaW 2016e)) and one putative hybrid were recorded within the Study Area. These taxa represent 63 families and 177 genera. The most well-represented families were Fabaceae (80 taxa, plus one known and one putative hybrid), Poaceae (62 taxa), Malvaceae (38 taxa), Cyperaceae (21 taxa), Amaranthaceae (20 taxa) and Asteraceae (17 taxa).

Average taxon richness per quadrat was 22.5 (± 12.8), with the greatest number of taxa recorded in a single quadrat being 75, and the lowest number being three. A full list of taxa recorded in the Study Area (including both quadrat data and opportunistic collections) is presented in Appendix I. Raw quadrat data, including species lists for each quadrat, will be provided separately.

5.2 Significant Flora Taxa

A total of 16 significant flora taxa were recorded during the surveys of the Study Area. Table 9 presents the list of significant flora taxa recorded in the Study Area, together with location information. Records displayed are from the current surveys of the Study Area (labelled as 'WEC'), and from DPaW's threatened flora databases (labelled as 'DPaW'). Locations of significant flora taxa from these surveys of the Study Area are presented in Appendix J, and also presented on an overview figure of the Study Area (Figure 6). Locations of significant flora taxa known from within and in the vicinity of the Study Area are also displayed in greater detail in Appendix K (Figures 6.0 – 6.44).

5.2.1 Listed Significant Flora Taxa

No Threatened Flora taxa listed under the WC Act, or Threatened Species listed under the EPBC Act, were recorded within the Study Area. Eleven DPaW-classified Priority Flora taxa were recorded within the Study Area, being:

- *Cochlospermum macnamarae* (P1);
- *Rothia indica* subsp. *australis* (P1);
- *Schoenus* sp. Marble Bar (D. Coultas & S. Coultas DCSC-Opp 07) (P1);
- *Stylidium weeliwolli* (P2);
- *Acacia levata* (P3);
- *Eragrostis crateriformis* (P3);
- *Heliotropium murinum* (P3);
- *Nicotiana umbratica* (P3);
- *Rostellularia adscendens* var. *latifolia* (P3);
- *Swainsona thompsoniana* (P3); and
- *Ptilotus mollis* (P4).

These taxa are discussed further below.

Table 9: Summary of Significant Flora Taxa Known from within the Study Area

Taxon	Conservation Code	Total Number of Point Locations Recorded in Study Area by WEC	Total Number of Individuals Recorded in Study Area by WEC	Total Number of Locations Known in the Study Area	Total Number of Individuals Known in the Study Area	Vegetation Types	Record Source
Cochlospermum macnamarae	P1	8	154	8	154	2	WEC
Rothia indica subsp. *australis*	P1	13	255	13	255	2	WEC
Schoenus sp. Marble Bar (D. Coultas & S. Coultas DCSC-Opp 07)	P1	1	50	1	50	1	WEC
Stylidium weeliwolli	P2	1	2	1	2	1	WEC
Acacia levata	P3	10	239	16	245	1, 10, 11, C	WEC; DPaW
Eragrostis crateriformis	P3	14	272	14	272	2, 5, 7	WEC
Heliotropium murinum	P3	3	3	3	3	4	WEC
Nicotiana umbratica	P3	2	115	2	115	3, 9	WEC
Rostellularia adscendens var. *latifolia*	P3	2	101	2	101	10, 15	WEC
Swainsona thompsoniana	P3	3	3	3	3	6	WEC
Ptilotus mollis	P4	36	779	36	779	10, 11, 13, 14	WEC
Abutilon aff. *hannii*	Potentially undescribed	3	Not counted	3	Not counted	14	WEC
Oldenlandia sp.	Potentially undescribed	1	1	1	1	15	WEC
Portulaca sp.	Potentially undescribed	1	Not counted	1	Not counted	14	WEC
Acrostichum speciosum	Significantly Disjunct Record	1	3	1	3	3	WEC
Eriocaulon pusillum	Significantly Disjunct Record	1	10	1	10	1	WEC

760000 765000 770000 775000 780000 785000 790000

7655000 7650000 7645000 7640000 7635000 7630000 7625000 7620000 7615000

Radl
Swt
Swt
Osp
Hmur
Hmur
Ecr
Ecr
Ecr
Num
Rin
Alev
Alev
Alev
Alev
Swe
Epus
SspM
Alev
Psp
Alev
Radl
Aah
Acsp
Pmo
Pmo
Pmo
Pmo
Num
Taa
Pmo
Pmo
Aah
Pmo
Pmo
Pmo
Pmo
Pmo
Aah
Cmac
Cmac
Cmac
Pmo
Pmo
Pmo

Legend

Project Study Area

Vegetation Types

1
2
3
4
5
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7
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15
C
NS

Significant Flora

- Aah *Abutilon* aff. *hannii*
- Acsp *Acrostichum* speciosum
- Alev *Acacia* levata *(P3)*
- Cmac *Cochlospermum* macnamarae *(P1)*
- Ecr *Eragrostis* crateriformis *(P3)*
- Epus *Eriocaulon pusillum*
- Hmur *Heliotropium* murinum *(P3)*
- Num *Nicotiana umbratica* (P3)
- Osp *Oldenlandia* sp.
- Pmo *Ptilotus* mollis *(P4)*
- Psp *Portulaca* sp.
- Radl *Rostellularia* adscendens *var.* latifolia *(P3)*
- Rin *Rothia* indica *subsp.* australis *(P1)*
- SspM *Schoenus* sp. Marble Bar (D. Coultas & S. Coultas DCSC-Opp 07) (P1)
- Swe *Stylidium weeliwolli* (P2)
- Swt *Swainsona* thompsoniana *(P3)*
- Taa *Triumfetta* aff. *appendiculata*

760000 765000 770000 775000 780000 785000 790000

WOODMAN ENVIRONMENTAL

This map should only be used in conjunction with WEC report Atlas16-15-01.

N

Overview of Vegetation Types and Significant Flora of the Study Area

Revision: A - 07-12-2016 Scale: 1:125,000 (A3)

Author: Bethea Loudon

WEC Ref: Atlas16-05-01

Filename: Atlas16-05-01-f06.mxd

Projection: GDA 1994 MGA Zone 50

Figure

6

***Cochlospermum macnamarae* (P1)**

Cochlospermum macnamarae (P1) is a spreading, multi-stemmed seasonally deciduous shrub to 2 m high (Plate 1), occurring on granite outcrops, and until recently was only known from the type locality (Hislop *et al.* 2013). This taxon is endemic to Western Australia, occurring over a range of approximately 105 km, from southeast of the Study Area in the east to south of the intersection of the Great Northern Highway and Hillside-Woodstock Road in the west (DPaW 2016d). There are eight DPaW records of this taxon in Western Australia, representing four broad localities (groups of point records in close proximity). None of these localities occur in conservation reserves (DPaW 2016d). This taxon was previously recorded in the McPhee Creek Haul Road Project Study Area (Woodman Environmental 2014c) and the McPhee Creek Rail Spur Project Study Area (Woodman Environmental 2014d).

Cochlospermum macnamarae (P1) was recorded at eight point locations during the surveys of the Study Area, with 154 individuals recorded (Table 9). All locations occur on granite outcrops in the south-west corner of the Study Area (Appendix K, Figure 6.40).

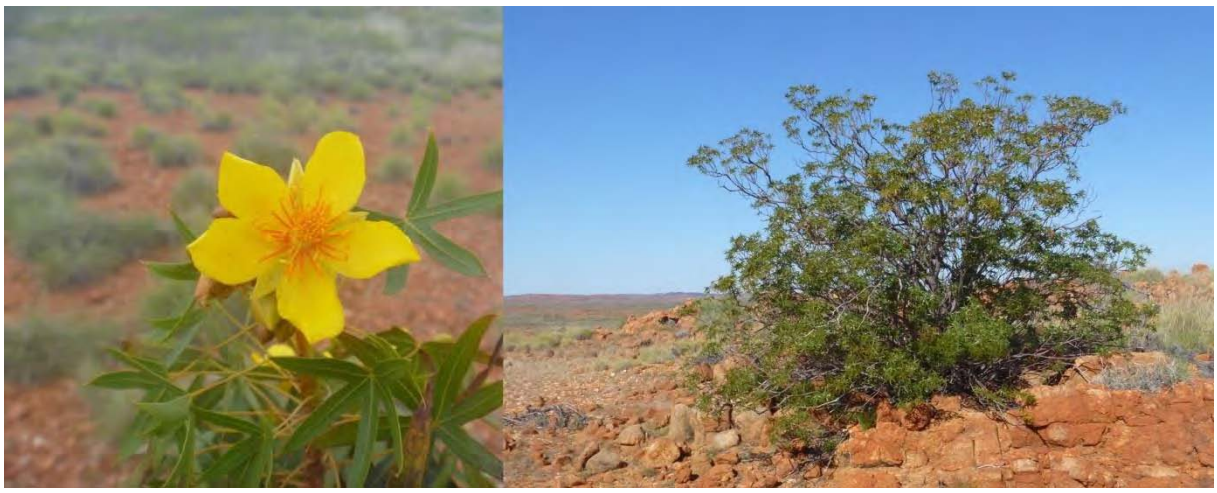

Plate 1: *Cochlospermum macnamarae* (P1) (Photos: Woodman Environmental)

***Rothia indica* subsp. *australis* (P1)**

Rothia indica subsp. *australis* (P1) is a prostrate, hairy ephemeral herb to 0.3 m high (Plate 2), occurring on sand hills and sandy flats, often near drainage lines (DPaW 2016e; Woodman Environmental 2014c). This taxon occurs over a range of approximately 980 km in Western Australia, from De Grey Station in the west to near Kiwirrkurra in the Gibson Desert in the east (DPaW 2016d). It also occurs in the Northern Territory and Queensland (Council of Heads of Australasian Herbaria 2016). There are 19 DPaW records of this taxon in Western Australia, (DPaW 2016e). These records occur at nine localities across its range in Western Australia. None of these localities occur in conservation reserves (DPaW 2016d). This taxon was recorded in the Mt Webber DSO Project (Woodman Environmental 2012c), the McPhee Creek Haul Road Project Study Area (Woodman Environmental 2014c) and the McPhee Creek Rail Spur Project Study Area (Woodman Environmental 2014d).

This taxon was recorded at 13 point locations during these surveys within of the Study Area, with approximately 255 individuals recorded (Table 9). These point locations all occur at

one locality within close proximity (within a few hundred meters) of each other in sandy soil adjacent to sheet flow and small drainage lines in the lower eastern section of the Study Area (Appendix K, Figure 6.23).

Plate 2: *Rothia indica* subsp. *australis* (P1) (Photos: Woodman Environmental)

***Schoenus* sp. Marble Bar (D. Coultas & S. Coultas DCSC-Opp 07) (P1)**

Schoenus sp. Marble Bar (D. Coultas & S. Coultas DCSC-Opp 07) (P1) is an annual tufted grass-like sedge growing to 0.15 m high. This species was found to occur on a granite seepage area with brown sandy loam (DPaW 2016d).

A specimen collected within the Study Area in 2014 was identified by a specialist taxonomist at the WA Herbarium as being a new undescribed taxon; it has since been named *Schoenus* sp. Marble Bar (D. Coultas & S. Coultas DCSC-Opp 07). As this record is the only known collection, this taxon is presently of conservation significance and has been listed as P1 (DPaW 2016e). It was recorded at a single point location during this survey of the Study Area, where approximately 50 individuals were noted (Table 9). The location is in a seepage area on the edge of granite outcropping (Appendix K, Figure 6.18). The area is in the central west section of the Study Area, the same location where *Stylidium weeliwolli* (P2) and *Eriocaulon pusillum* were recorded.

***Stylidium weeliwolli* (P2)**

Stylidium weeliwolli (P2) is an ephemeral herb to 0.25 m high (Plate 3), which occurs on the edges of pools and watercourses, and in seepage areas (DPaW 2016e). This taxon is endemic to Western Australia, occurring over a range of approximately 360 km, from Mount Augustus in the south-west, to near the western edge of Hillside Station in the north-east (DPaW 2016d). There are 38 DPaW records of this taxon (DPaW 2016d), none of which occur in the Study Area. These records represent 10 broad localities across its range. One

locality each occurs in Mount Augustus National Park and Barlee Range Nature Reserve (DPaW 2016d).

The collection in the Study Area is an extension of the known range of this taxon. It was recorded at a single point location during the survey, in the central west section of the Study Area, where two flowering individuals were noted (Table 9). It is likely that further individuals that had finished flowering were present, but not discernible. The location is in a seepage area on the edge of granite outcropping (Appendix K, Figure 6.18).

Plate 3: *Stylidium weeliwolli* (P2) (Photo: Woodman Environmental)

***Acacia levata* (P3)**

Acacia levata (P3) is a spreading, multi-stemmed shrub to 3 m high (Plate 4), which occurs in sandy loam over granite on hill slopes and plains (DPaW 2016e, Woodman Environmental 2014d). This taxon is endemic to Western Australia, occurring over a range of approximately 135 km, from south of the southern boundary of Kangan Station in the west, to the north-west corner of Bonney Downs Station in the east (DPaW 2016d). There are 22 DPaW records of this taxon located in Western Australia which occur at nine broad localities across its range. None of these localities occur in conservation reserves (DPaW 2016d). This taxon was also recorded in the McPhee Creek Haul Road Project Study Area (Woodman Environmental 2014c).

This taxon was recorded at 10 point locations during the surveys of the Study Area, consisting of approximately 239 individuals (Table 9). An additional six locations are known from the Study Area (DPaW 2016c), bringing the total known locations in the Study Area to 19, consisting of a total of approximately 245 individuals. All locations occur on undulating hills underlain by granite (or rarely metamorphosed granite) generally in the north-west corner of the Study Area (Appendix K, Figures 6.18 and 6.25). Three additional locations to the west of the Study Area were also recorded while traversing to the Study Area.

Plate 4: *Acacia levata* (P3) (Photos: Woodman Environmental)

***Eragrostis crateriformis* (P3)**

Eragrostis crateriformis (P3) is a delicate, ephemeral grass to 0.4 m high (Plate 5), which occurs on clay creek banks and in clay depressions (DPaW 2016e; Woodman Environmental 2014c). This taxon occurs over a range of approximately 1,370 km in Western Australia, from near Onslow in the west, to near Balgo Hills in the Tanami Desert in the east (DPaW 2016d). It also occurs in the Northern Territory (Council of Heads of Australasian Herbaria 2016; DPaW 2016d). There are 34 DPaW records of this taxon (DPaW 2016e) in Western Australia. These records occur at 17 broad localities across its range in Western Australia. Two of these localities occur in Millstream-Chichester National Park (DPaW 2016d). This taxon was recorded in the McPhee Creek Iron Ore Project (Woodman Environmental 2013b, c), McPhee Creek Haul Road Project Study Area (Woodman Environmental 2014c) and the McPhee Creek Rail Spur Project Study Area (Woodman Environmental 2014d).

Eragrostis crateriformis (P3) was recorded at 13 point locations during the surveys of the Study Area, with approximately 260 individuals recorded (Table 9). The locations occur in clay depressions and minor drainage lines in the central section of the Study Area (Appendix K, Figures 6.16 and 6.23).

Plate 5: *Eragrostis crateriformis* (P3) (Photos: Woodman Environmental)

***Heliotropium murinum* (P3)**

Heliotropium murinum (P3) is a perennial, herb to 0.4 m high (Plate 6), which generally occurs on red sand plains, sometimes with granite (DPaW 2016e; Woodman Environmental 2014c). This taxon is endemic to Western Australia, occurring over a range of approximately 150 km, from Woodstock Reserve in the west, to ex-Meentheena Station in the east (DPaW 2016d). There are 10 DPaW records of this taxon (DPaW 2016d) in Western Australia consisting of seven broad localities. One locality occurs in the DPaW-managed ex-Meentheena Station. This taxon was also recorded in the Mt Webber DSO Project Area (Woodman Environmental 2012c), the McPhee Creek Haul Road Project Study Area (Woodman Environmental 2014c) and the McPhee Creek Rail Spur Project Study Area (Woodman Environmental 2014d). .

Heliotropium murinum was recorded at 3 point locations consisting of 3 plants (Table 9). The locations occur on plains in the central section of the Study Area (Appendix K, Figures 6.16).

Plate 6: *Heliotropium murinum* (P3) (Photos: Woodman Environmental)

***Nicotiana umbratica* (P3)**

Nicotiana umbratica (P3) is an erect, aromatic, short-lived perennial or ephemeral herb to 0.7 m high (Plate 7), which occurs in shaded sites such as under boulders or cliffs on granite outcrops and in gorges (DPaW 2016e, Woodman Environmental 2014c). This taxon is endemic to Western Australia, occurring over a range of approximately 435 km, from near Shay Gap in the north-east, to near Paraburdoo in the south-west (DPaW 2016d). There are 23 DPaW records of this taxon occurring at 17 broad localities across its range. One locality occurs in Karijini National Park (DPaW 2016d). This taxon was recorded in the Mt Webber DSO Project (Woodman Environmental 2012c), the McPhee Creek Haul Road Project Study Area (Woodman Environmental 2014c) and the McPhee Creek Rail Spur Project Study Area (Woodman Environmental 2014d).

Nicotiana umbratica (P3) was recorded at two point locations during the surveys of the Study Area, with 115 individuals recorded (Table 9). Both locations occur in gorges under boulders in the north-eastern and south-eastern parts of the Study Area (Appendix K, Figures 6.22 and 6.37).

Plate 7: *Nicotiana umbratica* (P3) (Photo: Woodman Environmental)

***Rostellularia adscendens* var. *latifolia* (P3)**

Rostellularia adscendens var. *latifolia* (P3) is an erect, perennial herb to 0.3 m high (Plate 8), which occurs near creeks or on rocky hills (DPaW 2016e). This taxon occurs over a range of approximately 420 km in Western Australia, from Warrawagine Station in the north-east, to near Hamersley Station in the south-west (DPaW 2016d). It also occurs in the Northern Territory, South Australia, Queensland and New South Wales (Council of Heads of Australasian Herbaria 2016). There are 35 DPaW records of this taxon in Western Australia (DPaW 2016e). This taxon was also recorded in the McPhee Creek Rail Spur Project Study Area (Woodman Environmental 2014d). These records occur at 28 broad localities across its range, with six of these localities occurring in Karijini National Park (DPaW 2016d).

This taxon was recorded at two point locations during the surveys of the Study Area consisting of over 100 individuals (Table 9). One location was in a rocky creekline on a hill slope in the central western part of the Study Area, and the other was in a drainage line in the northern section of the Study Area (Appendix K, Figures 6.32 and 6.4 respectively).

Plate 8: *Rostellularia adscendens* var. *latifolia* (P3) (Photos: Woodman Environmental)

***Swainsona thompsoniana* (P3)**

Swainsona thompsoniana (P3) is a prostrate herb to 0.2 m high (DPaW 2016e). It occurs across a range of approximately 320 km from near Nullagine in the east to Millstream-Chichester National Park in the west. There are a total of 17 DPaW records of this taxon consisting of 14 broad localities. Two of these localities occur in Millstream-Chichester National Park and two occur in Karijini National Park (DPaW 2016d).

This taxon was recorded at three point locations during the surveys of the Study Area, with three individuals noted (Table 9). These locations were all within VT 5 in the northern part of the Study Area (Appendix K, Figures 6.4 and 6.6).

***Ptilotus mollis* (P4)**

Ptilotus mollis (P4) is a low, compact shrub with soft grey foliage to 0.5 m high (Plate 9), which occurs on stony hill tops and scree slopes (DPaW 2016e). This taxon occurs over a range of approximately 640 km in Western Australia, from near the north-western edge of Karlamilyi (formerly Rudall River) National Park in the east, to the north-eastern corner of Cane River Conservation Park in the west (DPaW 2016d). There are 36 DPaW records of this taxon in Western Australia (DPaW 2016d) occurring across at 15 broad localities across its range. There is one locality of *Ptilotus mollis* within Karijini National Park and one within Cane River Conservation Park (DPaW 2016e). This taxon also recorded in the McPhee Creek Haul Road Project Study Area (Woodman Environmental 2014c).

Ptilotus mollis was recorded at 36 point locations during the surveys of the Study Area, consisting of approximately 779 individuals (Table 9). All locations occur on cliffs and scree slopes of ranges of eroded dolerite origin in the southern part of the Study Area (Appendix K, Figures 6.34, 6.35, 6.37, 6.39, 6.40, 6.41). It was also recorded at an additional five

locations to the south of the Study Area while traversing to the Study Area, with 90 individuals recorded.

Plate 9: *Ptilotus mollis* (P4) (Photo: Woodman Environmental)

5.2.2 Non-listed Significant Flora Taxa

Abutilon* aff. *hannii

A collection identified by a specialist taxonomist at the WA Herbarium as *Abutilon* aff. *hannii* was collected within the Study Area. This specimen matches a small number of other collections from the Pilbara bioregion (one of which is currently lodged as *Abutilon hannii*). However, these collections differ significantly in indumentum characters from all other *Abutilon hannii* collections in Western Australia (which are all from the Kimberley region). Although there has been speculation as to whether these collections may represent introgression between *Abutilon macrum* and *Abutilon hannii*, this was considered to be very unlikely given that, typical *Abutilon hannii* does not occur anywhere near the Pilbara. Therefore, these collections may represent an undescribed taxon. However, *Abutilon* is currently under active revision, and it may fall within the concept of a described taxon upon publication of this revision (M. Hislop *pers. comm.* 2014, 2016).

Abutilon aff. *hannii* was recorded at three locations in the Study Area however no counts of individuals were made (Table 9; Appendix K, Figures 6.36, 6.39, 6.41). It was also recorded at three locations in the McPhee Creek Rail Spur Project Study Area (Woodman Environmental 2014d), and one location in the Abydos DSO Project area (Woodman Environmental 2012a). It appears to be restricted to rocky drainage lines, and was not commonly encountered during this or the aforementioned surveys. As this taxon appears to be fairly uncommon in the Pilbara region, and is not currently known from any conservation

reserves, it is considered that it should be treated as being of significance, pending taxonomic resolution.

***Portulaca* sp.**

A specimen identified by a specialist taxonomist at the WA Herbarium as *Portulaca* sp. was collected within the Study Area in 2014. *Portulaca* is currently under revision, with almost all recognised names currently being applied tentatively at best. However, this collection does not match other taxa commonly collected in the Pilbara, and appears to be similar to *Portulaca digyna* (M. Hislop *pers. comm.* 2014), a species currently known only from the Kimberley region (DPaW 2016e). It therefore may represent an undescribed taxon. As the collection from the Study Area is the only known collection of this potentially undescribed taxon, this taxon is considered to be of significance. It was recorded at a single point location during the surveys of the Study Area however no counts of individuals were made (Table 9). The location is in a minor, slightly rocky drainage line (Appendix K, Figure 6.27).

Acrostichum speciosum

A collection of a fern species, *Acrostichum speciosum,* was made from a single location within the Study Area, in a gorge with permanent or semi-permanent flowing water (Figure 6). Although this species is widely distributed in the Kimberley region of WA, and is also widely distributed in the Northern Territory, Queensland and northern New South Wales (Council of Heads of Australasian Herbaria 2014), there is currently only one other record from the Pilbara bioregion (Council of Heads of Australasian Herbaria 2014). The collection of this species in the Study Area represents a highly disjunct location of a species that occupies a relatively specific habitat type (permanently or semi-permanently wet, shaded areas) that is uncommon and likely to be restricted in the general region. Therefore, it is considered that the location of this species in the Study Area should be treated as being of significance. Three clumps of stems were noted at the single location in the Study Area (Table 9; Appendix K, Figure 6.34).

Eriocaulon pusillum

A collection of *Eriocaulon pusillum* was made from a single location within the Study Area, in a seepage area on the edge of granite outcropping, the same location where *Stylidium weeliwolli* (P2) and *Schoenus* sp. Marble Bar (D. Coultas & S. Coultas DCSC-Opp 07) (P1) (Section 5.2.1) were recorded (Appendix K, Figure 6.1). This specimen was identified by a specialist taxonomist at the WA Herbarium, who noted that this species is not known to occur in the Pilbara region, being restricted to the Kimberley region. The two collections of *Eriocaulon cinereum* lodged at the WA Herbarium (the only species of *Eriocaulon* known to occur in the Pilbara) need to be re-examined to confirm their identity, and it is possible they may represent *Eriocaulon pusillum* also (M. Hislop *pers. comm.* 2014).

Although *Eriocaulon pusillum* is widely distributed in the Kimberley region of WA, and is also widely distributed in the Northern Territory and Queensland (Council of Heads of Australasian Herbaria 2014), the collection of this species in the Study Area represents a highly disjunct location of a species that occupies a relatively specific habitat type (permanent or semi-permanently wet, shaded areas) that is uncommon and likely restricted in the general region. Therefore, it is considered that the location of this species in the

Study Area be treated as being of significance. Approximately 10 individuals were noted at the single location (Table 9) in the central west section of the Study Area (Appendix K, Figure 6.18).

***Oldenlandia* sp.**

A collection of *Oldenlandia* sp. was made from a single location within the Study Area, in a drainage line (Appendix K, Figure 6.9). A specialised taxonomist described this collection as either atypical material of *Oldenlandia crouchiana* (not conservation significant), or otherwise potentially an unrecognised taxon. However, the collection of additional material is required to clarify taxonomic status of *Oldenlandia* sp. (M. Hislop *pers. comm.* 2016).

5.3 Other Taxa of Interest

***Abutilon* sp.**

A collection identified by a specialist taxonomist at the WAHerb as *Abutilon* sp. was collected within the Study Area. This collection could not be assigned to any taxa known to occur in the Pilbara region. It may represent an undescribed taxon, however *Abutilon* is currently under active revision, and it may fall within the concept of a described taxon upon publication of this revision (M. Hislop *pers. comm.* 2014).

It was recorded in nine quadrats in the Study Area, and was also recorded at 25 locations in the McPhee Creek Haul Road Project Study Area (Woodman Environmental 2014c), and 11 in the McPhee Creek Rail Spur Project Study Area (Woodman Environmental 2014d), usually on dolerite hills. It was noted as being common at many of these locations. Although it is considered to be of taxonomic interest, it is not considered to be of significance, given that it is known to be fairly widespread and common, and is expected to occur elsewhere in the region based on the landforms and soils it is known to occur on.

Bonamia* aff. *pilbarensis

A collection identified by a specialist taxonomist at the WAHerb as *Bonamia* aff. *pilbarensis* was collected within the Study Area. This collection is of interest; it has close affinities to *Bonamia pilbarensis*, sharing the same winged seed character, however its indumentum of dense hairs, which gives it an overall grey colour, is very much at variance with the sparse indumentum and overall green colour of *Bonamia pilbarensis*. *Bonamia* is currently under active revision, and this entity may fall within the concept of a described taxon upon publication of this revision (M. Hislop *pers. comm.* 2013).

It was recorded in 17 quadrats in the Study Area, generally on calcrete areas. *Bonamia* aff. *pilbarensis* was also recorded at numerous locations in the McPhee Creek Haul Road Project Study Area (Woodman Environmental 2014c), and the McPhee Creek Rail Spur Project Study Area (Woodman Environmental 2014d). It was relatively common at most locations. Although it is considered to be of taxonomic interest, it is not considered to be of significance, given that it is known to be fairly widespread and common, and is expected to occur elsewhere in the region based on the landforms and soils it is known to occur on.

Corchorus aff. *walcottii*

A collection identified as *Corchorus* aff. *walcottii* was collected within the Study Area. This collection is similar to *Corchorus walcottii* in indumentum characters. However, the collection appears to have persistent sepals in fruit, at variance to *Corchorus walcottii* and similar to *Corchorus laniflorus.* The fruit collected was relatively immature, and therefore collection of more mature fruit is desirable to facilitate a taxonomic resolution. This collection may therefore represent an undescribed taxon. In a revision of *Corchorus*, it was noted that a number of collections examined from the Pilbara region required further study (Halford 2004); judging by this, as well as numerous collections lodged at the WAHerb that have not been determined to species level (DPaW 2016e), further study of *Corchorus* as a whole in the Pilbara region is required.

This entity was recorded in three quadrats in the Study Area, on granitic soils and in drainage lines. It was also recorded at two locations in the McPhee Creek Rail Spur Project Study Area (Woodman Environmental 2014d). Recent re-examination of collections identified as *Corchorus laniflorus* from the McPhee Creek Haul Road Project Study Area has resulted in these collections also being determined as this entity, with this entity recorded in 20 quadrats within the McPhee Creek Haul Road Project Study Area (Woodman Environmental 2014c). This entity is not considered to be of conservation significance, given that it is known to be fairly widespread and common, and is expected to occur elsewhere in the region based on the landforms and soils it is known to occur on.

Goodenia aff. *microptera*

A collection identified by a specialist taxonomist as *Goodenia* aff. *microptera* was collected within the Study Area. This collection is of interest; it has some affinity to *Goodenia microptera,* however differs in a number of respects, including stem indumentum and robustness, and in having a wing above the auricle on the upper corolla lobes that is equal in size to the opposite one. In the latter respect, the collection is similar to *Goodenia nuda*, however this species differs from the collection in leaf and stem indumentum. Similar collections have been seen from a number of other locations elsewhere in the Pilbara (L. Sage *pers. comm.* 2014).

Goodenia aff. *microptera* was recorded in six quadrats in the Study Area, usually associated with granite or occasionally dolerite hills, and was relatively common at most locations. Although it is considered to be of taxonomic interest, it is not considered to be of significance, given that it is known to occur elsewhere in the Pilbara, and is expected to be relatively common.

Triumfetta aff. *appendiculata*

A collection identified by a specialist taxonomist at the WAHerb as *Triumfetta* aff. *appendiculata* was collected within the Study Area. This collection is of interest; it has affinity to *Triumfetta appendiculata,* however differs most noticeably in having much longer sepal appendages than the known range for this species. Several collections noted in the most recent revision of *Triumfetta* (Halford 1997) as *Triumfetta* aff. *appendiculata* do not match the collection from the Study Area, as they have sepal appendages within the normal range for *Triumfetta appendiculata* (M. Hislop *pers. comm.* 2014). Further study is required,

with the collection potentially representing an extreme form of *Triumfetta appendiculata*, or potentially an undescribed taxon.

It was recorded in 32 quadrats in the Study Area, often on rocky dolerite or metamorphosed granite hills, and was relatively common at most locations. Although it is considered to be of taxonomic interest, it is not considered to be of significance, given that it is common over a relatively wide area of the Study Area, and is likely to occur elsewhere in the region based on the landforms it occurs on.

Hybrids

The hybrid taxon *Senna glutinosa* subsp. *x luerssenii* was collected in the Study Area. This is a known hybrid that is listed on the Census of Western Australian Plants (DPaW 2016e). *Acacia ancistrocarpa* x *tumida* var. *pilbarensis* was also collected in the Study Area. *Acacia ancistrocarpa* x *tumida* var. *pilbarensis* is a putative hybrid and is not listed on the Census of Western Australian Plants (DPaW 2016e). Neither of these entities are considered to be of significance.

5.4 Distribution Extensions and Distribution Gaps

Table 10 presents taxa where the collections from the Study Area represent extensions to the known distribution of such taxa, or otherwise fill gaps within the known distribution of such taxa, according to NatureMap (DPaW 2016d).

Table 10: Taxa Where Collections Represent Range Extensions to the Known Ranges of these Taxa, or Fill Distribution Gaps (DPaW 2016d)

Taxon	Description
Abutilon malvifolium	Fills gap in known distribution
Acacia arrecta	Extension of known distribution to the north
Acrostichum speciosum	Fills gap in known distribution
Austrobryonia pilbarensis	Fills gap in known distribution
Bergia ammannioides	Fills gap in known distribution
Bergia pedicellaris	Fills gap in known distribution
Blumea tenella	Fills gap in known distribution
Buchnera linearis	Fills gap in known distribution
Calotropis procera	Extension of known distribution to the south
Clerodendrum tomentosum var. *lanceolatum*	Fills gap in known distribution
Cochlospermum macnamarae (P1)	Extension of known distribution to the north
Crotalaria dissitiflora subsp. *benthamiana*	Extension of known distribution to the east
Cullen graveolens	Fills gap in known distribution
Eleocharis geniculata	Fills gap in known distribution
Eragrostis desertorum	Fills gap in known distribution
Eriachne flaccida	Fills gap in known distribution
Eriocaulon pusillum	Extension of known distribution to the south
Euphorbia coghlanii	Fills gap in known distribution
Ficus platypoda	Fills gap in known distribution
Fimbristylis elegans	Fills gap in known distribution
Gastrolobium grandiflorum	Fills gap in known distribution
**Passiflora foetida* var. *hispida*	Fills gap in known distribution
Peplidium sp. E Evol. Fl. Fauna Arid Aust. (A.S. Weston 12768)	Fills gap in known distribution

Taxon	Description
Peripleura virgata	Fills gap in known distribution
Podolepis capillaris	Extension of known distribution to the north
Rostellularia adscendens var. *latifolia*	Fills gap in known distribution
Schoenus falcatus	Fills gap in known distribution
Sida macropoda sens lat.	Extension of known distribution to the south
Sida spinosa	Fills gap in known distribution
Sida sp. Excedentifolia (J.L. Egan 1925)	Fills gap in known distribution
Sonchus oleraceus	Fills gap in known distribution
Stylidium weeliwolli (P2)	Extension of known distribution to the north
Swainsona thompsoniana (P3)	Extension of known distribution to the east
Tephrosia clementii	Fills gap in known distribution
Tephrosia stipuligera	Fills gap in known distribution

5.5 Introduced Taxa

A total of 18 introduced flora taxa were recorded during the surveys of the Study Area. Table 11 presents a list of the introduced flora taxa recorded in the Study Area, together with location information, and ratings for each introduced taxon under the Environmental Weed Strategy for Western Australia (CALM 1999). There were no Declared Pests under the *Biosecurity and Agriculture Management Act 2007* (BAM Act) (WA) recorded within the Study Area (DAF 2016). Locations of each of these flora taxa are presented in Appendix J, and an overview of locations throughout the Study Area displayed on Figure 7. Appendix L (Figures 7.0 – 7.44) presents further detail with regards to the location of these taxa.

Table 11: Summary of Introduced Taxa Recorded from within the Study Area

Taxon	Number of Locations Recorded in the Study Area	Vegetation Types	Environmental Weeds Rating (CALM 1999)
Aerva javanica	71	4, 5, 10, 12, 14, 15	High
?*Amaranthus viridis*	2	14, 15	Low
Argemone ochroleuca subsp. *ochroleuca*	2	14	Mild
Calotropis procera	14	14, 15	High
Cenchrus ciliaris	133	2, 4, 5, 6, 7, 8, 10, 11, 12, 14, 15	High
Cenchrus setiger	1	15	High
Chloris barbata	3	8, 15	Low
Cynodon dactylon	8	14, 15	Moderate
Echinochloa colona	4	15	Mild
Flaveria trinervia	4	14, 15	Not assessed
Malvastrum americanum	3	10, 14	Moderate
Passiflora foetida var. *hispida*	2	3	High
Portulaca pilosa	1	1	Not assessed
Setaria verticillata	1	15	Low
Solanum nigrum	1	15	Moderate
Sonchus oleraceus	2	15	Moderate
Tribulus terrestris	1	15	Not assessed
Vachellia farnesiana	1	15	High