13. Flora and Vegetation

This Chapter describes the flora and vegetation of the Mineral Leases and assesses the potential risks of the Project in terms of local and regional biodiversity. Mitigation measures that will be implemented in order to minimise the impact of vegetation clearing and mine operations are discussed. A detailed flora and vegetation assessment is provided in Appendix M.

The potential impacts and associated mitigation measures identified in this chapter form the basis of the flora and vegetation component of the project risk assessment undertaken in Chapter 5. The project risk assessment includes consequence, likelihood and residual risk ratings for flora and vegetation impact after management measures are implemented.

13.1 Background

The Mt Todd Gold Project is located in the Pine Creek Bioregion. It is a region of mostly foothills located west of the western Arnhem Land sandstone massif. It is dominated by Darwin stringybark (*Eucalyptus tetrodonta*) and Darwin woollybutt (*E. miniata*) open forest, eucalypt woodlands, riparian vegetation and some patches of monsoon thicket. An annual rainfall of about 1,000mm inland to 1,600mm on the coast supports a relatively species-rich flora. There are 12 known threatened species of flora. There is one known threatened ecological community that occurs in the Pine Creek Bioregion: Arnhem Plateau Sandstone Shrubland Complex Ecological Community. This community is listed under the EPBC Act as endangered (gazetted November 2011).

Vegetation in the Pine Creek bioregion is well conserved with at least 12,124km^2 or 42.6% of the region under conservation management in parks and reserves (NRETA 2005). This includes large areas in Kakadu, Nitmiluk, Litchfield and Mary Rivers National Parks.

DLRM (formerly NRETAS) determined that the Mineral Leases were part of the Yinberrie Hills SOCS. The designation of the area as a SOCS is largely based on the presence of threatened fauna and their habitats.

The flora and vegetation are described and potential impacts on the area's biodiversity assessed according to the criteria listed in the Draft EIS Guidelines for the Project. Vegetation of the Mineral Leases was mapped and a flora species list developed.

The extensive historical information base and additional data collected specifically for this Draft EIS provide a solid base for assessing the local and regional significance of the flora of the Mineral Leases, and the risks posed to it by the current mining proposal. Previous information and the results of recent investigations are provided in Appendix M. That report contains detailed assessments of risk and mitigation of potential impacts on flora and vegetation.

13.2 Methodology

13.2.1 Desktop Review

A permit to interfere with wildlife under the *Territory Parks and Wildlife Conservation Act 2006* (TPWC Act) was obtained prior to conducting field work. Conditions of the permit were adhered to.

Existing information on the vegetation and flora of the Mineral Leases and adjacent areas was reviewed prior to initiating investigations. Searches of government databases sought documentation of vegetation and flora species previously recorded or predicted to occur within 10km of the project area. The review

included previous vegetation mapping, aerial photography, topographic maps, a digital terrain model, the scientific literature, technical reports and investigations conducted for the original Mt Todd Draft EIS (Wilson and Clark 1990).

13.2.2 Field Surveys

Existing 1:50,000 scale vegetation mapping (Wilson and Clark 1990) and aerial photography were acquired and used to develop a preliminary vegetation map of the Mineral Leases. Vegetation mapping was in accordance with *Northern Territory Guidelines and Field Methodology for Vegetation Survey and Sampling* (Brocklehurst *et al.* 2007). Field surveys ground-truthed the boundaries and sampled quadrats to describe the structure and plant species composition of the vegetation types. Field surveys occurred during the Wet and Dry Seasons to allow for seasonal variation.

Intensive searches were conducted for the potential presence of threatened plant species listed under the TPWC Act and EPBC Act (9 to 13 May 2011, 24 to 27 February 2012 and 16 to 17 October 2012).

A regional perspective of the vegetation was obtained from a digitised 1:250,000 scale vegetation map of an area extending from immediately south of the Mineral Leases, east to Nitmiluk (Katherine Gorge) National Park, north-east to Kakadu National Park and north-west to near Pine Creek (Wilson and Clark 1990). This area encloses the Mineral Leases and approximately 88% of the Yinberrie Hills SOCS.

The preliminary 1:50,000 scale vegetation map was amended where required to accurately delineate the vegetation types. Adjustments were minor. These were required because of the use of higher quality aerial photography than was available for the 1990 study. Vegetation types were classified based on groups of characteristic species (Brocklehurst *et al.* 2007) and a structural vegetation classification developed. Vegetation types were described according to the National Vegetation Information System (NVIS), Level V: Association NVIS; (Brocklehurst *et al.* 2007).

The area of each vegetation type in the Mineral Leases and the percentages of each likely to be cleared were determined at a 1:50,000 scale. This included areas cleared during previous mining, areas to be cleared under this proposal, and the cumulative area of each vegetation type that is, or will be, cleared. Similar estimates were developed for cumulative losses of vegetation types from the Yinberrie Hills SOCS at a scale of 1:250,000 (mapping from Wilson and Clark 1990).

A species list was compiled from previous data and from field investigations undertaken for this proposal. The flora of the vegetation quadrats was analysed to establish patterns in the distribution of species.

Vegetation types providing breeding habitat for the threatened Gouldian finch (*Erythrura gouldiae*) (listed as endangered under the EPBC Act and vulnerable under the TPWC Act) were mapped, and the characteristics of the two vegetation types compared using PATN analysis.

Further details of the methods are provided in Appendix M.

13.3 Results

13.3.1 Existing vegetation

Eight vegetation types were mapped in the Mineral Leases (Figure 13-1) at 1:50,000 including two degraded forms of vegetation types. Each of these is listed in Table 13-1, along with the area of Mineral Lease occupied. A full description of each type can be found in Appendix M. Areas of vegetation types mapped at 1:250,000 are provided in Table 13-2. The relationships between the 1:50,000 and 1:250,000 classifications of vegetation types are provided in Table 13-3.

Jatbula Road

Edith Falls Road

removed

LEGEND

Mount Todd Mineral Lease Extents

Proposed Future Vegetation Disturbance

Access Roads

Community

1 *Melaleuca* forest, with bare areas

2 *E. bigalerita Eucalyptus* spp. open-forest

4 *E. tintinnans Eucalyptus* spp.*Erythrophleum chlorostachys* woodland

4B *E. tintinnans Eucalyptus* spp.*Erythrophleum chlorostachys* woodland (Disturbed)

6 *E. tintinnans C dichromophloia* woodland

6B *E. tintinnans C dichromophloia* woodland (Disturbed)

9 *E. tectifica* woodland

10 *E. tectifica C. confertiflora* woodland

11 *E. latifolia E. bigalerita* open-woodland with areas of grassland

16 *E. tectifica* woodland \ *E. tintinnans Eucalyptus* spp. *Erythrophleum chlorostachys* woodland

999 Disturbance

1:30,000 (at A3)

0 250 500 750 1,000

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 53

N

Vista Gold Australia Pty Ltd
Mt Todd Gold Project

Job Number 43-21801
Revision 1
Date 27 May 2013

Vegetation of the Mineral Lease

Figure 13-1

G:\43\21801\GIS\Maps 30000 TPA\EIS\FloraVegetation\4321801_205E.mxd

66 Smith Street Darwin NT 0800 Australia T 61 8 8982 0100 F 61 8 8981 1075 E drwmail@ghd.com W www.ghd.com.au

Data source: NRETAS/GHD - Vegetation (1990 (Edited by GHD: 2012)). Vista Gold - Mining Lease (2011), GHD - Roads (2011), Proposed Future Vegetation Disturbance (2013). Created by: CM

Table 13-1 Areas of Vegetation Types of the Mineral Leases at 1:50,000

Vegetation Type	Description	Area (ha)
1	Melaleuca forest, with bare areas	15.01
2	*Eucalyptus bigalerita, E. spp.* open forest	367.09
4	*E. tintinnans, E. spp., Erythrophleum chlorostachys* woodland	1690.48
4 (degraded)	*E. tintinnans, E. spp., Erythrophleum chlorostachys* woodland	60.38
6	*E. tintinnans, C. dicromophloia* woodland	734.33
6 (degraded)	*E. tintinnans, C. dicromophloia* woodland	49.77
9	*E. tectifica* woodland	1385.13
10	*E. tectifica, Corymbia confertiflora* woodland	42.39
11*	*Corymbia latifolia, E. bigalerita* open-woodland with areas of grassland	171.11
16	*E. tectifica* woodland / *E. tintinnans, E. spp., Erythrophleum chlorostachys* woodland	58.33
Cleared	Cleared	888.54
Total		5462.56

Table 13-2 Areas of Vegetation Types of the Mineral Leases at 1:250,000

Vegetation Type	Description	Area (ha)
1	*Corymbia latifolia, Eucalyptus bigalerita, Erythrophleum chlorostachys, E. spp*. open-forest	398.06
2*	*Melaleuca spp., Syzygium spp*., riparian open-forest on sandstone	10.88
7	*Erythrophleum chlorostachys, E. tintinnans, E. spp.* woodland	3.59
10	*Corymbia dichromophloia, E. tintinnans, Erythrophleum chlorostachys* woodland	1138.97
12	*E. tectifica, E. latifolia, E. tintinnans, E. spp.* woodland	1914.53
13	*E. phoenicea, Corymbia latifolia* low woodland – woodland (scattered *E. tintinnans*)	1234.21
16	*Corymbia dichromophloia, Erythrophleum chlorostachys* woodland (scattered *E. tintinnans*)	582.13
38	*Corymbia latifolia, E. bigalerita* open woodland with areas of grassland	32.97
50	Man-made clearings, infrastructure	34.08
51	*E. spp., Melaleuca spp., Lophostemon spp., Syzygium spp*. mixed species woodlands to open forest along watercourses, alluvial flats and creek lines	113.08

Table 13-3 Relationship between Classifications of Mineral Lease Vegetation Types Mapped at 1:50,000 and 1:250,000

1:250,000 Vegetation Type	Area (ha)	Wilson and Clark (1990) 1:250,000 Scale Description	Relationship to 1:50,000 Scale Vegetation Types
1	398.06	*Corymbia latifolia, Eucalyptus bigalerita, Erythrophleum chlorostachys, E. spp*. open-forest	Batman Creek, Stow Creek and Edith River drainage lines and riparian zones. Mapped at the local scale as *E. bigalerita, E. spp.* open forest (type 2) and *C. latifolia, E. bigalerita* open woodland with areas of grassland (type 11).
2*	10.88	*Melaleuca spp., Syzygium spp*., riparian open-forest on sandstone	Small part in extreme east in rocky hills east of TSF 2. Is mapped at the local scale as *E. bigalerita, E. spp.* open forest (type 2).
7	3.59	*Erythrophleum chlorostachys, E. tintinnans, E. spp.* woodland	Small part in Mineral Leases at extreme south. Area is south of Edith River and at the local scale mapped as *C. latifolia, E. bigalerita* open woodland with areas of grassland (type 11).
10	1138.97	*Corymbia dichromophloia, E. tintinnans, Erythrophleum chlorostachys* woodland	Woodlands on north / south aligned ridges including Mt Todd. The shape matches closely with the local scale vegetation type: *E. tintinnans, C. dichromophloia* woodland (type 6).
12	1914.53	*E. tectifica, E. latifolia, E. tintinnans, E. spp*. woodland	Lower slopes and basins draining hills to the south of the site. The shape loosely matches with the local scale vegetation type *E. tectifica* woodland (type 9).
13*	1234.21	*E. phoenicea, Corymbia latifolia* low woodland – woodland (scattered *E. tintinnans*)	Hilly woodland west of Batman Pit. The shape matches closely with the local scale vegetation types: *E. tintinnans, Euc. spp., Erythrophleum chlorostachys* woodland (type 4) and *E. tintinnans, C. dichromophloia* woodland (type 6)
16*	582.13	*Corymbia dichromophloia, Erythrophleum chlorostachys* woodland (scattered *E. tintinnans*)	Lower slopes and basins draining hills in east of site under TSF2. Matches a shape mapped as *E. tectifica* woodland (type 9).
38	32.97	*Corymbia latifolia, E. bigalerita* open woodland with areas of grassland	This area is in the area now a part of the Batman Pit.
50	34.08	Man-made clearings, infrastructure	Associated with what is now the raw water dam in the north east of the site.
51*	113.08	*E. spp., Melaleuca spp., Lophostemon spp., Syzygium spp*. mixed species woodlands to open forest along watercourses, alluvial flats and creek lines	Associated with the drainage line in the north east which is now under the raw water dam and area of vegetation upstream, which is a small area mapped at the local scale as *E. bigalerita, E. spp.* open forest (type 2).

*Denotes vegetation types where regional and local scale vegetation descriptions do not have equivalent dominant species.

Analysis of quadrat data showed that native sorghum (*Sarga timorense*) was more abundant in the eastern side of the Mineral Leases than in the west, and that quadrats in the west that lacked sorghum had cockatoo grass (*Alloteropsis semialata*) with up to 30% and 50% ground cover. This species was mostly absent from the eastern quadrats. Golden beard grass and curly spinifex were found in the western half of the leases with none recorded in the eastern half.

The Gouldian finch habitats, salmon gum (*Eucalyptus tintinnans*), *E. spp.*, ironwood (*Erythrophleum chlorostachys*) woodland, and variable-barked bloodwood (*Corymbia dichromophloia*) woodlands, lie largely in the west of the leases and mostly west and north of Batman Pit (Figure 13-1). The two communities had significantly differing densities of iron wood (*E. chlorostachys*) and variable-barked bloodwood (*C. dichromophloia*) and the latter type a richer level of stem diversity. The vegetation types did not differ in terms of *E. tintinnans* density or basal area.

The Arnhem Plateau Sandstone Shrubland Complex Ecological Community is the only community in the Pine Creek bioregion that is listed as threatened. It is not found in the study area. Rainforest, riparian and wetland areas in the region have been identified as being at risk due to impacts from feral animals, weeds, livestock or fire.

13.3.2 Past and Proposed Land Clearing

A summary of past, proposed and cumulative land clearing of vegetation types in the Mineral Lease is provided in Table 13-4. The Melaleuca forest, Darwin box (*E. tectifica*), cabbage gum (*C. confertiflora*) woodland and Darwin box (*E. tectifica*) woodland / salmon gum (*E. tintinnans*), *E. spp.*, ironwood (*E. chlorostachys*) woodland were not subject to clearing during the 1990s' mining and none is planned under this proposal. These vegetation types are not listed in Table 13-2. The 1990s' mining resulted in clearing of 888.54ha of native vegetation and an additional 608.72ha is proposed, causing a cumulative loss of 59.44% of native vegetation in the Mineral Lease.

Assessment of the cumulative clearing of the 1:250,000 vegetation types in the Mineral Leases provides a basis for determining the significance of potential impacts from the mine on the Yinberrie Hills SOCS. The extent of clearing of each affected vegetation type is provided in Table 13-5.

The largest amount of clearing of any one vegetation type in the Yinberrie Hills SOCS is the proposed removal of 16.16% of *Corymbia dichromophloia, Erythrophleum chlorostachys* woodland (scattered *E. tintinnans*). This equates to 14% of this vegetation type within the Katherine to Pine Creek region.

There would be a cumulative loss of 0.85% of salmon gum (*E. tintinnans*) woodlands from the Yinberrie Hills.

13.3.3 Flora

The Northern Territory's Flora Database contains records of 840 species (from 8,261 individual records) for the Mineral Lease area plus a 10km buffer. This compares with 173 taxa recorded by Wilson and Clark (1990), of which 29 species were not previously recorded in the Northern Territory's Flora Database. Recent survey work for this Draft EIS identified 226 taxa, of which 67 were not previously recorded on the Northern Territory's Flora Database or Wilson and Clark (1990) lists. The total number of species known from the area is now 959.

Table 13-4 Cumulative 1:50,000 Scale Vegetation Loss in Mineral Leases Pre-1990, Current and Proposed

Local Scale Vegetation Map unit Number	Vegetation Type	Original Area (1990)	Loss Due to Activity 1990-Current (ha)	Loss of Original Area from Activity 1990-Current (%)	Proposed Loss due to Mt Todd Project (ha)	Proposed Loss of Original Area (1990) from Mt Todd Project (%)	Total Cumulative Loss from Mining if Mt Todd Project Occurs (ha)	Total Cumulative Loss from Mining if Mt Todd Project Occurs (%)
2	*E. bigalerita, E. spp* open forest	407.44	75.83	18.61	96.08	23.58	171.91	42.19
4*	*E. tintinnans, E. spp., Erythrophleum chlorostachys* woodland	1522.55	92.44	6.07	57.11	3.75	149.55	9.82
6*	*E. tintinnans, E. dicromophloia* woodland	723.26	62.96	8.70	83.17	11.50	146.13	20.20
9	*E. tectifica* woodland	2088.99	525.99	25.18	294.83	14.11	820.82	39.29
11	*Corymbia latifolia, E. bigalerita* open-woodland with areas of grassland	284.22	104.83	36.88	77.53	27.28	182.36	64.16
Total		NA	888.54	NA	608.72	NA	1470.77	NA

*Not included in this table as vegetation types are the areas covered by patches of these vegetation types that were modified or converted into what are now mapped as 'degraded' types of vegetation during activity 1990 – Current. It is assumed that the modification occurred during this time as the areas were mapped as vegetation types 4 and 6 respectively by Wilson and Clark (1990). The patches account for an additional 60.38ha of vegetation type 4 (now mapped as 4B) and 49.77ha of vegetation type 6 (now mapped as 6B).

Table 13-5 Vegetation Losses in the Yinberrie Hills Site of Conservation Significance

1:250,000 Scale Vegetation Type Map Unit No.	Wilson and Clark (1990) 1:250,000 Scale Description	Area Removed for the Project	Area in Proposed Development Footprint (ha)	Vegetation in Yinberrie Hills SOCS	
				Area present (ha)	% loss*
1	*Corymbia latifolia, Eucalyptus bigalerita, Erythrophleum chlorostachys, E. spp*. open-forest	30.24	87.02	2354.56	3.68
7**	*Erythrophleum chlorostachys, E. tintinnans, E. spp.* woodland	0.13	0	1738.29	0
10	*Corymbia dichromophloia, E. tintinnans, Erythrophleum chlorostachys* woodland	151.05	175.51	10312.78	1.70
12	*E. tectifica, E. latifolia, E. tintinnans, E. spp*. woodland	544.36	521.68	27966.49	1.86
13	*E. phoenicea, Corymbia latifolia* low woodland – woodland (scattered *E. tintinnans*)	47.73	50.56	24338.98	0.25
16	*Corymbia dichromophloia, Erythrophleum chlorostachys* woodland (scattered *E. tintinnans*)	28.51	276.90	1713.59	16.16
38**	*Corymbia latifolia, E. bigalerita* open woodland with areas of grassland	29.50	29.47	105.12	28.03
50**	Man-made clearings, infrastructure	23.66	22.57	100.56	22.44
51	*E. spp., Melaleuca spp., Lophostemon spp., Syzygium spp*. mixed species woodlands to open forest along watercourses, alluvial flats and creek lines	33.35	83.43	3076.47	2.71

*Proposed loss of vegetation types based on the footprint of the Mt Todd Gold Project, with 1:250,000 scale map adjusted to include the current disturbance polygon.

**This vegetation type has been removed from the mineral lease during the period 1990-current as a consequence of the Batman Pit development.

The only threatened plant species recorded from the general area of the Mineral Leases is the bladderwort, *Utricularia singeriana*. The TPWC Act lists this species as vulnerable to extinction. The Northern Territory's Flora Database records the species as located approximately six kilometres west of the western border of the Mineral Leases. It has not been recorded from the Mineral Leases, and could not be located during surveys for this proposal. Habitat similar to that of the location of the species was found inside the Mineral Leases, although well to the south of the area of proposed mining activity.

One flora taxon with regional significance was recorded in the Mineral Leases. This sedge (*Fimbristylis fimbristyloides*) is endemic to the Pine Creek Bioregion and recorded in vegetation type 4 (NRETA 2004).

A description of the habitat of the vulnerable bladderwort and a complete list of flora species can be found in the Appendix M.

Introduced Flora

Seventeen species of introduced flora have been recorded from the Mineral Leases. Thirteen are recorded in the Northern Territory's Flora Database and this study found 12, five of which are new records for the area. These species include eight listed as class A or B (or both) under the *Weeds Management Act 2001.* Both classes require management, with class A to be eradicated and growth and spread of class B to be contained. Species include Gamba grass, devil's claw, hyptis, mission grass, bellyache bush and coffee senna.

13.4 Potential Impacts on Flora and Vegetation

The footprint of the Mt Todd Gold Project will cover 1267.13ha. Of this:

- 608.72ha is non-disturbed vegetation;
- 28.83ha is degraded (or modified) vegetation; and
- 629.58ha is cleared land.

Potential sources of impact on flora and vegetation are assessed relative to the potential for impact to flora and vegetation of the Yinberrie Hills area of conservation significance. The boundaries of the Mineral Leases hold no biological or conservation significance, being relatively arbitrary lines on a map drawn for regulating mining. The Yinberrie Hills in contrast is an area recognised by DLRM as having conservation significance, and has been nominated to the National Heritage Register for biological and ecological values.

Potential sources of impact include:

- clearing for the mine expansion (including within drainage line buffers specified by the NT EPA (formerly NRETAS) clearing guidelines) leading to potential loss of vegetation and flora;
- introduction of weeds potentially damaging vegetation and flora;
- contamination of groundwater and / or altering of water tables leading to potential damage to vegetation and flora; and
- Mine-generated dust potentially impacting negatively on vegetation and flora.

13.4.1 Land Clearing

The largest amount of clearing of any one vegetation type in the Yinberrie Hills SOCS is the proposed removal of 16.16% of *Corymbia dichromophloia, Erythrophleum chlorostachys* woodland (scattered *Eucalyptus tintinnans*). This equates to 14% of this vegetation type within the Katherine to Pine Creek region.

All of the vegetation types to be cleared by the proposed Mt Todd Gold Project are represented in the Yinberrie Hills SOCS with more than 71% of each vegetation type remaining after the proposed clearing for the Mt Todd Gold Project.

If the buffer widths around drainage lines as specified by the NT EPA are respected, no impact on the water dependent vegetation types (i.e. vegetation types 1, 2 and 11) is anticipated. If the buffer widths are compromised there could potentially be impacts on the water dependent vegetation types along the drainage lines downstream of the proposed developments.

There are land clearing guidelines specific to the Daly catchment and sub-catchments. There is a limit on clearing of 40% of each major vegetation type in a sub-catchment and 40% of all vegetation in any sub-

catchment. The Project occurs in the Fergusson River sub-catchment. The clearing proposed for this Project does not constitute 40% of any major vegetation type or total vegetation in this sub-catchment.

Clearing will not impact the threatened bladderwort or habitat that may be suitable for the bladderwort.

13.4.2 Weeds

Construction and operation of the Project may result in the introduction of introduced flora to, and spread of introduced flora around the mine site.

Gamba grass (*Andropogon gayanus*) and mission grass (*Pennisetum polystachion*) pose a risk to the environment, life and property. These species increase fuel loads and pose a significant potential risk of fire. Wildfire in areas infested with these species can cause significant change in the species composition and structure of vegetation (including the tree layer) (NRETA 2007; NRETAS 2008).

Weeds are currently distributed along the interface between cleared areas and bushland. The interiors of the native vegetation are mostly weed free. There is an active weed management program at the site.

13.4.3 Dust

There has been no report of impact to vegetation arising from dust during mining in the 1990s. The robust sclerophyllous nature of the more dominant plant species in the site's vegetation and the long vertically hanging petioles of the dominant eucalypts and *Corymbia* would tend to minimise accumulation of dust in the Dry Season minimising potential impacts (Neinhuis and Barthlott 1998). The open leaf structure of eucalypt woodlands i.e. low optical density would aid in minimising impacts on the plants (Raupach *et al*. 2001).

Levels of dust deposition would need to exceed 7g/m^2 for impact to be expected (Farmer 1993). These levels were for cement dust which is more likely to be damaging than dust from the mine. The area covered by this contour is restricted to the near vicinity of the mine and possibly impact on a relatively small area of the salmon gum woodland (Appendix T). The potentially impacted area is over 6km from the location of the threatened bladderwort.

Levels of predicted ground level dust (24-hour PM_{10}) greater than the NSW Office of Environment and Heritage criteria (DEC 2005) for TSP of 50µg/m^3 are predicted to encompass most of the Mineral Leases, extending well to the south and well outside the leases to the west and northwest (Appendix T).

13.4.4 Contamination of Groundwater and / or Alteration of the Water Table

The impermeable nature of the hornfels in the western portion of the mine sites, and the hornfels basement rock to the south and east are expected to cause a localised drawdown of the water table (Appendix K). The basement rock to the east is overlain by the less metamorphosed Burrell Creek Formation and is more permeable. This is likely to result in a reversal in groundwater flow towards the pit. Groundwater in the vicinity of water storages (to the east and south of the pit) at the mine site is causing water mounding and contamination of groundwater with metals. Areas to the immediate north and west of the mine (hornfels) are unlikely to suffer significant lowering of the water table or contamination (Appendix K). Mounding and contamination are proposed for rehabilitation during the course of the mine life.

Areas of hornfels to the west of the pit are unlikely to be affected by drawdown from mining. Areas to the east and south of the mine are largely cleared and this will expand during mine development.

None of the above potential impacts is likely to occur in the vicinity of the threatened bladderwort.

13.5 Risks to Vegetation and Flora

The level of risk posed to vegetation and flora by each source of impact is assessed using standard semi-qualitative risk assessment procedures. The process is consistent with AS/NZS ISO 31000:2009 'Risk Management – Principles and guidelines' with a matrix form (Table 13-6). The likelihood of a particular consequence to fauna from a source of potential impact is determined (five levels, "Rare" to "Almost Certain"), as is the severity of that consequence (five levels, "Minor" to "Critical"). These together determine the level of risk on a scale of five levels, "Very Low" to "Extreme". Risk assessments assume standard mitigation of potential impacts has been implemented.

Level of likelihood and severity of consequences is defined in Table 13-7 and Table 13-8 respectively. Table 13-9 contains the assessment of significance of the Mt Todd Gold Project on the biological and ecological values contained within the Mineral Leases.

Table 13-6 Qualitative Risk Analysis Matrix

		Severity of Consequence				
		Critical (5)	**Major (4)**	**Significant (3)**	**Moderate (2)**	**Minor (1)**
Likelihood of Consequence	**Almost Certain (5)**	Extreme	Extreme	High	High	Medium
	Likely (4)	Extreme	High	High	Medium	Medium
	Possible (3)	Extreme	High	Medium	Medium	Low
	Unlikely (2)	High	Medium	Medium	Low	Very Low
	Rare (1)	Medium	Medium	Low	Low	Very Low

Table 13-7 Definition of Likelihood

Level of Likelihood	Definitions
Almost certain	The event is expected to occur in most circumstances (The event is likely to occur once per year).
Likely	The event will probably occur in most circumstances (The event is likely to occur once every 1 – 2 years).
Possible	The event might occur at some time (The event is likely to occur once every 2 – 5 years).
Unlikely	The event could occur at some time (The event is likely to occur once every 5 – 10 years).
Rare	The event may occur only in exceptional circumstances (The event is unlikely to occur in any to year period).

Table 13-8 Definitions of Consequence

Levels of Consequence	Definitions*
Critical	Extensive long term environmental harm and / or harm that is extremely widespread. Impacts unlikely to be reversible within 10 years.
Major	Major or widespread, unplanned environmental impact on or off the site. Significant resources required to respond and rehabilitate.
Significant	Significant, unplanned environmental impact contained within the site or minor impact that is off the site.
Moderate	Moderate, unplanned localised environmental impact (maybe of a temporary nature) or discharge contained on-site or with negligible off-site impact.
Minor	Minor environmental impact. Any impacts are contained on-site and short term in nature. No detrimental effect on the environment.

The consequences examined are those provided by the EPBC Significant Impact Guideline 1.1: Matters of National Environmental Significance (National Heritage Places with Natural Heritage Values: Biological and Ecological Values). The consequences listed in the guidelines are:

- modify or inhibit ecological processes in a National Heritage place;
- reduce diversity or modify the composition of plant and animal species in a National Heritage place;
- fragment or damage habitat important for the conservation of biological diversity in a National Heritage place;
- cause a long-term reduction in rare, endemic or unique plant or animal populations or species in a National Heritage place; and
- fragment, isolate or substantially damage habitat for rare, endemic or unique animal populations or species in a National Heritage place.

An impact is regarded as significant if the risk analysis indicates that the consequence has a risk rating of “Extreme” or “High”. It is customary for additional mitigation / management to be put in place should there be an “Extreme” or “High” risk. The effectiveness of proposed additional management is determined by repeating the analysis and determining the level of residual risk i.e. risk after management is applied.

Complete documentation of the risk assessment can be found in Appendix M. None of the risks from any of the sources of impact for any of the consequences is greater than “Medium” (Appendix M). Mitigation measures to eliminate or reduce risk are discussed in Section 13.6.

Table 13-9 provides a summary of the risk assessment based on the cumulative outcomes of assessing the various sources of risk affecting each of the guidelines’ consequences.

Redevelopment of the Mt Todd mine is unlikely to have a significant impact on the Yinberrie Hills’ vegetation and flora. Consequences of some of the potential impacts will be subject to monitoring as described in Section 13.6. Additional mitigation will be applied should actual or predicted risk of impact become “Extreme” or “High”.

Table 13-9 Risk Assessment Summary

Risk	Consequence	Likelihood	Risk
Modify or inhibit ecological processes in a National Heritage place	Significant	Possible	Medium
Reduce the diversity or modify the composition of plant and animal species in a National Heritage place	Significant	Possible	Medium
Fragment or damage habitat important for the conservation of biological diversity in a National Heritage place	Significant	Possible	Medium
Cause a long-term reduction in rare, endemic or unique plant or animal populations or species in a National Heritage place	Significant	Possible	Medium
Fragment, isolate or substantially damage habitat for rare, endemic or unique animal populations or species in a National Heritage place	Significant	Possible	Medium

13.6 Management Measures

13.6.1 Land Clearing

Vegetation clearance will be staged to maintain ground cover and protect soil. The boundaries of all approved clearing will be clearly delineated to prevent encroachment into areas of vegetation to be retained. Areas not associated with direct project impact will be temporarily fenced and marked as 'no-go' areas. This will be reinforced during formal staff inductions.

Clearing of vegetation will be staged to minimise areas of bare ground and land will be cleared only as required and in accordance with the Erosion and Sediment Control Plan. Clearing will be avoided during the Wet Season (December to May) to minimise erosion.

A revegetation plan will be prepared to guide the revegetation of areas temporarily or recently disturbed. This plan will focus on the establishment of ground cover as an immediate treatment of bare areas (e.g. kangaroo grass, *Themeda triandra*) and the collection and propagation of locally-sourced plants.

Areas of potential habitat for *U. singeriana* will be fenced off and clearly marked as 'no-go' areas.

13.6.2 Dust

Standard dust mitigation will include:

- chemical treatment of roads to reduce dust generation;
- use of water sprays;
- wetting of ore prior to crushing;
- use of hooded crushers; and
- use of enclosed HPGRs.

Additional mitigation measures are planned should dust levels prove excessive. These are discussed in Chapter 5 and Chapter 16.

13.6.3 Wildfire

The existing system of early Dry Season controlled burns will be maintained. Subsequent fires late in the Dry Season (following early Dry Season burns) will be avoided. Expansion of fire management to the entire Yinberrie Hills SOCS is recommended.

Appropriate fire management regimes can assist in minimising vegetation damage. Controlled fires should focus on burning patches of vegetation in a mosaic during all times of the year to maintain grass species diversity.

13.6.4 Weeds

A Weed Management Plan will be prepared to assist in preventing introduced flora from being brought to the mine site or colonising un-infested areas. This will include:

- protocols for the movement of people and machinery around the mine site and to and from the mine site;
- management of soil stockpiles to prevent sediment and / or weed transfer into adjacent areas of vegetation;
- management of water and sediment movement across the site;
- protocols for sourcing soil and other earthen materials from offsite (where required);
- vehicle washing and inspection protocols for vehicles coming onto the mine site;
- quarantine for materials (e.g. clay) imported to the site known or likely to contain seeds of introduced flora;
- continuation of active weed control measure at the mine site; and
- surveillance of the greater mine area for newly established infestations.